Chapter 7

Resources and Energy

Chapter Outline

Inquiry Lab

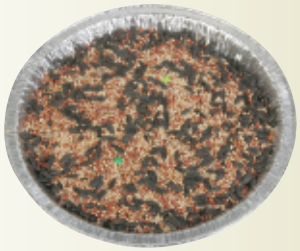
20 min

Modeling Mining

From your teacher, obtain a **pie plate** containing **birdseed** and **colored beads** that represents an area to "mine" using a **plastic spoon.** As you find sunflower seeds and different colors of beads, place them in separate piles. Determine the total value of your resources using these values: yellow beads, $25; green beads, $15; and sunflower seeds, $5. Your teacher will tell you the value that each white bead represents.

Questions to Get You Started

1. Determine your group's profit.
2. Why do you think the beads and seeds had different values?



Why It Matters

People convert many types of energy to energy that is more useful. The energy of water moving through Hoover Dam is used to generate electricity. Supplies of some resources are diminishing. By understanding how these resources are used, scientists can search for sustainable, alternative resources.

READING TOOLBOX

These reading tools will help you learn the material in this chapter.

Science Terms

Everyday Words Used in Science Many words used in science are familiar words from everyday speech. However, when these words are used in science, their meanings are often different from the everyday meanings.

Your Turn As you read Section 1, make a table like the one below for the terms *placer deposit, native element,* and *hydrothermal solution*. Write the scientific context of each term in the second column. Then, write the everyday meaning of each word listed in the third column.

Term	Scientific Context	Everyday Meaning
placer deposit		deposit—
native element		native—
hydrothermal solution		solution—

Predictions

The Language of Prediction Scientific theories can be used to explain things that happened in the past. They can also be used to make predictions about what will happen in the future. To recognize a statement of prediction, look for words such as these:

- the word *will* before a verb
- words such as *might* or *may*
- the word *if* followed first by a condition and then by a result

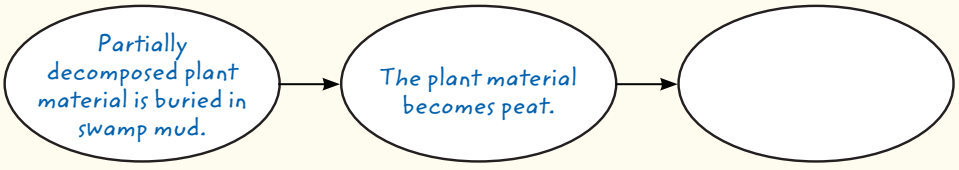
Your Turn As you read Sections 2 and 3, make a list of statements of prediction. In each statement, underline the key words that tell you the statement is a prediction. Some examples are given below.

Prediction Statements
- If a fission reaction is allowed to continue uncontrolled, the reaction will escalate quickly and may result in an explosion.
- If a nucleus is struck by a free neutron, however, the nucleus of the atom may split.

Graphic Organizers

Chain-of-Events Chart Use a chain-of-events chart when you need to remember the steps in a process.

Your Turn As you read Section 2, complete the chain-of-events chart that outlines the formation of coal.



For more information on how to use these and other tools, see **Appendix A.**

SECTION 1

Mineral Resources

ENVIRONMENTAL CONNECTION

Key Ideas	Key Terms	Why It Matters
❯ Explain what ores are and where they form. ❯ Identify why mineral resources are important. ❯ Describe four methods by which humans obtain mineral resources.	**ore** **lode** **placer deposit** **gemstone**	Minerals are sources of many types of useful materials. People use various mining techniques to obtain minerals.

Earth's crust contains useful mineral resources. The processes that formed many of these resources took millions of years. Many of these mineral resources are mined for human use. Mineral resources can be either *metals*, such as gold, Au, silver, Ag, and aluminum, Al, or *nonmetals*, such as sulfur, S, and quartz, SiO_2.

Ores

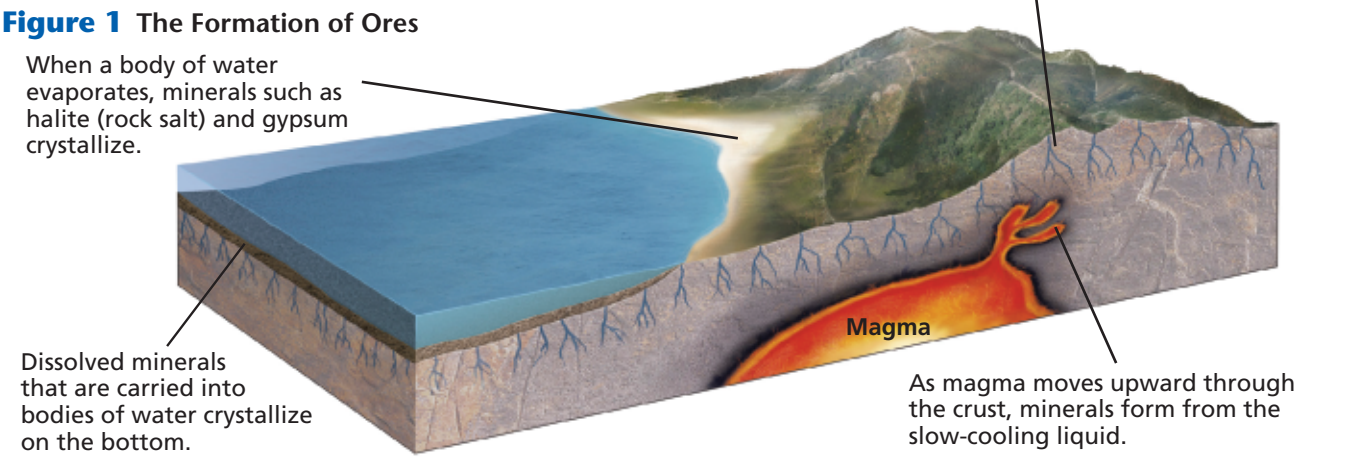
Metallic minerals, such as gold, silver, and copper, Cu, are called *native elements* and can exist in Earth's crust as nuggets of pure metal. But most other minerals in Earth's crust are *compounds* of two or more elements. Mineral deposits from which metals and nonmetals can be removed profitably are called **ores**. For example, the metal iron, Fe, can be removed from naturally occurring deposits of the minerals magnetite and hematite. Mercury, Hg, can be separated from cinnabar. Aluminum can be separated from bauxite.

ore a natural material whose concentration of economically valuable minerals is high enough for the material to be mined profitably

Ores Formed by Cooling Magma

Ores form in a variety of ways, as shown in **Figure 1.** Some ores, such as ores of chromium, Cr, nickel, Ni, and lead, Pb, form within cooling magma. As the magma cools, dense metallic minerals sink. As the minerals sink, layers of these minerals accumulate at the bottom of the magma chamber to form ore deposits.

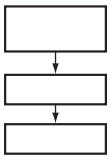
Figure 1 The Formation of Ores



READING TOOLBOX

Chain-of-Events Chart

Create a chain-of-events chart to describe the process of contact metamorphism.



Ores Formed by Contact Metamorphism

Some ores of lead, copper, and zinc, Zn, form through the process of contact metamorphism. *Contact metamorphism* is a process that occurs when magma comes into contact with existing rock. Heat and chemical reactions with hot fluids from the magma can change the composition of the existing rock. These changes sometimes form ores.

Contact metamorphism can also form ore deposits when hot fluids called *hydrothermal solutions* move through small cracks in a large mass of rock. In this process, minerals from the surrounding rock dissolve into the hydrothermal solution. Over time, new minerals precipitate from the solution and form narrow zones of rock called *veins*. Veins commonly consist of ores of valuable heavy minerals, such as gold, tin, Sn, lead, and copper. When many thick mineral veins form in a relatively small region, the ore deposit is called a **lode.** Stories of a "mother lode" kept people coming to California during the California gold rush in the late 1840s and 1850s.

lode a mineral deposit within a rock formation

placer deposit a deposit that contains a valuable mineral that has been concentrated by mechanical action

Academic Vocabulary

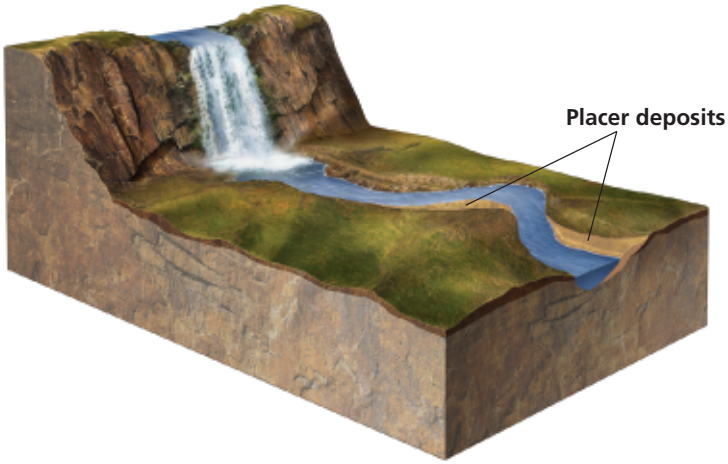
release (ri LEES) to set free; to let go

Ores Formed by Moving Water

The movement of water helps to form ore deposits. First, tiny fragments of native elements, such as gold, are released from rock as it breaks down by weathering. Then, streams carry the fragments until the currents become too weak to carry these dense metals. Finally, because of the mechanical action of the stream, the fragments become concentrated at the bottom of stream beds in **placer deposits.** A placer deposit is shown in **Figure 2.**

Reading Check **Name two ways water creates ore deposits.** (See Appendix G for answers to Reading Checks.)

Figure 2 Placer deposits may occur at a river bend (left) or in holes downstream from a waterfall (right). Gold is a mineral that is commonly found in placer deposits. A stream carries heavy gold grains and nuggets, and then drops them where the current is weak.



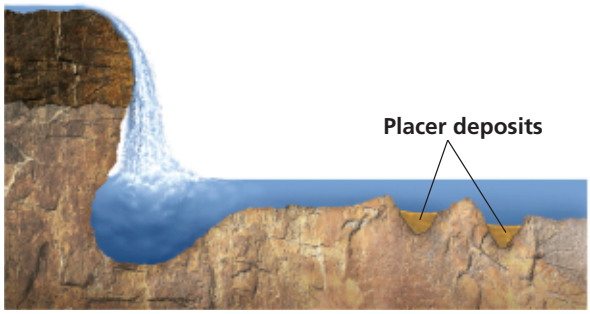


Table 1 Minerals and Their Uses

Metallic minerals	Uses
Hematite and magnetite (iron)	for making steel
Galena (lead)	in car batteries; in solder
Gold, silver, and platinum	in electronics and dental work; as objects such as coins, jewelry, eating utensils, and bowls
Chalcopyrite (copper)	as wiring; in coins and jewelry; as building ornaments
Sphalerite (zinc)	for making brass and galvanized steel
Nonmetallic minerals	**Uses**
Diamond (carbon)	in drill bits and saws (industrial grade); in jewelry (gemstone quality)
Graphite (carbon)	in pencils, paint, lubricants, and batteries
Calcite	in cement; as building stone
Halite (salt)	for food preparation and preservation
Kaolinite (clay)	in ceramics, paper, cement, and bricks
Quartz (sand)	in glass and computer chips
Sulfur	in gunpowder, medicines, and rubber
Gypsum	in plaster and wallboard

Uses of Mineral Resources

Some metals, such as gold, platinum, Pt, and silver, are prized for their beauty and rarity. Metallic ores are sources of these valuable minerals and elements. Certain rare nonmetallic minerals called **gemstones** display extraordinary brilliance and color when they are specially cut for jewelry. Other nonmetallic minerals, such as calcite and gypsum, are used as building materials. **Table 1** shows some metallic and nonmetallic minerals and their common uses.

gemstone a mineral, rock, or organic material that can be used as jewelry or an ornament when it is cut and polished

Mineral Exploration and Mining

Companies that mine and recover minerals are often looking for new areas to mine. These companies identify areas that may contain enough minerals for economic recovery through mineral exploration. In general, an area is considered for mining if it has at least 100 to 1,000 times the concentration of minerals that are found elsewhere.

During mineral exploration, people search for mineral deposits by studying local geology. Airplanes that carry special equipment are used to measure and identify patterns in magnetism, gravity, radioactivity, and rock color. Exploration teams collect and test rock samples to determine whether the rock contains enough metal to make a mine profitable.

SCILINKS
www.scilinks.org
Topic: Using Mineral Resources
Code: HQX1587
Topic: Mining Minerals
Code: HQX0968

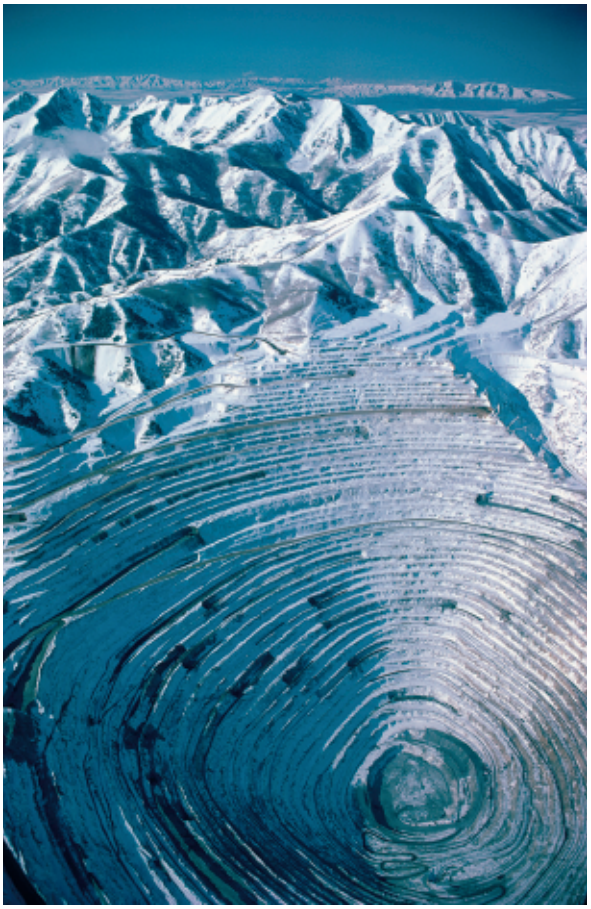


Figure 3 With a rim diameter of 4 km and a depth of almost 1 km, the Bingham Canyon Mine in Utah is the largest copper mine in the world.

Subsurface Mining

Many mineral deposits are located below Earth's surface. These minerals are mined by miners who work underground to recover the deposits. This type of mining is called *subsurface mining*.

Surface Mining

When mineral deposits are located close to Earth's surface, they may be mined by using *surface mining* methods. In these methods, the overlying rock material is stripped away to reveal the mineral deposits. A large openpit copper mine is shown in **Figure 3.**

Placer Mining

Minerals in placer deposits are mined by dredging. In placer mining, large buckets are attached to a floating barge. The buckets scoop up the sediments in front of the barge. Dense minerals from placer deposits are separated from the surrounding sediments. Then, the remaining sediments are released into the water.

Undersea Mining

The ocean floor also contains mineral resources. *Nodules* are lumps of minerals on the deep-ocean floor that contain iron, manganese, Mn, and nickel, and that could become economically important if they could be recovered efficiently. However, because of their location, these deposits are very difficult to mine. Mineral deposits on land can be mined less expensively than deposits on the deep-ocean floor can.

Section 1 Review

Key Ideas

1. **Define** *ore*.
2. **Describe** three ways that ore deposits form.
3. **Identify** two uses for each of the following minerals: sulfur, copper, and diamond.
4. **Summarize** the four main types of mining.

Critical Thinking

5. **Applying Ideas** Which properties of gold and copper make these metals suitable for use in electronics?
6. **Understanding Relationships** Why are dense minerals more likely to form placer deposits than less dense minerals are?
7. **Making Inferences** Why do you think that mining on land is less costly than mining in the deep ocean is?

Concept Mapping

8. Use the following terms to create a concept map: *mineral, ore, magma, contact metamorphism, vein, lode, placer deposit,* and *mine*.

SECTION 2

ENVIRONMENTAL CONNECTION

Nonrenewable Energy

Key Ideas	Key Terms	Why It Matters
❯ Explain why coal is a fossil fuel. ❯ Describe the formation of petroleum and natural gas. ❯ Describe how fossil fuels are used today. ❯ Explain how nuclear fission generates electricity.	**nonrenewable resource** **fossil fuel** **nuclear fission** **nuclear fusion**	Nonrenewable resources, such as fossil fuels, are limited in supply. People use fossil fuels as an energy resource. People use nuclear energy to generate electricity.

Many of Earth's resources are used to generate energy. Energy is used for transportation, manufacturing, and countless other activities that are important to society as we know it. Energy resources that exist in limited amounts and cannot be replaced quickly once they are used are examples of **nonrenewable resources.**

Fossil Fuels

Some of the most important nonrenewable resources are buried within Earth's crust. These natural resources—coal, petroleum, and natural gas—formed from the remains of living things. Because of their organic origin, coal, petroleum, and natural gas are called **fossil fuels.** Fossil fuels consist primarily of compounds of carbon and hydrogen called *hydrocarbons*. These compounds contain stored energy originally obtained from sunlight by plants and animals that lived millions of years ago. When hydrocarbons are burned, the formation of chemical bonds with oxygen (oxidation) releases energy as heat and light. Much of the energy humans use every day comes from the burning of fossil fuels.

nonrenewable resource a resource that forms at a rate that is much slower than the rate at which the resource is consumed

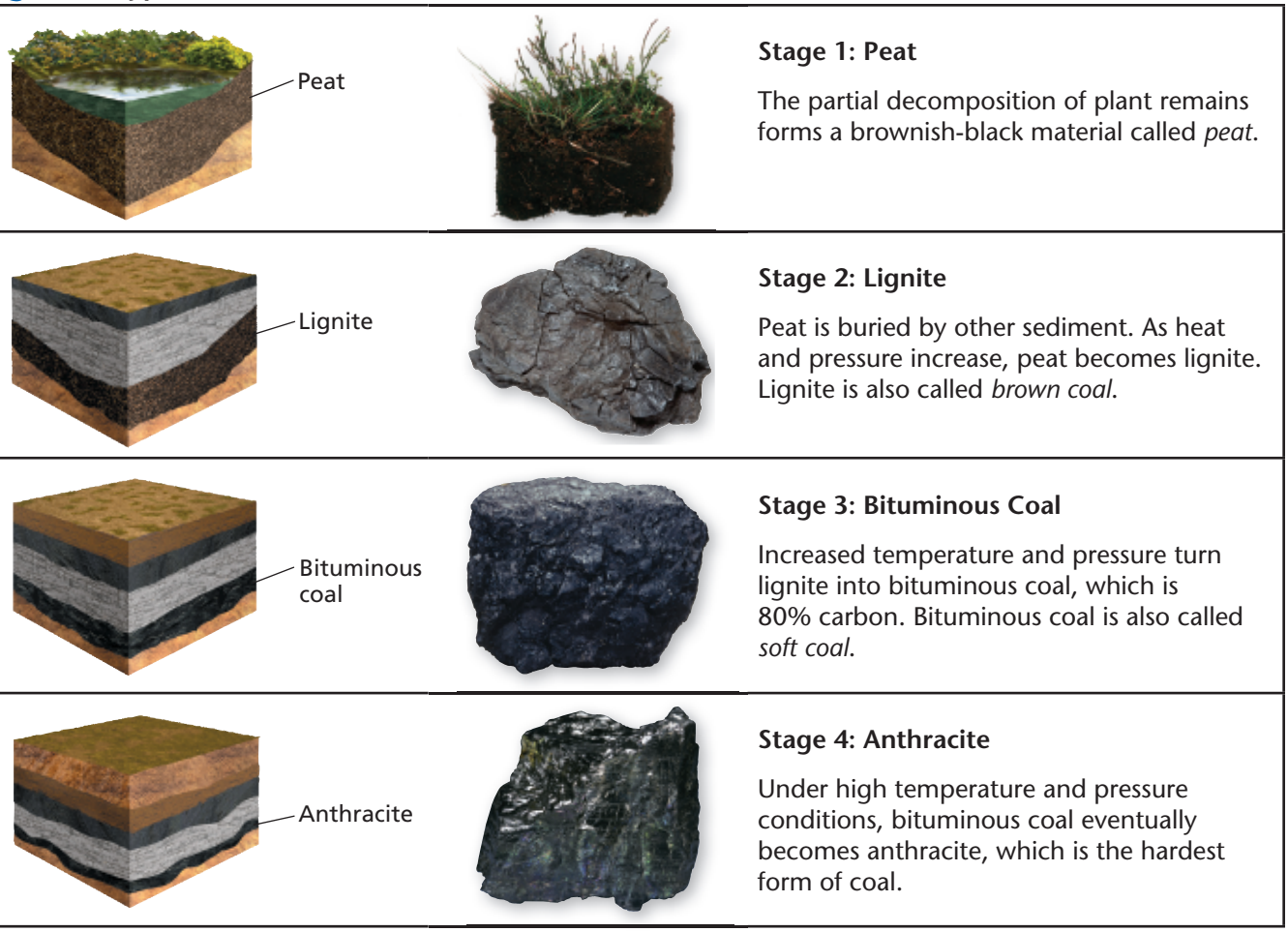
fossil fuel a nonrenewable energy resource formed from the remains of organisms that lived long ago

Formation of Coal

The most commonly burned fossil fuel is coal. The coal deposits of today are the remains of plants that have undergone a complex process called *carbonization*. Carbonization occurs when partially decomposed plant material is buried in swamp mud and becomes peat. Bacteria consume some of the peat and release the gases methane, CH_4, and carbon dioxide, CO_2. As gases escape, the chemical content of the peat gradually changes until mainly carbon remains. The complex chemical and physical changes that produce coal happen only if there is no oxygen in the swamp. If the conditions are not right for carbonization or if the time required for coal formation has not elapsed, peat remains. Peat can also be used as an energy source, as shown in **Figure 1.**

Figure 1 Some people in Ireland and Scotland heat their houses with peat.

Figure 2 Types of Coal



Types of Coal Deposits

As peat is covered by layers of sediments, the weight of these sediments squeezes out water and gases. A denser material called *lignite* forms, as shown in the second stage of **Figure 2.** The increased temperature and pressure of more sediments compacts the lignite and forms *bituminous coal*. Bituminous coal is the most abundant type of coal. Where the folding of Earth's crust produces high temperatures and pressure, bituminous coal changes into *anthracite*, the hardest form of coal. Bituminous coal is made of 80% carbon, and anthracite is made of 90% carbon. Both release large amounts of energy as heat when they burn.

Math Skills

Coal Reserves There is thought to be more than 1,000 billion tons of coal on Earth that can be mined. If 4.5 billion tons are used worldwide every year, for how many years will Earth's coal reserves last? If coal use increases to 10 billion tons per year, for how many years will Earth's coal reserves last?

Formation of Petroleum and Natural Gas

When microorganisms and plants died in shallow prehistoric oceans and lakes, their remains accumulated on the ocean floor and lake bottoms and were buried by sediment. As more sediments accumulated, heat and pressure increased. Over millions of years, the heat and pressure caused chemical changes to convert the remains into petroleum and natural gas.

Petroleum and natural gas are mixtures of hydrocarbons. Petroleum, which is also called *oil*, is made of liquid hydrocarbons. Natural gas is made of hydrocarbons in the form of gas.

Petroleum and Natural Gas Deposits

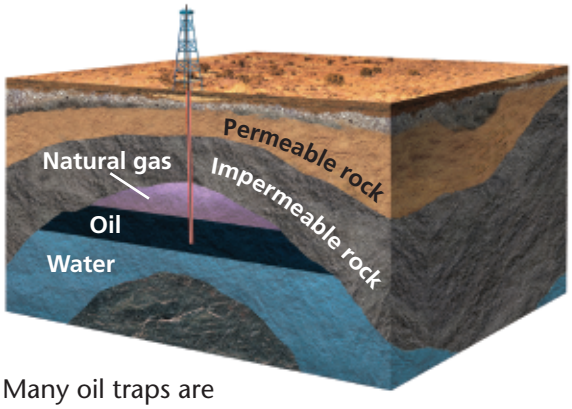
Petroleum and natural gas are very important sources of energy for transportation, farming, and many other industries. Because of their importance, petroleum and natural gas deposits are valuable and are highly sought after. Petroleum and natural gas are most often mined from permeable sedimentary rock. *Permeable rocks* have interconnected spaces through which liquids can easily flow.

As sediments accumulate and sedimentary rock forms, pressure increases. This pressure forces fluids, including oil and gas, out of the pores and up through the layers of permeable rock. The fluids move upward until they reach a layer of *impermeable rock*, or rock through which liquids cannot flow, called *cap rock*. Petroleum that accumulates beneath the cap rock fills all the spaces to form an oil reservoir. Because petroleum is less dense than water, petroleum rises above any trapped water. Similarly, natural gas rises above petroleum, because natural gas is less dense than both oil and water.

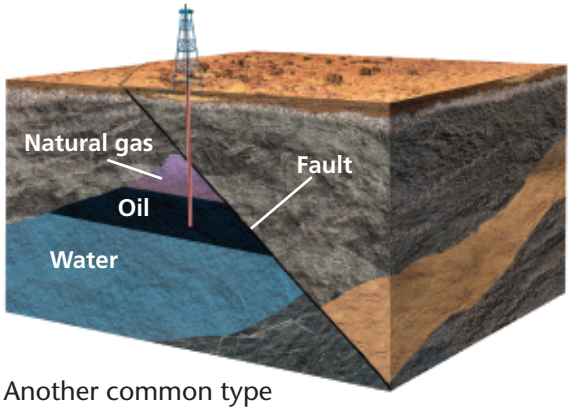
Oil Traps

Geologists explore Earth's crust to discover the kinds of rock structures that may trap oil or gas. They look for oil trapped in places such as the ones shown in **Figure 3.** When a well is drilled into an oil reservoir, the petroleum and natural gas often flow to the surface. When the pressure of the overlying rock is removed, fluids rise up and out through the well.

Figure 3 Oil Traps



Many oil traps are anticlines, or upward folds in rock layers.



Another common type of oil trap is a fault, or crack, in Earth's crust that seals the oil- or gas-bearing formation.

Fossil-Fuel Supplies

Fossil fuels, like minerals, are nonrenewable resources. Globally, fossil fuels are one of the main sources of energy. *Crude oil*, or unrefined petroleum, is also used in the production of plastics, synthetic fabrics, medicines, waxes, synthetic rubber, insecticides, chemical fertilizers, detergents, shampoos, and many other products.

Coal is the most abundant fossil fuel in the world. Every continent has coal, but almost two-thirds of known deposits occur in three countries—the United States, Russia, and China. Scientists estimate that most of the petroleum reserves in the world have been discovered. However, scientists think that there are undiscovered natural gas reserves. There is also a relatively abundant material called *oil shale* that contains petroleum. But the cost of mining oil from shale is far greater than the present cost of recovering oil from other sedimentary rocks.

Reading Check **What is cap rock?**

SCILINKS

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Topic: Nonrenewable Resources
Code: **HQX1044**
Topic: Fossil Fuels
Code: **HQX0614**

Nuclear Energy

Academic Vocabulary
fundamental (FUHN duh MENT'l) basic

When scientists discovered that atoms had smaller fundamental parts, scientists wondered if atoms could be split. In 1919, Ernest Rutherford first studied and explained the results of bombarding atomic nuclei with high-energy particles. In the 30 years that followed his research, scientists developed nuclear (NOO klee uhr) technologies that allowed atomic weapons to be made and allowed nuclear reactions to be used to generate electricity. Energy that is produced by using these technologies is called *nuclear energy*.

nuclear fission the process by which the nucleus of a heavy atom splits into two or more fragments; the process releases neutrons and energy

Nuclear Fission

One form of nuclear energy is produced by splitting the nuclei of heavy atoms. This splitting of the nucleus of a large atom into two or more smaller nuclei is called **nuclear fission.** The process of nuclear fission is shown in **Figure 4.**

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Topic: Nuclear Energy
Code: HQX1047

The forces that hold the nucleus of an atom together are more than 1 million times stronger than the strongest chemical bonds between atoms. If a nucleus is struck by a free neutron, however, the nucleus of the atom may split. When a large nucleus splits, it releases additional neutrons as well as energy. The newly released neutrons strike other nearby nuclei, which causes those nuclei to split and to release more neutrons and more energy. A chain reaction occurs as more neutrons strike neighboring nuclei. If a fission reaction is allowed to continue uncontrolled, the reaction will escalate quickly and may result in an explosion. However, controlled fission produces heat that can be used to generate electricity.

Reading Check **What causes a chain reaction during nuclear fission?**

THINK central
INTERACT ONLINE
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Figure 4 An Example of a Nuclear Fission Reaction

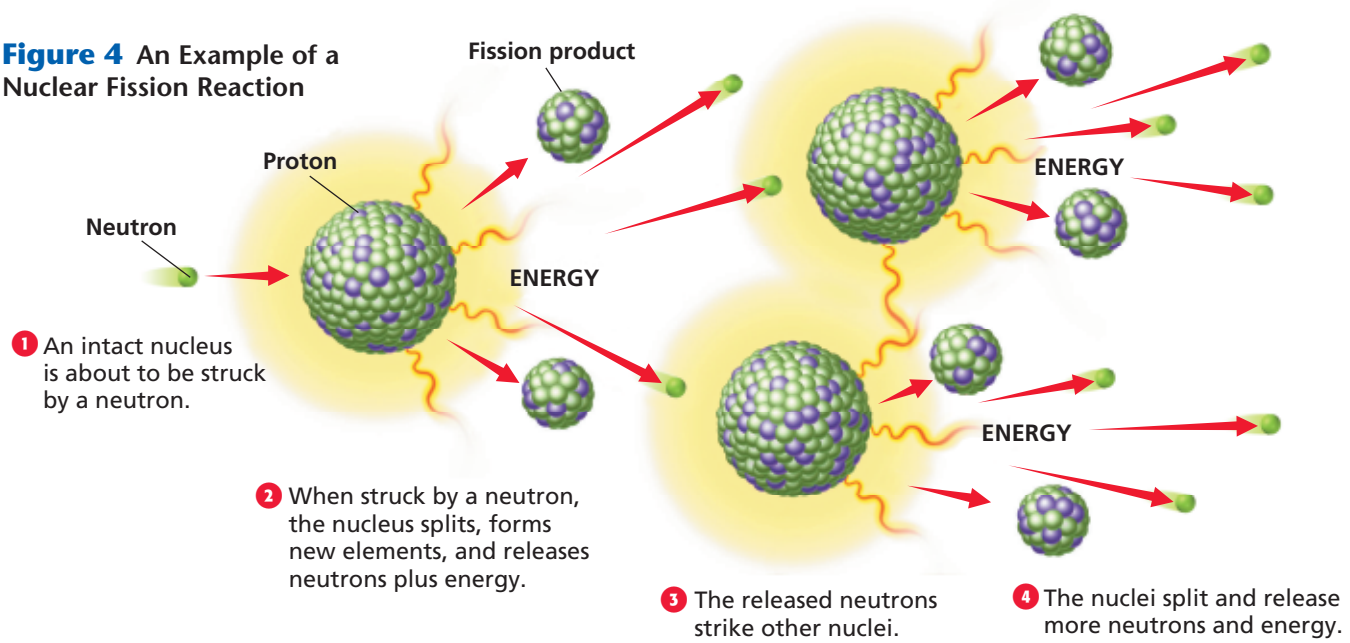
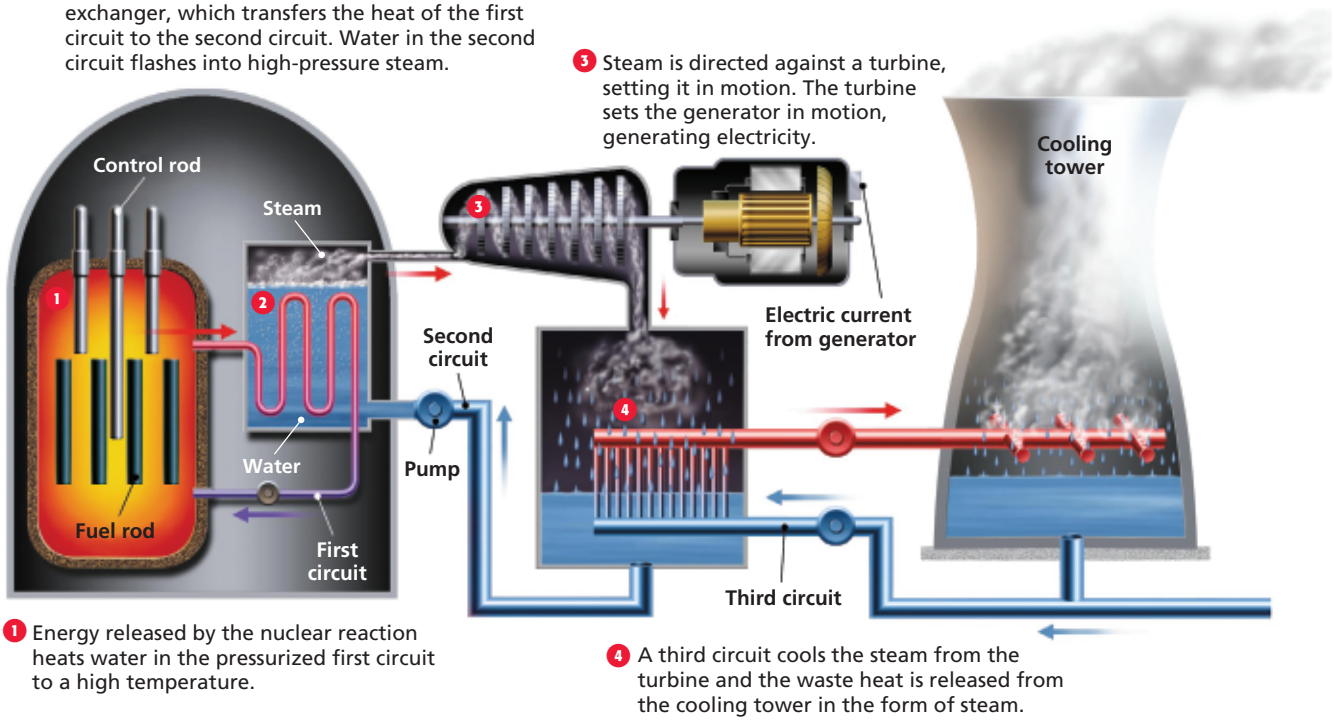


Figure 5 How a Nuclear Power Plant Generates Electricity



How Fission Generates Electricity

When a nuclear power plant is working correctly, the chain reaction that occurs during nuclear fission is controlled. The flow of neutrons into the fission reaction is regulated so that the reaction can be slowed down, speeded up, or stopped as needed. The specialized equipment in which controlled nuclear fission is carried out is called a *nuclear reactor*.

During fission, a tremendous amount of heat energy is released. This heat energy can, in turn, be used to generate electricity. **Figure 5** shows how nuclear fission inside a nuclear reactor can be used to generate electricity. Currently, only one kind of naturally occurring element is used for nuclear fission. It is a rare isotope of the element uranium called *uranium-235*, or ^{235}U. Because ^{235}U is rare, the ore that is mined is processed into fuel pellets that have a high ^{235}U content. After this process is complete, the fuel pellets are said to be uranium-enriched pellets.

These enriched fuel pellets are placed into rods to make *fuel rods*. Bundles of these fuel rods are then bombarded by neutrons. When struck by a neutron, the ^{235}U nuclei in the fuel rods split and release neutrons and energy. The resulting chain reaction causes the fuel rods to become very hot.

Water is pumped around the fuel rods to absorb and remove the heat energy. The water is then pumped into a second circuit, where the water becomes steam. The steam turns the turbines that provide power for electric generators. A third water circuit carries away excess heat and releases it into the environment.

READING TOOLBOX

Chain-of-Events Chart

Create a chain-of-events chart to describe the process by which fission is used to generate electricity.

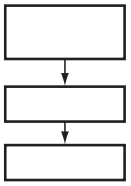


Figure 6 These water pools store radioactive wastes. The blue glow indicates that the waste products are highly radioactive.

Advantages and Disadvantages of Nuclear Fission

Nuclear power plants burn no fossil fuels and produce no air pollution. But because nuclear fission uses and produces radioactive materials that have very long half-lives, wastes must be safely stored for thousands of years. These waste products give off high doses of radiation that can destroy plant and animal cells and can cause harmful changes in the genetic material of living cells.

Currently, nuclear power plants store their nuclear wastes in dry casks or in onsite water pools, as shown in **Figure 6.** Other wastes are either stored onsite or transported to one of three disposal facilities in the United States. The U.S. Department of Energy has plans for a permanent disposal site for highly radioactive nuclear wastes.

Nuclear Fusion

All of the energy that reaches Earth from the sun is produced by a kind of nuclear reaction, called nuclear fusion. During **nuclear fusion,** the nuclei of hydrogen atoms combine to form larger nuclei of helium. This process releases energy. Fusion reactions occur only at temperatures of more than 15,000,000 °C.

For more than 50 years, scientists have been trying to harness the energy released by nuclear fusion to produce electricity. More research is needed before a commercial fusion reactor can be built. If such a reactor could be built in the future, hydrogen atoms from ocean water might be used as the fuel. With ocean water as fuel, the amount of energy available from nuclear fusion would be almost limitless. Scientists also think that wastes from fusion would be much less dangerous than wastes from fission. The only byproducts of fusion are helium nuclei, which are harmless to living cells.

nuclear fusion the process by which nuclei of small atoms combine to form a new, more massive nucleus; the process releases energy

Section 2 Review

Key Ideas

1. **Explain** why coal, petroleum, and natural gas are called *fossil fuels*.
2. **Compare** how coal, petroleum, and natural gas form.
3. **Describe** the kinds of rock structures in which petroleum reservoirs form.
4. **Identify** the naturally occurring element that is used for nuclear fission.
5. **Explain** how nuclear fission generates electricity.
6. **Summarize** the process of nuclear fusion.

Critical Thinking

7. **Analyzing Relationships** Why have we been able to build nuclear power plants for only the last 50 years?
8. **Recognizing Relationships** Can the waste products of nuclear fission be safely disposed of in rivers or lakes? Explain your answer.
9. **Making Comparisons** How do the processes of nuclear fusion and nuclear fission differ?

Concept Mapping

10. Use the following terms to create a concept map: *nonrenewable resource, fossil fuel, coal, carbonization, peat, lignite, bituminous coal, anthracite coal, petroleum,* and *natural gas.*

SECTION 3

Renewable Energy

ENVIRONMENTAL CONNECTION

Key Ideas	Key Terms	Why It Matters
❯ Explain how geothermal energy may be used as a substitute for fossil fuels. ❯ Describe two methods for harnessing energy from the sun. ❯ Describe four sources of renewable alternative energy.	**renewable resource** **geothermal energy** **solar energy** **hydroelectric energy** **biomass**	Sources of renewable energy can be replaced quickly. Using renewable energy sources reduces pollution caused by the burning of fossil fuels.

If current trends continue and worldwide energy needs increase, the world's supply of fossil fuels may be used up in the next 200 years. Nuclear energy does not use fossil fuels, but numerous safety concerns are associated with it. Therefore, many nations are researching alternative energy sources to ensure that safe energy resources will be available far into the future. Resources that can be replaced within a human life span or as they are used are called **renewable resources.**

Geothermal Energy

In many locations, water flows far beneath Earth's surface. This water may flow through rock that is heated by nearby magma or by hot gases that are released by magma. This water becomes heated as it flows through the rock. The hot water, or the resulting steam, is the source of a large amount of heat energy. This heat energy is called **geothermal energy,** which means "energy from the heat of Earth's interior."

renewable resource a natural resource that can be replaced at the same rate at which the resource is consumed

geothermal energy the energy produced by heat within Earth

Engineers and scientists have harnessed geothermal energy by drilling wells to reach the hot water. Sometimes, water is first pumped down into the hot rocks if water does not already flow through them. The resulting steam and hot water can be used as a source of heat. The steam and hot water also serve as sources of power to drive turbines, which generate electricity.

The city of San Francisco, for example, obtains some of its electricity from a geothermal power plant located in the nearby mountains. In Iceland, 85% of the homes are heated by geothermal energy. Italy and Japan have also developed power plants that use geothermal energy. A geothermal power plant is shown in **Figure 1.**

Figure 1 These swimmers are enjoying the hot water near a geothermal power plant in Svartsbening, Iceland.

Solar Energy

Another source of renewable energy is the sun. Every 15 minutes, Earth receives enough energy from the sun to meet the energy needs of the world for one year. Energy from the sun is called **solar energy.** The challenge engineers face is how to capture even a small part of the energy that travels to Earth from the sun.

solar energy the energy received by Earth from the sun in the form of radiation

Converting sunshine into heat energy can be done in two ways. A house that has windows facing the sun collects solar energy through a *passive system.* The system is passive because it does not use moving parts. Sunlight enters the house and warms the building material, which stores some heat for the evening. An *active system* includes the use of solar collectors. One type of *solar collector* is a box that has a glass top. The box is commonly placed on the roof of a building. Water circulates through tubes within the box. The sun heats the water as it moves through the tubes, which provides heat and hot water. On cloudy days, however, there may not be enough sunlight to heat the water. So, the system must use heat that was stored from previous days.

Photovoltaic cells are another active system that converts solar energy directly into electricity. Photovoltaic cells work well for small objects, such as calculators. Producing enough electricity from these cells to power cities is under investigation.

READING TOOLBOX

Everyday Words Used in Science

As you read this section, make a list of scientific terms that contain the word *energy* or *system.* Then, compare the familiar meaning of the words with the scientific meaning of the terms.

Quick Lab Solar Collector

30 min

Procedure

1. Line the inside of a **small, shallow pan** with **black plastic.** Use **tape** to attach a **thermometer** to the inside of the pan. Fill the pan with enough **room-temperature water** to cover the end of the thermometer. Fasten **plastic wrap** over the pan with a **rubber band.** Be sure you can read the thermometer.
2. Place the pan in a sunny area. Use a **stopwatch** to record the temperature every 5 min until the temperature stops rising. Discard the water.
3. Repeat steps 1 and 2, but do not cover the pan with plastic wrap.
4. Repeat steps 1 and 2, but do not line the pan with black plastic.
5. Repeat steps 1 and 2. But do not line the pan with black plastic, and do not cover the pan with plastic wrap.
6. Calculate the rate of temperature change for each trial by subtracting the beginning temperature from the ending temperature. Divide your result by the number of minutes the temperature increased to find the rate of temperature change.

Analysis

1. What are the variables in this investigation? Which trial had the greatest rate of temperature change? the smallest rate of temperature change?
2. Which variable that you tested has the most significant effect on temperature change?
3. What materials would you use to design and build an efficient solar collector? Explain your answer.

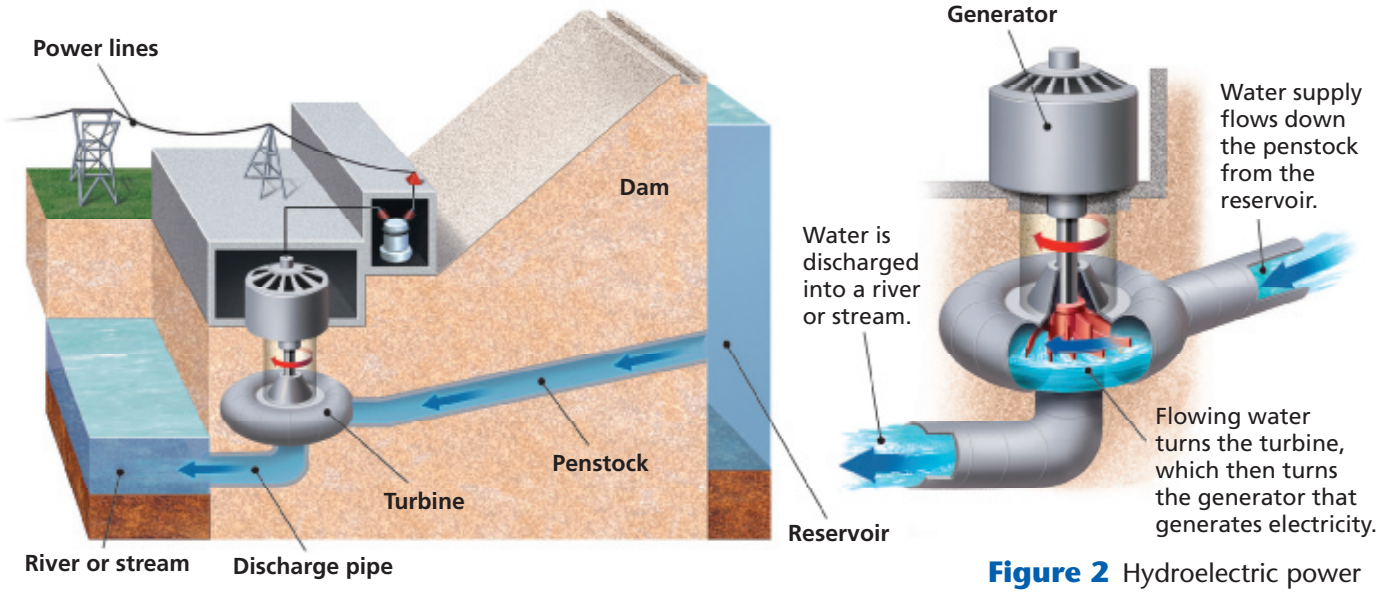


Figure 2 Hydroelectric power plants use moving water to turn turbines. The movement of each turbine powers a generator that generates electricity.

Energy from Moving Water

One of the oldest sources of energy comes from moving water. Energy can be harnessed from the running water of rivers and streams or from ocean tides. In some areas of the world, energy needs can be met by **hydroelectric energy,** or the energy produced by running water. Today, 6% of the electricity in the United States comes from hydroelectric power plants. At a hydroelectric plant, massive dams hold back running water and channel the water through the plant. Inside the plant, the water spins turbines, which turn generators that produce electricity. An example of a hydroelectric plant is shown in **Figure 2.**

Another renewable source of energy that comes from moving water is the tides. Tides are the rising and falling of sea level at certain times of the day. To make use of this tidal flow, people have built dams to trap the water at high tide and then release it at low tide. As the water is released, it turns the turbines within the dams.

hydroelectric energy electrical energy produced by the flow of water

biomass plant material, manure, or any other organic matter that is used as an energy source

Energy from Biomass

Other renewable resources are being exploited to help supply our energy needs. Renewable energy sources that come from plant material, manure, and other organic matter, such as sawdust or paper waste, are called **biomass.** Biomass is a major source of energy in many developing countries. More than half of all trees that are cut down are used as fuel for heating or cooking. Bacteria that decompose the organic matter produce gases, such as methane, that can also be burned. Liquid fuels, such as ethanol, also form from the action of bacteria on biomass. All of these resources can be burned to generate electricity.

Academic Vocabulary

exploit (EKS PLOYT) to use to the greatest possible advantage

SCILINKS

www.scilinks.org
Topic: Renewable Resources
Code: HQX1291

Reading Check **Name three sources of renewable energy.**

Figure 3 The spinning blades of a wind turbine are connected to a generator. When winds cause the blades to spin faster, the generator produces more energy.

Energy from Wind

Wind is the movement of air over Earth's surface. Wind results from air-pressure differences caused by the sun's uneven heating of Earth's surface. Wind turbines use the movement of air to convert wind energy into mechanical energy, which is used to generate electricity.

Wind energy is now being used to produce electricity in locations that have constant winds. Small, wind-driven generators are used to meet the energy needs of individual homes. *Wind farms,* such as the one shown in **Figure 3,** may have hundreds of giant wind turbines that can produce enough energy to meet the electricity needs of entire communities. However, wind generators are not practical everywhere. Even in the most favorable locations, such as in windy mountain passes, the wind does not always blow. Because the wind does not always blow, wind energy cannot be depended on as the only energy source for most locations.

Section 3 Review

Key Ideas

1. **Explain** why many nations are researching alternative energy resources.
2. **Explain** how geothermal energy may be used as a substitute for fossil fuels.
3. **Describe** both passive and active methods of harnessing energy from the sun.
4. **Summarize** how electrical energy is generated from running water.
5. **Describe** how biomass can be used as fuel to generate electricity.
6. **Explain** how water and wind can be harnessed to generate electricity.

Critical Thinking

7. **Making Comparisons** Both fossil fuels and biomass fuels come from plant and animal matter. Why are fossil fuels considered to be nonrenewable, while biomass fuels are considered to be renewable?
8. **Demonstrating Reasoned Judgment** If you were asked to construct a power plant that uses only renewable energy sources in your area, what type of energy would you use? Explain.

Concept Mapping

9. Use the following terms to create a concept map: *renewable resource, solar collector, geothermal energy, solar energy, passive system, active system, hydroelectric energy, biomass,* and *wind energy.*

SECTION 4

Resources and Conservation

ENVIRONMENTAL CONNECTION

Key Ideas	Key Terms	Why It Matters
❯ Describe the importance of using fossil fuels wisely. ❯ Explain how the environmental impacts of mining can be reduced. ❯ Identify how conservation protects natural resources.	**conservation** **recycling**	The supply of fossil fuels is limited. Wise use of natural resources decreases waste and helps to protect the environment.

Scientists estimate that worldwide coal reserves will last about 200 years at the present rate of use. Many scientists also think that humans have already used half of Earth's oil supply. This limited supply of fossil fuels and other traditional energy resources has inspired research into possible new energy sources.

Scientists are also studying how the use of traditional energy sources affects Earth's ecosystems. We have learned that mining can damage or destroy fragile ecosystems. Fossil fuels and nuclear power generation may add pollution to Earth's air, water, and soil. However, people can reduce the environmental impact of their resource use. Many governments and public groups have worked to create and enforce policies that govern the use of these natural resources.

Environmental Impacts of Mining

Mining for minerals can cause a variety of environmental problems. Mining may cause both air and noise pollution. Nearby water resources may also be affected by water that carries toxic substances from mining processes. Surface mining is particularly destructive to wildlife habitats. For example, surface mining often uses controlled explosions to remove layers of rock and soil, as shown in **Figure 1.** Some mining practices cause increased erosion and soil degradation. Regions above subsurface mines may sink, or subside, because of the removal of the materials below. This sinking results in the formation of sinkholes. Fires in coal mines are also very difficult to extinguish and are commonly left to burn out, which may take several decades or centuries.

Figure 1 The surface of this gold mine in Nevada is being blasted to remove layers of rock.

Quick Lab

30 min

Reclamation

Procedure

1. Use a **plastic spoon** to remove the first layer of gelatin from a **multi-layered gelatin dessert cup** into a **small bowl.**
2. Remove the next layer of gelatin, and discard it.
3. Restore the dessert cup by replacing the first layer of gelatin.

Analysis

1. What does the first layer of gelatin on the restored dessert cup represent?
2. Does the "reclaimed" dessert cup resemble the original, untouched dessert cup?
3. What factors would you address to make reclamation more successful?

Academic Vocabulary

procure (proh KYUR) to get as a result of effort; obtain or acquire

Mining Regulations

In the United States, federal and state laws regulate the operation of mines. These laws are designed to prevent mining operations from contaminating local air, water, and soil resources. Some of these federal laws include the Clean Water Act; the Safe Drinking Water Act; and the Comprehensive Environmental Response, Compensation, and Liability Act. All mining operations must also comply with the federal Endangered Species Act, which protects threatened or endangered species and their habitats from being destroyed by mining practices.

Mine Reclamation

To reduce the amount of damage done to ecosystems, mining companies are required to return mined land to its original condition after the mining has been completed. This process, called *reclamation,* helps reduce the long-lasting environmental impact of mining. In addition to reclamation, some mining operations work hard to reduce environmental damage through frequent inspections and by using processes that reduce environmental impacts.

Fossil Fuels and the Environment

Fossil-fuel procurement affects the environment. Strip mining of coal can leave deep holes where coal was removed. Without plants and topsoil to protect it, exposed land often erodes quickly. When rocks that are exposed during mining get wet, they can weather to form acids. If runoff carries the acids into nearby rivers and streams, aquatic life may be harmed.

Fossil-fuel use also contributes to air pollution. The burning of coal that has a high sulfur content releases large amounts of sulfur dioxide, SO_2, into the atmosphere. When SO_2 combines with water in the air, acid precipitation forms. When petroleum and natural gas are burned, they also release pollutants that can damage the environment. The burning of gasoline in cars is a major contributor to air pollution. But emissions testing, which is shown in **Figure 2,** and careful maintenance help reduce the amount of pollutants released into the air. Emissions testing and maintenance include the testing of a car's catalytic converter, a device that removes numerous pollutants from the exhaust before the exhaust leaves the car.

Figure 2 Emissions testing and maintenance of pollution-reducing devices in today's vehicles can help reduce air pollution.

Reading Check **Name two ways the use of fossil fuel affects the environment.**

Conservation

Many people and businesses around the world have adopted practices that help reduce the negative effects of the burning of fossil fuels and the use of other natural resources. This preservation and wise use of natural resources is called **conservation.** By conserving natural resources, people can ensure that limited natural resources last longer. Conservation can also help reduce the environmental damage and amount of pollution that can result from the mining and use of natural resources.

Mineral Conservation

Earth's mineral resources are being used at a faster rate each year. Every new person added to the world's population represents a need for additional mineral resources. In developing countries, people are using more mineral resources as their countries become more industrialized. This increased demand for minerals has led many scientists to look for ways to conserve Earth's minerals.

One way to conserve minerals is to use other abundant or renewable materials instead of scarce or nonrenewable minerals. Another way to conserve minerals is by recycling them. **Recycling** is the process of using materials more than once. Some metals, such as iron, copper, and aluminum, are often recycled, as shown in **Figure 3.** Glass and many building materials can also be efficiently recycled. Recycling does require energy, but recycling uses less energy than the mining and manufacturing of new resources does.

Figure 3 These cubes are made up of metals that have been compacted and are being sent to a recycling plant. ***Can you identify the source of these metals?***

conservation the preservation and wise use of natural resources

recycling the process of recovering valuable or useful materials from waste or scrap; the process of reusing some items

Why It Matters

Disposing of Electronic Waste

EYE ON THE ENVIRONMENT

Consumers purchase millions of cell phones, MP3 players, and computers every year, often to replace broken or slightly outdated equipment. But electronic devices contain toxic materials such as heavy metals. Recycling electronics instead of throwing them in the trash prevents toxins from entering the environment.

Some recycled electronics can be reused or repaired. Others can be taken apart to recover components and materials.

YOUR TURN

ONLINE RESEARCH

Where in your area can you recycle electronic waste?

Figure 4 Fiberglass insulation is used in homes to reduce the energy required for heating and cooling.

Fossil-Fuel Conservation

Fossil fuels can be conserved by reducing the amount of energy used every day. If less energy is used, fewer fossil fuels must be burned every day to supply the smaller demand for energy. Energy can be conserved in many ways. **Figure 4** shows insulation being installed into a new house to reduce the amount of energy that will be needed for cooling and heating. Using energy-efficient appliances also reduces the amount of electricity used every day. In addition, simple actions, such as turning off lights when you leave a room and washing only full loads of laundry and dishes will reduce energy use.

Reducing the amount of driving you do also conserves fossil fuels. There is evidence that an average car produces more than 8 kg of carbon dioxide for every 3.8 L (1 gal) of gasoline burned. Even fuel-efficient and hybrid cars release some pollutants into the air. When making short trips, consider walking or riding a bicycle. If you need to use a car, combine errands so that you can make fewer trips.

Conservation of Other Natural Resources

Conservation is important for other natural resources, such as water. Some scientists estimate that by the year 2025, the world will have a critical shortage of freshwater resources because of the increased need by a larger human population. Water can be conserved by using water-saving shower heads, faucets, and toilets. By turning off the faucet as you brush your teeth, you can conserve up to 1 gallon of water every day. If you have a garden, you can help to conserve water by watering plants in the morning or at night and by planting native plants.

READING TOOLBOX

The Language of Prediction

As you read this page, make a list of statements of prediction. Underline the key words that tell you each statement is a prediction.

Section 4 Review

Key Ideas

1. **Name** two environmental problems associated with the mining and use of coal.
2. **Explain** two ways the environmental impacts of mining can be reduced.
3. **Describe** two reasons why scientists are looking for alternatives to fossil fuels.
4. **Define** the term *reclamation* in your own words.
5. **Identify** three ways that you can conserve natural resources every day.
6. **State** one way that recycling can help conserve energy.

Critical Thinking

7. **Analyzing Concepts** How do you think fossil-fuel use affects soil resources?
8. **Applying Ideas** Why does recycling require less energy than developing a new resource does?
9. **Drawing Conclusions** List 10 ways a small community can conserve energy and resources.

Concept Mapping

10. Use the following terms to create a concept map: *recycling, conservation, alternative energy source, renewable energy source, environmental impact, acid precipitation,* and *reclamation.*

REAL WORLD

What Does Your Dream Car Run On?

Why pay lots of money for fuel that pollutes the environment? Scientists are developing cleaner alternatives to fossil fuels. One day you may be able to drive a zero-emission solar vehicle. People now build and race solar-powered cars, but the cars are not practical for day-to-day use. Adding features to the cars for safety and comfort would add too much weight and make the cars unacceptably slow. Right now, however, some mass-produced vehicles use hybrid technologies that reduce their need for fossil fuels.

Alternative-fuel vehicles

Because golf carts are lightweight, low-speed vehicles, **solar cells** can provide enough energy to run them.

Biofuels, such as the biodiesel this bus runs on, are made from plant and animal wastes.

Hybrid cars use two or more power sources. They produce fewer emissions than cars that run only on gasoline.

Cars that run mainly on **compressed air** are being developed. They produce little to no pollution.

YOUR TURN

UNDERSTANDING CONCEPTS

What are advantages of using alternatives to fossil fuels?

Inquiry **Lab**

90 min

Blowing in the Wind

MEMO

To: Division of Research and Development

Quixote Alternative Energy Systems is accepting design proposals to develop a windmill that can be used to lift window washers to the tops of buildings. As part of the design engineering division, your team has been asked to develop a working model of such a windmill. Your task is to design and build a model that can lift 30 large paper clips a vertical distance of 50 cm. The job will be given to the team whose model can lift the paper clips the fastest.

What You'll Do

- **Prepare** a detailed sketch of your solution to the design problem.
- **Design and build** a functional windmill that lifts a specific weight as quickly as possible.

What You'll Need

blow-dryer, 1,500 W
dowel or smooth rod
foam board
glue, white
paper clips, large (30)
paper cup, small
spools of thread, empty (2)
string, 50 cm
optional materials for windmill blades:
foam board, paper plates, paper cups, or any other lightweight materials

Safety

Ask a Question

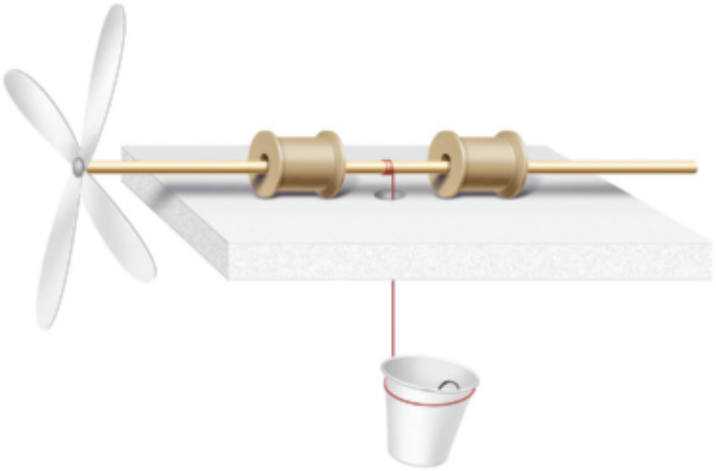
1. What is the best windmill design?

Form a Hypothesis

2. Brainstorm with a partner or small group of classmates to design a windmill using only the objects listed in the materials list. Sketch your design, and write a few sentences about how you think your windmill will perform.

Test the Hypothesis

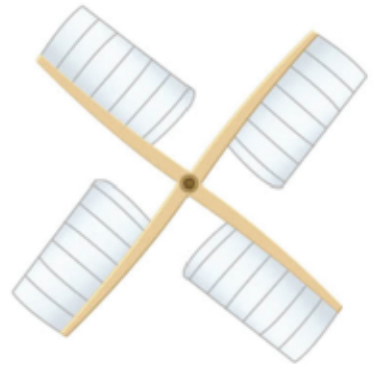
3. Have your teacher approve your design before you begin construction. Build the base for your windmill by using glue to attach the two spools to the foam board. Pass a dowel rod through the center of the spools. Make sure the spools are parallel and the dowel can rotate freely before you glue the spools. Attach one end of the string securely to the dowel between the two spools.

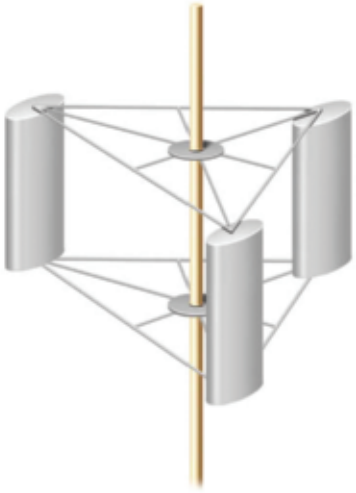


Step 3

4. Poke a hole through the middle of the foam board to allow the string to pass through. Place your windmill base between two lab tables or in any area that will allow the string to hang freely.
5. After you have decided on your final design, attach the windmill blades to the base.
6. If you have time, you may want to try using different materials to construct your windmill blades. Test the various blades to determine whether they improve the original design. You may also want to vary the number and size of the blades on your windmill.
7. Attach the cup to the end of the string. Fill the cup with 30 paper clips. Turn on the blow-dryer, and measure the time it takes for your windmill to lift the cup.

Step 2
Sample windmill blade designs





Analysis and Conclusion

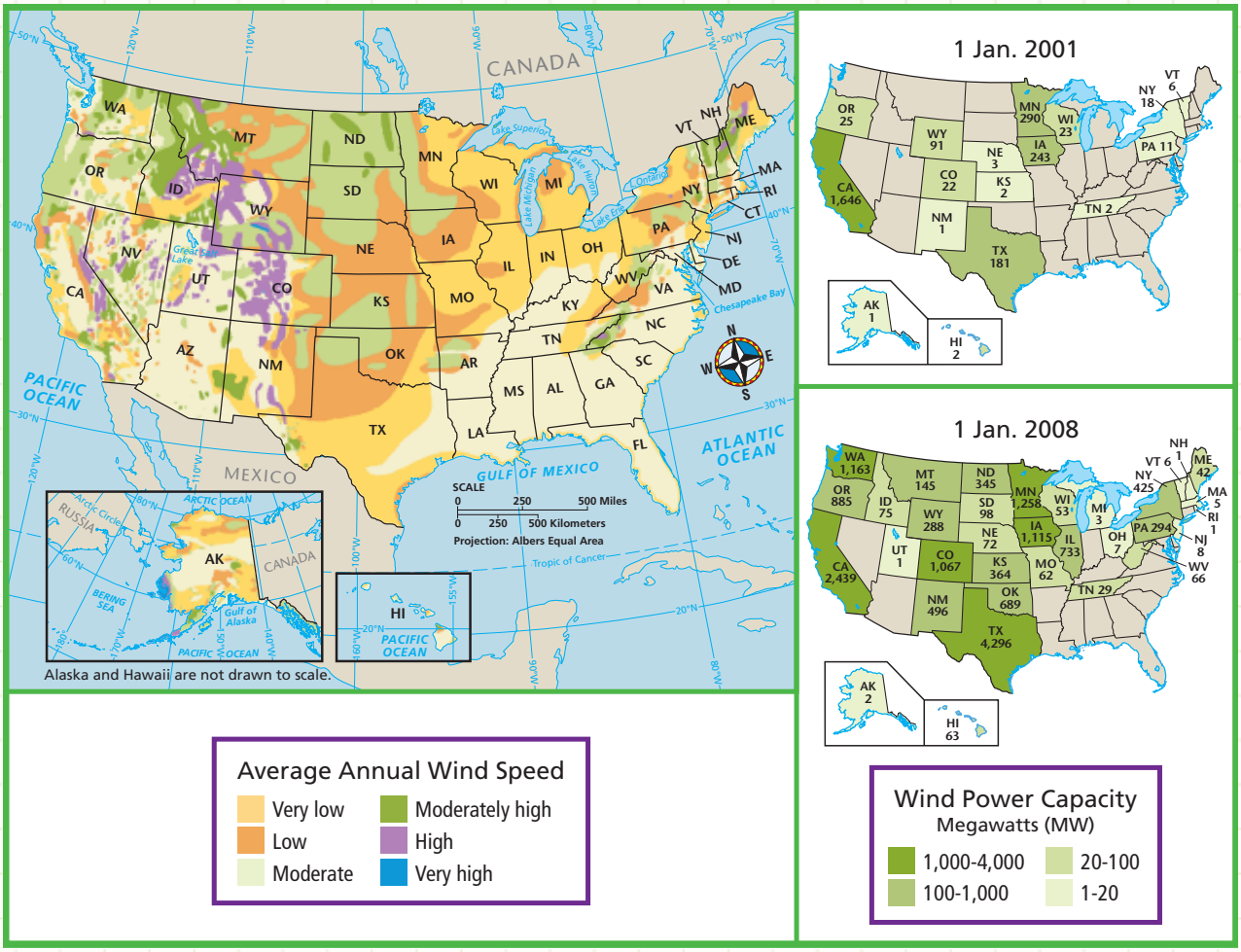
1. **Evaluating Methods** As a class, test all the designs to determine which design takes the shortest amount of time to lift the cup with the paper clips. What elements of the design do you think made the winning design the fastest?
2. **Evaluating Models** Describe how you would change your design to make your windmill work better or faster.

Extension

Research Windmills have been used for more than 2,000 years. Research the three basic types of vertical axis machines and the applications in which they are used. Prepare a report of your findings.

Making Models Adapt your design to make a water wheel. You will find that a water wheel can lift much more weight than a windmill can. Find designs on the Internet for micro-hydropower water wheels, such as the Pelton wheel, and use the designs as inspiration for your model. You can even design your own dam and reservoir.

Wind Power in the United States



Map Skills Activity

This map shows average wind speeds and the locations of wind power projects throughout the United States. Use the map to answer the questions below.

1. **Using a Key** Name two states that have areas of very high wind speed.
2. **Using a Key** Which two states had the most wind power capacity in 2001?
3. **Making Comparisons** Did the two states with the most wind power capacity in 2001 still hold that rank in 2008? Explain.
4. **Analyzing Data** According to the map, which state has an area with the highest average annual wind speed?
5. **Inferring Relationships** Examine Idaho, Wyoming, Montana, and Colorado. What landscape feature might account for the strong winds in those states?
6. **Identifying Trends** Which states increased their wind power capacity by at least 10 times between 2001 and 2008?
7. **Making Comparisons** Because of their potential for wind power projects, the Great Plains states (MT, WY, CO, ND, SD, NE, KS, OK, TX, MN, and IA) have been called the "Saudi Arabia of wind energy." Why do you think this comparison has been made?

Chapter 7

Summary

THINK central
SUPER SUMMARY
Keyword: HQXRENS

Key Ideas	Key Terms

Section 1

Mineral Resources

- Ores are mineral deposits in Earth's crust from which metallic and nonmetallic minerals can be profitably removed.
- Minerals are important sources of many useful and valuable materials.
- Humans obtain mineral resources through subsurface, surface, placer, and undersea mining.

ore, p. 167
lode, p. 168
placer deposit, p. 168
gemstone, p. 169

Section 2

Nonrenewable Energy

- Chemical and physical processes changed the remains of ancient plants into coal.
- Petroleum and natural gas formed from the remains of ancient microorganisms.
- Today, fossil fuels provide much of the world's energy.
- The energy released by nuclear fission—the splitting of the nuclei of heavy atoms—can be used to generate electricity.

nonrenewable resource, p. 171
fossil fuel, p. 171
nuclear fission, p. 174
nuclear fusion, p. 176

Section 3

Renewable Energy

- Geothermal energy is energy from the heat of Earth's interior. Unlike fossil fuels, it can be replaced as it is used.
- Solar energy from the sun can be harnessed by both passive and active methods.
- Alternative sources of renewable energy include hydroelectric, tidal, solar, and wind energy.

renewable resource, p. 177
geothermal energy, p. 177
solar energy, p. 178
hydroelectric energy, p. 179
biomass, p. 179

Section 4

Resources and Conservation

- Fossil fuels are nonrenewable resources. Once a nonrenewable resource is depleted, the resource may take millions of years to be replenished.
- Responsible mining operations work hard to return mined land to good condition through reclamation.
- Conservation is the preservation and wise use of natural resources to ensure that they last longer.

conservation, p. 183
recycling, p. 183

Chapter 7 Review

1. **The Language of Prediction** In your own words, rephrase in the form of statements of prediction the explanation in Section 4 of how obtaining and using fossil fuels affect the environment.

USING KEY TERMS

Use each of the following terms in a separate sentence.

2. *placer deposit*
3. *solar energy*
4. *conservation*

For each pair of terms, explain how the meanings of the terms differ.

5. *renewable resource* and *nonrenewable resource*
6. *ore* and *lode*
7. *nuclear fission* and *nuclear fusion*
8. *fossil fuel* and *biomass*
9. *geothermal energy* and *hydroelectric energy*

UNDERSTANDING KEY IDEAS

10. Metals are known to
    a. have a dull surface.
    b. provide fuel.
    c. conduct heat and electricity well.
    d. occur only in placer deposits.
11. Energy resources that formed from the remains of once-living things are called
    a. minerals. **c.** metals.
    b. gemstones. **d.** fossil fuels.
12. Impermeable rock that occurs at the top of an oil reservoir is called
    a. coal.
    b. peat.
    c. cap rock.
    d. water.
13. Plastics, synthetic fabrics, and synthetic rubber are composed of chemicals that are derived from
    a. anthracite. **c.** peat.
    b. petroleum. **d.** minerals.
14. The splitting of the nucleus of an atom to produce energy is called
    a. geothermal energy.
    b. nuclear fission.
    c. nuclear fusion.
    d. hydroelectric power.
15. Energy experts have harnessed geothermal energy by
    a. building dams.
    b. building wind generators.
    c. drilling wells.
    d. burning coal.
16. In a hydroelectric power plant, running water produces energy by spinning a
    a. turbine.
    b. windmill.
    c. fan.
    d. reactor.

SHORT ANSWER

17. Compare the three ways that ores commonly form.
18. Name two regulations that mining operations must follow to reduce the impact they have on the environment.
19. Identify and describe the uses for three mineral resources.
20. Describe one advantage and one disadvantage of obtaining energy from nuclear fission.
21. Describe one advantage and one disadvantage of the use of solar energy.
22. Identify two ways recycling can reduce energy use.
23. Explain two ways that moving water can be used to generate electricity.
24. Compare two types of mining, and describe the possible environmental impact of each type.

CRITICAL THINKING

25. Applying Ideas You learn that the price of iron is higher than it has been in 20 years. Do you think it might be profitable for a company to mine hematite? Explain your answer.

26. Understanding Relationships A certain area has extensive deposits of shale. Why might a petroleum geologist be interested in examining the area?

27. Identifying Trends Hybrid cars have efficient gasoline and electric motor combinations. They have other design elements that make them extremely fuel efficient. Do you expect that there will be more or fewer hybrid cars on the road in the future? Explain.

28. Making Inferences A certain company in your area produces ^{235}U pellets and fuel rods. With which energy source is the company involved? Explain.

CONCEPT MAPPING

29. Use the following terms to create a concept map: *resource, renewable, nonrenewable, fossil fuel, nuclear energy, geothermal energy, solar energy, hydroelectric energy,* and *conservation.*

MATH SKILLS

Math Skills

30. Making Calculations In one year, the United States produced 95,000 megawatts of power from renewable energy sources. If 3% of this power came from wind energy, how much energy did wind power produce that year?

31. Making Calculations A water-efficient washing machine uses 16 gallons of water per load of laundry. Older washing machines use more than 40 gallons of water per load of laundry. If you wash an average of 10 loads of laundry a month, how many gallons of water would you save in a year if you switched to the water-efficient washer?

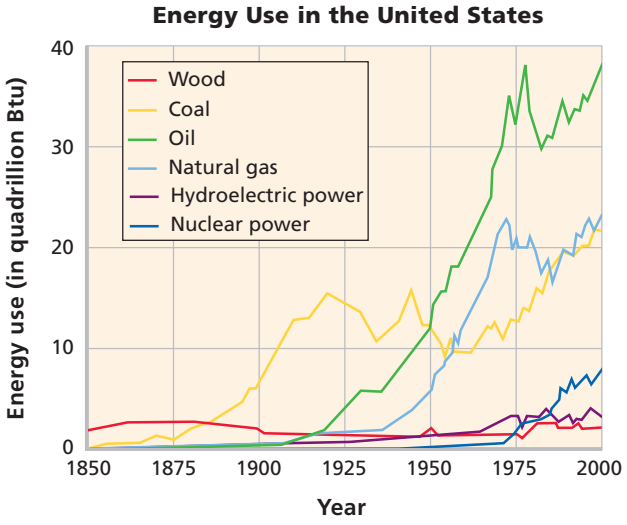
WRITING SKILLS

32. Researching Information A debate surrounds municipal recycling programs. Do some research, and write a paragraph explaining each side of the debate. Write another paragraph explaining your view on whether recycling programs should be continued.

33. Writing Persuasively Research the pros and cons of building dams to harness energy. Write a letter to the editor of a local newspaper to express your opinion about whether dams should be used for generating electricity.

INTERPRETING GRAPHICS

The graph below shows the different contributions of various fuels to the U.S. energy supply since 1850. Use this graph to answer the questions that follow.



34. What were the two main energy sources used in 1875?

35. When did oil first become a more widely used energy source than coal?

36. The use of oil and natural gas rise and fall together. How do you explain this pattern?

Chapter 7 Standardized Test Prep

Understanding Concepts

Directions (1–5): For each question, write on a separate sheet of paper the letter of the correct answer.

1. Which of the following is an example of a nonmetal mineral resource?
- **A.** gold
- **B.** quartz
- **C.** aluminum
- **D.** copper

2. Scientists estimate that worldwide coal reserves will last
- **F.** less than 20 years.
- **G.** about 200 years.
- **H.** about 1,000 years.
- **I.** indefinitely.

3. A mineral deposit called a *lode* is formed by
- **A.** metal fragments deposited in stream beds.
- **B.** layers accumulating in cooling magma.
- **C.** hot mineral solutions in cracks in rock.
- **D.** precipitation of minerals from seawater.

4. Which of the following is an example of a nonrenewable resource?
- **F.** natural gas
- **G.** sunlight
- **H.** falling water
- **I.** wind

5. A material from which mineral resources can be mined profitably is a(n)
- **A.** gemstone.
- **B.** ore.
- **C.** nodule.
- **D.** renewable resource.

Directions (6–8): For each question, write a short response.

6. Federal and state laws require mining companies to return land to its original condition, or better, when mining operations have been completed. What is this process called?

7. What are the three forms of fossil fuels, and what form does each one take?

8. Name three common items that may be recycled to save energy and natural resources.

Reading Skills

Directions (9–11): Read the passage below. Then, answer the questions.

Fossil Fuels

All fossil fuels form from the buried remains of ancient organisms. But different types of fossil fuels form in different ways and from different types of organisms. Petroleum and natural gas form mainly from the remains of microscopic sea life. When these organisms die, their remains collect on the ocean floor, where they are buried by sediment. Over time, the sediment slowly becomes rock and traps the organic remains. Through physical and chemical changes over millions of years, the remains become petroleum and natural gas. Gradually, more rocks form above the rocks that contain the fossil fuels. Under the pressure of overlying rocks and sediments, the fossil fuels are able to move through permeable rocks. Permeable rocks are rocks that allow fluids, such as petroleum and natural gas, to move through them. These permeable rocks become reservoirs that hold petroleum and natural gas.

9. What process causes organic remains to turn into fossil fuels?
- **F.** pressure caused by overlying rocks and sediments
- **G.** the constant layering of remains from microscopic sea life
- **H.** millions of years of physical and chemical changes
- **I.** the movement of fluids through layers of permeable rock

10. Which of the following statements can be inferred from the information in the passage?
- **A.** Fossil fuel formation is ongoing, and current remains may become petroleum in the future.
- **B.** Fossil fuel formation happened millions of years ago and no longer takes place today.
- **C.** Current petroleum and natural gas reservoirs are found only beneath the ocean floor.
- **D.** Permeable rocks are also a good place to find other fossil fuels, such as coal.

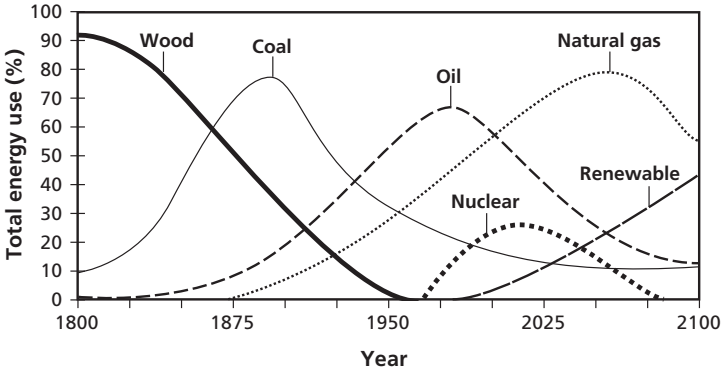
11. Why do we consider petroleum and natural gas to be nonrenewable resources?

Interpreting Graphics

Directions (12–14): For each question below, record the correct answer on a separate sheet of paper.

The graph below illustrates the sources of energy used in the United States since 1850. Future statistics are predicted based on current trends and technology development. Use this graph to answer questions 12 and 13.

U.S. Energy Use from 1850 to 2100



12. Which of the following is the main reason that coal became a more widely used energy source than wood in the mid-1800s?

F. Coal burns easier than wood does.
G. Coal is renewable resource, unlike wood.
H. Coal is a more efficient energy producer than wood.
I. Coal produces fewer byproducts and waste than wood does.

13. Evaluate reasons why nuclear power is predicted to peak in usage around the year 2025, and then steadily decline in usage.

The table below shows common minerals and their uses. Use this table to answer question 14.

Minerals and Their Uses

Minerals	Uses
Gold	electronics, coins, dental work, and jewelry
Galena	solder and batteries
Quartz	glass
Sulfur	medicines, gunpowder, and rubber
Graphite	pencils, paint, and lubricants
Hematite	steel
Chalcopyrite	coins, jewelry, and cables

14. Use your everyday knowledge of automobiles to describe the part of an automobile for which each mineral listed in the table may be used.

Test Tip

When a question refers to a graph, study the data plotted on the graph to determine any trends or anomalies before you try to answer the question.

Why It Matters

Geology Connections

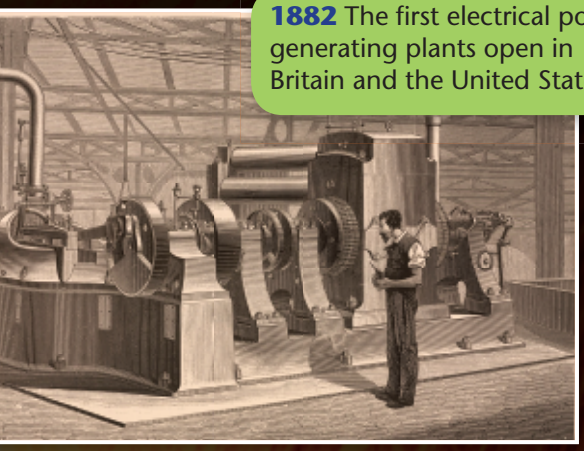
Science, technology, and society are closely linked. This flowchart shows just a few of the connections in the history of geology.

359–299 Ma Forests, swamps, and oceans cover large areas of Earth's surface during the warm, humid Carboniferous Period.

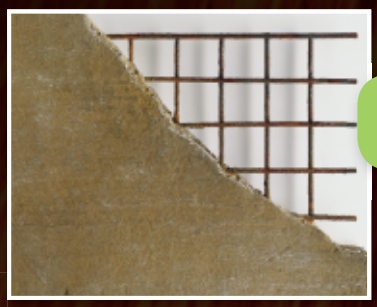
1751 Benjamin Franklin publishes his theory of electricity.

8,000 B.C.E. Stone-age people in what is now China begin to mine coal for fuel use.

1200 B.C.E. The Iron Age begins in India, Greece, and the Near East. Early steel is produced in Africa.



1882 The first electrical power generating plants open in Britain and the United States.



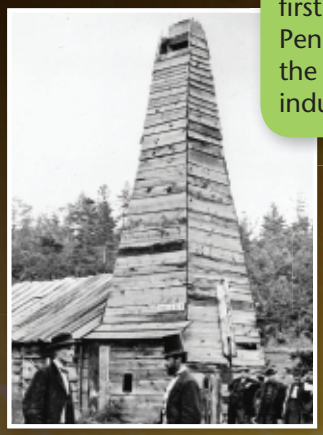
1849 Frenchman Joseph Monier invents steel-reinforced concrete.

1824 Joseph Aspdin invents Portland cement.

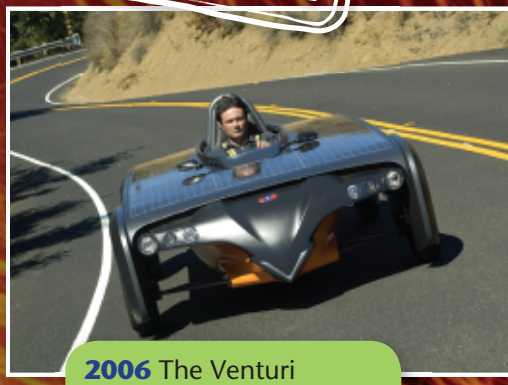
300 B.C.E. Roman builders add volcanic ash to cement, building structures that still exist today.

HISTORY IN SCIENCE

1859 Edwin Drake drills the first oil well in Western Pennsylvania, which leads to the growth of the modern oil industry in the Americas.



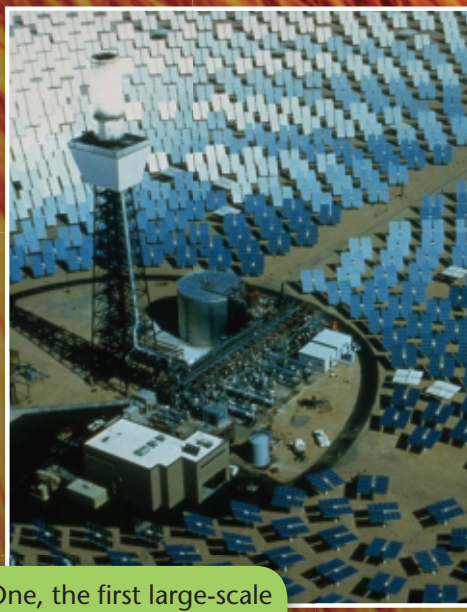
1886 Karl Benz receives a patent for inventing the first gasoline-fueled car.



2006 The Venturi *Astrolab* becomes the world's first commercially available solar-electric hybrid car.

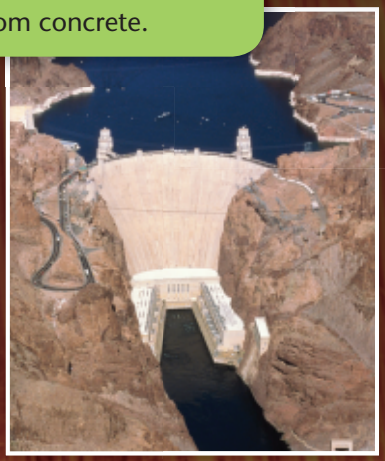
1855 The Bessemer process makes steel abundant and inexpensive.

1970s Oil shortages promote interest in conservation and alternative energy resources.



1982 Solar One, the first large-scale solar power plant, begins operation near Barstow, California.

1935 Hoover Dam is the world's first major dam to be constructed from concrete.



2007 Alamosa Skatepark Environment opens in Albuquerque, New Mexico.

YOUR TURN

UNDERSTANDING CONCEPTS
When did people first start using iron?

CRITICAL THINKING
How are the forests and swamps of the Carboniferous Period related to the coal we use today?