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Technology and Inventions

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BRITANNICA LEARNING LIBRARY: TECHNOLOGY AND INVENTIONS 2008

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Technology and Inventions

I N T R O D U C T I O N

How can you draw with light?
What was Gutenberg's gift? Where does medicine come from?
Can eyes ever hear?

In
Technology and Inventions,
you'll discover answers to these questions and many more. Through pictures, articles, and fun facts, you'll learn about the great inventors and inventions that have changed our lives.

To help you on your journey, we've provided the following guideposts in *Technology and Inventions*:

- **Subject Tabs—**The colored box in the upper corner of each right-hand page will quickly tell you the article subject.
- **Search Lights—**Try these mini-quizzes before and after you read the article and see how much—*and how quickly*—you can learn. You can even make this a game with a reading partner. (Answers are upside down at the bottom of one of the pages.)
- **Did You Know?—**Check out these fun facts about the article subject. With these surprising "factoids," you can entertain your friends, impress your teachers, and amaze your parents.
- **Picture Captions—**Read the captions that go with the photos. They provide useful information about the article subject.
- **Vocabulary—**New or difficult words are in **bold type**. You'll find them explained in the Glossary at the end of the book.
- **Learn More!—**Follow these pointers to related articles in the book. These articles are listed in the Table of Contents and appear on the Subject Tabs.

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Have a great trip!

Hot-air balloons fill the skies at the Albuquerque International Balloon Fiesta in New Mexico in 1989.
© Joseph Sohm—Chromosohm Inc./Corbis

Technology and Inventions

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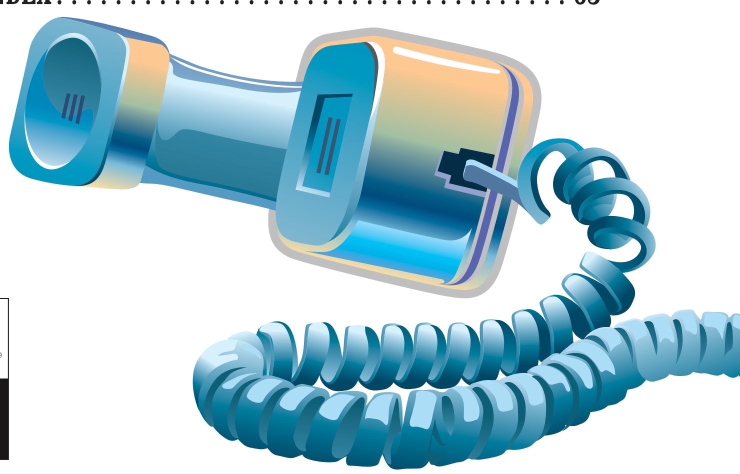

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Before There Were Automobiles

Long ago most people had to walk wherever they wanted to go on land. Later, when large animals began to be **domesticated**, some people rode camels, horses, donkeys, oxen, and even elephants.

Then came the discovery of wheels. The people of Mesopotamia (now in Iraq) built wheeled carts nearly 5,000 years ago. But so far the earliest cart that has actually been found is one made later than those in Mesopotamia, by people in ancient Rome. It was simply a flat board. At first, people themselves pulled carts. Later, they trained animals to do this.

As people used more and more carts, they had to make roads on which the carts could travel easily. In Europe and North America carts developed into great covered wagons and then into stagecoaches. Pulled by four or six fast horses, stagecoaches first bounced and rolled along the roads in the mid-1600s. They became important public transportation during the 19th century.

It wasn't until the steam engine was invented that a better means of transportation developed—and that was the train. Steam **locomotives** used steam pressure from boiling water to turn their wheels.

DID YOU KNOW?
In the days of stagecoaches a 350-mile journey could take 36 hours and 24 changes of horses. Today it would take less than six hours and one tank of gas.

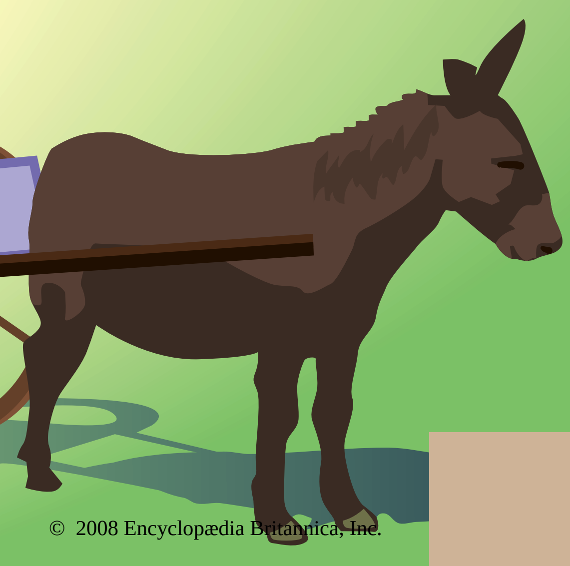
The first passenger train service began in England in 1825. Soon trains were rushing hundreds of thousands people wherever iron tracks had been laid.

The first automobiles were not built until the late 1890s. Some of the earliest were made in the United States and England, though they were slow and broke down a lot. They looked much like carts with fancy wheels. What most of us recognize as a car wouldn't come along for several more years.

LEARN MORE! READ THESE ARTICLES…
AIRPLANES • AUTOMOBILES • SHIPS

SEARCH LIGHT

What were the first things people used to get around?
a) their own feet
b) carts
c) donkeys



Answer: a) their own feet

How Henry Ford Made the American Car

Henry Ford was born near Dearborn, Michigan, U.S., in July 1863. As a boy, he loved to play with watches, clocks, and machines—good experience for the person who would build the first affordable car.

Cars had already been built in Europe when Ford experimented with his first **vehicle** in 1899. It had wheels like a bicycle's and a gasoline-powered engine that made it move. It was called a Quadricycle and had only two speeds and no reverse.

Within four years Ford had started the Ford Motor Company. His ideas about making automobiles would change history.

Carmakers at the time used parts others had made and put them all together. Ford's company made each and every part that went into its cars. What's more, the company made sure that each kind of part was exactly the same.

In 1908 Ford introduced the Model T. This car worked well and was not costly. It was a big success, but the company couldn't make them quickly enough to satisfy Henry Ford.

In 1913 he started a large factory that made use of his most important idea: the assembly line. Instead of having workers go from car to car, the cars moved slowly down a line while workers stood in place adding parts to them. Each worker added a different part until a whole car was put together.

This meant more autos could be built more quickly at a lower cost. By 1918 half of all cars in the United States were Model Ts. Ford's company had become the largest automobile manufacturer in the world. And Ford had revolutionized the process of **manufacturing**.

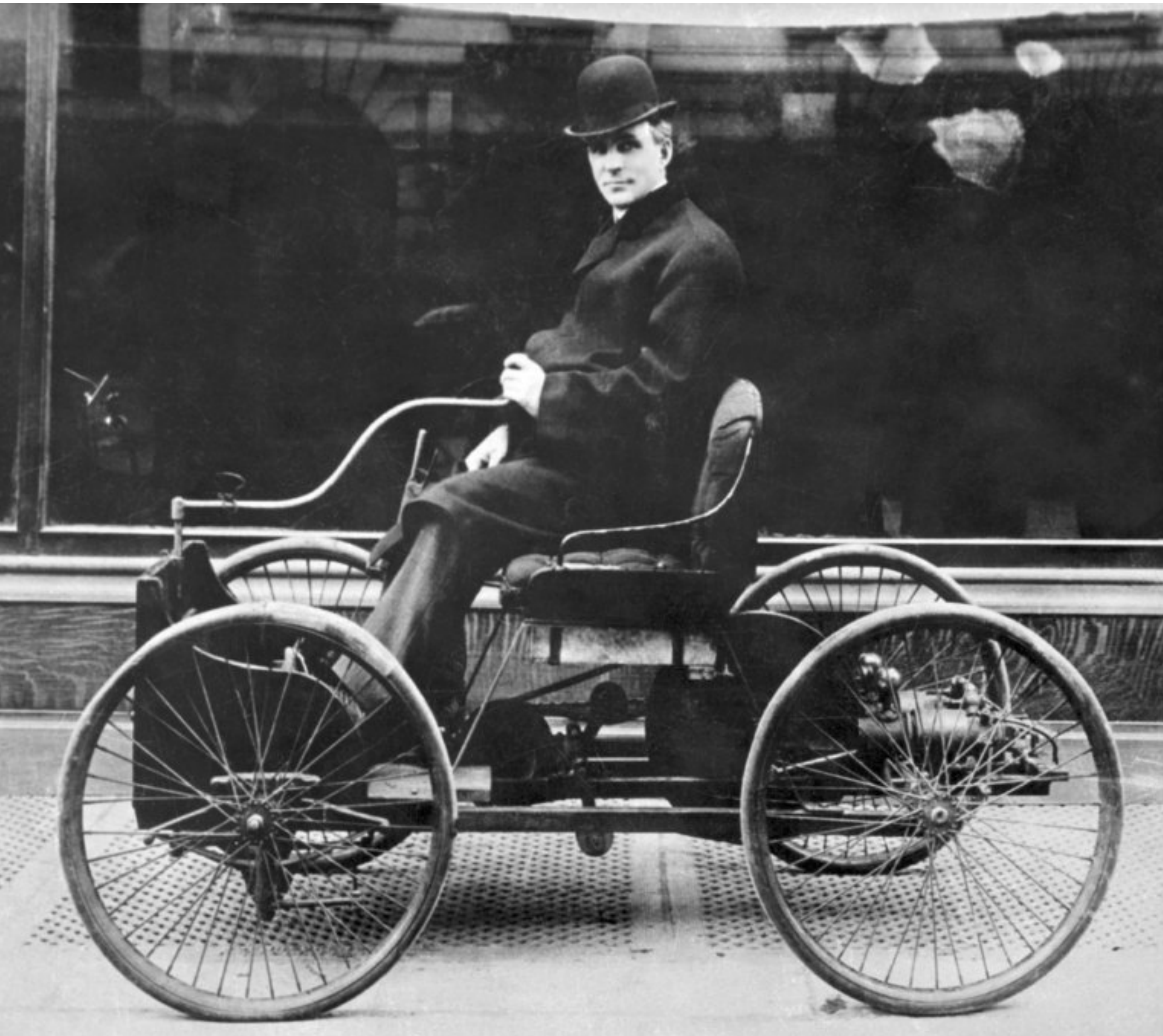
SEARCH LIGHT

True or false? Henry Ford built the very first automobile.

LEARN MORE! READ THESE ARTICLES…
AIRPLANES • OIL • TRANSPORTATION

DID YOU KNOW?

Henry Ford is reported to have once said that his customers could get a Model T in "any color they like, as long as it's black."



Henry Ford's first car was the Quadricycle, seen here with Ford driving. It had only two forward speeds and could not back up.
© Underwood & Underwood/Corbis

Answer: FALSE. Henry Ford built the first inexpensive automobile. Gottlieb Daimler, a German, gets credit for building the very first automobile.

SEARCH LIGHT

What modern machine's name sounds a lot like "ornithopter," the flapping-wing machine that people tried to fly?

The First Flights

From the earliest times people wanted to fly, but no one knew how. Some people thought it would help if their arms were more like bird wings. So they strapped large feathery wings to their arms. Not one left the ground. A few even tried machines with flapping wings, called "ornithopters." These didn't work either.

DID YOU KNOW?
In 1986 Dick Rutan and Jeana Yeager made the first nonstop round-the-world flight in an airplane. They did the whole trip without refueling.

Then in 1799 a scientist named George Cayley wrote a book and drew pictures explaining how birds use their wings and the speed of the wind to fly. About a hundred years later, two American brothers named Orville and Wilbur Wright read Cayley's book. Although they were bicycle makers, they decided to build a flying machine.

The Wright brothers' machine, *Flyer I*, had the strong light wings of a **glider**, a gasoline-powered engine, and two **propellers**. Then, from a list of places where strong winds blow, they selected the Kill Devil Hills near Kitty Hawk, North Carolina, U.S., as the site of their experiment.

In 1903 Orville, lying flat on the lower wing of *Flyer I*, flew a distance of 120 feet. That first flight lasted only 12 seconds. The next year the Wrights managed to fly their second "aeroplane," *Flyer II*, nearly 3 miles over a period of 5 minutes and 4 seconds.

Soon Glenn Curtiss, another bicycle maker, made a faster airplane called the "1909 type." Not long after that Louis Blériot from France did something no one had tried before. He flew his plane across the English Channel. He was the first man to fly across the sea.

The age of flight had begun.

LEARN MORE! READ THESE ARTICLES…
AUTOMOBILES • SHIPS • WIND POWER

The Wright brothers had read that wind was very important for flying. That's why they chose the windy hill in North Carolina.
© Bettmann/Corbis

Answer: How about the "helicopter"? The "-opter" part of both words means "wing." A helicopter's name means "whirling wing." An ornithopter's means "bird wing."

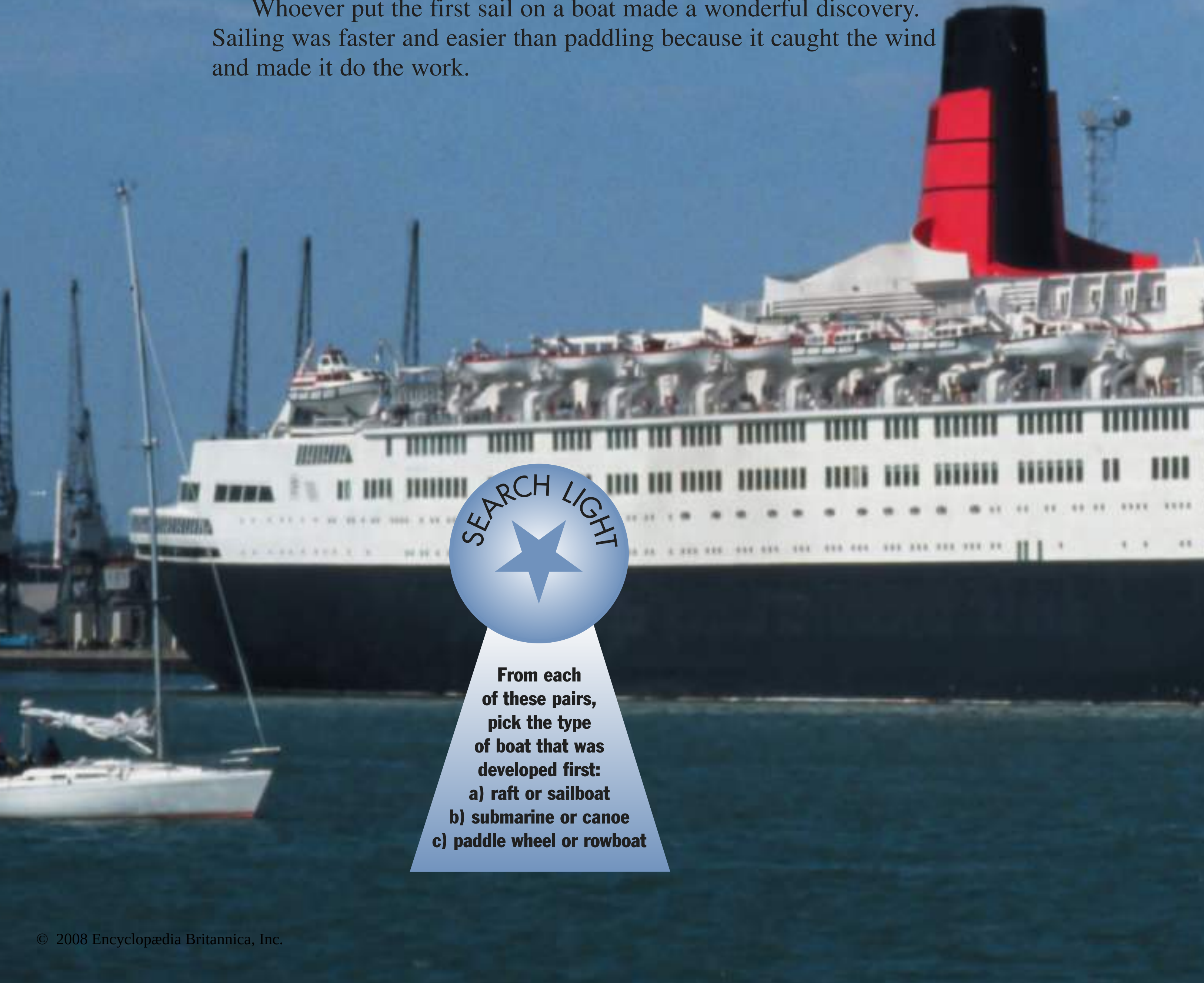
From Rafts to Ocean Liners

We don't know exactly how the first human transportation over water happened. But it's not hard to imagine how it might have come about.

Long ago, people used anything that would float to move things across water—bundles of reeds, even jars and covered baskets.

Perhaps one day someone tied three or four logs together. This made a raft. Maybe someone else hollowed out a log as a kind of **canoe**. These log boats could be moved by people paddling with their hands. Later they might have used a stick or a pole to make their boat move faster.

Whoever put the first sail on a boat made a wonderful discovery. Sailing was faster and easier than paddling because it caught the wind and made it do the work.



SEARCH LIGHT

From each of these pairs, pick the type of boat that was developed first:
a) raft or sailboat
b) submarine or canoe
c) paddle wheel or rowboat

Eventually, someone built a ship that used a sail and long paddles, called "oars." When there was little or no wind, the sailors rowed with the oars. In time, sailors learned to turn, or "set," a sail to make the boat go in almost any direction they wished.

Paddles began to be used again much later in giant wheels that moved large boats through the water. A steam engine powered these paddle wheels, which were too heavy to turn by hand. Steamboats cruised rivers, lakes, and oceans all over the world.

Today ships and boats use many different kinds of engines. Most ships use oil to **generate** power. Some submarines run on nuclear power. But on warm days, many people still enjoy traveling on water by paddling, sailing, and even rafting.

DID YOU KNOW?
In 1947 Norwegian scientist Thor Heyerdahl and a small crew sailed some 5,000 miles of ocean on a balsawood raft called the *Kon-Tiki*. It was an experiment to see if ancient Americans could have settled some Pacific islands.

LEARN MORE! READ THESE ARTICLES…
SUBMARINES • WATER POWER • WIND POWER

Today's ocean liners provide a popular way for people to get from one place to another and to vacation on the way.
© Melvyn P. Lawes—Papilio/Corbis

Answer: a) raft b) canoe c) rowboat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Silent Stalkers of the Sea

Because they are meant to spend most of their time underwater, submarines are designed and built quite differently from other ships.

Submarines must be airtight so that water won't come in when they **submerge**. They also need strong **hulls** because the pressure of seawater at great depths is strong enough to crush ships. And submarines need special engines that don't use air when they are underwater. Otherwise, they would quickly run out of air and shut down! So most modern subs are powered by electric batteries when they're submerged. Some are powered by nuclear energy.

Because a submarine is all closed up, it must have special instruments to act as its eyes and ears underwater. A periscope is a viewing **device** that can be raised up out of the water to let the submarine officers see what's around them. Another special system, sonar, "hears" what's under the water by sending out sound waves that bounce off everything in their path. These echoes send a sound picture back to the sub.

But why build submarines in the first place? Well, submarines have proved very useful in times of war. They can hide underwater and take enemy ships by surprise.

Submarines have peaceful uses too. Scientists use smaller submarines, called "submersibles," to explore the huge ocean floors and the creatures that live there. People also use submersibles to search for sunken ships and lost treasures. The luxury liner *Titanic* was discovered and explored with a submersible 73 years after it sank in the Atlantic Ocean.

SEARCH LIGHT

Fill in the blanks: Submarines need _______ that don't use up _______.

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NUCLEAR ENERGY • RADIO • SHIPS

DID YOU KNOW?

The *Nautilus*, the first nuclear sub, was once caught by a fishing net. The unhappy crew of the fishing boat was towed for several miles before the situation was fixed.

When a submarine runs above the water, officers can stand on top of the conning tower. That's the raised deck of the ship.
© George Hall/Corbis

Answer: Submarines need engines that don't use up air.


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Turning Trees to Paper

The sheets in your notebook are made of paper that came from a factory. So are the pages of your book.

The factory got the paper from a paper mill. The mill probably made the paper from logs. And the logs were cut from trees that grew in a forest. Pine trees are often used to make paper.

If you visit a **traditional** paper mill, you will see people working at large noisy machines that peel bark off the logs and then cut the wood into smaller pieces. Other machines press and grind this wood into pieces so tiny that they can be mashed together like potatoes. This gooey stuff is called "wood **pulp**."

After it is mixed with water, the pulp flows onto a screen, where the water drains off, leaving a thin wet sheet of pulp.

Big hot rollers press and then dry this wet pulp as it moves along **conveyor belts**. At the end of the line the dried pulp comes out as giant rolls of paper. These giant rolls are what the paper factories make into the products that you use every day, such as newspapers, paper towels, and the pages of books that you read.

Because we use so much paper, we must be careful how many trees are cut down to make it. Fortunately, today a lot of used paper can be remade into new paper by **recycling**. And you can help save trees by recycling the magazines, newspapers, and other paper that you use in school and at home.

SEARCH LIGHT

Starting with the tree in the forest, arrange these mixed-up steps in the order they should happen in papermaking:

(*Start*) tree →
chop tree, ***dry,***
peel bark, ***roll out sheets,***
cut wood, ***press flat,***
grind into pulp

LEARN MORE! READ THESE ARTICLES…
PHOTOGRAPHY • PRINTING • WEAVING

DID YOU KNOW?
According to Chinese historical records, the first paper was made from tree bark, hemp (a plant used to make rope), rags, and fishnets.

In a paper mill like this, the rolls of paper are sometimes as big as the trees they are made from.
© Philip Gould/Corbis

Answer: tree → chop tree → peel bark → cut wood → grind into pulp → press flat → dry → roll out sheets

Gutenberg's Gift

Before about 550 years ago very few people owned books. In fact, there weren't many books to own. Back then most books had to be written out by hand. Some books were printed by using wooden blocks with the letters of an entire page hand-carved into each one. The carved side of the block was dipped in ink and pressed onto paper. Both handwritten and woodblock-printed books took a lot of time, energy, and money. Only rich people could afford to buy them.

Then, in the 1450s, a man in Germany named Johannes Gutenberg had an idea for printing books faster.

First, he produced small blocks of metal with one raised, backward letter on each block. These blocks with their raised letters were called "type." He then spelled out words and sentences by lining up the individual pieces of type in holders.

The second part of his invention was the printing press. This was basically a "bed" in which the lines of type could be laid out to create a page. When he inked the type and then used a large plate to press them against a sheet of paper, lines of words were printed on the paper.

Gutenberg's blocks became known as movable type, which means that he could take his lines apart and reuse the letters. Once he had carved enough sets of individual letters, he didn't have to carve new ones to make new pages.

The Bible was one of the earliest books printed by using Gutenberg's movable type. By 1500 the printing presses of Europe had produced some 6 million books!

SEARCH LIGHT

Why did Gutenberg make the letters on individual pieces of type facing backward? (Hint: Think about looking at writing in a mirror.)

LEARN MORE! READ THESE ARTICLES…
BRAILLE • PAPER • TELEVISION

DID YOU KNOW?
The Chinese actually invented a kind of movable type 400 years before Gutenberg. But the Chinese did not invent a press to go with the type.

The artist had to imagine Gutenberg and his first page of print. But the printing press in the background is a fairly accurate image of what the inventor worked with.
© Bettmann/Corbis

Answer: Because the letters were backward on the blocks, they came out facing forward on the paper. Try it yourself!

Louis Braille completed his raised-dot alphabet for the blind when he was only 15 years old. A person can even learn to read music through the Braille system.
Will and Deni McIntyre/Photo Researchers, Inc.

SEARCH LIGHT

Louis Braille invented his Braille alphabet when he was 15. At that age, how many years had he been blind?

Books to Touch

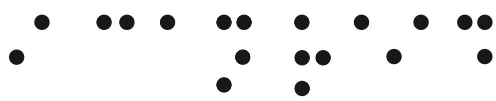
More than 175 years ago in France, young Louis Braille thought of a way to help blind people read and write. He himself could not see. He had hurt his eyes when he was just 3 years old, while he was playing with his father's tools.

Fortunately, Louis was a clever child. When he was 10 years old, he won a **scholarship** to the National Institute for Blind Children in Paris.

At the school Louis heard about how Captain Barbier, an army officer, had invented a system of writing that used dots. It was called "night writing," and it helped soldiers read messages in the dark. These messages were of small, bump-like dots pressed on a sheet of paper. The dots were easy to make and could be felt quickly.

Louis decided to use similar dots to make an alphabet for the blind. It was slow to be accepted but was eventually a great success. His alphabet used 63 different dot patterns to represent letters, numbers, punctuation, and several other useful signs. A person could even learn to read music by feeling dots.

Today blind people all over the world can learn the Braille alphabet. Look at these dots:



In an actual Braille book, the tips of your fingers would be able to cover each small group of dots.

Can you guess what this pattern of dot letters spells?

It spells the words "I can read."

LEARN MORE! READ THESE ARTICLES…
RADIO • PRINTING • SIGHT AND SOUND

DID YOU KNOW?
On its Web site, the American Foundation for the Blind has a great area where you can learn Braille yourself. Go to http://afb.org and click on "Braille Bug."

Answer: Louis Braille had been blind for 12 years when he invented his alphabet.

Eyes That Hear, Speech That's Seen

Mary: "Can you come to the store with me?"

Sara: "I'll ask my mother."

If Mary and Sara were like most girls you know, their conversation would not be unusual. But Mary and Sara are deaf, which means that they cannot hear. Still they understand each other.

How?

Well, one way that people who are deaf communicate is by using sign language. Sign language replaces spoken words with finger and hand movements, **gestures**, and facial expressions. People using sign language can actually talk faster than if they spoke out loud.

Another way people who are deaf may communicate is through lipreading. People who lip-read have learned to recognize spoken words by reading the shapes and movements speakers make with their lips, mouths, and tongues. Lip-readers usually speak out loud themselves even though they can't hear what others say.

Deaf child learning to speak using touch, sight, and imitation.
© Nathan Benn/Corbis

Some people who are deaf use hearing aids or cochlear **implants** to help them hear the sounds and words that others hear. (The cochlea is part of the ear.) Hearing aids usually fit outside the ear and make sounds louder. Cochlear implants are inside the ear and use electrical signals to imitate sounds for the brain. Often, children and adults with hearing aids or implants take lessons to learn to speak as hearing people do.

There are many schools for children who are deaf or hearing-**impaired**. There they may learn all or some of the skills of lipreading, sign language, **oral** speech, and the use of hearing aids and implants. Older students may attend Gallaudet University in Washington, D.C., a school of higher education especially for people who are deaf.

SEARCH LIGHT

The article mentions several ways that people who are deaf can know what another person is saying. One is lipreading. What is another?

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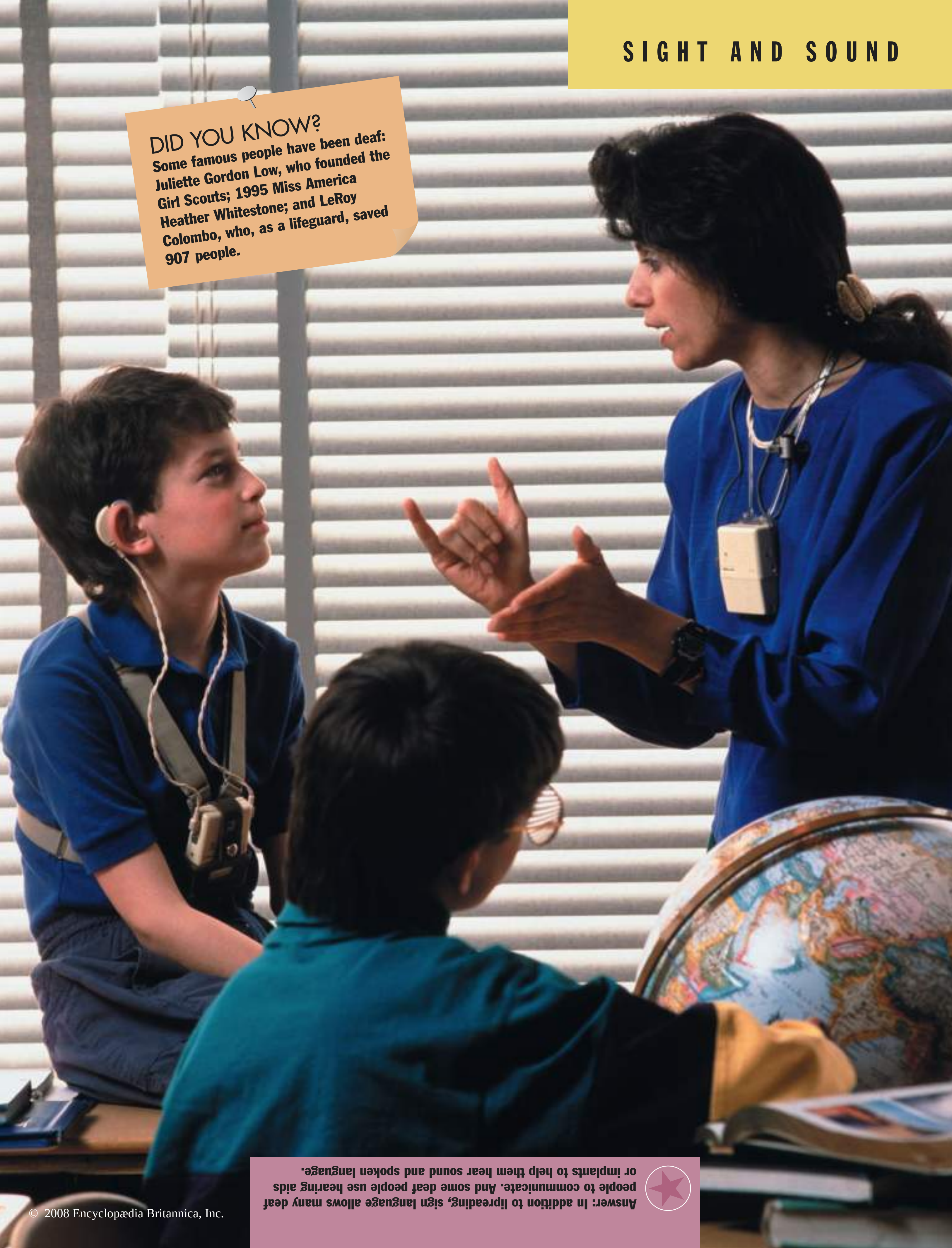
BRAILLE • INTERNET • TELEPHONE

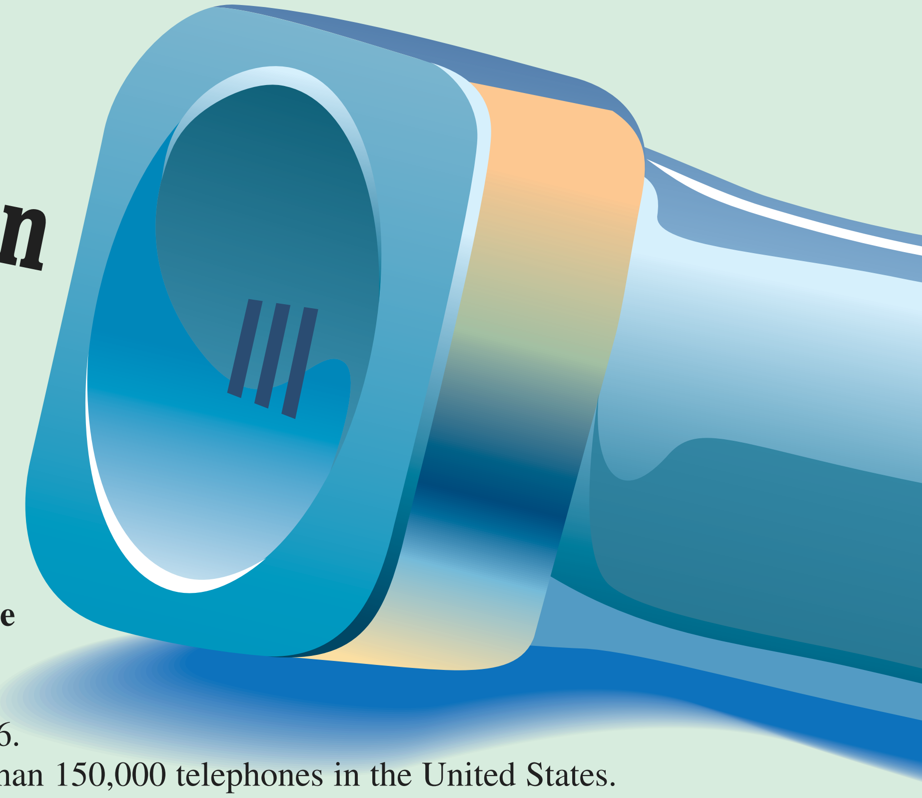
Many deaf children learn to communicate by using sign language.
© Mug Shots/Corbis



DID YOU KNOW?
Some famous people have been deaf: Juliette Gordon Low, who founded the Girl Scouts; 1995 Miss America Heather Whitestone; and LeRoy Colombo, who, as a lifeguard, saved 907 people.

Answer: In addition to lipreading, sign language allows many deaf people to communicate. And some deaf people use hearing aids or implants to help them hear sound and spoken language.

Staying in Touch



The telephone is the most popular communication **device** of all time.

Alexander Graham Bell invented the telephone in 1876. In 11 years there were more than 150,000 telephones in the United States. In 2001 there were an estimated 1,400,000,000 telephones worldwide.

Traditional telephones have three main parts: a **transmitter**, a receiver, and a dialer. There is also a switch hook, which hangs up and disconnects the call.

When you speak into the phone, the transmitter changes the sound of your voice into an electrical signal. The transmitter is basically a tiny **microphone** in the mouthpiece. On the other end of the call, the receiver in the listener's earpiece changes that electrical signal back into sound. The receiver is a tiny vibrating disk, and the electrical signal vibrates the disk to make the sounds of the caller's voice.

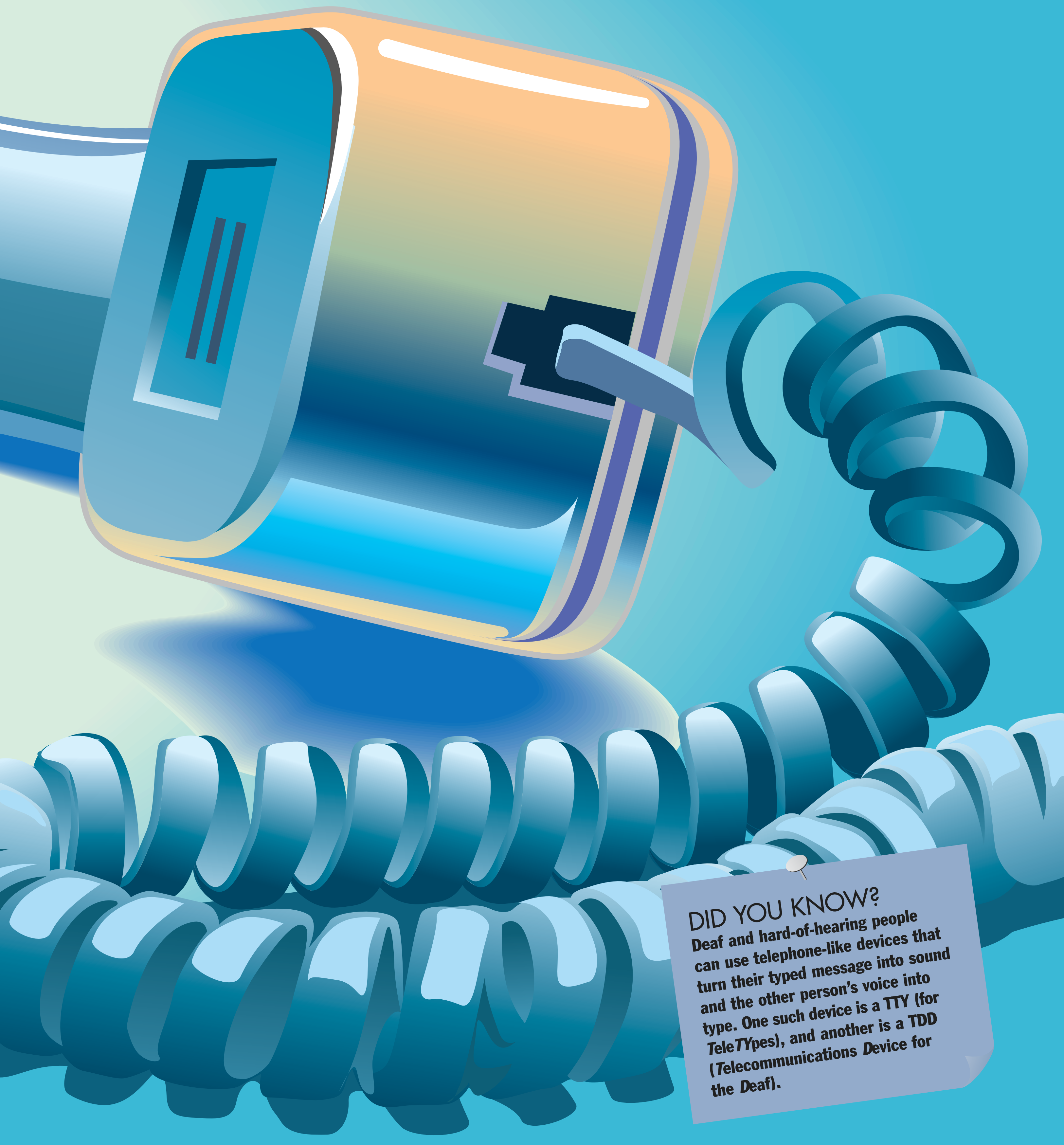
When you make a call, the phone's dialer sends a series of clicks or tones to a switching office. On a rotating dial phone, dialing the number 3 causes three clicks to interrupt the normal sound on the line (the dial tone). On a touchtone phone, a pushed number interrupts the dial tone with a new sound. These interruptions are a form of code. The switching office "reads" the code and sends the call to the right telephone receiver.

Since the 1990s cellular phones have become hugely popular worldwide. Cell phones connect with small transmitter-receivers that each control an area, or "cell." As a person moves from one cell to the next, the cell phone system switches the signal to the new cell.

SEARCH LIGHT

A telephone receiver is a
a) vibrating disk.
b) dial tone.
c) tiny microphone.

LEARN MORE! READ THESE ARTICLES…
INTERNET • RADIO • SIGHT AND SOUND



DID YOU KNOW?

Deaf and hard-of-hearing people can use telephone-like devices that turn their typed message into sound and the other person's voice into type. One such device is a TTY (for *TeleTY**pes*), and another is a TDD (*T*elecommunications *D*evice for the *D*eaf).**

Answer: a vibrating disk.

SEARCH LIGHT

Find and correct the error in the following sentence: A set of instructions that a computer uses to solve problems and do work is called "memory."

The Machines That Solve Problems

The first computers were expensive room-sized machines that only business and government offices could afford. Today most computers are smaller, and many people have one in their own home or school. These "personal computers" (PCs) first appeared in the mid-1970s.

A Palm Pilot, one of the tiny but powerful modern computers.
© RNT Productions/Corbis

Computers can find the answers to many math problems and can simplify work that has many steps and would otherwise take lots of time. They can do this because they can remember, in order, the individual steps of even long and complicated instructions.

The sets of instructions for computers are called "programs" or "software." A computer's brain is its microprocessor—a tiny electronic **device** that reads and carries out the program's instructions.

Because they are programmed in advance, you can use computers to solve math problems, remember facts, and play games. Computers can also help you draw, write papers, and make your own greeting cards.

Computers need two kinds of memory. "Main memory" is what handles the information that the computer is using as it is doing its work. Main memory operates amazingly fast and powerfully to speed up a computer's work. The second kind of computer memory is **storage** for its programs and for the results of its operations. The most important storage space is on the computer's hard drive, or hard disk. CD-ROMs, DVDs, and flash drives are removable storage devices.

Since 1990 very small computers have been developed. Today there are laptop or notebook computers, as well as handheld computers. Handheld computers weigh only a few ounces, but they can handle more **data** more quickly than most of the first giant computers.

DID YOU KNOW?
It was a weaving machine, a loom, that led to the first computers. At one time looms used punched cards to set weaving patterns. Early computers used this system of coding in their programming "languages."

LEARN MORE! READ THESE ARTICLES…
ELECTRICITY • INTERNET • PRINTING

Answer: A set of instructions that a computer uses to solve problems and do work is called a "program" [or "software"].

Network of People

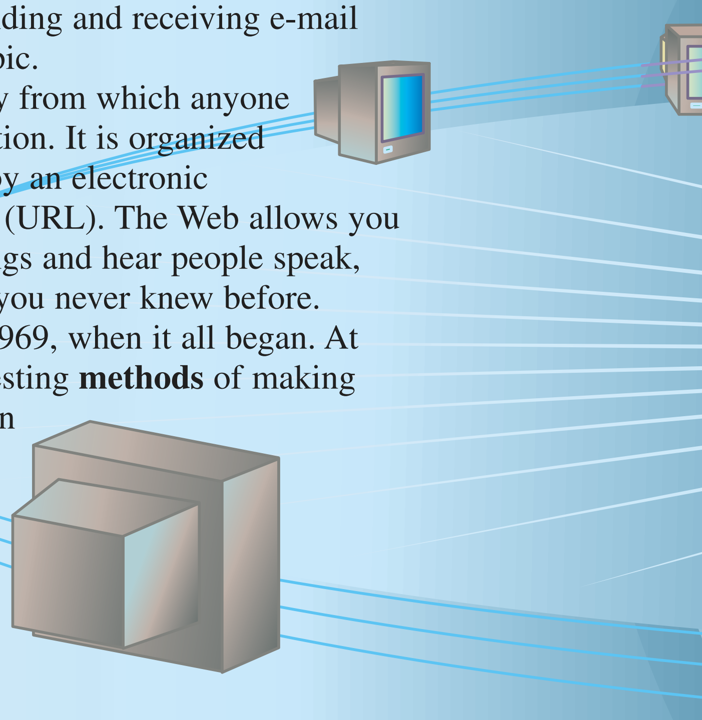
You can do things with your friends and family even when they are thousands of miles away simply by sitting at your computer. The Internet makes this possible.

As the name suggests, the Internet is like a large net whose every strand connects a different computer. It is an international web linking millions of computer users around the world. Together with the World Wide Web (WWW, or Web), it is used for sending and receiving e-mail and for sharing information on almost any topic.

The Web is an enormous electronic library from which anyone connected to the Internet can receive information. It is organized into tens of millions of sites, each identified by an electronic address called the “uniform resource locator” (URL). The Web allows you to view photographs and movies, listen to songs and hear people speak, and find out about **countless** different things you never knew before.

The Internet has come a long way since 1969, when it all began. At that time the U.S. Defense Department was testing **methods** of making their computers survive a military attack. Soon their networks were extended to various research computers around the United States and then to countries around the world.

By early 1990 the Internet and the World Wide Web had entered homes. Today many people wonder how they ever got by without the Internet.



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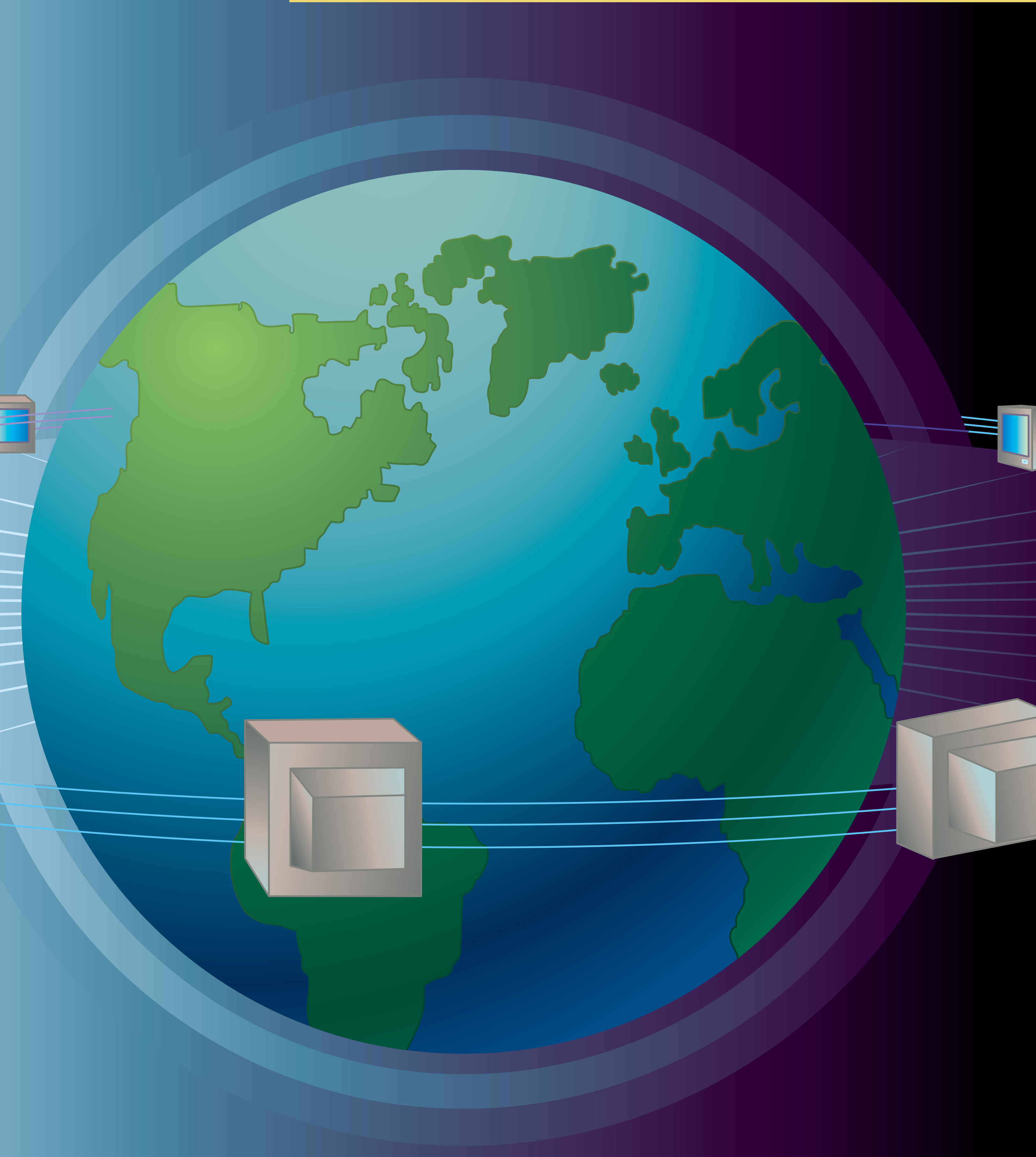
COMPUTERS • RADIO • TELEPHONE

DID YOU KNOW?
Radio took about 38 years to gain 50 million listeners. TV took about 13 years to have 50 million viewers. The Internet took only 4 years to get 50 million users.

SEARCH LIGHT
True or false? The Internet is less than 20 years old.



Answer: FALSE. The Internet is more than 30 years old.

Cables, Fuses, Wires, and Energy

You can't see electricity, but you know it's there when you watch an electric light go on, hear the telephone ring, or see the television on.

Electricity comes into your house through thick wires called "cables." The cables join a **fuse** box. From the fuse box run all the electric wires for your house. Each wire connects to an outlet or a switch. From the outlets electricity passes along the plugs and cords that go to a lamp or television.

Electricity moves easily along things that are made of metal, such as silver, copper, or iron. That's why copper wires are used to carry the electricity. Electricity doesn't pass through rubber or plastic. That's why wires carrying electricity are usually coated with rubber or plastic.

This coating is important, because electricity will flow wherever it can. Loose, it can be very dangerous. It can cause shocks, start fires, or even kill.

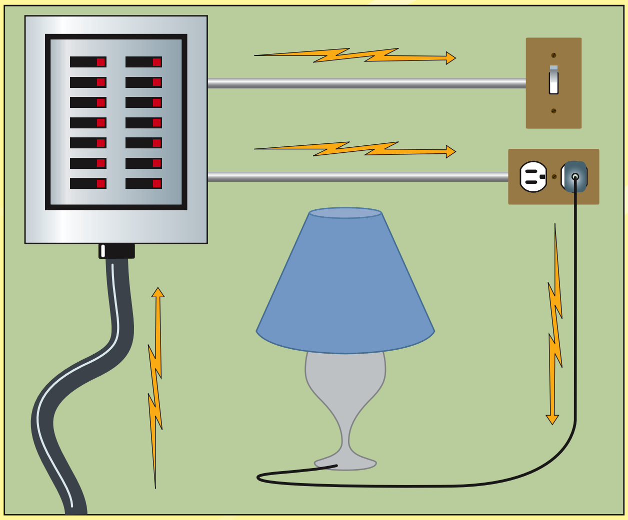
Did you know that electricity can be used to make a magnet? If a wire is wound into a coil and wrapped around a piece of iron, the iron will become a magnet when electricity is sent through the coil. The iron will then attract other things made of iron and steel. Such a magnet is called an "electromagnet."

As soon as the electricity is turned off, the electromagnet isn't a magnet anymore. If the magnet is holding something when the electricity is turned off, that thing will drop.

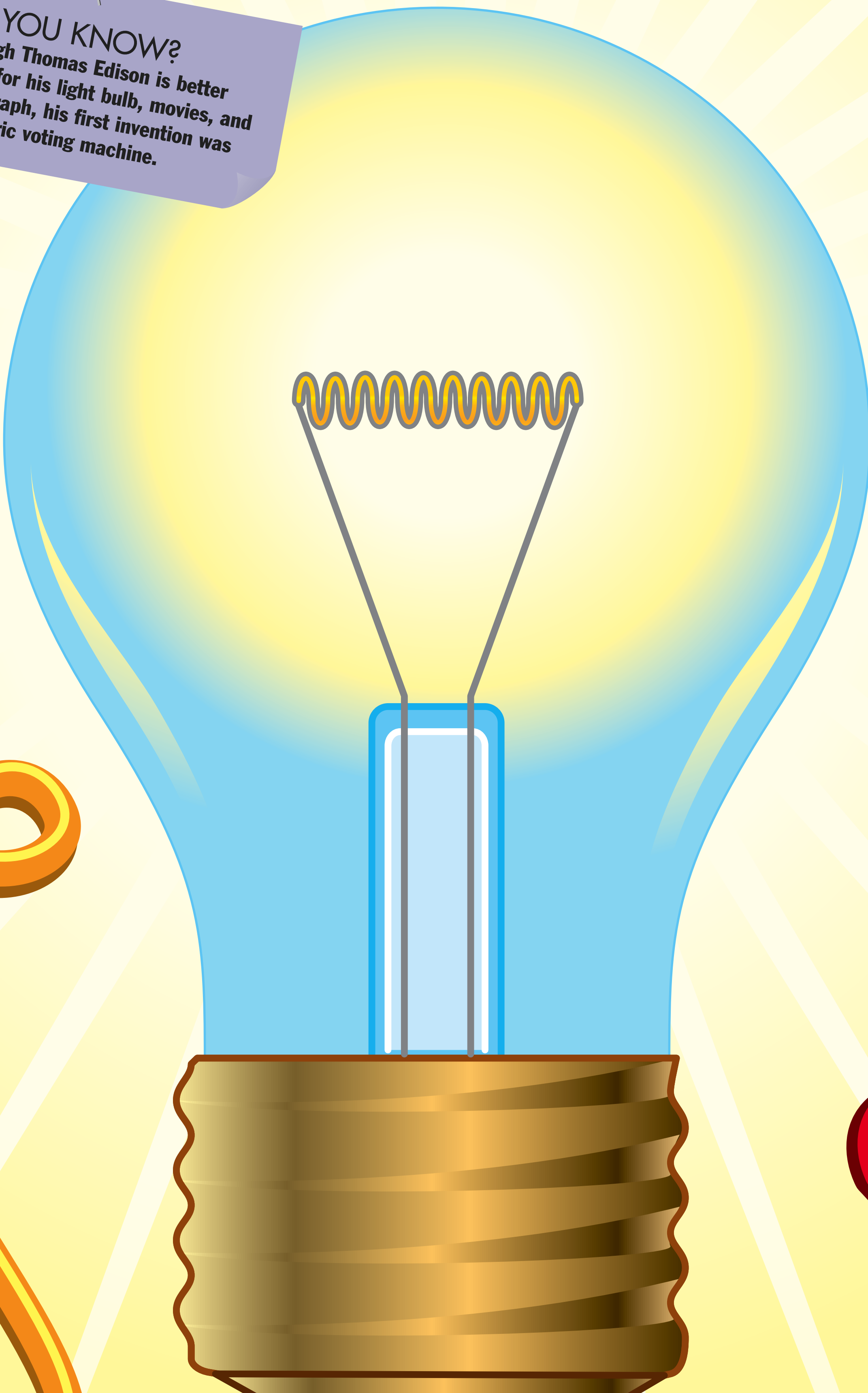
SEARCH LIGHT

Fill in the blanks: To prevent shocks, electric wires should be wrapped with _______ or _______.

LEARN MORE! READ THESE ARTICLES…
TELEPHONE • WATER POWER • WIND POWER



DID YOU KNOW?
Although Thomas Edison is better known for his light bulb, movies, and phonograph, his first invention was an electric voting machine.



Answer: To prevent shocks, electric wires should be wrapped with rubber or plastic.

Hundreds of wind turbines like these in Denmark are set up on "wind farms" in constantly windy areas to produce large amounts of electricity.
© Adam Woolfitt/Corbis

SEARCH LIGHT

Which of the following are advantages of wind power?
It's cheap.
It works everywhere.
It's clean.
It's endless.

DID YOU KNOW?

The total wind power of our atmosphere, at any one time, is estimated to be 3.6 billion kilowatts. That's enough energy to light 36 billion light bulbs all at once.

Energy in the Air

Wind power has been used for many hundreds of years. Its energy has filled the sails of ships and powered machines that grind grain, pump water, drain marshes, saw wood, and make paper. Wind provides a clean and endless source of energy.

In the 1890s windmills in Denmark became the first to use wind power to generate electricity. But it took the major energy crisis of the 1970s to focus people's thoughts seriously again on using wind energy to produce electricity.

Traditional windmills in the Netherlands.
© ML Sinibaldi/Corbis

Windmills provide power to make electricity when their sails are turned by wind blowing against them. Originally the sails were long narrow sheets of canvas stretched over a wooden frame. Later windmills used different materials and designs. Usually there are four sails shaped like large blades.

When the sails turn, the axle they are attached to turns as well, much as car wheels turn on their axles. The axle causes various **gears** to turn, which then causes a large crankshaft to turn. The crankshaft is a long pole running the length of the windmill tower. At its other end the crankshaft is attached to a generator, a motor that can make and store electricity. So when the wind blows, the generator runs, making electricity.

Today modern efficient wind machines called "wind turbines" are used to generate electricity. These machines have from one to four blades and operate at high speeds. The first of these wind turbines appeared in the mid-1990s.

LEARN MORE! READ THESE ARTICLES…
ELECTRICITY • SHIPS • WATER POWER

Answer: Wind power is cheap, clean, and endless. Unfortunately, it's not a usable way to generate power in areas with little or no wind.

Energy from Heat

Energy means power—the power to do work. And thermal, or heat, energy can do a lot of work. When heat is applied to water, for instance, it makes the water boil. Boiling water then changes to vapor, or steam, which can apply great force as it escapes a container. Large quantities of steam powered the earliest train engines.

The most important source of thermal energy for our Earth is the Sun's rays. This "**solar** energy" is used to heat houses, water, and, in some countries, ovens used for cooking. Solar power can even be **converted** to electricity and stored for later use.

SEARCH LIGHT

Fill in the blank: When steam escapes, it gives a mighty push. This push is so strong that it was used to move the early _______ engines.

© Keren Su/Corbis

© Paul A. Souders/Corbis

(Top) Sun's heat focused and used for cooking on solar oven by Tibetan monk. (Bottom) Locomotive fireman shovels coal to burn, boiling water to produce steam power.

To human beings the second most important source of thermal energy is the store of natural fuels on and in the Earth. When these fuels—mainly coal, oil, gas, and wood—are burned, they produce heat. This heat can be used for warmth, made to power a machine directly, or converted into electricity. For example, a car engine burns gasoline (an oil product) for direct thermal power. In some areas coal is burned to produce the electricity that powers people's homes.

In a very few parts of the world, an interesting third form of heat energy comes from "living" heat inside the Earth itself. This "geothermal energy" comes from such sources as natural hot springs and the heat of active volcanoes ("geo-" means "earth"). Naturally escaping steam and hot water are used to heat and power homes and businesses in Reykjavik, Iceland. And though volcanoes are mostly too hot to tap directly, worldwide experiments continue as other major fuel supplies **dwindle**.

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AUTOMOBILES • ELECTRICITY • OIL

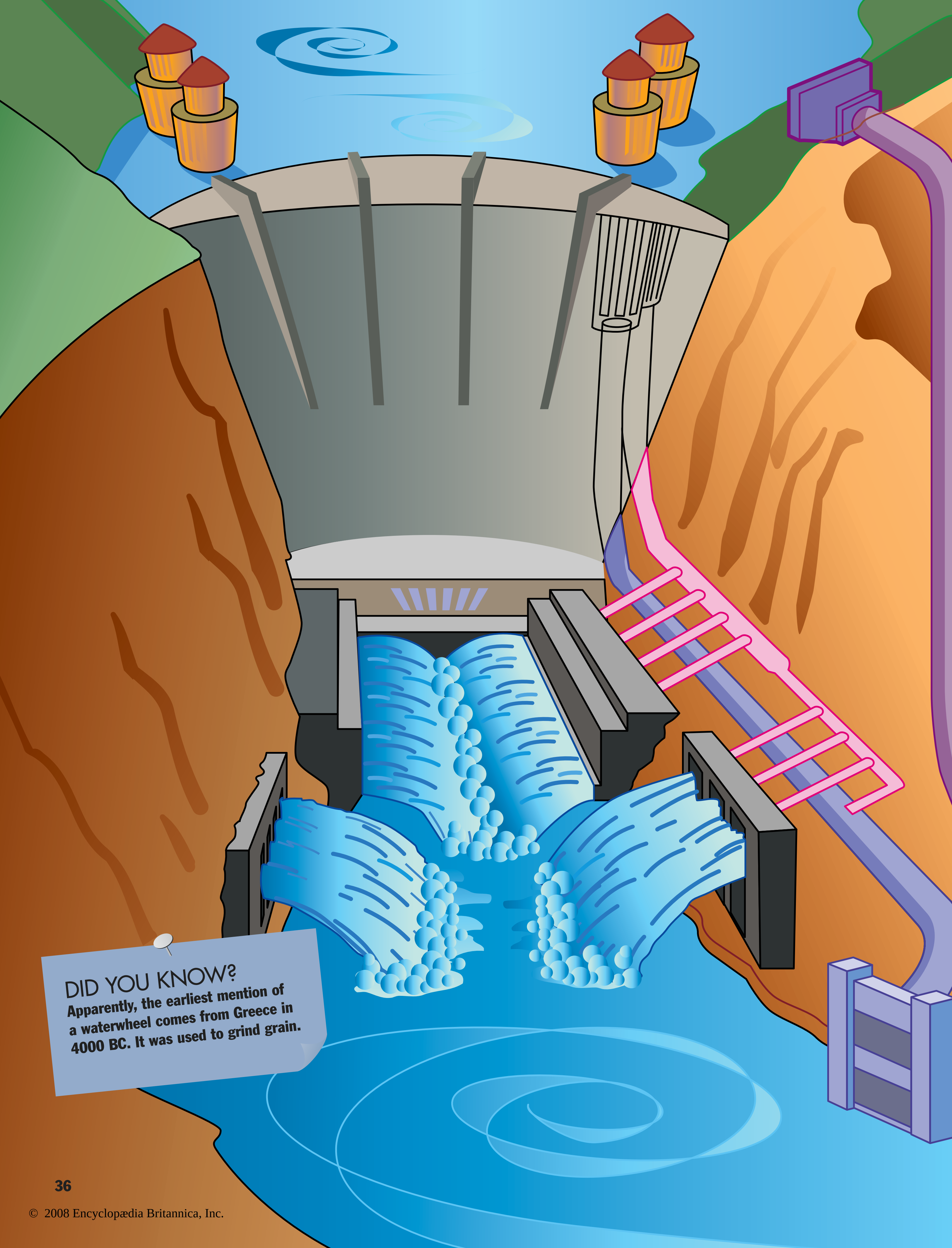
© Raymond Gehman/Corbis

The intense power of the Earth's heat energy sometimes bursts into geysers—hot springs that send roaring columns of steam and boiling water high above the surface. This geyser is the famous Old Faithful in Yellowstone National Park in Wyoming, U.S.

DID YOU KNOW?

Hot-air ballooning, a popular sport in the 1960s, relies on thermal power. A gas burner heats air that is then fed into a large airtight balloon. And because hot air rises, the balloon rises up and away–carrying people or cargo along in its basket or container.

Answer: When steam escapes, it gives a mighty push. This push is so strong that it was used to move the early train engines.



DID YOU KNOW?

Apparently, the earliest mention of a waterwheel comes from Greece in 4000 BC. It was used to grind grain.

Streams of Energy

We have only to hear the roar of a waterfall to guess at the power of water. Its force is also clear anytime we see the damage caused by floods. But the water power can be extremely useful as well as destructive.

One excellent aspect of water power is that the water can be reused. Unlike such fuels as coal and oil, water does not get used up when **harnessed** for power. And it doesn't pollute the air either.

The power of water lies not in the water itself but in the flow of water. The power produced by water depends upon the water's weight and its height of fall, called "head." Generally, the faster that water moves, the more power it can generate. That's why water flowing from a higher place to a lower place, as a waterfall does, can produce so much energy.

© Hubert Stadler/Corbis

Since ancient times humans have used the energy of water for grinding wheat and other grains. They first **devised** the waterwheel, a wheel with paddles around its rim. As the photograph shows, the wheel was mounted on a frame over a river. The flowing water striking the blades turned the wheel.

Later, larger waterwheels were used to run machines in factories. They were not very reliable, however. Floodwaters could create too much power, whereas long rainless periods left the factories without any power at all.

Today streamlined metal waterwheels called "turbines" help produce electricity. The electricity produced by water is called "hydroelectric power" ("hydro-" means "water"). Enormous dams, like the one pictured here, provide this **superior** source of electricity.

SEARCH LIGHT

Fill in the blank:
Unlike gas or coal power, water power doesn't cause air ______.

LEARN MORE! READ THESE ARTICLES…
ELECTRICITY • SHIPS • THERMAL POWER

Answer: Unlike gas or coal power, water power doesn't cause air pollution.

Big Energy from a Small Source

All **matter** is made up of tiny particles called "molecules." In turn, all molecules are made up of even tinier particles called "atoms."

The central part of an atom is called a "nucleus." When the nucleus splits in two, it produces enormous energy. This breaking apart is called "nuclear fission." If two nuclei join and form a bigger nucleus—a process called "nuclear fusion"—even more energy is produced.

The nuclear energy released from fission and fusion is called "radiation." Radiation—the process of giving off **rays**—is a powerful spreading of heat, light, sound, or even invisible beams.

SEARCH LIGHT

What's the main problem with nuclear energy?

One of the first uses of nuclear energy was to build deadly weapons. Atomic bombs built during World War II and dropped on Hiroshima and Nagasaki in Japan largely destroyed those cities and killed many thousands of people. People worldwide now try to make sure these things never happen again.

Today, however, nuclear energy has many helpful uses. Nuclear power plants produce low-cost electricity. Nuclear energy also fuels submarines. And it has also allowed doctors to see more details inside the body than ever before.

But nuclear energy has its **drawbacks**. Nuclear energy produces nuclear waste. Living beings exposed to the waste can suffer radiation poisoning. They may experience damaged blood and organs, effects that can be deadly. And the radiation can remain active for thousands of years wherever nuclear waste is thrown away.

Unfortunately, no country has yet discovered the perfect way for storing nuclear waste. But the benefits make it worthwhile to keep trying.

DID YOU KNOW?

We all actually enjoy the benefits of nuclear energy every day. The Sun, like all stars, is simply one giant nuclear power plant. Its heat and light are the product of nuclear energy.

LEARN MORE! READ THESE ARTICLES…
SUBMARINES • THERMAL POWER • WATER POWER

Nuclear power plant on the coast of California, U.S.
© Galen Rowell/Corbis

Answer: Nuclear energy produces poisonous waste that stays deadly for generations. No one has yet come up with a safe and highly reliable way to get rid of the waste.

From the Ground to the Filling Station

Up comes the thick black oil from the oil well and...out pours the gasoline into your family's car. But how does the oil become fuel for automobiles?

Petroleum, or crude oil, is oil as it is found deep within the Earth. This raw form has many unwanted substances in it that must eventually be removed in a process called "refining."

From a well drilled deep into the ground, the oil often goes through long pipelines under the ground. There are pipelines in some very surprising places—under streets, mountains, deserts, frozen lands, and even lakes and rivers.

Pumping stations keep the thick oil moving through the pipes. Each station gives the oil enough of a push to get it to the next station. There are pumping stations built all along the pipelines. Here and there along the pipelines, oil is directed into smaller pipes that take it to huge storage tanks.

From the storage tanks the oil goes into a **refinery**, where it is heated until it is very hot. The hot oil is separated into many different substances. The heavy part that settles down at the bottom is used for road building. Other parts become machine oils and waxes. **Kerosene** and gasoline also separate as the oil is heated. Finally, the lightest parts of the oil—cooking gas and other kinds of gases—are collected.

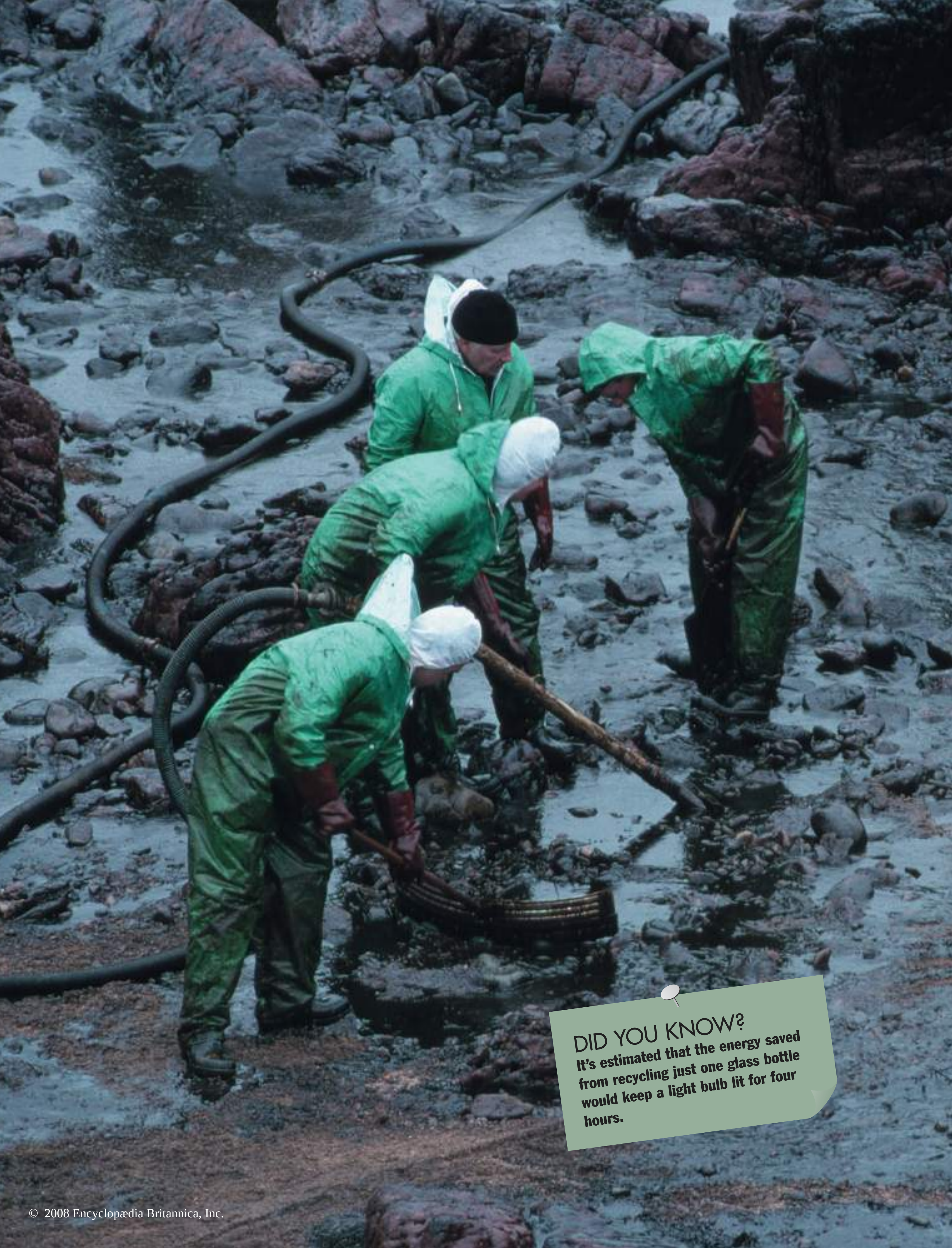
From the refineries more pipelines carry oil to round storage tanks in tank farms. Gasoline trucks fill up at the storage tanks and take the gasoline to filling stations, where your car and others can then fill up.

LEARN MORE! READ THESE ARTICLES…
AUTOMOBILES • POLLUTION • THERMAL ENERGY

SEARCH LIGHT

Put the different stages in the proper order, beginning with the oil well.
(Start) oil well →
pipelines, filling station, pipelines, refinery, storage tank, pumping station

Answer: oil well → pipelines → pumping station → storage tank
→ refinery → pipelines → filling station



DID YOU KNOW?

It's estimated that the energy saved from recycling just one glass bottle would keep a light bulb lit for four hours.

Harming Our Environment

Have you ever seen black smoke spilling out of factory chimneys, turning the sky a dirty gray? This is air pollution. Cars, trucks, buses, and even lawnmowers release gases and particles that pollute the air too. Smoke from fires and barbeque grills pollutes the air.

Land pollution, water pollution, and even noise pollution are also big problems. Both factories and ordinary citizens may thoughtlessly dump trash and **waste** on land or in water. When farm chemicals that kill insect pests or help crops grow sink into the ground and water, they pollute too. And noise pollution is created by loud machines and honking cars.

Ocean life isn't safe from pollution. The picture you see here shows a cleanup crew at a polluted seashore after an oil spill. Ships carrying petroleum sometimes have accidents that dump their oil into the ocean.

Dirty air, land, and water are dangerous. Dirty air, or **smog**, is hard to breathe and makes people and animals sick. Dirty water makes people and animals sick when they drink it or wash or live in it. It also kills plants. If land takes in too much waste, nothing will grow on it, and it becomes unfit to live on.

Stopping pollution isn't easy. Most people find it hard to change the way they live, even if they want to. And governments and big companies find it even harder to change, since the changes are often unpopular or costly.

Even small changes help, however. Reusing things instead of throwing them away helps. Using less water each day helps. So does **recycling**. And perhaps the future will find people using cleaner forms of energy, such as wind power and solar energy.

SEARCH LIGHT

Match each item to the kind of pollution it creates.

litter	***air***
smog	***land***
car honking	***water***
oil spill	***noise***

LEARN MORE! READ THESE ARTICLES…
AUTOMOBILES • NUCLEAR ENERGY • WIND POWER

Answer: **litter** = *land* **smog** = *air* **oil spill** = *water* **car honking** = *noise*

Making Cloth

"Shu-dul-ig! Shu-dul-og!"

The shuttle in this weaver's left hand flies back and forth, carrying its thread.

A shuttle is part of a loom, a machine that makes cloth. Cloth is composed of threads crisscrossing each other.

"Warp" threads run up and down lengthwise on the loom. The shuttle carries the "weft" thread back and forth, passing it over and under the sets of warp thread. This is how simple cloth like muslin is woven. Making patterned and other fancy cloth is a more complex weaving process.

The threads for weaving cloth are made of fibers—thin, wispy strands often tangled together. Some fibers come from animals, some from plants, and some from synthetic (artificial) sources. Fine silk fibers come from the cocoon of a silkworm—actually the caterpillar stage of a moth. People learned to spin fibers into threads a very long time ago.

The most commonly used animal fiber is wool. Most wool is the hair of sheep, but some comes from goats, camels, llamas, and several other animals. Woolen cloth keeps you nice and warm when it's cold outside.

Cotton is a plant fiber. Some cotton fibers are so thin that just one pound of them can be spun into a thread 100 miles long! Work clothing and summer clothes are often made of cotton.

Fine silk cloth is shiny and smooth. It costs more than cotton because silkworms need a lot of care. And each silkworm makes only a small amount of silk.

Today weaving by hand has become mostly a specialized **craft**. As with much other manufacturing, modern cloth is usually produced by machines.

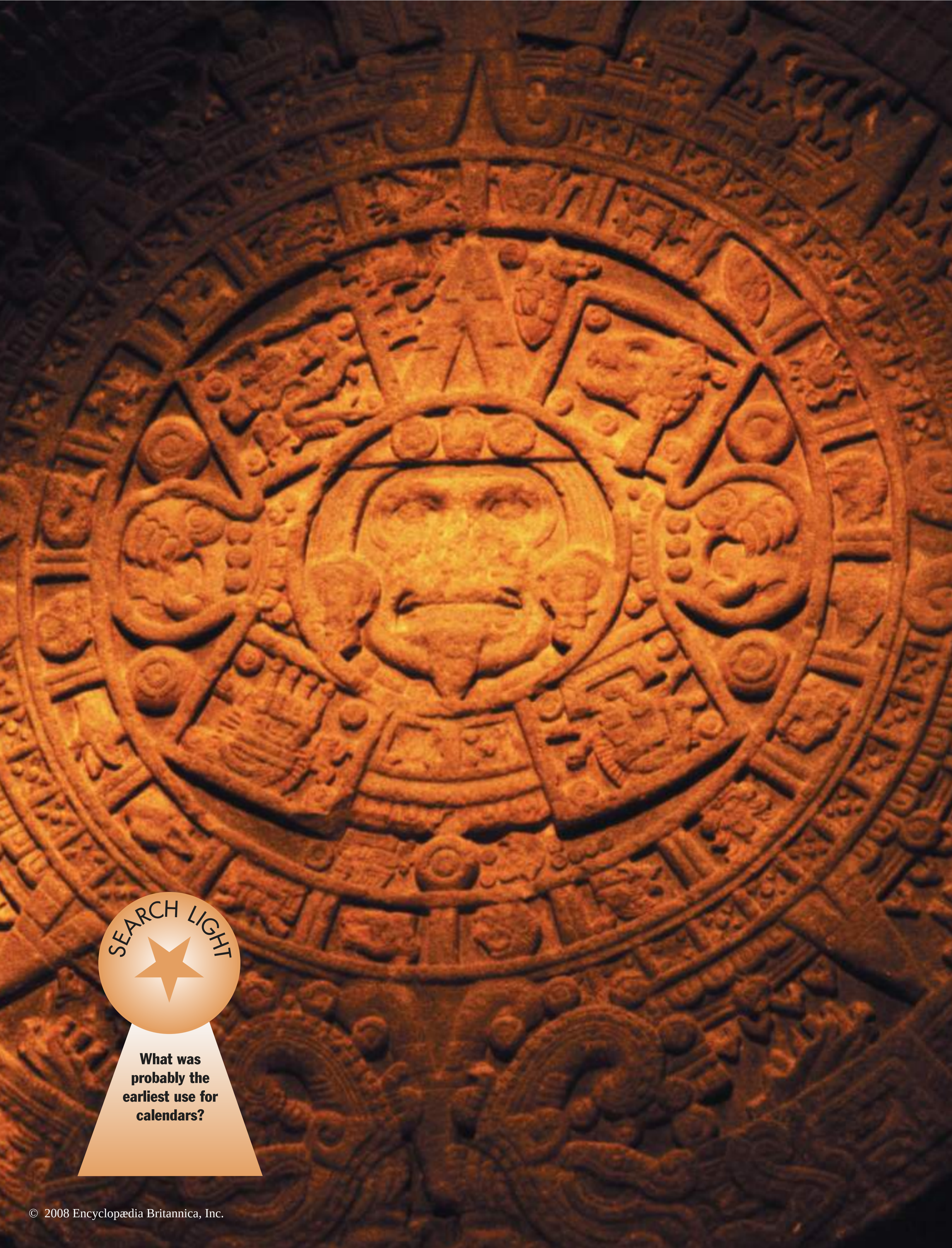
SEARCH LIGHT

Which of the following descriptions matches the term "weft"?
a) cross threads
b) up-and-down threads
c) weaving machine
d) source of silk

LEARN MORE! READ THESE ARTICLES…
BRAILLE • COMPUTERS • MEASUREMENT

DID YOU KNOW?
The strongest piece of weaving anywhere is a spiderweb. One strand of spider silk is thought to be stronger than an equal-sized piece of steel.

Answer: a) cross threads



SEARCH LIGHT

What was probably the earliest use for calendars?

Charting the Year

A calendar, like a clock, provides a way to count time—though calendars count days and months rather than minutes and hours. The modern calendar has 12 months of 30 or 31 days each (February has 28, sometimes 29). The calendar year has 365 days, which is about how long it takes the Earth to circle the Sun once. That makes it a **solar** calendar.

DID YOU KNOW?
The Chinese calendar names each year for one of 12 animals. In order, these are: rat, ox, tiger, hare, dragon, snake, horse, sheep, monkey, fowl, dog, and pig. The year 2003 is the Year of the Sheep (or Ram), 2004 the Year of the Monkey, and so on.

Today's calendar, with a few changes, has been in use since 1582. Pope Gregory XIII had it designed to correct errors in the previous calendar. For this reason it is called the "Gregorian calendar."

The oldest calendars were used to figure out when to plant, harvest, and store crops. These were often "**lunar** calendars," based on the number of days it took the Moon to appear full and then **dwindle** away again.

Jewish calendar (in Hebrew) from the 1800s.
© Archivo Iconografico, S.A./Corbis

The traditional Chinese calendar is a lunar calendar. It has 354 days, with months of either 29 or 30 days.

Many calendars have religious origins. In Central and South America, the ancient Aztec and Mayan calendars marked **ritual** days and celebrations. Jews, Muslims, and Hindus have religious calendars, each with a different number of days and months.

All these calendars have one thing in common: they're wrong. None of them measures the Earth's year-long journey around the Sun precisely. Extra days must be added to keep the count in step with the actual seasons. We add an extra day to February every four years. (Actually, even our corrections are wrong. Once every 400 years we *don't* add that day.)

But if we didn't make some kind of correction, we'd eventually have New Year's Eve in the middle of the year!

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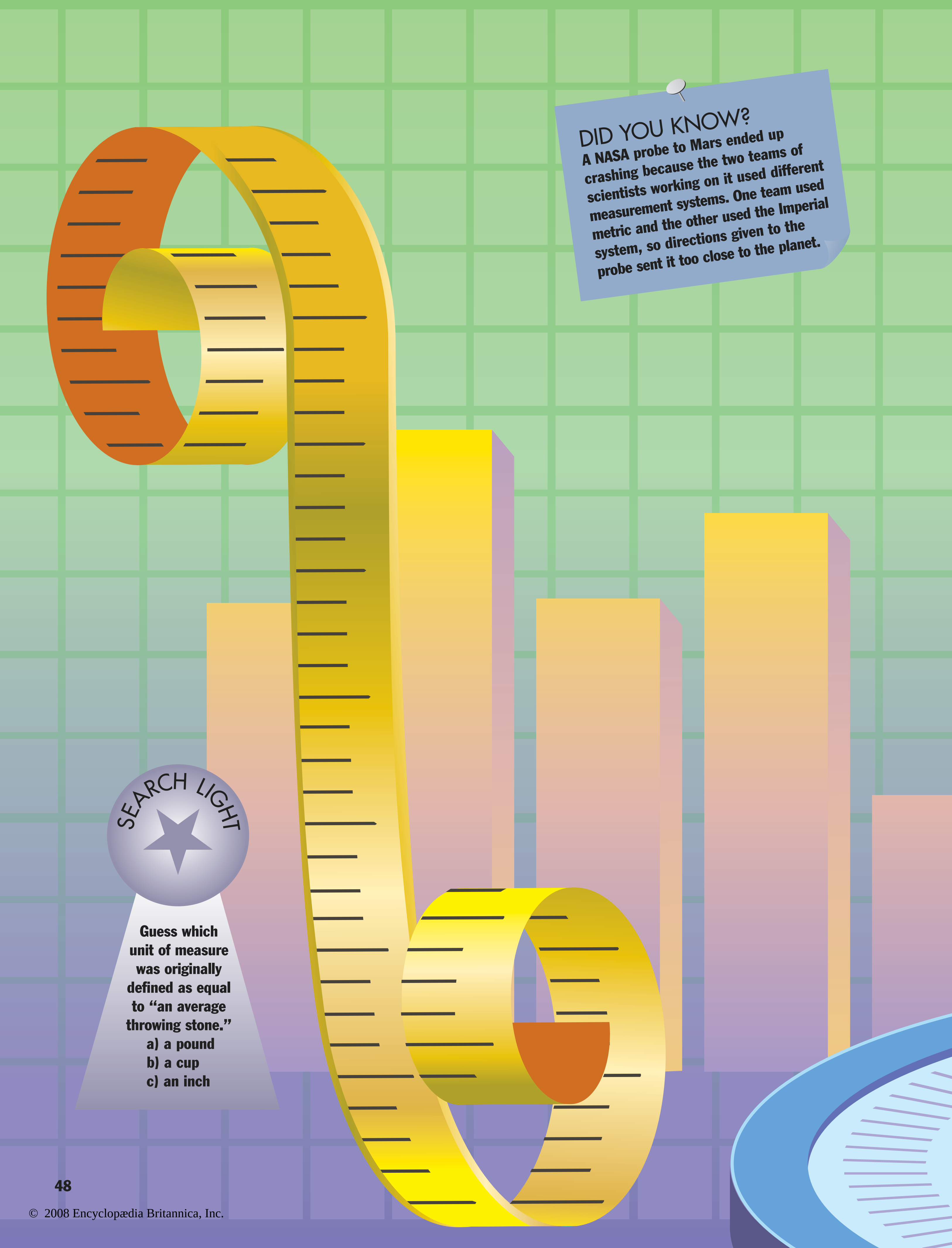
COMPUTERS • MEASUREMENT • PRINTING

This ancient Aztec calendar stone weighs about 25 tons. Its central image of the Aztec sun god, Tonatiuh, indicates the important role religion plays in how major civilizations measure time.
© Randy Faris/Corbis

Answer: The earliest calendars were likely used to tell the right time to plant and harvest crops.



DID YOU KNOW?

A NASA probe to Mars ended up crashing because the two teams of scientists working on it used different measurement systems. One team used metric and the other used the Imperial system, so directions given to the probe sent it too close to the planet.

SEARCH LIGHT

Guess which unit of measure was originally defined as equal to "an average throwing stone."

a) a pound
b) a cup
c) an inch

Figuring Out Size and Distance

How far away is the nearest chair? You can make your own measurement to tell how many shoes away that chair is.

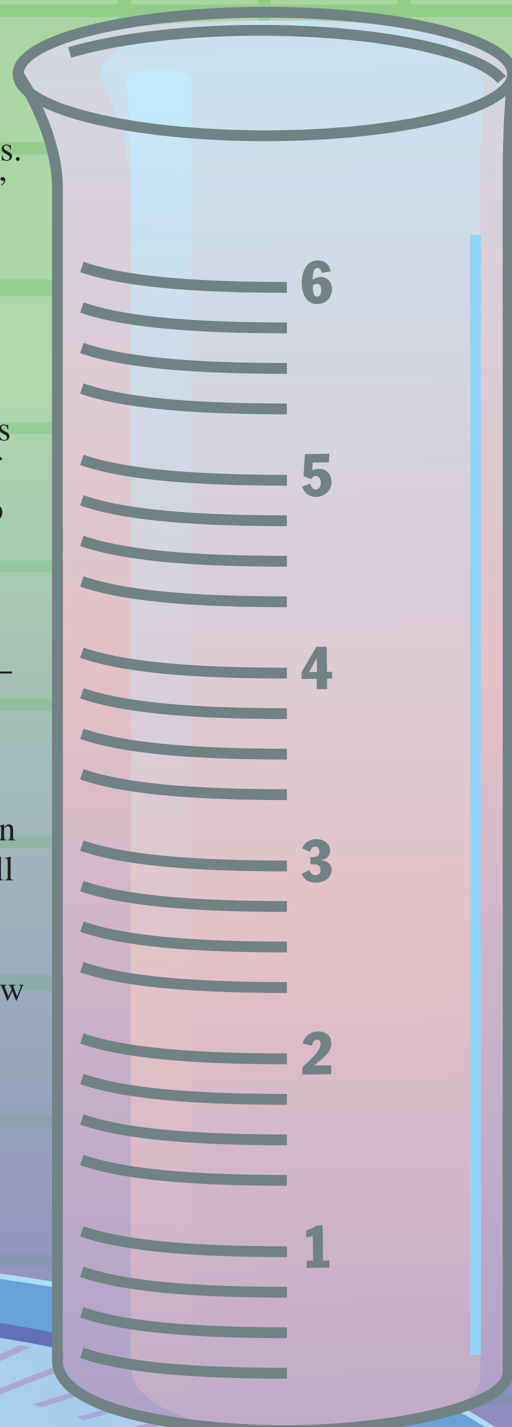
Stand up where you are and face the chair. Count “one” for your right shoe. Now place the heel of your left shoe against the toe of your right and count “two.” Continue stepping, heel-to-toe, right-left, counting each shoe length you walk, until you get to the chair.

Centuries ago, people did just what you are doing now. They used parts of the body to measure things. An inch was about the width of a man’s thumb. A foot was the length of his foot. A yard was the distance from the tip of his nose to the end of his thumb when his arm was stretched out. But since everybody’s thumbs, feet, and arms were different sizes, so were everybody’s inches, feet, and yards.

Finally, in the 1800s, all these terms were standardized–that is, everyone in England agreed on a specific definition for each one. They became part of the English system of measurement, the British **Imperial** System.

Another system, called the “metric system,” measures in centimeters and meters, grams and kilograms, and liters. All these measurements can be multiplied or divided by 10. Fortunately, most of the world accepts the Imperial or the metric system as the **standard** of measurement. So we know today that one measurement will mean the same thing no matter where it is used or who is doing the measuring.

LEARN MORE! READ THESE ARTICLES…
AUTOMOBILES • CALENDAR • COMPUTERS



Answer: a) a pound. Though people agreed on a pound as the weight of „an average throwing stone,“ there were actually as many different „pounds“ as there were people!

Drawing with Light

The word "photography" comes from two ancient Greek words: *photo*, for "light," and *graph*, for "drawing."

Photography, the process of taking pictures, requires a camera. Cameras work basically as our eyes do. Light enters the front and shines a picture on the back. A camera may be any dark lightproof box with a small opening at one end that lets in the light. Most cameras have glass **lenses** to help focus the light into the back of the box.

In your eye light enters through an opening called the "pupil." The camera's opening is its aperture. Your iris controls how much light enters your eye. The camera's shutter does the same. In eyes and in most cameras, the light then passes through a lens. In your eye the picture is

SEARCH LIGHT

Match the parts of the camera to the similar parts of an eye:

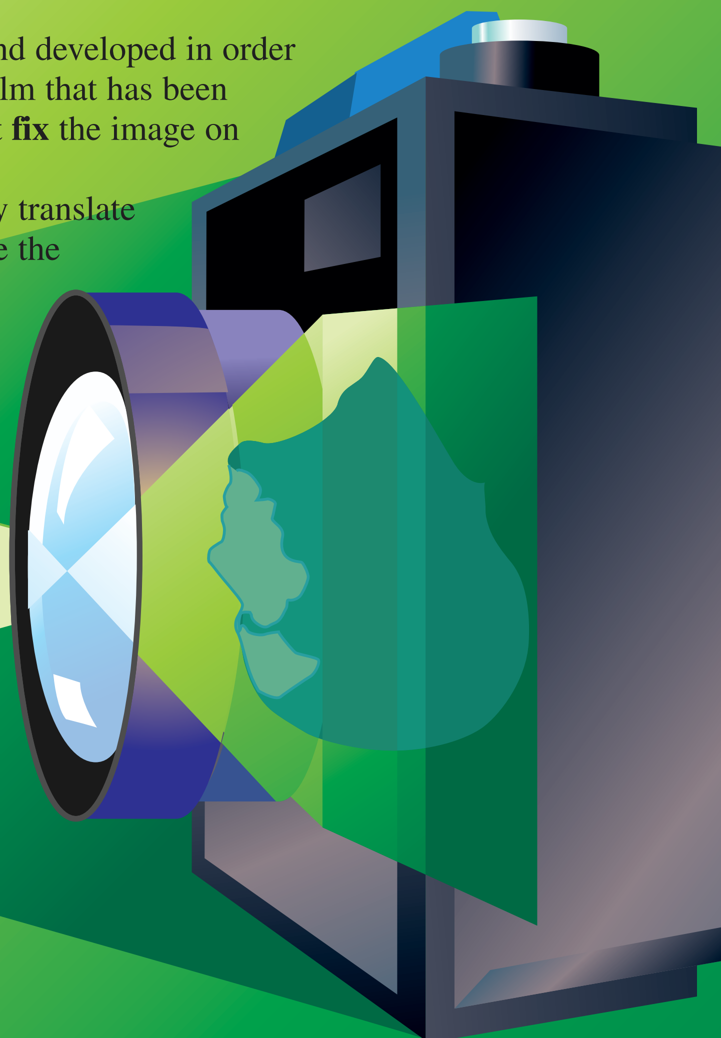
1. pupil **a) lens**
2. iris **b) film**
3. lens **c) shutter**
4. retina **d) aperture**

produced on the retina, the back lining of the eye. In a traditional camera, film receives and captures the image.

Film is special material that has been treated with chemicals to make it **sensitive** to light. Light shining on film changes the film's chemical makeup. Depending on how much light shines on each part of the film, different shades or colors result.

The film has to be taken out of the camera and developed in order to finish the process of creating a photograph. Film that has been exposed to light is processed with chemicals that **fix** the image on special paper.

Digital cameras do not use film. Instead, they translate the image into numbers recorded on a disk inside the camera. A computer decodes these numbers and displays a picture.



LEARN MORE! READ THESE ARTICLES…
MOTION PICTURES • PRINTING • SIGHT AND SOUND

DID YOU KNOW?
The first photograph—a farmhouse with some fruit trees—was taken in about 1826 by French inventor Joseph Nicéphore Niépce.

Answer: 1d; 2c; 3a; 4b

Photos That Move

Sitting in a darkened movie theater, caught up in the adventures of Frodo Baggins or Batgirl, you might find it difficult to believe that you're watching a series of still photographs. These still photos are projected onto the screen so fast, one after another, that you're tricked into seeing movement.

Motion picture film comes in long wound **spools** or **cartridges**. A camera records pictures on the film at either 18 or 24 shots per second. Sometimes there are three or four cameras that shoot a scene from different angles. Sound is recorded at the same time but with separate equipment.

Later, the film is **edited** by cutting out parts that the director doesn't want. The parts being kept are then put together to tell the story. The sound and the pictures are joined together on a single piece of film to create the finished movie.

DID YOU KNOW?

When a system that added sound to silent movies was invented, the major movie companies thought it would be a big failure. One small company, Warner Brothers, thought it might be interesting and soon produced the first "talking pictures."

SEARCH LIGHT

True or false? Movies are really just a long string of photographs.

Filmmaking is a long and complicated process, involving many people. The actors are the most visible, but there are many others as well. The director has total control over how the story will be filmed. A whole crew of people help with costumes, choreography, lighting, sound, camera operations, special effects, and the actors' makeup and hairstyles.

After the film has been shot, there are different people to edit it and other people who advertise the movie and get the public talking about it. Finally, the film reaches the movie theaters. There you buy your popcorn or other refreshments and settle into your seat to enjoy the magic world of the finished motion picture.

LEARN MORE! READ THESE ARTICLES…
PHOTOGRAPHY • TELEVISION • RADIO

Answer: TRUE. When the string of photos is flashed by quickly, the pictures appear to move.

SEARCH LIGHT

Fill in the blank:
After World War I, radio grew from a two-way communication tool into a popular instrument for _______________.

Guglielmo Marconi, seen here in 1922, received the 1909 Nobel Prize for Physics for his development of a way to send electronic signals without using wires.
© Bettmann/Corbis

Thank You, Mr. Marconi

Before there was television, people got much of their news and entertainment from the radio. And many still do!

Invention of the radio began in 1896 when Italian scientist Guglielmo Marconi **patented** a wireless **telegraph** process. Marconi knew that energy can travel in invisible waves through the air and that these waves could be captured electronically to send and receive signals. His invention allowed people to send messages to each other over great distances without having to be connected by wires.

A Marconi wireless telegraph set (1912), the "parent" of the voice-transmitting radio.
© Underwood & Underwood/Corbis

> **DID YOU KNOW?**
> **On the eve of Halloween (October 30) of 1938, actor-director Orson Welles's realistic radio drama *The War of the Worlds* accidentally convinced millions of listeners that the Earth was being invaded by Martians!**

Marconi and others added to his invention, figuring out how to add sound to these messages to make the first radios. These were used simply for sending and receiving messages. During World War I the armed forces used radios for this purpose. It was after the war that radio became popular as a means of entertainment.

During the 1920s radio stations were set up all over the world. In the early days most of the radio programs gave news or **broadcast** lectures and some music. As more and more people began to listen to radio programs, more popular entertainment programs were added. These included comedies, dramas, game shows, mysteries, soap operas, and shows for children.

Radio shows remained highly popular until the 1950s. That's when television began to catch on. And as it happens, television actually works in the same basic ways as radio does! It uses special equipment to send and receive pictures and sound in the form of electronic signals.

Today radio **technology** is used in many ways. Cordless telephones, cellular phones, and garage-door openers all use radio technology. And radio entertainment programs are still going strong.

LEARN MORE! READ THESE ARTICLES…
ELECTRICITY • TELEPHONES • TELEVISION

Answer: After World War I, radio grew from a two-way communication tool into a popular instrument for entertainment.

The World in a Box

The British Broadcasting Corporation (BBC) offered the first public television (TV) programming in 1936. But World War II stalled the development and popularity of the new invention.

In the United States TV didn't find much of an audience in the beginning. People preferred radio programs. Early TV was black and white, the pictures were small and fuzzy, and the sound wasn't great. But when the 1947 World Series of baseball was shown on TV, many Americans watched and afterward decided to buy TV sets.

SEARCH LIGHT

True or false? In the beginning most people weren't very interested in the new invention known as "television."

The first TV programs—mostly comedies, variety shows, soap operas, and dramas—were based on popular radio shows. Gradually, detective programs, game shows, sports programs, newscasts, movies, and children's shows joined the lineup.

TV networks—groups of stations linked together as a business—made money from TV programs by selling advertising time to various companies. Most networks still make their money from commercials.

Broadcast TV works much as radio does. Special equipment changes images and sound into electrical signals. These signals are sent through the air and received by individual **antennas**, which pass the signals on to the TV sets. There they are read and changed back into images and sound.

Color TV became popular about the mid-1960s, cable TV in the '70s, videocassette recorders (VCRs) in the '80s, and digital videodiscs (DVDs) in the '90s. That **decade** also saw the arrival of digital high-definition TV, with sharper, clearer images and better sound.

Earth-orbiting satellites have improved TV broadcasting. In fact, the only things that haven't changed much are the kinds of shows people watch and enjoy!

LEARN MORE! READ THESE ARTICLES…
ELECTRICITY • MOTION PICTURES • RADIO

Big-screen TV and video recording have made the viewing experience very different from TV's early days. Now we can watch ourselves on TV!
© Jose Luis Pelaez, Inc./Corbis

DID YOU KNOW?

All the first television shows were live—that is, you saw everything as it was happening. And if people made mistakes, you saw those too.

Answer: TRUE. Early TV had poor picture and sound quality, and people preferred to listen to radio and use their imaginations.

Looking to Nature for Remedies

Two visitors watched a jaguar fall off its tree limb and lie quietly on the ground. Their guide in this South American forest had brought the cat down with a blowgun dart tipped with curare. Made from certain trees in the jungle, curare **paralyzes** the muscles in the body.

When scientists heard about this remarkable poison, they experimented with it. Although large doses of curare are deadly, they found that tiny doses can help people relax during **surgery**.

Many years ago a doctor might have treated your stomachache with a medicine containing a pinch of gold dust, a spoonful of ashes of a dried lizard, 20 powdered beetles, some burned cat's hair, and two mashed onions!

Not all the old recipes for medicine were as bad as this. Usually medicines were made from tree bark and leaves, berries and seeds, roots, and flowers. Some "folk remedies" have no scientifically proven value, but many modern drugs have been developed from plants, animals, and **minerals**.

The photograph, for example, shows a common flower called "foxglove" whose leaves are used to make "digitalis," which helps people with heart disease. Pods of the opium poppy are used to make painkillers.

Not so long ago a very important medicine was discovered in moldy bread. This medicine, penicillin, and others like it are called "antibiotics." They help fight many diseases by killing **bacteria**.

Today most medicines are synthesized—that is, made from combinations of chemicals rather than from plants or animals. This method is much more **economical** and lets scientists create much larger supplies of important medicines.

SEARCH LIGHT

Find and correct the error in the following sentence: Many medicines today still come from the bark of animals.

DID YOU KNOW?

Deadly nightshade is a highly poisonous plant that was often used in small amounts as a medicine. The tomato is its close relative.

LEARN MORE! READ THESE ARTICLES…
NUCLEAR ENERGY • POLLUTION • TRANSPORTATION

Answer: Many medicines today still come from the bark of trees.

Exploring the Sky

The stars we see in the night sky look like little points of light. But they are vastly larger than they look. Almost all of them are much bigger than our Earth. The stars look tiny because they're so far away. If you rode in the fastest rocket for your entire life, you wouldn't make it even halfway to the nearest star.

Fortunately, telescopes let us explore the stars without leaving the Earth.

A simple telescope is tube-shaped and has a special kind of **magnifying** glass, called a "**lens**," at each end. Other telescopes use mirrors or both lenses and mirrors to enlarge the faraway view. Lenses and mirrors gather the light from an object, making it seem brighter and easier to see.

Telescopes make stars and planets seem closer. And telescopes let us see much farther than we normally can. Through a simple telescope you can see the rings of Saturn, as well as galaxies outside our own Milky Way. Giant telescopes on mountaintops can view objects much farther away and see with much greater detail. Their lenses and mirrors are often enormous and therefore enormously powerful.

Some modern telescopes don't even look like the ones most of us might look through. These devices, which must travel into space beyond the Earth's atmosphere, can sense light and other **radiation** that's invisible to unaided human eyes. These sensitive instruments, such as the Infrared Space Observatory and the Hubble Space Telescope (pictured here), have shown scientists such wonders as the dust in space between galaxies and the birth and death of stars.

DID YOU KNOW?

Special radio telescopes "listen" to the radio signals produced by stars, galaxies, and other objects. One group of radio telescopes in New Mexico, U.S., includes 27 "dish" antennas spread over 24 miles.

SEARCH LIGHT

Find and correct the error in the following sentence: Telescopes make faraway objects seem faster than they look with the unaided eye.

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Behind the Hubble Space Telescope, you can see the Earth's atmosphere outlined.
NASA

Answer: Telescopes make faraway objects seem closer than they look with the unaided eye.

G L O S S A R Y

antenna dish, rod, or wire for sending or receiving radio waves or other energy

bacterium (plural bacteria) tiny one-celled organism too small to see with the unaided eye

broadcast send out a program or message to a public group, usually by radio, television, or the Internet

canoe a small, light, and narrow boat having sharp front and back ends and moved by paddling

cartridge sealed container

convert change

conveyor belt a loop of material that can move objects from one worker or workstation to the next for the steps needed to make a product

countless too many to count

craft (noun) a skill or trade; (verb) to make skillfully, usually by hand

data factual information or details

decade ten-year period

device tool or piece of equipment

devise figure out, invent, or plan

domesticate tame

drawback problem or bad side

dwindle become smaller or less

economical cheap and efficient

edit cut down to a different or shorter version

fix in photography, to make an image lasting

fuse an electrical safety device

gear a toothed wheel that works as part of a machine

generate create or be the cause of

gesture movement of the body, arms, hands, or legs to express feelings or thoughts

glider a soaring aircraft similar to an airplane but without an engine

harness control, much as an animal may be hitched up and controlled by its harness

hull hard outer shell of a seed or a boat or ship

impaired damaged or limited

imperial having to do with an emperor or empire

implant (noun) object inserted within living tissue; (verb) insert securely or deeply

kerosene fuel for lanterns

lens (plural lenses) curved piece of glass that concentrates rays of light

locomotive railway vehicle that carries the engine that moves train cars along

lunar having to do with the Moon

magnify make something appear larger

manufacture make from raw materials, by hand or by machine

matter physical substance or material from which something is made

method way or system

microphone a device that changes sound to electrical signals, usually in order to record or send sound

mineral naturally occurring nonliving substance

oral having to do with the mouth

paralyze make someone or something unable to move

patent (verb) legally protect the rights to make, use, or sell an invention; (noun) document that legally protects the ownership and use of an invention

propeller a device that uses blades that fan outward from a central hub to propel (move) a vehicle, such as a boat or an airplane

pulp mashed-up pasty glop; fleshy material of a soft fruit

radiation energy sent out in the form of rays, waves, or particles

ray beam

recycle to pass used or useless material through various changes in order to create new useful products from it

refinery factory that treats crude petroleum and separates it into different parts

ritual a formal custom or ceremony, often religious

scholarship an award of money to help pay for a person's education

sensitive easily affected

smog dirty air, a word made by combining "**sm**oke" and "f**og**" to describe how the air looks

solar having to do with the Sun

spool reel for winding lengths of materials such as tape, thread, or wire

standard commonly accepted amount or number

storage space to keep or hold onto things

submerge put under water

superior better than

surgery a medical procedure or operation for treating a disease or condition

technology the theories and discoveries of science put into practice in actual actions, machines, and processes

telegraph a device for sending coded messages over long distances by using electrical signals

traditional usual; well known because of custom or longtime use

transmitter a device that sends messages or code

vehicle a device or machine used to carry something

waste materials that are unused or left over after some work or action is finished

I N D E X

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