Section 1

Fossil Fuels

Reading Preview

Key Concepts

- How do fuels provide energy?
- What are the three major fossil fuels?
- Why are fossil fuels considered nonrenewable resources?

Key Terms

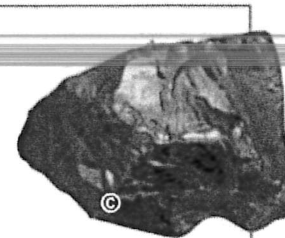
- fuel • energy transformation
- combustion • fossil fuel
- hydrocarbon • petroleum
- refinery • petrochemical

Target Reading Skill

Building Vocabulary Using a word in a sentence helps you think about how best to explain the word. After you read the section, reread the paragraphs that contain definitions of key terms. Use all the information you have learned to write a meaningful sentence using each key term.

Lab zone Discover **Activity**

What's in a Piece of Coal?



1. Observe a chunk of coal. Record your observations in as much detail as possible, including its color, texture, and shape.
2. Now use a hand lens to observe the coal more closely.
3. Examine your coal for fossils—imprints of plant or animal remains.

Think It Over

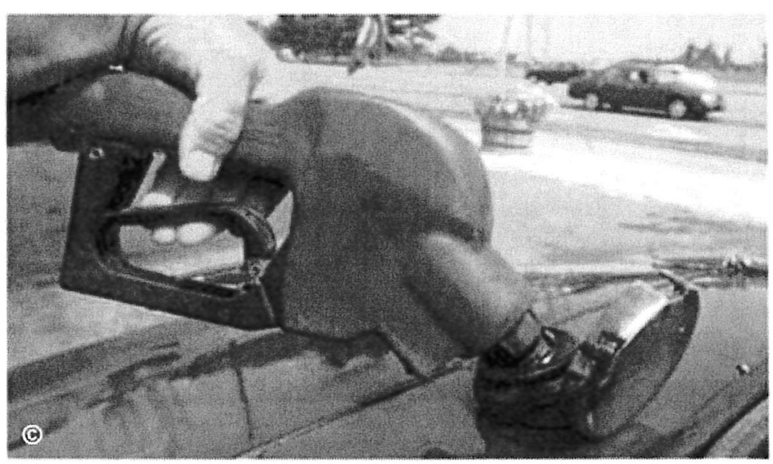
Observing What did you notice when you used the hand lens compared to your first observations? What do you think coal is made of?

How did you travel to school today? Whether you traveled in a car or a bus, walked, or rode your bike, you used some form of energy. The source of that energy was a fuel. A **fuel** is a substance that provides energy—such as heat, light, motion, or electricity—as the result of a chemical change.

Energy Transformation and Fuels

Rub your hands together quickly for several seconds. Did they become warmer? When you moved your hands, they had mechanical energy, the energy of motion. The friction of your hands rubbing together converted the mechanical energy to thermal energy, which you felt as heat. A change from one form of energy to another is called an **energy transformation,** or an energy conversion.

Gasoline is a fossil fuel. ▶



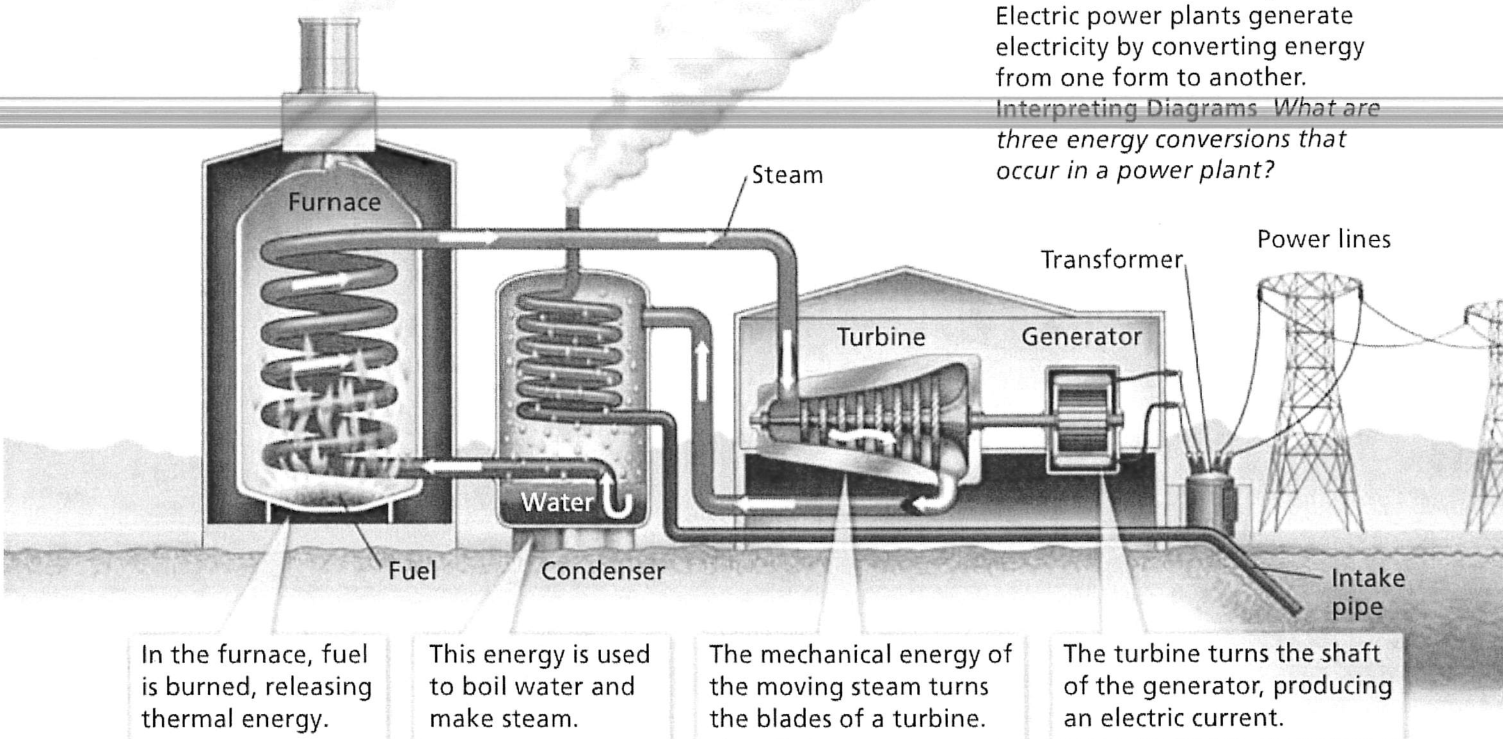


FIGURE 1
Production of Electricity
Electric power plants generate electricity by converting energy from one form to another.
Interpreting Diagrams *What are three energy conversions that occur in a power plant?*

Combustion Fuels contain stored chemical energy, which can be released by **combustion,** or burning. **When fuels are burned, the chemical energy that is released can be used to generate another form of energy, such as heat, light, motion, or electricity.** For example, when the gasoline in a car's engine is burned, it undergoes a chemical change. Some of the chemical energy stored in the gasoline is converted into thermal energy. This thermal energy is then converted to mechanical energy that moves the car.

Production of Electricity The chemical energy stored in fuels can be used to generate electricity. In an electric power plant, the thermal energy produced by burning fuel is used to boil water, making steam, as shown in Figure 1. The mechanical energy of the steam then turns a turbine. The turbine is connected to a generator, which consists of powerful magnets surrounded by coils of copper wire. As the magnets turn inside the wire coil, an electric current is produced. This current flows through power lines to homes and industries.

Reading Checkpoint What energy transformations occur in a car's engine?

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For: Links on fossil fuels
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Lab zone Skills Activity

Graphing

Use the data in the table below to make a circle graph showing the uses of energy in the United States. (To review circle graphs, see the Skills Handbook.)

End Use of Energy	Percent of Total Energy
Transportation	26.5
Industry	38.1
Homes and businesses	35.4

What Are Fossil Fuels?

Most of the energy used today comes from organisms that lived hundreds of millions of years ago. As these plants, animals, and other organisms died, their remains piled up. Layers of sand, rock, and mud buried the dead organisms. Over time, heat and the pressure of sediments changed the material into other substances. **Fossil fuels** are the energy-rich substances formed from the remains of organisms. **The three major fossil fuels are coal, oil, and natural gas.**

Fossil fuels are made of hydrocarbons. **Hydrocarbons** are chemical compounds that contain carbon and hydrogen atoms. During combustion, the carbon and hydrogen atoms combine with oxygen from the air to form carbon dioxide and water. Combustion releases energy in the forms of heat and light.

The combustion of fossil fuels provides more energy per kilogram than does the combustion of other fuels. One kilogram of coal, for example, can provide twice as much energy as one kilogram of wood. Oil and natural gas can provide three times as much energy as an equal mass of wood.

Reading Checkpoint What are hydrocarbons?

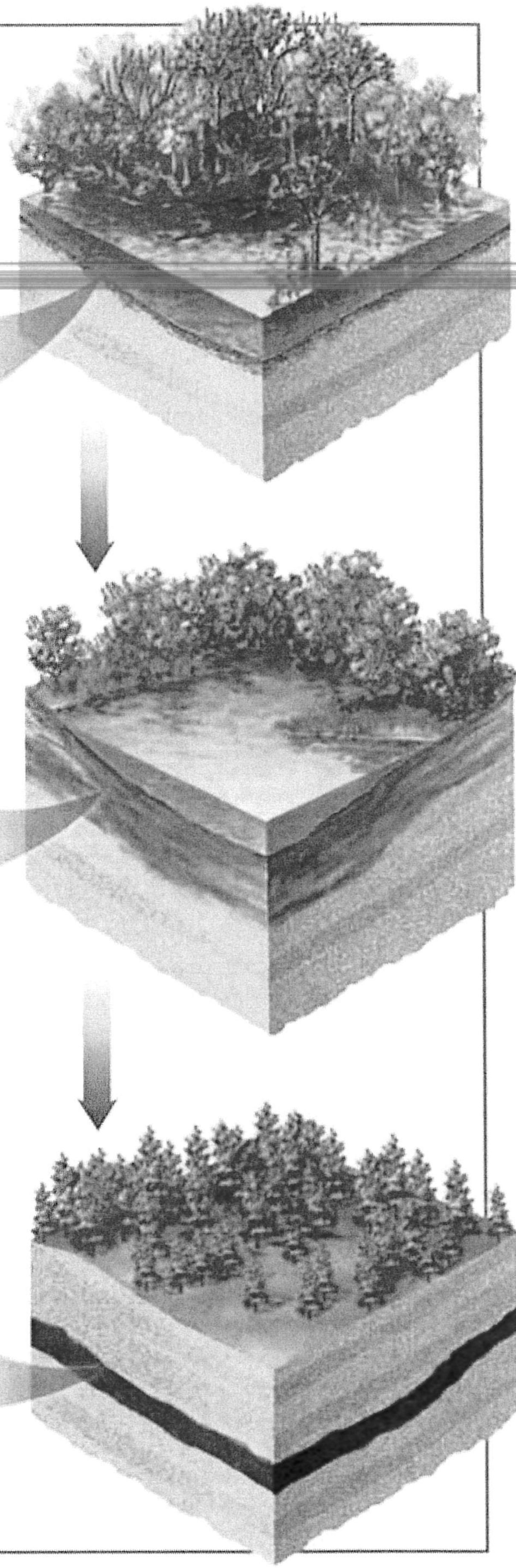
Coal Coal is a solid fossil fuel formed from plant remains. Figure 2 shows the process by which coal forms. People have burned coal to produce heat for thousands of years. Wood was more convenient and cheaper than coal for most people until the Industrial Revolution of the 1800s, however. The huge energy needs of growing industries then made it worthwhile to find, mine, and transport coal. Today, coal makes up about 23 percent of the fuel used in the United States. Most of that coal fuels electrical power plants.

Before coal can be used to produce energy, it has to be mined, or removed from the ground. Miners use machines to chop the coal into chunks and lift it to the surface. Coal mining can be a dangerous job. Thousands of miners have been killed or injured in accidents in the mines. Many more suffer from lung diseases. Fortunately, modern safety procedures and better equipment have made coal mining safer.

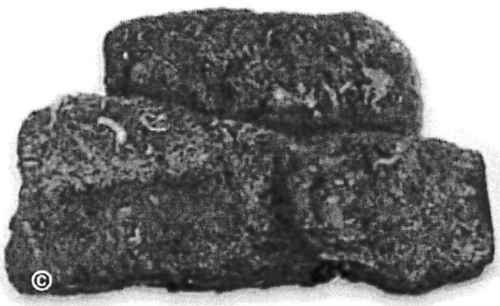
Coal is the most plentiful fossil fuel in the United States. It is fairly easy to transport and provides a lot of energy when burned. But coal also has some disadvantages. Coal mining can increase erosion. Runoff from coal mines can cause water pollution. Burning most types of coal results in more air pollution than other fossil fuels. And coal mining can be dangerous.

FIGURE 2
Coal Formation

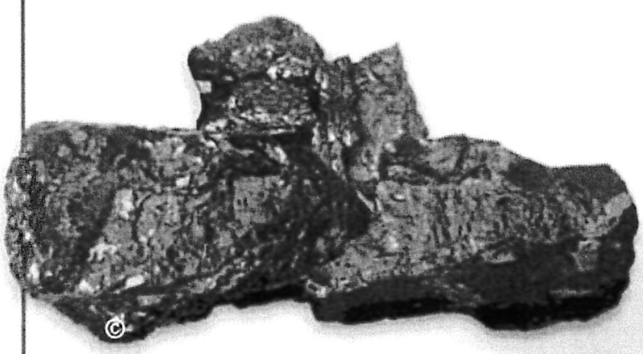
Coal is formed from the remains of trees and other plants that grew in swamps hundreds of millions of years ago. Relating Diagrams and Photos *What are two ways that peat and coal differ?*



Decomposing Plant Matter
When swamp plants die, their decomposing remains build up.

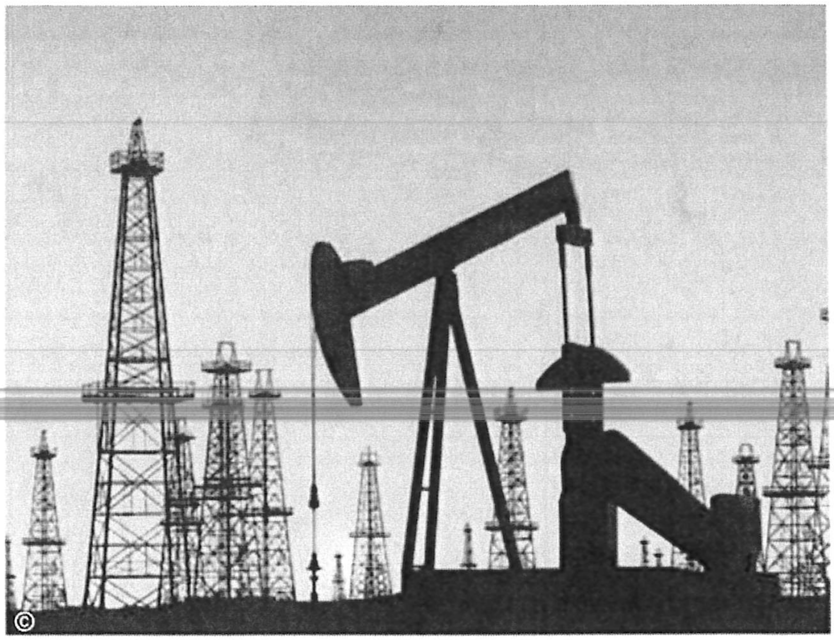


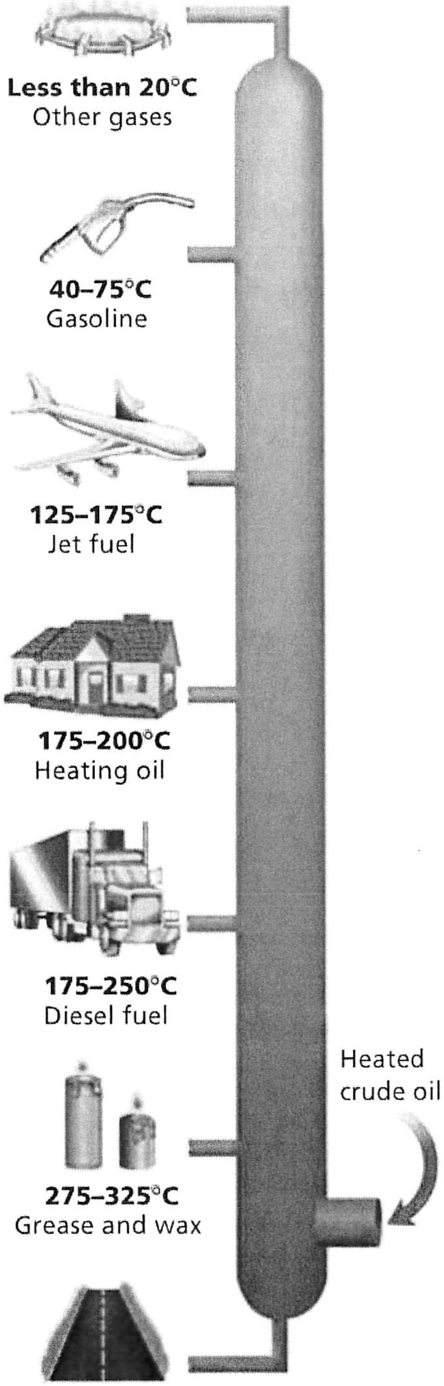
Peat
Over time, plant remains pile up and form peat. Peat can be burned as fuel.



Coal
Under increasing pressure from sediments, peat is compacted. Eventually, peat becomes coal. Coal is a more efficient fuel than peat.

FIGURE 3
Oil Production
Crude oil is first pumped out of the ground and then refined. In the refining process, crude oil is heated and separated to make different products.





Oil Oil is a thick, black, liquid fossil fuel. It formed from the remains of small animals, algae, and other organisms that lived in oceans and shallow inland seas hundreds of millions of years ago. **Petroleum** is another name for oil, from the Latin words *petra* (rock) and *oleum* (oil). Petroleum accounts for more than one third of the energy produced in the world. Fuel for most cars, airplanes, trains, and ships comes from petroleum. In addition, many homes are heated by oil.

Most oil deposits are located underground in tiny holes in sandstone or limestone. The oil fills the holes somewhat like the way water fills the holes of a sponge. Because oil deposits are usually located deep below the surface, finding oil is difficult. Scientists can use sound waves to test an area for oil. Even using this technique, however, only about one out of every six wells drilled produces a usable amount of oil.

When oil is first pumped out of the ground, it is called crude oil. To be made into useful products, crude oil must undergo a process called refining. A factory in which crude oil is heated and separated into fuels and other products is called a **refinery**. In Figure 3, you can see some of the products made by refining crude oil. Many other products you use every day are also made from crude oil. **Petrochemicals** are compounds that are made from oil. Petrochemicals are used to make plastics, paints, medicines, and cosmetics.

Reading Checkpoint **What is a refinery?**

Natural Gas Natural gas is a mixture of methane and other gases. Natural gas forms from some of the same organisms as oil. Because it is less dense than oil, natural gas often rises above an oil deposit, forming a pocket of gas in the rock.

Pipelines transport natural gas from its source to the places where it is used. If all the gas pipelines in the United States were connected, they would reach to the moon and back—twice! Natural gas can also be compressed into a liquid and stored in tanks as fuel for trucks and buses.

Natural gas has several advantages. It produces large amounts of energy but lower levels of many air pollutants than coal or oil. It is also easy to transport once the network of pipelines is built. One disadvantage of natural gas is that it is highly flammable. A gas leak can cause a violent explosion and fire.

Gas companies help to prevent dangerous explosions from leaks. If you use natural gas in your home, you probably are familiar with the "gas" smell that alerts you whenever there is unburned gas in the air. You may be surprised to learn that natural gas actually has no odor at all. What causes the strong smell? Gas companies add a chemical with a distinct smell to the gas before it is piped to homes and businesses so that people can detect a gas leak.

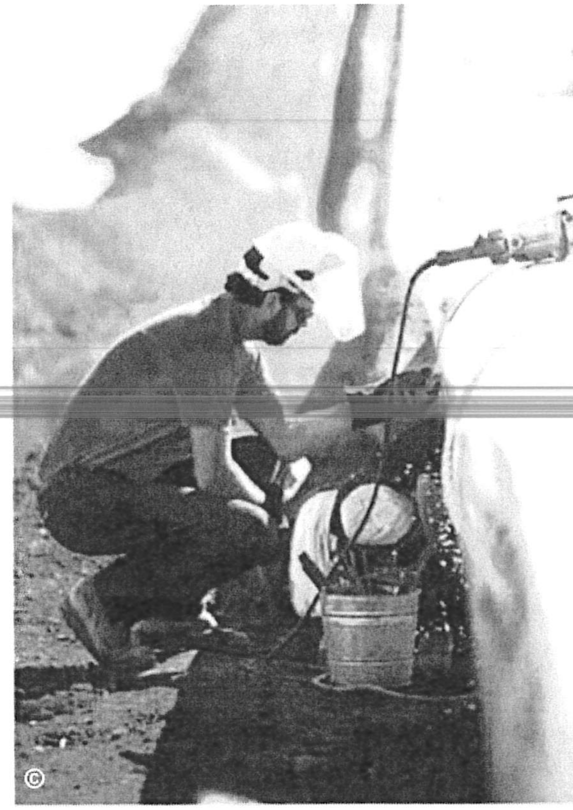


FIGURE 4
Natural Gas Pipelines
More than 2,500,000 kilometers of natural gas pipelines run underground in the United States. Here, a technician prepares a new section of pipe.

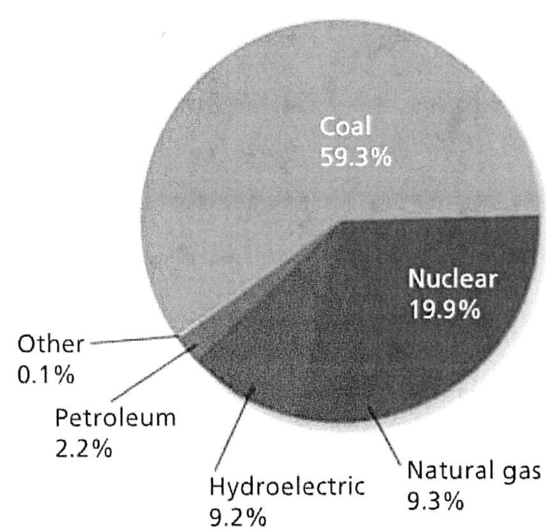
Math Analyzing Data

Fuels and Electricity

The circle graph shows which energy sources are used to produce electricity in the United States.

1. **Reading Graphs** What does each wedge of the circle represent?
2. **Interpreting Data** Which energy source is used to generate most of the electricity in the United States?
3. **Drawing Conclusions** What percentage of the electricity production in the United States relies on fossil fuels?
4. **Predicting** How might the circle graph differ 50 years from now? Give reasons to support your prediction.

United States Electricity Production by Energy Source



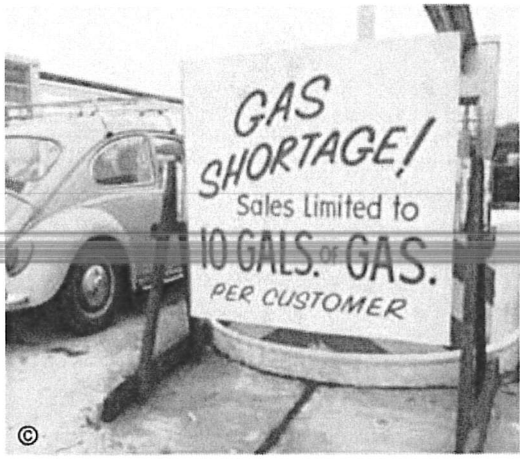


FIGURE 5
Supply and Demand
In the 1970s, a group of oil-exporting nations reduced their oil exports to the United States. Gasoline shortages resulted.

Fuel Supply and Demand

Fuels are natural resources. As natural resources, fuels can be classified as either renewable or nonrenewable. Renewable resources are either always available or are naturally replaced in a short time. Nonrenewable resources cannot be replaced in a useful time frame.

The many advantages of using fossil fuels as an energy source have made them essential to modern life. **But since fossil fuels take hundreds of millions of years to form, they are considered nonrenewable resources.** For example, Earth's known oil reserves took 500 million years to form. One fourth of this oil has already been used. If fossil fuels continue to be used more rapidly than they are formed, the reserves will eventually be used up.

Many nations that consume large amounts of fossil fuels have very small reserves. They have to buy oil, natural gas, and coal from nations with large supplies. The United States, for example, uses about one third of all the oil produced in the world. But only 3 percent of the world's oil supply is located in this country. The difference must be purchased from countries with large oil supplies. The uneven distribution of fossil fuel reserves has often been a cause of political problems in the world.

Reading Checkpoint **Why are some nations dependent on others for fossil fuels?**

Section 1 Assessment

Vocabulary Skill Prefixes How does knowing the meaning of the prefix *hydro-* help you remember what happens to hydrocarbons during combustion?

Reviewing Key Concepts

HINT
1. a. Defining What is a fuel?

HINT
b. Explaining How do fuels provide energy?

HINT
c. Sequencing Describe in order the energy transformations that occur in the production of electricity at a power plant.

HINT
2. a. Listing What are the three main fossil fuels?

HINT
b. Comparing and Contrasting List an advantage and a disadvantage of each fossil fuel discussed in this section.

HINT
c. Making Judgments Suppose you were designing a new power plant that would burn fossil fuel to generate electricity. Which fossil fuel would you recommend? Give two reasons for your answer.

3. a. Reviewing Why are fossil fuels considered nonrenewable resources? HINT

b. Problem Solving List three things you can do to reduce your dependence on fossil fuels. HINT

Lab zone At-Home Activity

Heating Fuel Pros and Cons Talk to an adult family member to find out what type of fuel heats or cools your home. Then, with the family member, list some advantages and disadvantages of that type of fuel. Share what you learned with your classmates. What fuel source is used by the majority of students in your class?

Section 2 · Tech & Design ·

Renewable Sources of Energy

Reading Preview

Key Concepts

- What forms of energy does the sun provide?
- What are some renewable sources of energy?

Key Terms

- solar energy
- hydroelectric power
- biomass fuel
- gasohol
- geothermal energy

Target Reading Skill

Previewing Visuals Before you read, preview Figure 7. Then write two questions that you have about the diagram in a graphic organizer like the one below. As you read, answer your questions.

Solar House

Q.	How does the house capture solar energy?
A.	
Q.	

Lab zone Discover Activity

Can You Capture Solar Energy?

1. Pour 250 milliliters of water into each of two resealable, clear plastic bags.
2. Record the water temperature in each bag. Seal the bags.
3. Put one bag in a dark or shady place. Put the other bag in a place where it will receive direct sunlight.
4. Predict what the temperature of the water in each bag will be after 30 minutes.
5. Record the temperatures after 30 minutes.

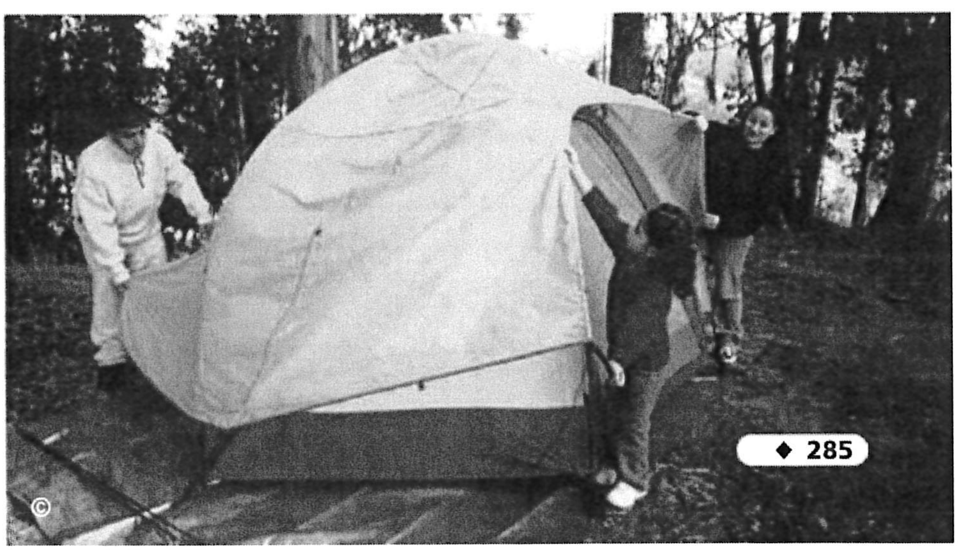
Think It Over

Developing Hypotheses How did the water temperature in each bag change? What could account for these results?

You've just arrived at the campsite for your family vacation. The sun streaming through the trees warms your face. A breeze stirs, carrying with it the smell of a campfire. Maybe you'll start your day with a dip in the warm water of a nearby hot spring.

You might be surprised to learn that even in these woods, you are surrounded by energy resources. The sun warms the air, the wind blows, and heat from inside Earth warms the waters of the spring. These sources of energy are all renewable—they are constantly being supplied. Scientists are trying to find ways to put these renewable energy resources to work to meet people's energy needs.

Campers surrounded by renewable resources ▶



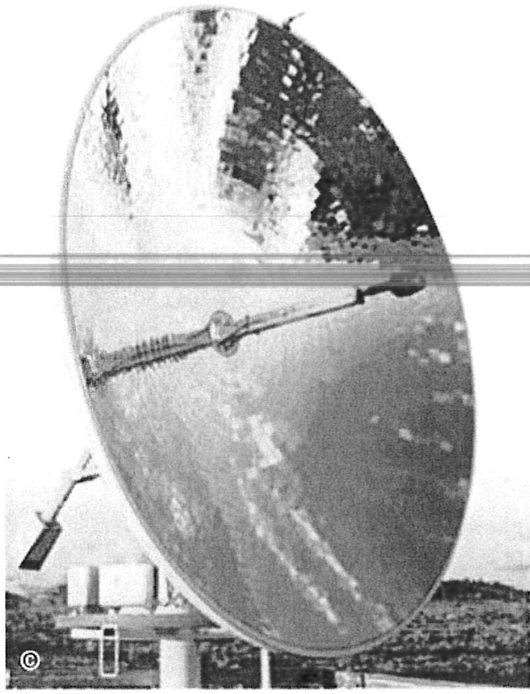


FIGURE 6
Solar Collector
This mirror collects energy from the sun and powers an electric plant in New South Wales, Australia. Inferring *Why is the Australian desert a practical location for a solar power plant?*

Harnessing the Sun's Energy

The warmth you feel on a sunny day is **solar energy**, or energy from the sun. **The sun constantly gives off energy in the forms of light and heat.** Solar energy is the source, directly or indirectly, of most other renewable energy resources. In one day, Earth receives enough solar energy to meet the energy needs of the entire world for 40 years. Solar energy does not cause pollution, and it will not run out for billions of years.

So why hasn't solar energy replaced energy from fossil fuels? One reason is that solar energy is only available when the sun is shining. Another problem is that the energy Earth receives from the sun is very spread out. To obtain a useful amount of power, it is necessary to collect solar energy from a large area.

Solar Power Plants One way to capture the sun's energy involves using giant mirrors. In a solar power plant, rows of mirrors focus the sun's rays to heat a tank of water. The water boils, creating steam, which can then be used to generate electricity.

Solar Cells Solar energy can be converted directly into electricity in a solar cell. A solar cell has a negative and a positive terminal, like a battery. When light hits the cell, an electric current is produced. Solar cells power some calculators, lights, and other small devices. However, it would take more than 5,000 solar cells the size of your palm to produce enough electricity for a typical American home.

Passive Solar Heating Solar energy can be used to heat buildings with passive solar systems. A passive solar system converts sunlight into thermal energy, which is then distributed without using pumps or fans. Passive solar heating is what occurs in a parked car on a sunny day. Solar energy passes through the car's windows and heats the seats and other car parts. These parts transfer heat to the air, and the inside of the car warms. The same principle can be used to heat a home.

Active Solar Heating An active solar system captures the sun's energy, and then uses pumps and fans to distribute the heat. First, light strikes the dark metal surface of a solar collector. There, it is converted to thermal energy. Water is pumped through pipes in the solar collector to absorb the thermal energy. The heated water then flows to a storage tank. Finally, pumps and fans distribute the heat throughout the building.

Reading Checkpoint **How do solar cells work?**

Discovery Channel School
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Video Preview
▶ Video Field Trip
Video Assessment

FIGURE 7

Solar House

A solar house uses passive and active heating systems to convert solar energy into heat and electricity.

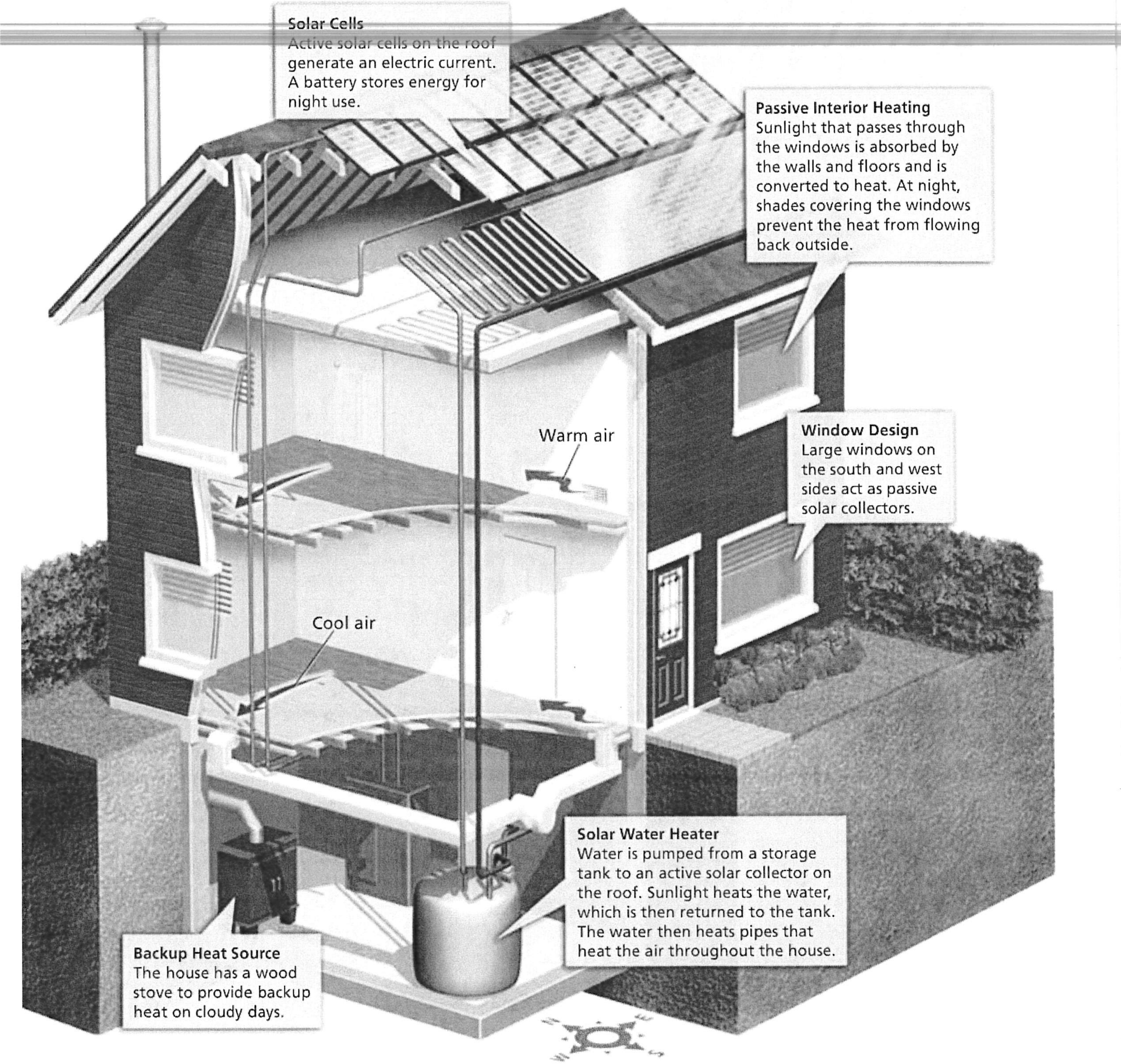
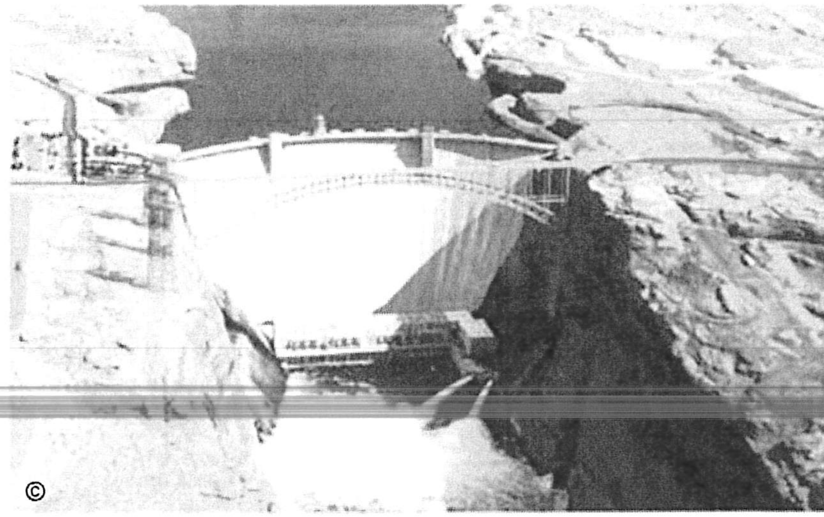
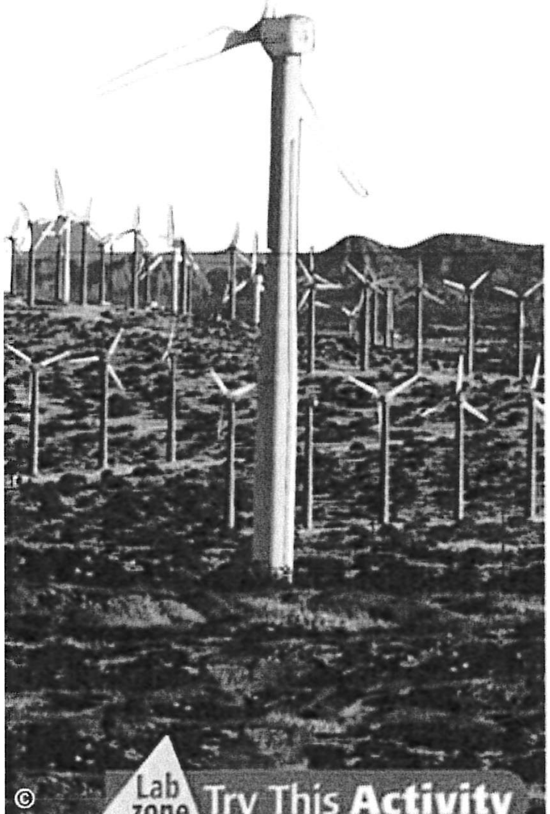


FIGURE 8
Water and Wind Power
Both this dam in Arizona and this wind farm in California use renewable sources of energy to generate power.





Hydroelectric Power

The sun is one source of renewable energy. **Other renewable sources of energy include water, the wind, biomass fuels, geothermal energy, and hydrogen.**

Solar energy is the indirect source of water power. Recall that in the water cycle, energy from the sun heats water on Earth's surface, forming water vapor. The water vapor condenses and falls back to Earth as rain and snow. As the water flows over the land, it provides another source of energy.

Hydroelectric power is electricity produced by flowing water. A dam across a river blocks the flow of water, creating a body of water called a reservoir. When a dam's control gates are opened, water flows through tunnels at the bottom of the dam. As the water moves through the tunnels, it turns turbines, which are connected to a generator.

Today, hydroelectric power is the most widely used source of renewable energy. Unlike solar energy, flowing water provides a steady supply of energy. Once a dam and power plant are built, producing electricity is inexpensive and does not create air pollution. But hydroelectric power has limitations. In the United States, most suitable rivers have already been dammed. And dams can have negative effects on the environment.

Reading Checkpoint **What is hydroelectric power?**

Lab zone **Try This Activity**

Blowing in the Wind

You can make a model that shows how wind can do the work necessary to produce energy. Using a pinwheel and other materials, construct a device that lifts a small object when the wind blows. Then use a fan to test your device.

Making Models What parts of a wind power plant do the fan and pinwheel represent?

Capturing the Wind

Like water power, wind energy is also an indirect form of solar energy. The sun heats Earth's surface unevenly. As a result of this uneven heating, different areas of the atmosphere have different temperatures and air pressures. The differences in pressure cause winds as air moves from one area to another.

Wind can be used to turn a turbine and generate electricity. Wind farms consist of many windmills. Together, the windmills generate large amounts of power.

Wind is the fastest-growing energy source in the world. Wind energy does not cause pollution. In places where fuels are difficult to transport, wind energy is the major source of power.

But wind energy has drawbacks. Few places have winds that blow steadily enough to provide much energy. Wind energy generators are noisy and can be destroyed by very strong winds. Still, as fossil fuels become more scarce, wind energy will become more important.

FIGURE 9
Biomass Fuels
Biomass fuels are fuels that are made from living things.
Comparing and Contrasting *How are biomass fuels similar to energy sources such as wind and water? How are they different?*

Biomass Fuels

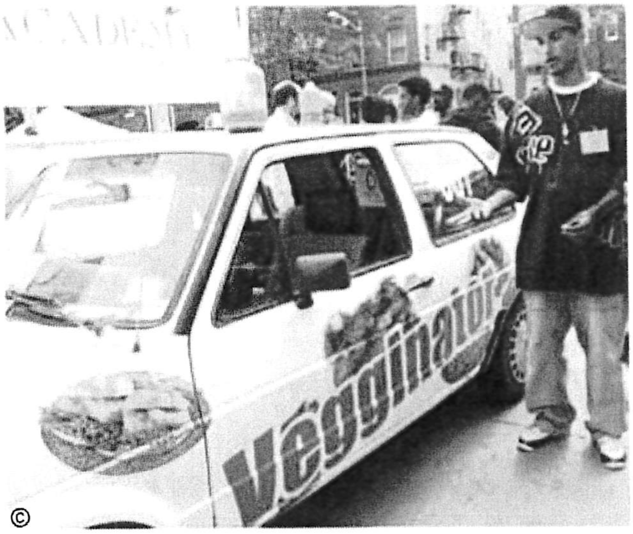
Wood was probably the first fuel ever used for heat and light. Wood belongs to a group of fuels called **biomass fuels,** which are made from living things. Other biomass fuels include leaves, food wastes, and even manure. As fossil fuel supplies shrink, people are taking a closer look at biomass fuels. For example, when oil prices rose in the early 1970s, Hawaiian sugar cane farmers began burning sugar cane wastes to generate electricity. At one point, these wastes provided almost one fourth of the electricity used on the island of Kauai.

Aside from being burned as fuel, biomass materials can also be converted into other fuels. For example, corn, sugar cane, and other crops can be used to make alcohol. Adding the alcohol to gasoline forms a mixture called **gasohol.** Gasohol can be used as fuel for cars. Bacteria can produce methane gas when they decompose biomass materials in landfills. That methane can be used to heat buildings. And some crops, such as soybeans, can produce oil that can be used as fuel, which is called biodiesel fuel.

Biomass fuels are renewable resources. But it takes time for new trees to replace those that have been cut down. And producing alcohol and methane in large quantities is expensive. As a result, biomass fuels are not widely used today in the United States. But as fossil fuels become scarcer, biomass fuels may play a larger role in meeting energy needs.

Reading Checkpoint **What is gasohol?**

▲ A woman uses a wood-fired oven in Nepal.



▲ This car runs on vegetable oil.

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Tapping Earth's Energy

Below Earth's surface are pockets of very hot liquid rock called magma. In some places, magma is very close to the surface. The intense heat from Earth's interior that warms the magma is called **geothermal energy.**

In certain regions, such as Iceland and New Zealand, magma heats underground water to the boiling point. In these places, the hot water and steam can be valuable sources of energy. For example, in Reykjavík, Iceland, 90 percent of homes are heated by water warmed underground in this way. Geothermal energy can also be used to generate electricity, as shown in Figure 10.

Geothermal energy is an unlimited source of cheap energy. But it does have disadvantages. There are only a few places where magma comes close to Earth's surface. Elsewhere, very deep wells would be needed to tap this energy. Drilling deep wells is very expensive. Even so, geothermal energy is likely to play a part in meeting energy needs in the future.

Reading Checkpoint **How can geothermal energy be used to generate electricity?**

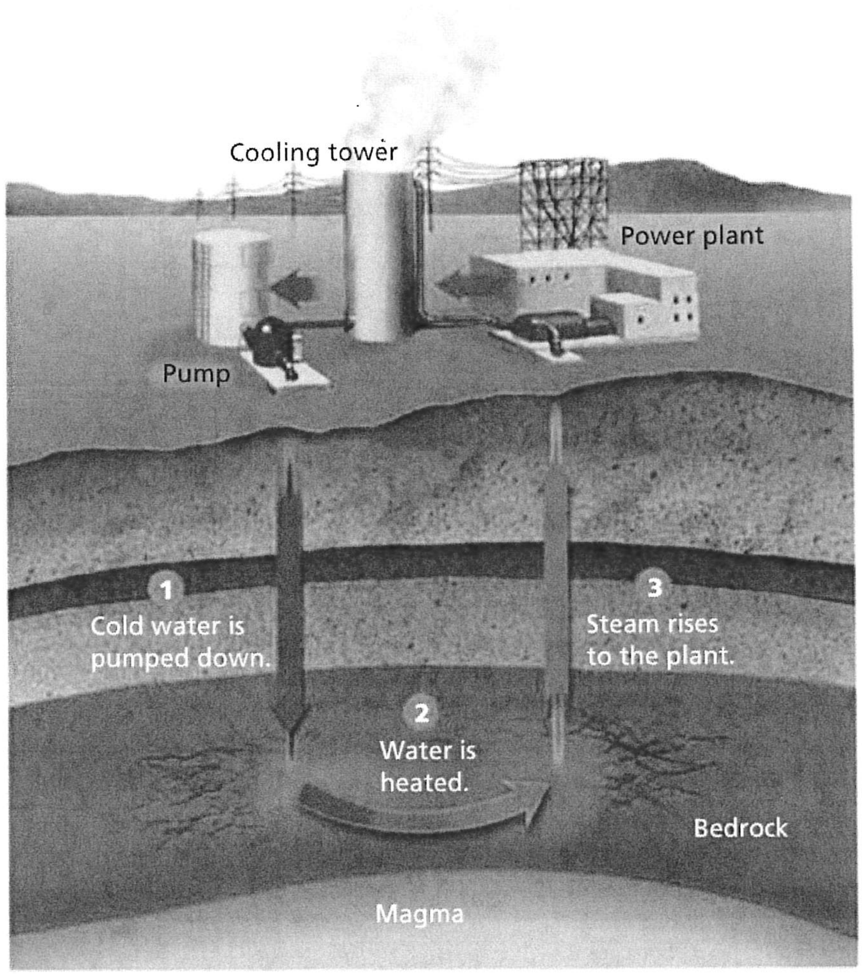


FIGURE 10
Geothermal Energy
A geothermal power plant uses heat from Earth's interior as an energy source. Cold water is piped deep into the ground, where it is heated by magma. The resulting steam can be used for heat or to generate electricity.
Making Generalizations *What is one advantage and one disadvantage of geothermal energy?*

The Promise of Hydrogen Power

Now that you have read about so many energy sources, consider a fuel with this description: It burns cleanly. It creates no smog or acid rain. It exists on Earth in large supply.

This ideal-sounding fuel is real—it's hydrogen. Unfortunately, almost all the hydrogen on Earth is combined with oxygen in water. Pure hydrogen can be obtained by passing an electric current through water. But it takes more energy to obtain the hydrogen than is produced by burning it.

Still, scientists find hydrogen power promising. At present, hydroelectric plants decrease their activity when the demand for electricity is low. Instead, they could run at full capacity all the time, using the excess electricity to produce hydrogen. Similarly, solar power plants often generate more electricity than is needed during the day. This extra electricity could be used to produce hydrogen. Scientists are also searching for other ways to produce hydrogen cheaply from water.

Car manufacturers are now developing cars that run on hydrogen fuel cells. These would produce water as emissions. That water might then be used again as fuel. You can see that if scientists can find a way to produce hydrogen cheaply, it could someday be an important source of energy.

Reading Checkpoint In what common substance is most hydrogen on Earth found?

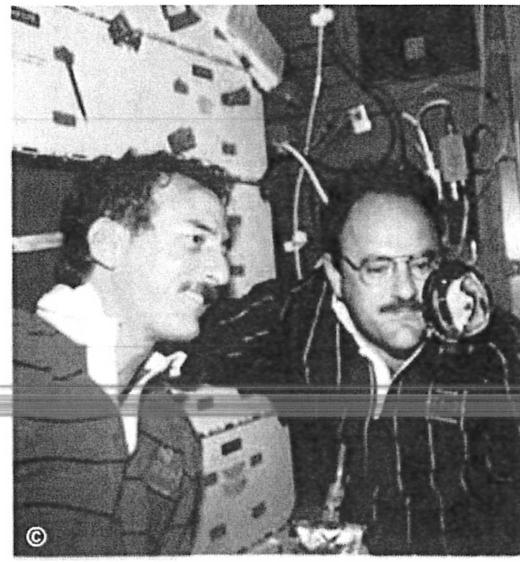


FIGURE 11
Hydrogen Power
The object fascinating these astronauts is a bubble of water—the harmless byproduct of the hydrogen fuel cells used on the space shuttle.

Section 2 Assessment

Target Reading Skill Previewing Visuals Compare your questions and answers about Figure 7 with those of a partner.

Reviewing Key Concepts

HINT 1. a. **Identifying** What two forms of energy does the sun supply?

HINT b. **Explaining** What are two reasons that solar energy has not replaced energy from fossil fuels?

HINT c. **Applying Concepts** A friend of yours argues that shopping malls should use solar energy to conserve fossil fuels. How would you respond?

HINT 2. a. **Listing** List five renewable energy sources other than solar energy.

HINT b. **Classifying** Which of the renewable energy sources that you listed are actually indirect forms of solar energy? Explain.

HINT c. **Predicting** Which source of renewable energy do you think is most likely to be used in your community in 50 years? Give reasons to support your answer.

Writing in Science

Advertisement Write an advertisement for one of the renewable energy sources discussed in this section. Be sure to mention how its advantages make it superior to the other energy sources. Also mention how scientists might be able to overcome its disadvantages.

Lab zone **Technology Lab**

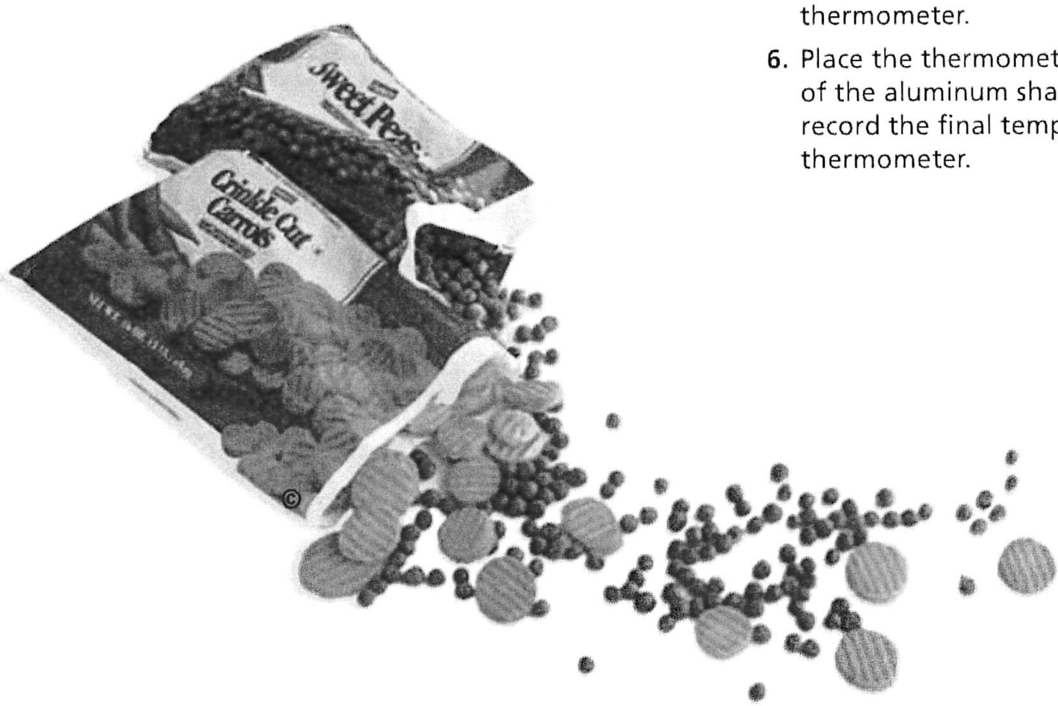
• Tech & Design •

Design and Build a Solar Cooker

Problem
What is the best shape for a solar cooker?

Skills Focus
designing a solution, evaluating the design

Materials
- scissors
- frozen vegetables
- 3 sheets of aluminum foil
- 3 sheets of oaktag paper
- wooden or plastic stirrers
- glue
- 3 thermometers
- tape
- clock or watch
- optional materials provided by your teacher



Procedure

PART 1 Research and Investigate

1. Glue a sheet of aluminum foil, shiny side up, to each sheet of oaktag paper. Before the glue dries, gently smooth out any wrinkles in the foil.
2. Bend one sheet into a U shape. Leave another sheet flat. Bend another sheet into a shape of your own choosing.
3. Predict which shape will produce the largest temperature increase when placed in the sun. Write down your prediction and explain your reasons.
4. Place the aluminum sheets in direct sunlight. Use wood blocks or books to hold the sheets in position, if necessary.
5. Record the starting temperature on each thermometer.
6. Place the thermometer bulbs in the center of the aluminum shapes. After 15 minutes, record the final temperature on each thermometer.

PART 2 Design and Build

7. Using what you learned in Part 1, design a solar cooker that can cook frozen vegetables. Your solar cooker should
   - be no larger than 50 cm on any side
   - cook the vegetables in less than 10 minutes
   - be made of materials approved by your teacher
8. Prepare a written description of your plan that includes a sketch of your cooker. Include a list of materials and an operational definition of a "well-cooked" vegetable. Obtain your teacher's approval for your design. Then build your solar cooker.

PART 3 Evaluate and Redesign

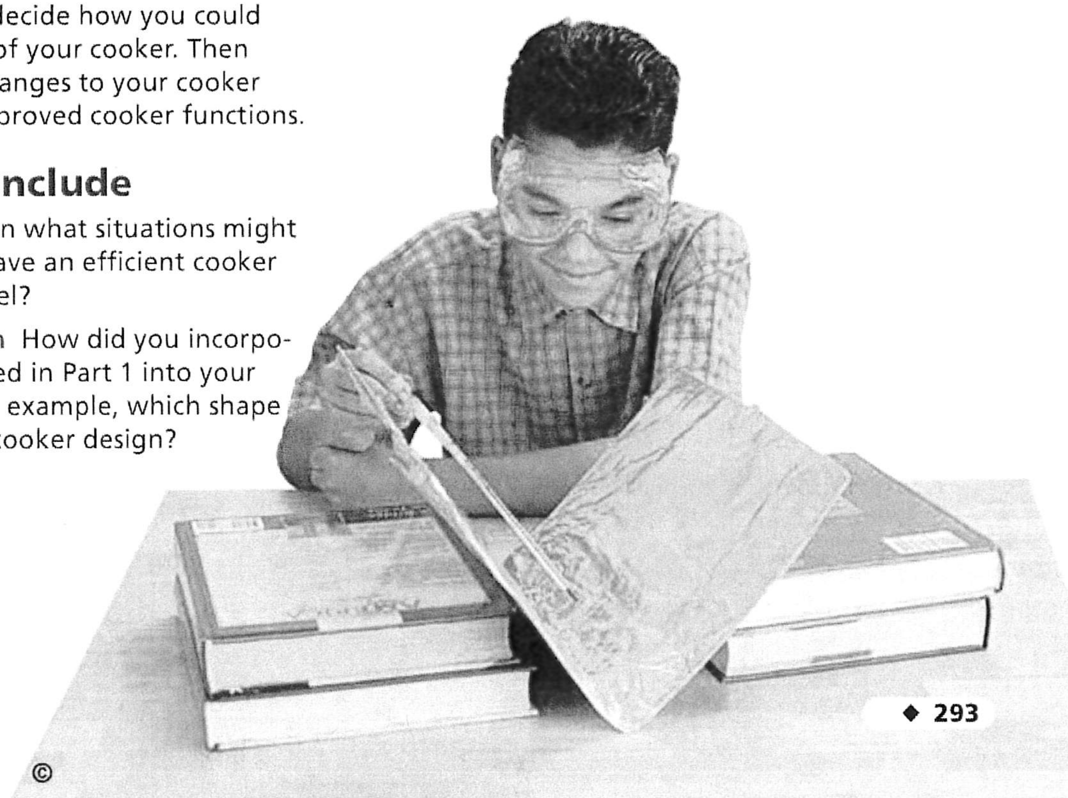
9. Test your solar cooker by spearing some frozen vegetables on the stirrers. Time how long it takes to cook the vegetables. Make note of any problems with your solar cooker design.
10. Based on your test, decide how you could improve the design of your cooker. Then make any desired changes to your cooker and test how the improved cooker functions.

Analyze and Conclude

1. Identifying a Need In what situations might it be important to have an efficient cooker that does not use fuel?
2. Designing a Solution How did you incorporate what you learned in Part 1 into your design in Part 2? For example, which shape did you use in your cooker design?
3. Evaluating the Design When you tested your solar cooker, what problems did you encounter?
4. Redesigning In what ways did you change your design for your second test? How did the redesign improve the performance of your cooker?
5. Working With Design Constraints Why might it be important for solar cookers to use inexpensive, readily available materials?
6. Evaluating the Impact on Society How can solar-powered devices help meet the world's future energy needs? What limitation do solar-powered devices have?

Communicate

Design an advertisement for your solar cooker that will appear in a camping magazine. Make sure your ad describes the benefits of solar cookers in general, and of your design in particular.



Section 3

Nuclear Energy

Reading Preview

Key Concepts

- What happens during a nuclear fission reaction?
- How does a nuclear power plant produce electricity?
- How does a nuclear fusion reaction occur?

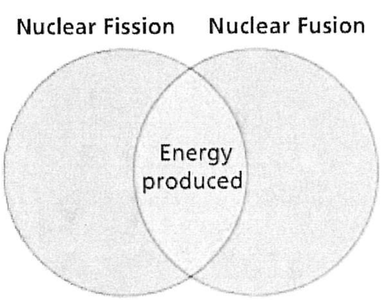
Key Terms

- nucleus
- nuclear fission
- reactor vessel
- fuel rod
- control rod
- meltdown
- nuclear fusion

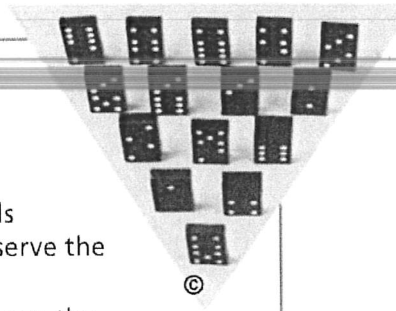
Target Reading Skill

Comparing and Contrasting

As you read, compare fission and fusion reactions in a Venn diagram like the one below. Write the similarities in the space where the circles overlap and the differences on the left and right sides.



Lab zone Discover Activity



Why Do They Fall?

1. Line up 15 dominoes to form a triangle.
2. Knock over the first domino so that it falls against the second row of dominoes. Observe the results.
3. Set up the dominoes again, but then remove the dominoes in the third row from the lineup.
4. Knock over the first domino again. Observe what happens.

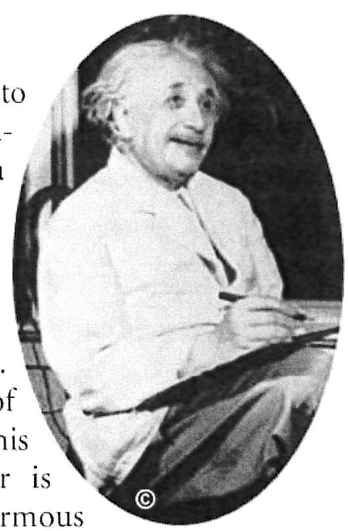
Think It Over

Inferring Suppose each domino produced a large amount of energy when it fell over. Why might it be helpful to remove the dominoes as you did in Step 3?

Wouldn't it be great if people could use the same method as the sun to produce energy? In a way, they can! The kind of reactions that power the sun involve the central cores of atoms. The central core of an atom that contains the protons and neutrons is called the **nucleus** (plural *nuclei*). Reactions that involve nuclei, called nuclear reactions, result in tremendous amounts of energy. Two types of nuclear reactions are fission and fusion.

Nuclear Fission

Nuclear reactions convert matter into energy. As part of his theory of relativity, Albert Einstein developed a formula that described the relationship between energy and matter. You have probably seen this famous equation: $E = mc^2$ the E represents energy and the m represents mass. The c, which represents the speed of light, is a very large number. This equation states that when matter is changed into energy, an enormous amount of energy is released.



▲ Albert Einstein 1879–1955

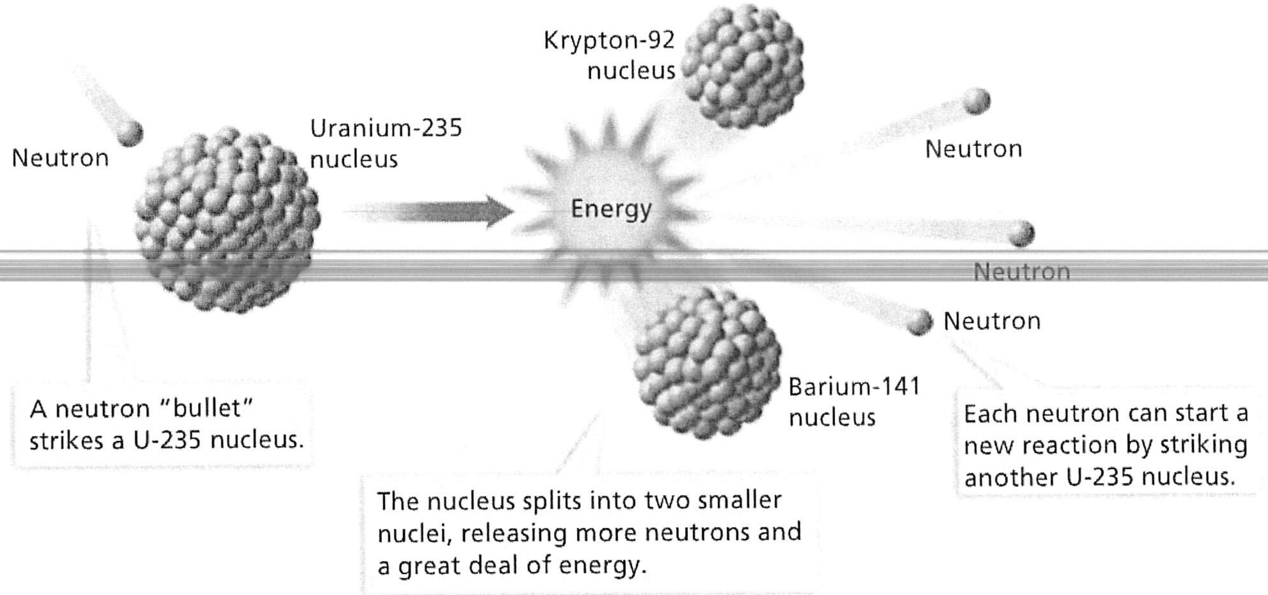


FIGURE 12
Nuclear Fission
A great deal of energy is released in a nuclear fission reaction.
Interpreting Diagrams *How does a nuclear fission reaction begin?*

Fission Reactions Nuclear fission is the splitting of an atom's nucleus into two smaller nuclei. The fuel for the reaction is a large atom that has an unstable nucleus, such as uranium-235 (U-235). A neutron is shot at the U-235 atom at high speed. **When the neutron hits the U-235 nucleus, the nucleus splits apart into two smaller nuclei and two or more neutrons.** The total mass of all these particles is a bit less than the mass of the original nucleus. The small amount of mass that makes up the difference has been converted into energy—a lot of energy, as described by Einstein's equation.

Meanwhile, the fission reaction has produced three more neutrons. If any of these neutrons strikes another nucleus, the fission reaction is repeated. More neutrons and more energy are released. If there are enough nuclei nearby, the process repeats in a chain reaction, just like a row of dominoes falling. In a nuclear chain reaction, the amount of energy released increases rapidly with each step in the chain.

Energy From Fission What happens to all the energy released by these fission reactions? If a nuclear chain reaction is not controlled, the released energy causes a huge explosion. The explosion of an atomic bomb is an uncontrolled nuclear fission reaction. A few kilograms of matter explode with more force than several thousand tons of dynamite. However, if the chain reaction is controlled, the energy is released as heat, which can be used to generate electricity.

Reading Checkpoint **What happens if a nuclear chain reaction is not controlled?**

Lab zone **Skills Activity**

Calculating

A pellet of U-235 produces as much energy as 615 liters of fuel oil. An average home uses 5,000 liters of oil a year. How many U-235 pellets would be needed to supply the same amount of energy?

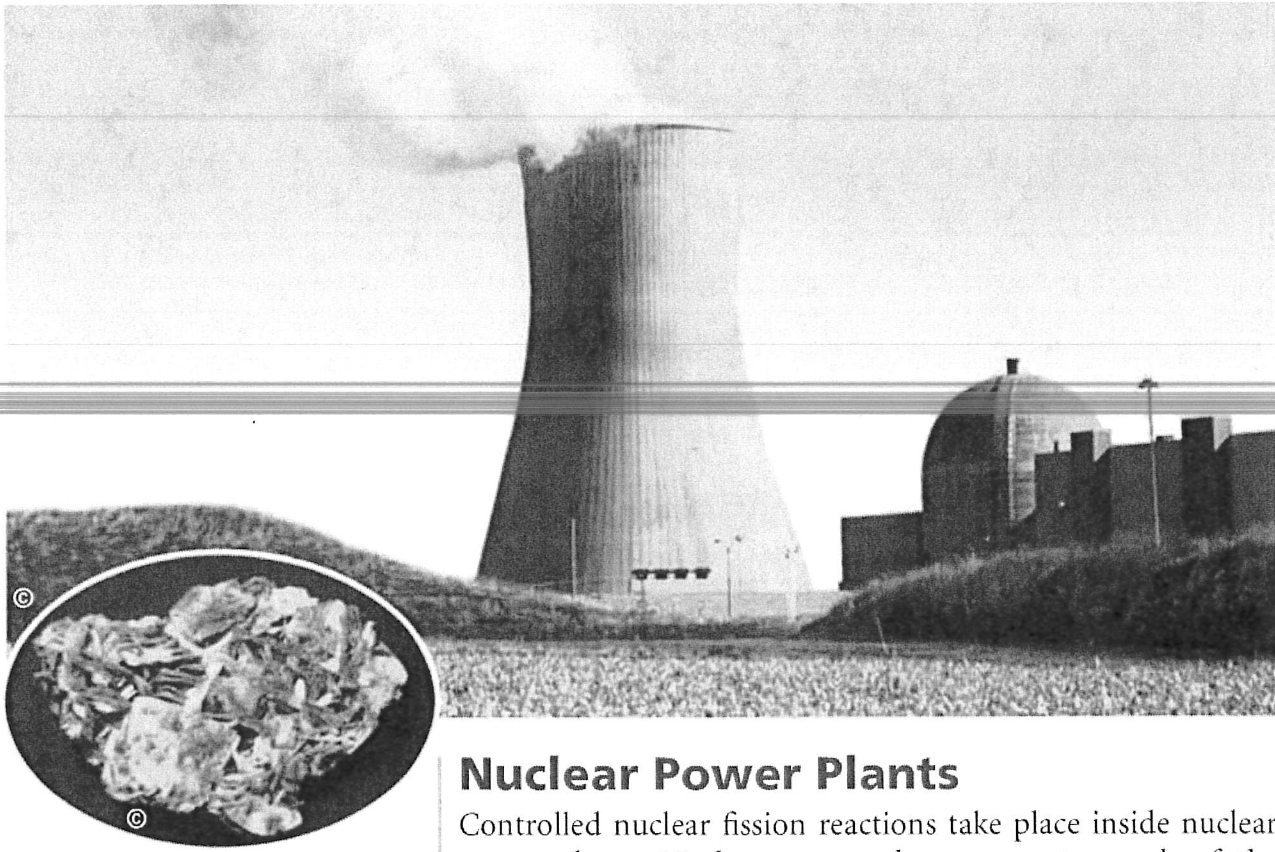


FIGURE 13
Nuclear Power
Nuclear power plants generate much of the world's electricity. The inset shows autunite, one of the ores of uranium. The uranium fuel for nuclear power plants is refined from uranium ores.

Nuclear Power Plants

Controlled nuclear fission reactions take place inside nuclear power plants. Nuclear power plants generate much of the world's electricity—about 20 percent in the United States and more than 70 percent in France. **In a nuclear power plant, the heat released from fission reactions is used to change water into steam. The steam then turns the blades of a turbine to generate electricity.** Look at the diagram of a nuclear power plant in Figure 14. In addition to the generator, it has two main parts: the reactor vessel and the heat exchanger.

Reactor Vessel The **reactor vessel** is the part of the nuclear reactor where nuclear fission occurs. The reactor contains rods of U-235, called **fuel rods.** When several fuel rods are placed close together, a series of fission reactions occurs.

If the reactor vessel gets too hot, control rods are used to slow down the chain reactions. **Control rods,** made of the metal cadmium, are inserted between the fuel rods. The cadmium absorbs neutrons released during fission and slows the speed of the chain reactions. The cadmium control rods can then be removed to speed up the chain reactions again.

Heat Exchanger Heat is removed from the reactor vessel by water or another fluid that is pumped through the reactor. This fluid passes through a heat exchanger. There, the fluid boils water to produce steam, which runs the electrical generator. The steam is condensed again and pumped back to the heat exchanger.

Reading Checkpoint **What is the purpose of a control rod?**

The Risks of Nuclear Power At first, people thought that nuclear fission would provide an almost unlimited source of clean, safe energy. But accidents at nuclear power plants have led to safety concerns. In 1986, the reactor vessel in a nuclear power plant in Chernobyl, Ukraine, overheated. The fuel rods generated so much heat that they started to melt, a condition called a **meltdown**. The excess heat caused a series of explosions, which injured or killed dozens of people. In addition, radioactive materials escaped into the environment.

Accidents can be avoided by careful planning and improved safety features. A more difficult problem is the disposal of the radioactive wastes. Radioactive wastes remain dangerous for many thousands of years. Scientists must find a way to store these wastes safely for a long period of time.

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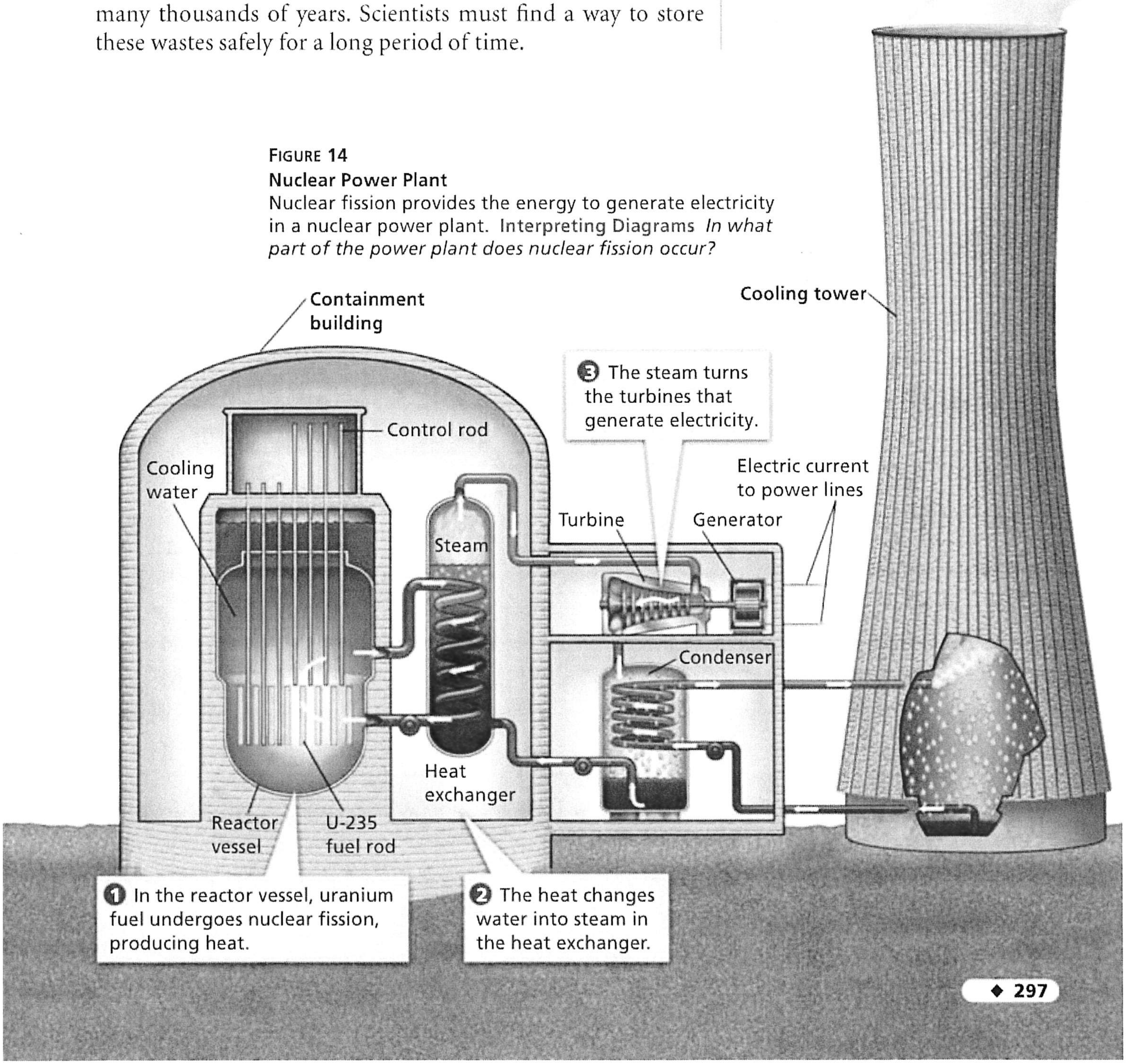
FIGURE 14
Nuclear Power Plant
Nuclear fission provides the energy to generate electricity in a nuclear power plant. Interpreting Diagrams *In what part of the power plant does nuclear fission occur?*



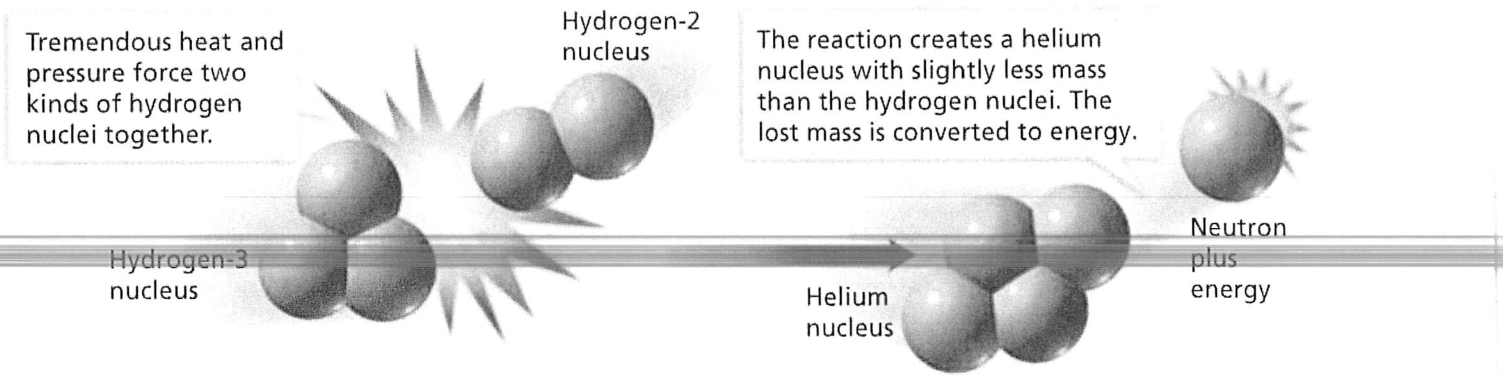


FIGURE 15
Nuclear Fusion
In nuclear fusion, two hydrogen nuclei are forced together, forming a helium nucleus, a neutron, and energy.
Interpreting Diagrams *What is released during a fusion reaction?*

The Quest to Control Fusion

Nuclear fusion is the combining of two atomic nuclei to produce a single larger nucleus. **In nuclear fusion, two hydrogen nuclei combine to create a helium nucleus, which has slightly less mass than the two hydrogen nuclei. The lost mass is converted to energy.**

Nuclear fusion could produce much more energy per unit of atomic mass than nuclear fission. The fuel for a fusion reactor is readily available—water contains one kind of hydrogen needed for fusion. Nuclear fusion should also produce less radioactive waste than nuclear fission. Unfortunately, the pressure and temperature required for a reaction make the construction of a fusion reactor impractical at this time.

Section 3 Assessment

Target Reading Skill Comparing and Contrasting Use the information in your Venn diagram to answer Questions 1 and 3 below.

Reviewing Key Concepts

HINT
HINT
HINT
HINT
HINT
HINT

1. a. **Defining** What is nuclear fission?
   b. **Sequencing** Describe the steps that occur in a nuclear fission reaction.
   c. **Classifying** Is nuclear fission a renewable or nonrenewable energy source? Explain.
2. a. **Identifying** What type of nuclear reaction produces electricity in a nuclear power plant?
   b. **Explaining** Explain how electricity is produced in a nuclear power plant.
   c. **Predicting** What might happen in a nuclear power plant if too many control rods were removed?
3. a. **Reviewing** Define nuclear fusion.
   b. **Relating Cause and Effect** How is energy produced during a nuclear fusion reaction?
   c. **Inferring** What is preventing fusion energy from filling our current energy needs?

HINT
HINT
HINT

Lab zone At-Home Activity

Shoot the Nucleus With a family member, make a model of a nuclear fission reaction. Place a handful of marbles on the floor in a tight cluster, so that they touch one another. Step back about a half meter from the marbles. Shoot a marble at the cluster. Note what effect the moving marble has on the cluster. Then using a diagram, explain how this event models a nuclear fission reaction.

Section 4 Energy Conservation

Reading Preview

Key Concept

- What are two ways to preserve our current energy sources?

Key Terms

- efficiency
- insulation
- energy conservation

Target Reading Skill

Using Prior Knowledge Before you read, write what you know about energy efficiency and conservation in a graphic organizer like the one below. As you read, write what you learn.

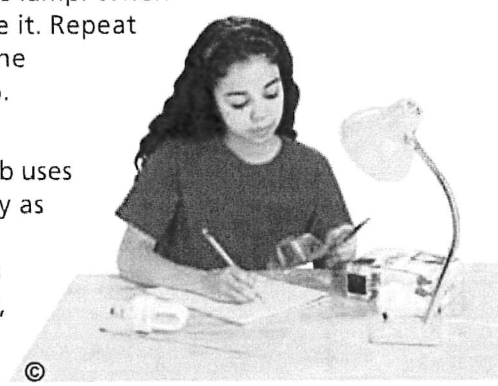
What You Know
1. I turn off lights to conserve energy. 2.

What You Learned
1. 2.

Lab zone Discover Activity

Which Bulb Is More Efficient?

1. Record the light output (listed in lumens) from the packages of a 60-watt incandescent light bulb and a 15-watt compact fluorescent bulb.
2. Place the fluorescent bulb in a lamp socket. **CAUTION:** *Make sure the lamp is unplugged.*
3. Plug in the lamp and turn it on. Hold the end of a thermometer about 8 centimeters from the bulb.
4. Record the temperature after five minutes.
5. Turn off and unplug the lamp. When the bulb is cool, remove it. Repeat Steps 2, 3, and 4 with the incandescent light bulb.



Think It Over

Inferring The 60-watt bulb uses four times as much energy as the 15-watt bulb. Does it also provide four times as much light output? If not, how can you account for the difference?

What would happen if the world ran out of fossil fuels today? The heating and cooling systems in most buildings would cease to function. Forests would disappear as people began to burn wood for heating and cooking. Cars, buses, and trains would be stranded wherever they ran out of fuel. About 70 percent of the world's electric power would disappear. Since televisions, computers, and telephones depend on electricity, communication would be greatly reduced. Lights, microwave ovens, and most other home appliances would no longer work.

Although fossil fuels won't run out immediately, they also won't last forever. Most people think that it makes sense to use fuels more wisely now to avoid fuel shortages in the future. **One way to preserve our current energy resources is to increase the efficiency of our energy use. Another way is to conserve energy whenever possible.**

Energy Efficiency

One way to make energy resources last longer is to use fuels more efficiently. **Efficiency** is the percentage of energy that is actually used to perform work. The rest of the energy is "lost" to the surroundings, usually as heat. People have developed many ways to increase energy efficiency.

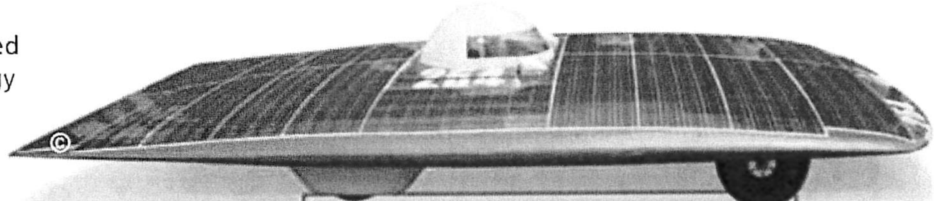
Heating and Cooling One method of increasing the efficiency of heating and cooling systems is insulation. **Insulation** is a layer of material that traps air to help block the transfer of heat between the air inside and outside a building. You have probably seen insulation made of fiberglass, which looks like pink cotton candy. A layer of fiberglass 15 centimeters thick insulates a room as well as a brick wall 2 meters thick!

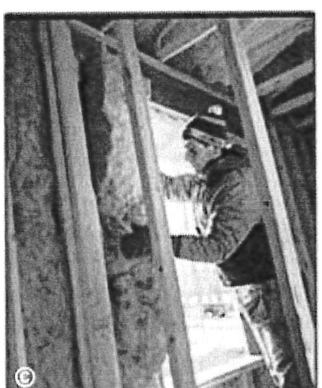
Trapped air can act as insulation in windows, too. Many windows consist of two panes of glass with space between them. The air between the panes of glass acts as insulation.

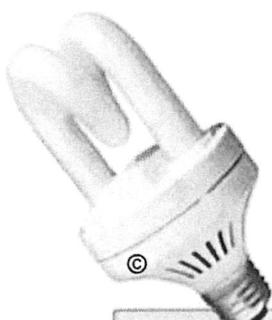
• Tech & Design in History •

Energy-Efficient Products

Scientists and engineers have developed many technologies that improve energy efficiency and reduce energy use.







1932 Fiberglass Insulation
Long strands of glass fibers trap air and keep buildings from losing heat. Less fuel is used for heating.

1936 Fluorescent Lighting
Fluorescent bulbs were introduced to the public at the hundredth anniversary celebration of the United States Patent Office. Because these bulbs use less energy than incandescent bulbs, most offices and schools use fluorescent lights today.

1958 Solar Cells
More than 150 years ago, scientists discovered that silicon can convert light into electricity. The first useful application of solar cells was to power the radio on a satellite. Now solar cells are even used on experimental cars like the one above.

1930 1940 1950 1960

Lighting Much of the electricity used for home lighting is wasted. For example, less than 10 percent of the electricity that an incandescent light bulb uses is converted into light. The rest is given off as heat. In contrast, compact fluorescent bulbs use about one fourth as much energy to provide the same amount of light.

Transportation Engineers have improved the energy efficiency of cars by designing better engines and tires. Another way to save energy is to reduce the number of cars on the road. In many communities, public transit systems provide an alternative to driving. Other cities encourage carpooling. Many cities now set aside lanes for cars containing two or more people.

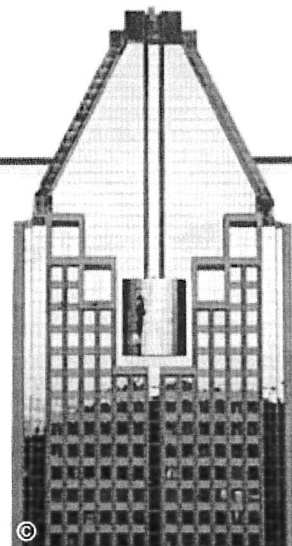
Reading Checkpoint What are two examples of insulation?

Writing in Science

Research and Write Design an advertisement for one of the energy-saving inventions described in this timeline. The advertisement may be a print, radio, or television ad. Be sure that your advertisement clearly explains the benefits of the invention.

1967 Microwave Ovens

The first countertop microwave oven for the home was introduced. Microwaves cook food by heating the water the food contains. Unlike a conventional oven, a microwave oven heats only the food. And preheating is unnecessary, saving even more energy.



1981 High-Efficiency Window Coatings

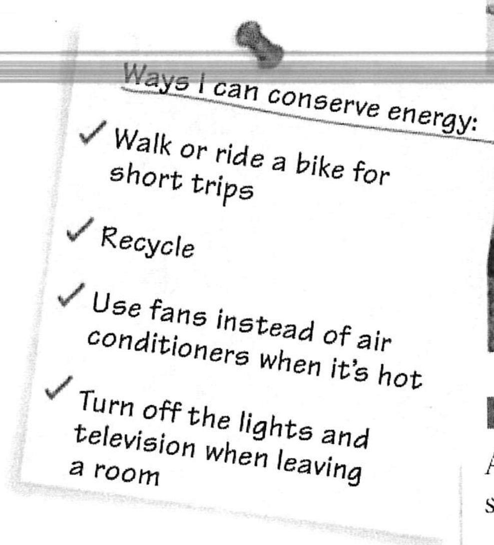
Materials that reflect sunlight were first used to coat windows in the early 1980s. This coating reduces the air conditioning needed to keep the inside of the building cool.

1997 Hydrogen-Powered Vehicles

Hydrogen fuel cells produce no polluting emissions. In 1997, two major automakers unveiled experimental hydrogen-powered cars. The first mass-produced hydrogen-powered cars are expected around 2010.

1970 | 1980 | 1990 | 2000

FIGURE 16
Energy Conservation
There are many ways you can conserve energy.



Energy Conservation

Another approach to making energy resources last longer is conservation. **Energy conservation** means reducing energy use.

You can reduce your personal energy use by changing your behavior in some simple ways. For example, if you walk to the store instead of getting a ride, you are conserving the gasoline it would take to drive to the store. You can also follow some of the suggestions in Figure 16.

While these suggestions seem like small things, multiplied by millions of people they add up to a lot of energy saved for the future.

✓ Reading Checkpoint **What are two ways you can reduce your personal energy use?**

Section 4 Assessment

Vocabulary Skill Prefixes The prefix *con-* and the Latin root *servare* form *conserve*, meaning "keep together" or "preserve." What is the meaning of *energy conservation*?

Reviewing Key Concepts

HINT **1. a. Identifying** What are the two keys to preserving our current energy resources?

HINT **b. Applying Concepts** How does insulating buildings help to preserve energy resources? How does carpooling preserve resources?

HINT **c. Predicting** One office building contains only incandescent lights. The building next door contains only fluorescent lights. Predict which building has higher energy bills. Explain your answer.

Writing in Science

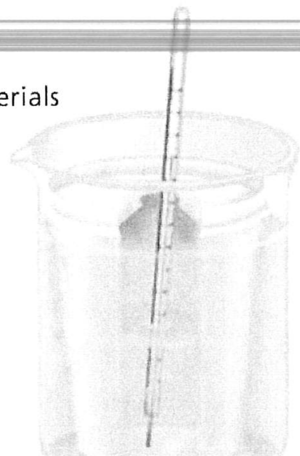
Energy Savings Brochure
Conduct an energy audit of your home. Look for places where energy is being lost, such as cracks around doors. Also look for ways to reduce energy use, such as running the dishwasher only when it is full. Then create a short, illustrated brochure of energy-saving suggestions. Keep the brochure where everyone can see it.

Lab zone **Consumer Lab**

Keeping Comfortable

Problem

How well do different materials prevent heat transfer?



Skills Focus

measuring, controlling variables

Materials

- watch or clock
- beakers
- ice water
- hot water
- thermometers or temperature probes
- containers and lids made of paper, glass, plastic, plastic foam, and metal

Procedure

1. Use a pencil to poke a hole in the lid of a paper cup. Fill the cup halfway with cold water.
2. Put the lid on the cup. Insert a thermometer into the water through the hole. (If you are using a temperature probe, see your teacher for instructions.) When the temperature stops dropping, place the cup in a beaker. Add hot water to the beaker until the water level is about 1 cm below the lid.
3. Record the water temperature once every minute until it has increased by 5°C. Use the time it takes for the temperature to increase 5°C as a measure of the effectiveness of the paper cup in preventing heat transfer.
4. Choose three other containers and their matching lids to test. Design an experiment to compare how well those materials prevent heat transfer. You can use a similar procedure to the one you used in Steps 1–3.

Analyze and Conclude

1. Measuring In Step 2, what was the starting temperature of the cold water? How long did it take for the temperature to increase by 5°C? In which direction did the heat flow? Explain.
2. Making Models If the materials in Steps 1–3 represented your home in very hot weather, which material would represent the rooms in your home? The outdoor weather? The building walls?
3. Controlling Variables In the experiment you conducted in Step 4, what were the manipulated and responding variables? What variables were kept constant?
4. Drawing Conclusions Which material was most effective at preventing the transfer of heat? Which was the least effective? Explain how your data support your conclusion.
5. Communicating Write a paragraph explaining why the results of your experiment could be useful to people building energy-efficient structures.

Design an Experiment

Design an experiment to compare how well the materials you tested would work if the hot water were inside the cup and the cold water were outside. *Obtain your teacher's permission before carrying out your investigation.*

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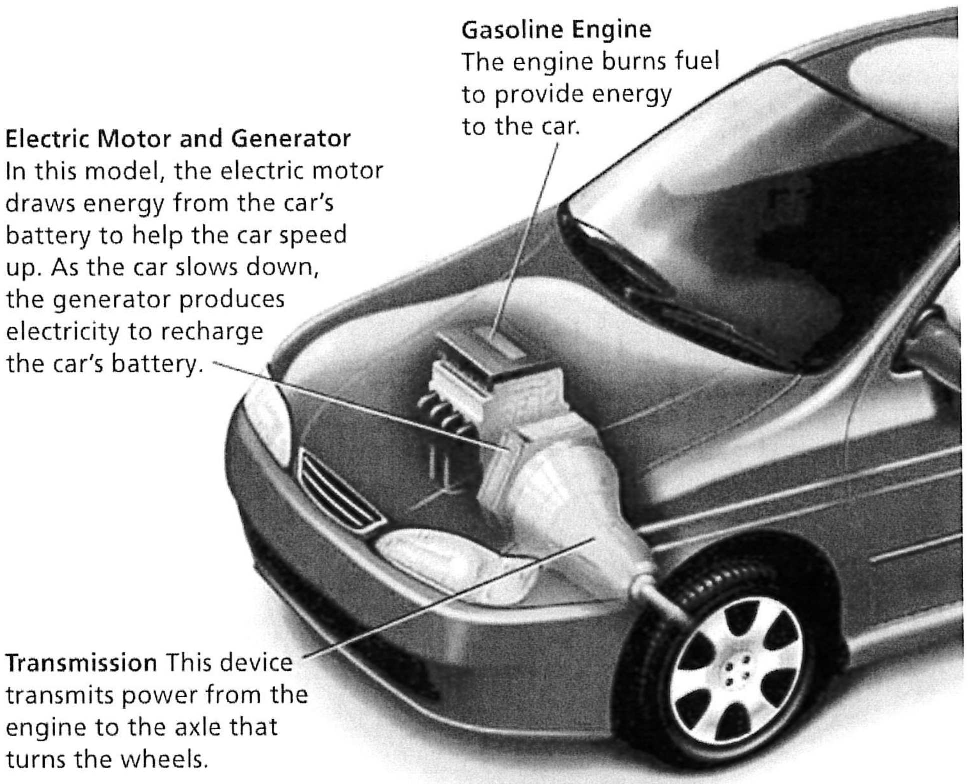
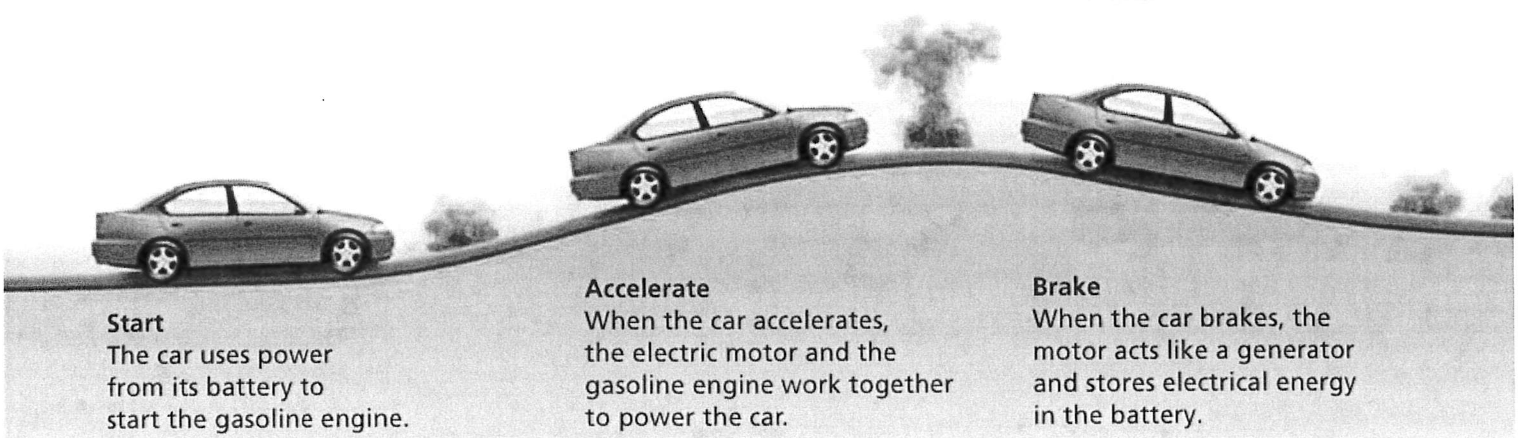
The Hybrid Car

How do you get from here to there? Like most people, you probably rely on cars or buses. Engines that burn fossil fuels power most of these vehicles. To conserve fossil fuels, as well as to reduce air pollution, some car companies have begun to produce hybrid vehicles.

How Are Hybrid Cars Different?

The power source for most cars is a gasoline engine that powers the transmission. Unlike conventional cars, hybrid cars can use both a gasoline engine and an electric motor to turn the transmission. The generated power can be used by the transmission to turn the wheels. Or power can be converted into electricity for later use by the electric motor. Any extra electricity is stored in the car's battery. The gasoline engine in a hybrid car is smaller, more efficient, and less polluting than the engine in a conventional car.

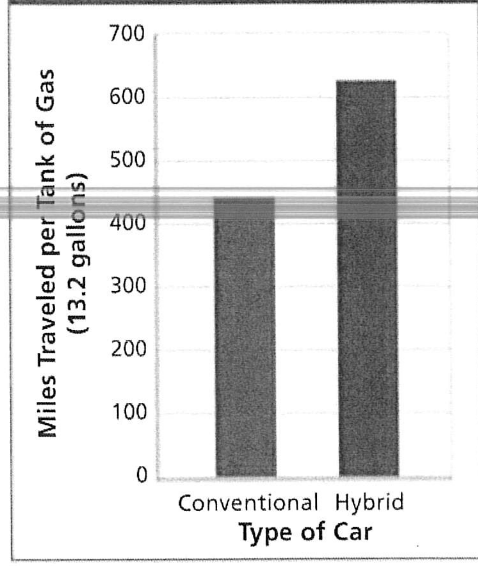


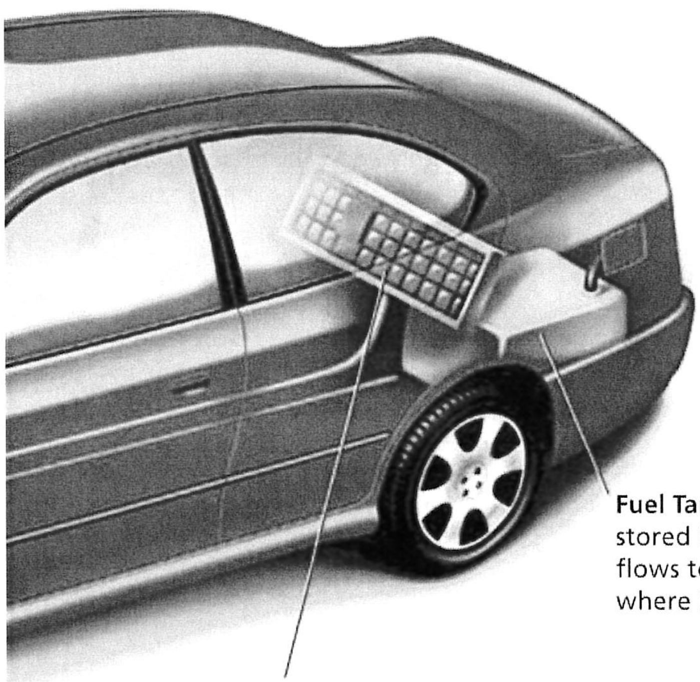


Are Hybrid Cars the Way to Go?

Hybrid cars consume less gas per mile and emit fewer pollutants than cars that run on gasoline alone. In spite of the benefits, there are some drawbacks to hybrid cars. In general, hybrid cars have less power for climbing steep hills and less acceleration than cars with larger engines. In addition, the large batteries could be an environmental hazard if they end up in a landfill. Drivers must make trade-offs in buying any car.

Mileage per Tank of Gas





Weigh the Impact

1. Identify the Need
Why are some car companies developing hybrid cars?

2. Research
Research hybrid cars currently on the market. Use your findings to list the advantages and disadvantages of hybrid-car technology.

3. Write
Should your family's next car be a conventional or hybrid model? Use the information here and your research findings to write several paragraphs supporting your opinion.

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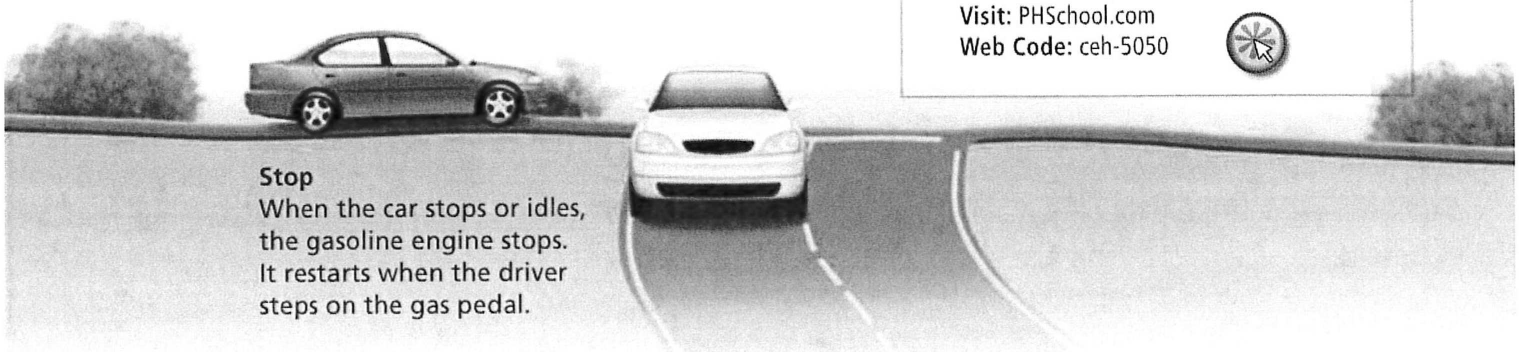


Chapter 9 Study Guide

The BIG Idea

Energy sources Renewable and nonrenewable energy resources differ in a variety of ways, including their costs, availability, and environmental impacts to produce and use.

1 Fossil Fuels

Key Concepts

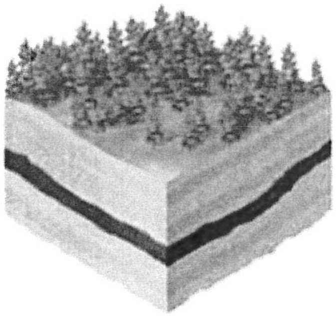
When fuels are burned, the chemical energy that is released can be used to generate another form of energy, such as heat, light, motion, or electricity.

The three major fossil fuels are coal, oil, and natural gas.

Since fossil fuels take hundreds of millions of years to form, they are considered nonrenewable resources.

Key Terms

fuel
energy transformation
combustion
fossil fuel
hydrocarbon
petroleum
refinery
petrochemical



2 Renewable Sources of Energy

Key Concepts

The sun constantly gives off energy in the forms of light and heat.

In addition to solar energy, renewable sources of energy include water, the wind, biomass fuels, geothermal energy, and hydrogen.

Key Terms

solar energy
hydroelectric power
biomass fuel
gasohol
geothermal energy

3 Nuclear Energy

Key Concepts

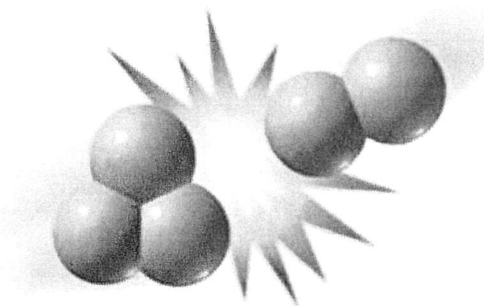
During nuclear fission, when a neutron hits a U-235 nucleus, the nucleus splits apart into two smaller nuclei and two or more neutrons.

In a nuclear power plant, the heat released from fission reactions is used to change water into steam. The steam then turns the blades of a turbine to generate electricity.

In nuclear fusion, two hydrogen nuclei combine to create a helium nucleus, which has slightly less mass than the two hydrogen nuclei. The lost mass is converted to energy.

Key Terms

nucleus
nuclear fission
reactor vessel
fuel rod
control rod
meltdown
nuclear fusion



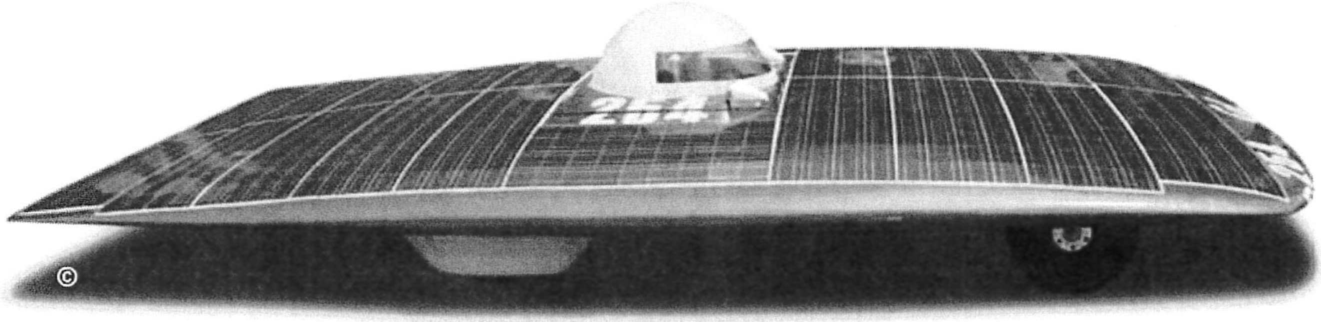
4 Energy Conservation

Key Concept

One way to preserve our current energy resources is to increase the efficiency of our energy use. Another way is to conserve energy whenever possible.

Key Terms

efficiency
insulation
energy conservation



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Web Code: cpa-0009

Organizing Information

Comparing and Contrasting Copy the graphic organizer about sources of energy onto a separate sheet of paper. Then complete it and add a title. (For more on Comparing and Contrasting, see the Skills Handbook.)

Energy Type	Advantage	Disadvantage
Coal	Easy to transport	a. ___?___
Oil	b. ___?___	Nonrenewable
Solar	c. ___?___	d. ___?___
Wind	e. ___?___	f. ___?___
Hydroelectric	No pollution	g. ___?___
Geothermal	h. ___?___	i. ___?___
Nuclear	j. ___?___	Radioactive waste

Reviewing Key Terms

Choose the letter of the best answer.

HINT 1. Which of the following is *not* a fossil fuel?
- a. coal
- b. wood
- c. oil
- d. natural gas

HINT 2. Wind and water energy are both indirect forms of
- a. nuclear energy.
- b. electrical energy.
- c. solar energy.
- d. geothermal energy.

HINT 3. Which of the following is *not* a biomass fuel?
- a. methane
- b. gasohol
- c. hydrogen
- d. sugar cane wastes

HINT 4. The particle used to start a nuclear fission reaction is a(n)
- a. neutron.
- b. electron.
- c. proton.
- d. atom.

HINT 5. A part of a nuclear power plant that undergoes a fission reaction is called a
- a. turbine.
- b. control rod.
- c. heat exchanger.
- d. fuel rod.

If the statement is true, write *true*. If it is false, change the underlined word or words to make the statement true.

6. The process of burning a fuel for energy is called combustion. HINT
7. Most of the energy used today comes from fossil fuels. HINT
8. Products made from petroleum are called hydrocarbons. HINT
9. Geothermal energy is an example of a nonrenewable energy source. HINT
10. Insulation means reducing energy use. HINT

Writing in Science

Letter In a letter to a friend, predict how solar energy will change your life over the next 20 years. Include specific details in your description.

Discovery Channel School

Energy Resources
- Video Preview
- Video Field Trip
- ▶ Video Assessment

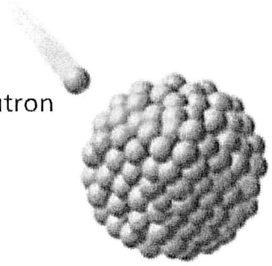
Review and Assessment

Checking Concepts

11. Describe how coal forms.
12. What is natural gas? How is natural gas transported to where it is needed?
13. Describe three features of a solar home. (Your answer may include passive and active solar systems.)
14. Explain why solar energy is the indirect source of hydroelectric power.
15. Explain how wind can be used to generate electricity.
16. How is a nuclear fission reaction controlled in a nuclear reactor?
17. Define energy efficiency. Give three examples of inventions that increase energy efficiency.

Thinking Critically

18. **Comparing and Contrasting** Discuss how the three major fossil fuels are alike and how they are different.
19. **Predicting** Do you think you will ever live in a solar house? Support your prediction with details about the climate in your area.
20. **Classifying** State whether each of the following energy sources is renewable or nonrenewable: coal, solar power, natural gas, hydrogen. Give a reason for each answer.
21. **Making Judgments** Write a short paragraph explaining why you agree or disagree with the following statement: "The United States should build more nuclear power plants to prepare for the future shortage of fossil fuels."
22. **Relating Cause and Effect** In the nuclear reaction shown below, a neutron is about to strike a U-235 nucleus. What will happen next?



Applying Skills

Use the information in the table to answer Questions 23–27.

The table below shows the world's energy production in 1973 and today.

Energy Source	Units Produced 1973	Units Produced Today
Oil	2,861	3,574
Natural gas	1,226	2,586
Coal	2,238	3,833
Nuclear	203	2,592
Hydroelectric	1,300	2,705
Total	7,828	15,290

23. **Interpreting Data** How did the total energy production change from 1973 to today?
24. **Calculating** What percentage of the total world energy production did nuclear power provide in 1973? What percentage does it provide today?
25. **Classifying** Classify the different energy sources according to whether they are renewable or nonrenewable.
26. **Inferring** How has the importance of hydroelectric power changed from 1973 to the present?
27. **Predicting** How do you think the world's energy production will change over the next 40 years? Explain.

Lab zone Chapter Project

Performance Assessment Share your energy-audit report with another group. The group should review the report for clarity, organization, and detail. Make revisions based on feedback from the other group. As a class, discuss each group's findings. Then prepare a class proposal with the best suggestions for conserving energy in your school.

Preparing for the CRCT

Test-Taking Tip

Eliminating Incorrect Answers

When answering a multiple-choice question, you can often eliminate some answer choices because they are clearly incorrect. By doing this, you increase your odds of selecting the correct answer.

Sample Question

Geothermal energy is not a widely used source of energy because

- **A** dams can have negative effects on the environment.
- **B** methane gas is produced as a waste product.
- **C** it is difficult to store.
- **D** magma only comes close to Earth's surface in a few locations.

Answer

The correct answer is D. You can eliminate A because dams are used to produce hydroelectric power. You can also eliminate B because methane gas is produced when bacteria decompose biomass materials. Of the two remaining choices, D is correct because geothermal energy uses magma from Earth's interior as an energy source.

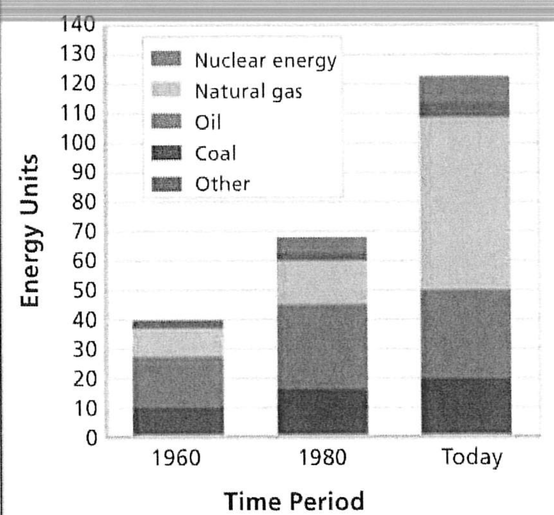
Choose the letter of the best answer.

1. The interior of your car heats up on a sunny day because of
   - **A** passive solar heating.
   - **B** solar cells.
   - **C** active solar heating.
   - **D** indirect solar heating. **S6E6.a**

2. The main function of a dam in producing electricity is to
   - **A** form a reservoir for recreation.
   - **B** prevent flooding after a heavy rain.
   - **C** provide a source of fast-moving water.
   - **D** provide a source of wind. **S6E6.a**

Use the graph to answer Questions 3–4.

Fuel Use in the United States



3. According to the graph, most of the fuel sources used in the United States today are
   - **A** renewable fuels.
   - **B** nuclear fuels.
   - **C** fossil fuels.
   - **D** solar energy.

   S6E6.b

4. Which statement about fuel use in the United States is best supported by the graph?
   - **A** Natural gas has become the most widely used fuel source.
   - **B** Nuclear energy is not used today.
   - **C** Coal is becoming the main source of fuel.
   - **D** The amount of oil being used today has greatly decreased since 1980. **S6E6.b**

5. Which of the following is the first step in producing electricity in a nuclear reactor?
   - **A** Steam turns the blades of a turbine.
   - **B** Water boils to produce steam.
   - **C** U-235 atoms are split by nuclear fission.
   - **D** Heat is released. **S6E6.b**

Constructed Response

6. Explain what is meant by this statement: Electricity is *not* itself a source of energy. Then choose one energy source and explain how it can be used to produce electricity.

   S6E6.b