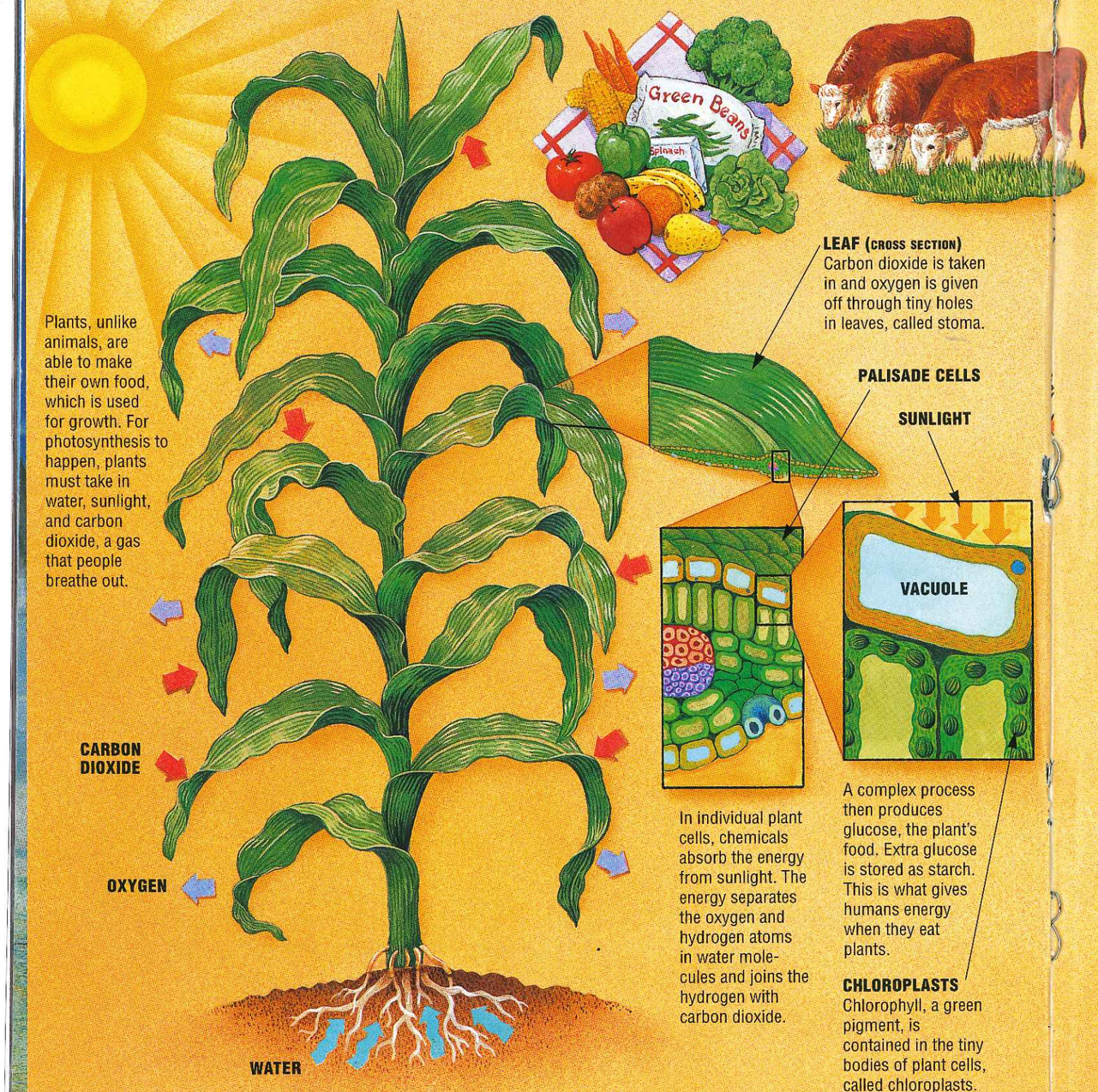
Muscle Power

What did you eat for breakfast today? Cereal and milk? Eggs and toast? Pancakes and sausage? Whatever it was, you were really consuming the sun's energy.

None of the food on earth would exist without the sun. Plants take in the sun's energy. Then people eat the plants, or they eat the flesh of animals that have eaten plants. One way or another, the sun's energy gets into us.

The sun's energy gets incorporated into food by a process called photosynthesis. The food's energy gets transferred to people by a process called digestion and absorption. Here's how it all happens.



Plants, unlike animals, are able to make their own food, which is used for growth. For photosynthesis to happen, plants must take in water, sunlight, and carbon dioxide, a gas that people breathe out.

In individual plant cells, chemicals absorb the energy from sunlight. The energy separates the oxygen and hydrogen atoms in water molecules and joins the hydrogen with carbon dioxide.

A complex process then produces glucose, the plant's food. Extra glucose is stored as starch. This is what gives humans energy when they eat plants.

CHLOROPLASTS
Chlorophyll, a green pigment, is contained in the tiny bodies of plant cells, called chloroplasts.

How does food give you energy? After you have chewed and swallowed food, it goes down your esophagus to your stomach, where it is churned into smaller pieces.

From there it passes into your small intestine for further churning.

CHECK IT OUT!
Why do marathon runners eat large quantities of pasta the day before a race?
(answer on back cover)

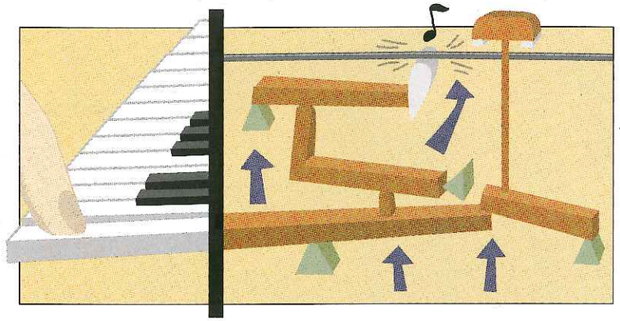
In the small intestine, finger-like projections called villi absorb sugar from the food and help it get into the bloodstream. Blood carries sugar to muscle cells where it is stored, ready to release energy.

Machines: Simple and Complex

Take a look around you. How many machines are you aware of? Perhaps you're sitting in a room with a computer. Maybe you can hear a dishwasher whirring in the kitchen. Possibly you can look out a window and see cars and buses passing by. All of these are machines—tools that help us make more efficient use of our energy. With them, we can do more work with less labor.

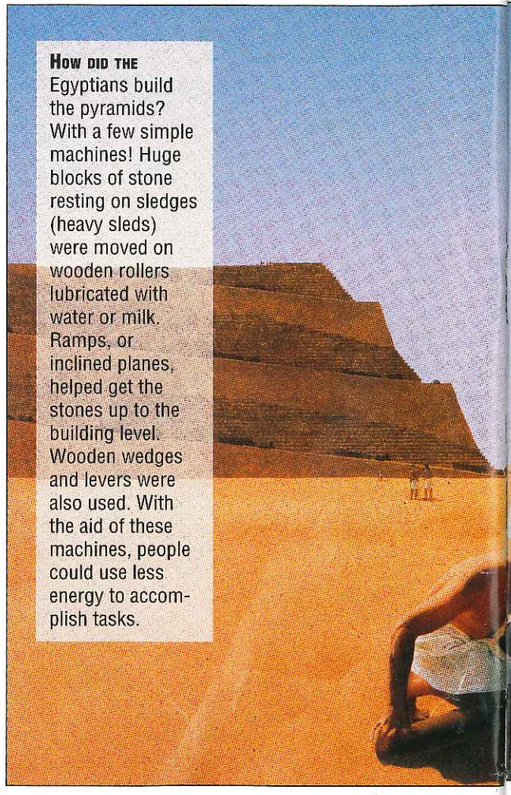
The earliest machines were quite simple, but very important. So important, that people still use them today. When you use nail clippers, scissors, or a bottle opener, you're using a simple tool called a lever.

In the last hundred years or so, machines have become more and more complex. Electric motors that lift elevators and operate vacuum cleaners and food processors, for example, operate not through the physical movement of gears, levers, and cogwheels but by the flow of electrical currents.



▲ People who take piano lessons know that getting sound out of a piano takes work, work that is accomplished by a series of levers. The levers transmit the energy from your fingertip to a felt-covered hammer, which strikes a wire that produces a sound.

▲ What household chore do you think this machine was supposed to make easier? Invented in 1888, it's a swinging way to wash your clothes. As the swing moved back and forth, the movement was transferred to two wooden bars. They transferred the motion to a metal fork, which activated a rod that turned the cleaning blades in the washtub. The energy comes from the swinger's muscle power.

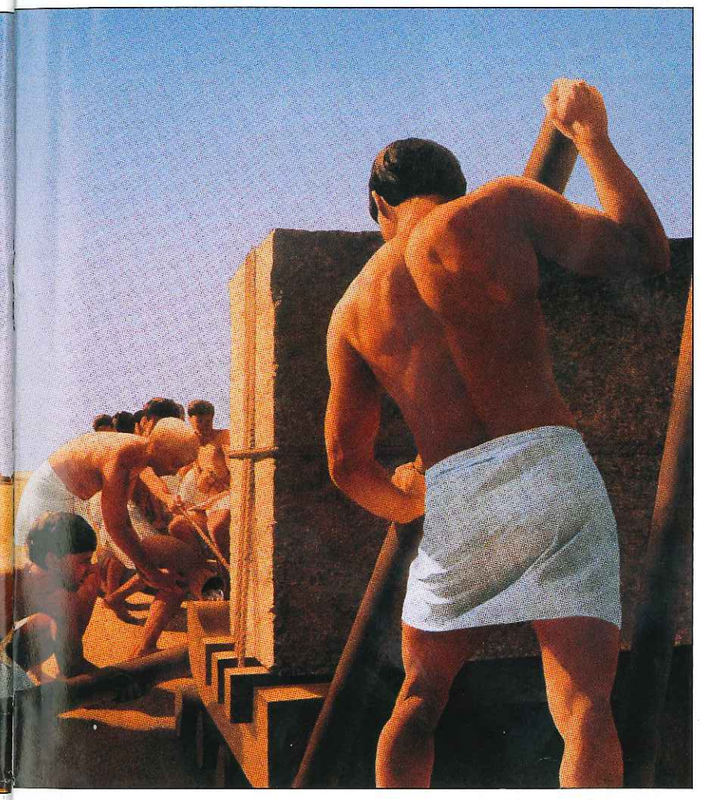


How did the Egyptians build the pyramids? With a few simple machines! Huge blocks of stone resting on sledges (heavy sleds) were moved on wooden rollers lubricated with water or milk. Ramps, or inclined planes, helped get the stones up to the building level. Wooden wedges and levers were also used. With the aid of these machines, people could use less energy to accomplish tasks.

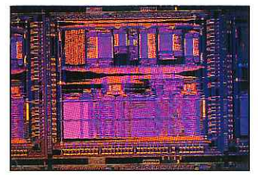
Think Piece!

What do you think is the most important machine ever invented? In other words, if you had to give up all but one machine, which would you keep?

▲ Imagine having a robot to clean your room, serve you a snack, drive you to school. It's not that far-fetched. A robot is simply a combination of a mechanical machine and a computer. Like a mechanical machine it has moveable parts. Like a computer it can be programmed to do specific tasks. The most advanced robots also have sensors that help them see, hear, and feel. Robots are used to perform repetitive tasks on factory assembly lines, deliver mail in offices, handle hazardous materials, and provide entertainment at family restaurants, saving energy that would have been used by people.



➤ Computers are labor-saving devices. However, they save brain power, rather than muscle power. By storing millions of bits of information in a tiny space (on a chip, right) and performing operations at top speed, computers free up human brains for things other than repetitive tasks.



➤ Is there any job that can't be made easier with electricity? We use it to light the dark, amplify our guitars, dry our hair, and on and on. But we pay a price. Much of our electricity is generated by burning fossil fuels, which pollute the air and which are quickly being used up. Scientists are busy devising energy-saving alternatives, including a microwave clothes dryer, which reduces drying time by 25 percent, and a dishwasher that cleans with sound waves, thus cutting down on hot water use.

Nikolaus August Otto (1832–1891) built the first four-cylinder engine, using the idea that energy is released when fuel is a vapor and is under pressure. His engine was the forerunner of later engines.

Save Your Energy!

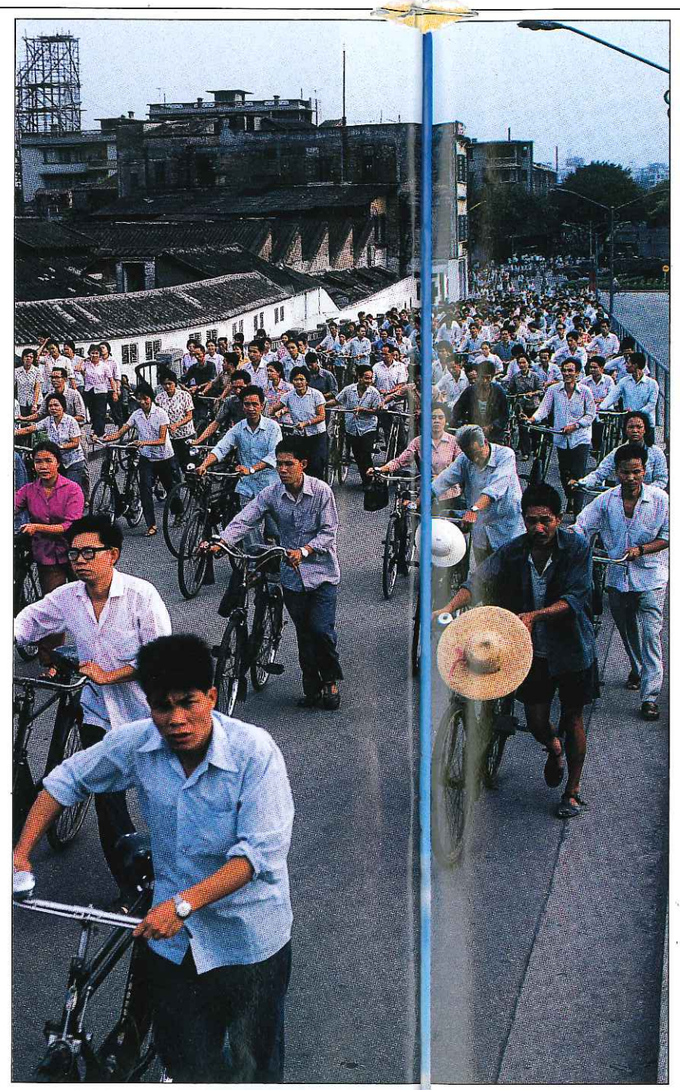
Why conserve energy? Because every known source of energy has its downside. Fossil fuels pollute and are in limited supply. Nuclear fission creates dangerous by-products. Nuclear fusion is still not practical. Solar collectors take up a lot of space. Wind farms are not very attractive. And building hydroelectric dams usually pushes people and animals out of their environment. So, it looks like energy conservation is the wise way to go. Here are some ways to use less energy.

▲ **These women of** The Fat of the Land Project try to save energy. They attempted to run their diesel-powered van across country on cooking oil! Along the way, they made pit stops at restaurants for used oil. Often they had to add diesel.

▲ **Want to get rid** of garbage and save money on fuel? Some towns burn their trash and use the resulting heat to power generators that produce electricity. Before the trash is burned, soil and material that will not burn are removed from the trash. The rest is burned for energy. In Cresswell, Pennsylvania, the electricity generated by burning garbage provides energy to 15,000 homes and earns the town $4,000 a week.

▲ **True or false?** Old tires are ugly and useless. Ugly, maybe. But not useless. A car tire contains the energy equivalent of about two and a half gallons of oil. Oxford Energy Company burns about 11 million tires a year in two power plants. The larger plant produces enough electricity for 15,000 people.

▼ **It's a bicycle.** It's a delivery truck. It's supercycle! Most people know that bicycles are a healthy and pollution-free alternative to cars—at least for short hauls. Now, a company called Human Powered Machines has made a 21-speed work bicycle that can carry 200 pounds of cargo. It's only as wide as its handlebars, so it can slip through traffic easily.



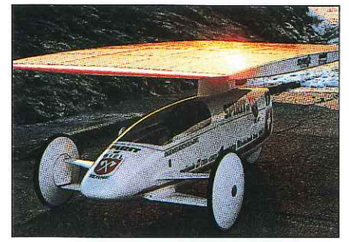
RIDDLE

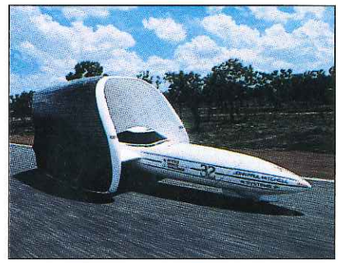
Why can't a bicycle stand by itself?
(answer on back cover)

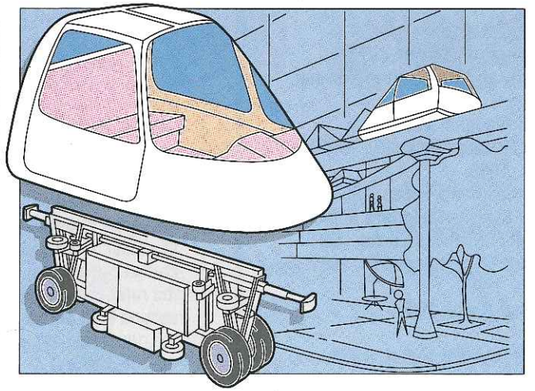
➤ **Why take a** fuel-guzzling plane when you could get there just as fast on a magnetic levitation train? Magnetic levitation simply means that the train, supported and propelled by a magnetic field, rides along on a cushion of air, cutting down on friction and thus using less energy. A model was clocked at a speed of 281 mph. Now the German government has committed itself to building the track for such a train between Germany's two largest cities. Supporters say it would cut a three-hour ride down to 66 minutes.

➤ **Is there a** battery-operated car in your future? Maybe. Early in 1994, General Motors tested its Impact, a car that runs on electricity, by loaning it out to test drivers throughout the country. The car can go about 55 miles before its batteries need to be recharged. Two weeks of driving should cost about $15 for electricity. Ask your parents how that compares with their gasoline costs.

➤ **In its time, the** gasoline-powered engine was a miracle machine, allowing people to get around more efficiently than ever before. But as oil reserves become depleted, people are searching for new ways to get around. Sun-powered cars may be one way. In 1986, a solar-powered car named Sunrider was driven from Greece to Portugal. Solar cars must be small and light, and they don't achieve great speed, but they can go long distances.







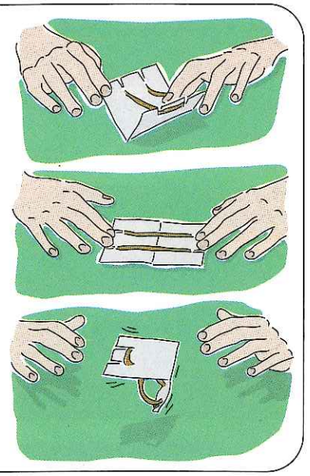
➤ **Replacing** private cars by public transportation saves energy, cuts down on pollution, and reduces city traffic jams. The problem is that a lot of people don't find it convenient enough. A group called Taxi 2000 wants to change all that with PRT (personal rapid transit). A model system is now being built near Chicago. In it, podlike cars holding one to four people and running swiftly along monorails will provide nonstop transportation from the rider's starting point to his or her destination.

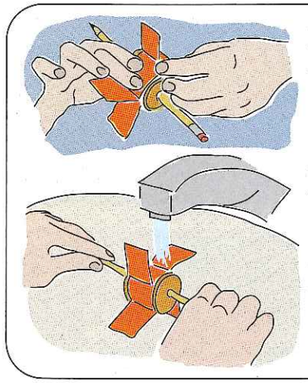
experimenting with ENERGY

Try these four simple activities to see some energy principles in action.

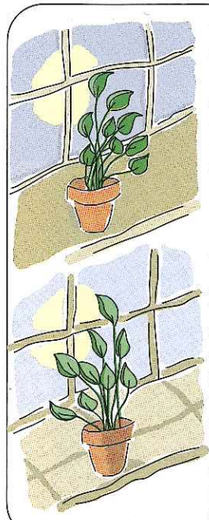
❶ Potential and Kinetic Energy
Fold a 3x5 inch index card in half horizontally so that it measures 3 x 2½ inches. On the 3-inch side that is not folded, cut two slits about an inch apart and an inch deep. Open the index card partway. Loop a rubber band through the four slits. With your fingers, flatten out the index card. Then let go of it. Notice what happens.

When you hold the card flat with your hand, you are using energy. Some of that energy is stored as potential energy in the rubber band. When you let go of the card, that potential energy is released and becomes the kinetic energy that moves the card.

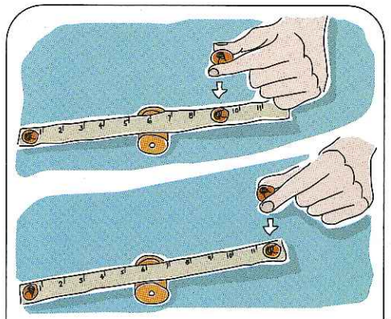




❷ Make Your Own Waterwheel
You'll need an empty thread spool, a pencil or knitting needle that will fit through the center of the spool loosely, some thin cardboard, and glue. Cut four pieces of cardboard about 1½ inches by 1 inch. These are the blades of the waterwheel. Fold each one in half and glue half of it to the spool. Put the pencil or knitting needle through the center of the spool and hold your "waterwheel" under gently running water. The water will turn the wheel.



❸ Phototropism in Action
If you have plants at home, you can see their efforts to soak up the sun's energy. In the morning, turn the plants so their leaves face away from the window. At night, notice where the leaves are facing. Watch different plants for several days. Do they all turn at the same rate? How long does it take each one to turn its leaves toward the sun?



❹ Using a Simple Machine
A lever is one of the simplest ways to lift objects with less effort. Here is a trick to see where to push on a lever to get the most energy for the least effort. Put an empty spool of thread under the middle of a ruler. Put a coin at one end of the ruler. Drop a second coin onto the other side of the ruler so that it hits the ruler about three inches from the middle. Notice how high the first coin goes into the air. Then do the same thing again, but drop the second coin close to the end of the ruler. Be sure to drop it from the same height as before. How high does the first coin jump this time? Where should you apply force to get the most work from a lever?

MORE READINGS ON ENERGY

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Graham Rickard, *Solar Energy,* Gareth Stevens Children's Books, 1991.
Graham Rickard, *Wind Energy,* Gareth Stevens Children's Books, 1991.
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Adult Books

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ENERGETIC ACROSTIC

Fill in the blanks with the answers to each clue. The letters in the suns spell the name of the first sun-powered airplane.

1. Source of most of earth's energy (It's big and very hot.) ___ ___ ___
2. Particle source of nuclear energy ___ ___ ___ ___
3. Electromagnetic radiation (Opposite of dark.) ___ ___ ___ ___ ___
4. Labor-saving device (A dishwasher is one.) ___ ___ ___ ___ ___ ___ ___
5. Visible spectrum ("Somewhere over the _____.") ___ ___ ___ ___ ___ ___ ___
6. Thinking machine (It can play chess with you.) ___ ___ ___ ___ ___ ___ ___ ___
7. Glucose stored in plants (It is found in spaghetti—and on some shirt collars!) ___ ___ ___ ___ ___ ___
8. Kind of energy produced by boiling water (Rhymes with beam.) ___ ___ ___ ___ ___
9. This kind of light causes sunburn ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
10. Stored energy ___ ___ ___ ___ ___ ___ ___ ___
11. Energy in motion ___ ___ ___ ___ ___ ___ ___
12. Name of first sun-powered car ___ ___ ___ ___ ___ ___ ___ ___
13. The ability to get work done (Some days you have lots of it.) ___ ___ ___ ___ ___ ___
14. The energy of moving molecules and atoms (It comes from a radiator.) ___ ___ ___ ___
15. A machine that can look like a person ___ ___ ___ ___ ___

The letters in the suns spell ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

ROOTING FOR ROOTS

Several words in this issue have Greek roots, which are used to form many other words. Read the roots and their meanings below. Then match the words containing the roots in Column A with their definitions in Column B. Greek roots: photo–light; micro–small; hydro–water; thermo–heat; geo–the earth; bio–life.

Column A	Column B
____ **1.** phototropism	**a.** device for regulating temperature
____ **2.** microscopic	**b.** study of life and living things
____ **3.** hydroponics	**c.** movement of a plant toward light
____ **4.** thermostat	**d.** study of the physical nature of earth
____ **5.** geology	**e.** science of growing plants in water rather than soil
____ **6.** biology	**f.** invisible to the naked eye