

A person who explores caves is a spelunker.



15 min


InquiryLab



The Greenhouse Effect

Gases in the atmosphere trap heat and keep Earth warm. In this activity, you will model this process called the *greenhouse effect*.

Procedure

-  **CAUTION: Handle the glass thermometer and jar with care.** Insert a **thermometer** through a hole in the lid of a **quart jar**. Tape the thermometer in place.
- Place the jar about 30 cm from a **heat source**, such as a sunlit window.
- Record the temperature inside and outside the jar every 30 s for 5 min.
- Remove the jar from the heat source. Record the temperature inside and outside the jar every 30 s for another 5 min.

Analysis

- Compare** the change in temperature inside the jar with the change in temperature outside the jar.
- Identify** the part of your model that represents the gases in the atmosphere.
- Explain** a possible reason why global temperatures on Earth have increased. Include what you learned from your model of the greenhouse effect.



These reading tools can help you learn the material in this chapter. For more information on how to use these and other tools, see **Appendix: Reading and Study Skills**.

Using Words

Word Parts You can tell a lot about a word by taking it apart and examining its prefix, root, and suffix.

Your Turn Use the information in the table to define the following words.

1. biodiversity
2. deforestation

Word Parts		
Word Part	Type	Meaning
bio-	prefix	life
versi	root	various
de-	prefix	remove
-ation	suffix	a state of being

Using Language

Hypothesis or Theory? To scientists, a theory is a well-supported scientific explanation that makes useful predictions. The main difference between a theory and a hypothesis is that a hypothesis has not been tested, and a theory has been tested repeatedly and seems to correctly explain all the available data.

Your Turn Use information from the chapter to answer the following questions.

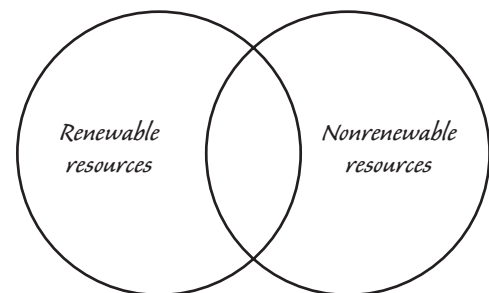
1. Is the greenhouse effect a hypothesis or theory? Explain.
2. Write your own hypothesis that explains the increase in global temperatures.

Using Graphic Organizers

Venn Diagrams A Venn diagram is a useful tool for comparing two or three topics in science. A Venn diagram shows which characteristics the topics share and which characteristics are unique to each topic.

Your Turn Create a Venn diagram that describes the characteristics of renewable and nonrenewable resources.

1. Draw a diagram like the one shown here. Draw one circle for each topic. Make sure that each circle partially overlaps the other circles.
2. In each circle, write a topic that you want to compare with the topics in the other circles.
3. In the areas of the diagram where circles overlap, write the characteristics that the topics in the overlapping circles share.
4. In the areas of the diagram where circles do not overlap, write the characteristics that are unique to the topic of the particular circle.



An Interconnected Planet

Key Ideas

- ▶ How are humans and the environment connected?
- ▶ What is the difference between renewable resources and nonrenewable resources?
- ▶ How can the state of the environment affect a person's health and quality of life?

Key Terms

fossil fuel

Why It Matters

The environment provides the resources that we need to live. When the environment is damaged, our resources are damaged.

We depend on the environment for food, water, air, shelter, fuel, and many other resources. However, human actions can affect the quality and availability of these important resources. The study of the impact of humans on the environment is called *environmental science*.

Humans and the Environment

10,000 years ago, there were only about 5 million people on Earth. The development of dependable food supplies, sanitation, and medical care have allowed the population to grow to more than 6 billion. The population will likely exceed 10 billion before it stabilizes. All 10 billion of these people will need a place to live. Humans now live in almost every kind of ecosystem on Earth. **Figure 1** shows one type of ecosystem in which humans live. As human population increases, the impact of humans on the environment increases. ▶ **Humans are a part of the environment and can affect the resilience of the environment.** The more that the human population grows, the more resources from the environment we will need to survive. Today's humans consume more resources than their ancestors did. The environment does not have an infinite amount of resources with which to meet humans' demand.

Earth is an interconnected planet: we depend on the environment, and the environment is affected by our actions. Learning about this connectedness helps us care for the environment and helps ensure that the environment will continue to support us and other species on Earth.

- ▶ **Reading check** *How is Earth an interconnected planet? (See the Appendix for answers to Reading Checks.)*

Figure 1 This housing development lies in the marshlands along Myrtle Beach, South Carolina. ▶ **Can you describe another ecosystem that humans live in?**



ACADEMIC VOCABULARY

resource anything that can be used to take care of a need

SCILINKS

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Topic: Renewable and nonrenewable resources

Code: HX81290

fossil fuel a nonrenewable energy resource formed from the remains of organisms that lived long ago; examples include oil, coal, and natural gas

Figure 2 Windmills produce renewable wind energy, while the oil rig extracts a nonrenewable energy resource. ➤ Can you think of another example for each renewable and nonrenewable resource?

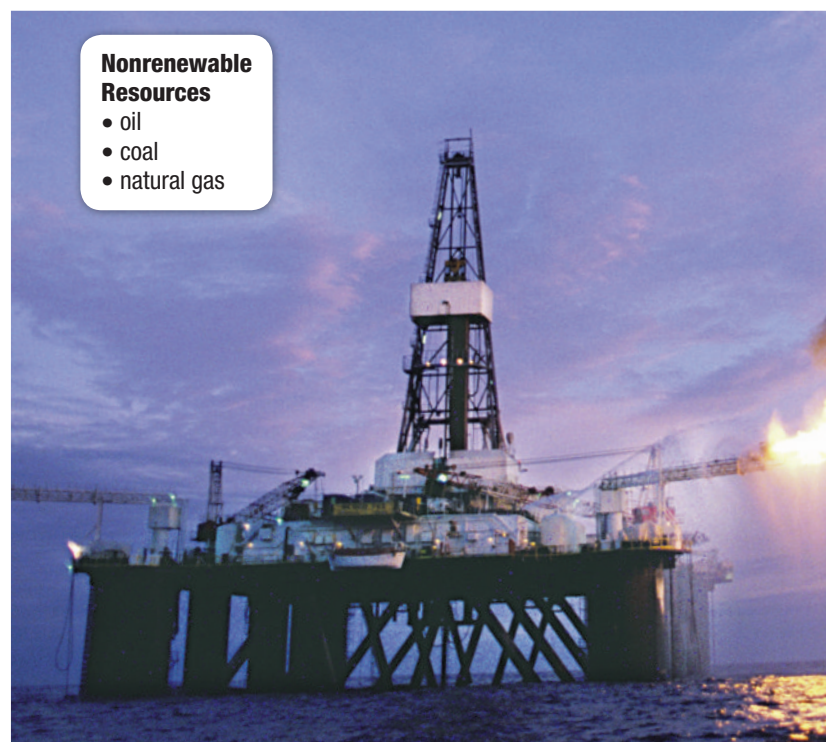
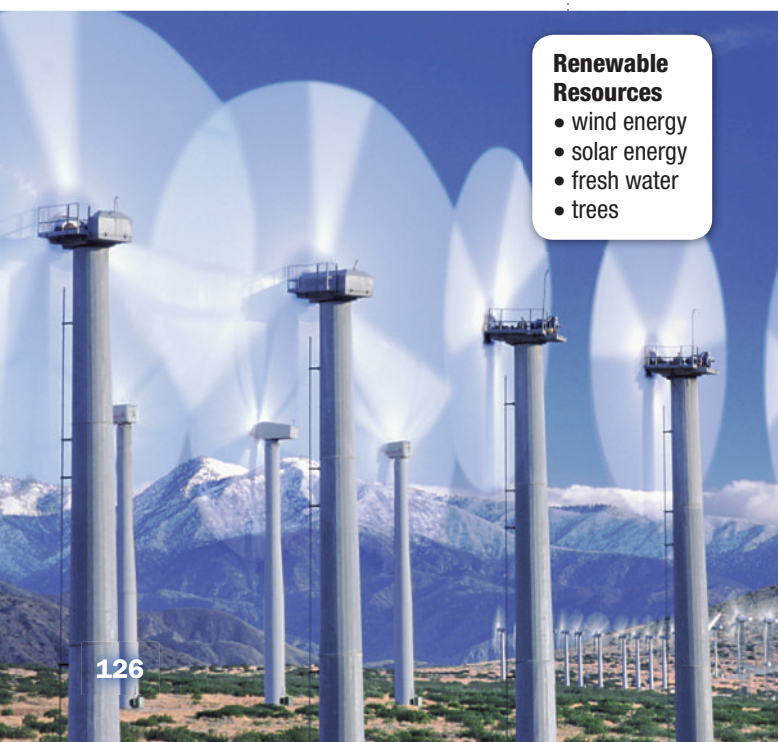
Resources

What would your day be like if you didn't have water to drink or electricity to provide lighting and heat? Water and fuel that generates electricity are two of Earth's many resources. Earth's resources are described as renewable or nonrenewable, as shown in **Figure 2**.

Renewable Resources Fresh water, solar energy, and fish are examples of renewable resources. ➤ **Renewable resources** are natural resources that can be replaced at the same rate at which they are consumed. A renewable resource's supply is either so large or so constantly renewed that it will never be used up. However, a resource can be renewable but still be used up if it is used faster than it can be renewed. For example, trees are renewable. But, some forests are being cut down faster than new forests can grow to replace them.

Nonrenewable Resources Many resources that we depend on, such as minerals, coal and oil, are nonrenewable resources. ➤ **Nonrenewable resources** are resources that form at a rate that is much slower than the rate at which they are consumed. Most of our energy today comes from fossil fuels. **Fossil fuels** are nonrenewable energy resources that formed from the remains of organisms that lived long ago. Examples of fossil fuels are coal, oil, and natural gas. Coal, oil, and natural gas are nonrenewable resources because it takes millions of years for them to form. They form from the remains of organisms that were buried by sediment millions of years ago. As sediment accumulated over the remains, heat and pressure increased. Over time, the heat and pressure caused chemical changes that changed the remains into oil and natural gas. We use fossil fuels at a rate that is faster than the rate at which they form. So, when these resources are gone, millions of years will pass before more have formed.

➤ **Reading check** Explain why natural gas is a nonrenewable resource.





Contaminated Water

In this activity, you will learn how contaminated water can spread an infectious disease.

Procedure

- CAUTION:** Do not taste or touch the fluids used in this lab. Obtain one **test tube** of **fluid** from your teacher. Some test tubes contain pure water. One test tube contains water that has been “contaminated”.
- Pour half your fluid into the test tube of a classmate. Your classmate will then pour an equal amount back into your test tube. Exchange water with three classmates in this way.
- Your teacher will now put a small amount of a **test chemical** into your test tube. If your water turns cloudy, you have been “contaminated.”

Analysis

- CRITICAL THINKING Analyzing Conclusions** Who had the test tube that started the “infection?”
- Identify** a disease that could be spread in water.

The Environment and Health

Our health and quality of life are affected by the state of the environment. ➤ **Pollution and habitat destruction destroy the resources we need to live, such as the air we breathe, the water we drink, and the food we eat.** Air pollution can cause headaches, sore throats, nausea, and upper respiratory infections. Air pollution has also been connected to lung cancer and heart disease. Some chemical pollutants in drinking water can lead to birth defects and cancer. Many infectious diseases, such as cholera, are spread by water polluted by sewage. Habitat destruction can also affect our safety. The root networks of trees help hold soil in place. Cutting down trees increases the number of landslides and floods, which can cause deaths and injuries.

READING TOOLBOX

Word Parts Look up the suffix *-tion* in the dictionary. Also, look up the words *pollute* and *destroy* in a dictionary. Then, write your own definition for *pollution* and *destruction*.

Section

1

Review

KEY IDEAS

- Explain** how human population affects the environment.
- Describe** the difference between renewable resources and nonrenewable resources.
- State** a nonrenewable resource that you used today.
- State** three ways that environmental problems may affect human health.

CRITICAL THINKING

- Inferring relationships** Events such as floods and landslides are commonly called *natural disasters*. Explain how both natural events and human actions might have contributed to a natural disaster that you have learned about.
- Analyzing data** Consider a 1,000-year-old forest and a 30-year-old tree farm. How do differences between these resources affect how renewable the resources are?

WRITING FOR SCIENCE

- Evaluating viewpoints** A classmate argues that pollution is a necessary evil to produce food, jobs, and a high standard of living. Write a one-page paper describing your opinion of your classmate's argument. Support your opinion with facts.

Environmental Issues

Key Ideas	Key Terms	Why It Matters
<ul style="list-style-type: none"> ➤ What are the effects of air pollution? ➤ How might burning fossil fuels lead to climate change? ➤ What are some sources of water pollution? ➤ Why is soil erosion a problem? ➤ How does ecosystem disruption affect humans? 	<p>acid rain global warming greenhouse effect erosion deforestation biodiversity extinction</p>	<p>In the course of meeting their basic needs, humans can unintentionally damage the global environment.</p>

Human activities can affect every ecosystem on Earth. Understanding these effects and the problems that they can cause is the first step to successfully solving them.

Air Pollution

Have you ever breathed air that smelled bad or made your lungs burn? The bikers in **Figure 3** have. Natural processes, such as volcanic activity, can affect air quality. However, most air pollution is caused by human activities. Industries, power plants, and vehicles must burn fossil fuels for energy. The burning of fossil fuels releases the pollutants carbon dioxide (CO₂), sulfur dioxide (SO₂), and nitrogen oxides (NO₂ and NO₃) into the air. ➤ Air pollution causes respiratory problems for people, results in acid rain, damages the ozone layer, and may affect global temperature.

Acid rain is precipitation that has an unusually high concentration of sulfuric or nitric acids, which is caused by pollution. Acid rain damages forests and lakes. The ozone layer protects life on Earth from the sun's damaging ultraviolet (UV) rays. The ozone layer has been damaged by *chlorofluorocarbons* (CFCs). CFCs are human-made chemicals that are used as coolants in refrigerators and air conditioners and as propellants in spray cans. Global temperature may be affected by air pollutants. **Global warming** is the gradual increase in the average global temperature.

Figure 3 Workers leaving the steel mill in Baotou, China, wear masks to avoid breathing in the pollution.





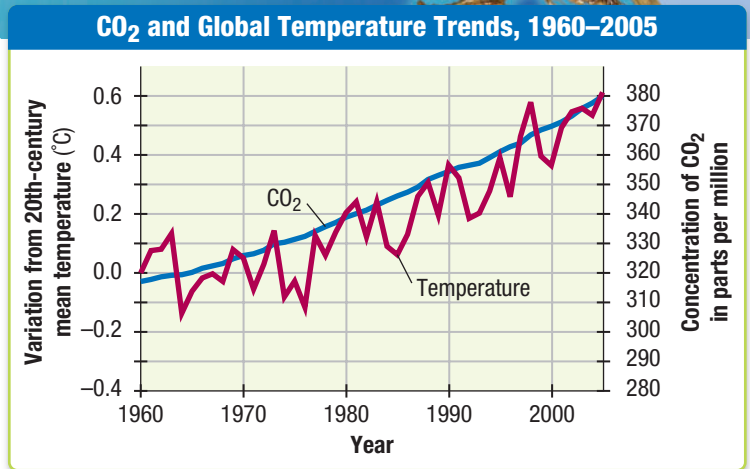
Global Warming

What does it feel like to climb into a car on a hot, sunny day? The inside of the car is hot because the sun's energy passes through the glass windows. The inside of the car absorbs the solar energy and changes it to heat energy. The heat energy cannot easily pass back through the glass windows. Therefore, the heat is trapped and makes the inside of the car hot. The atmosphere traps heat and warms the Earth in a similar way. The **greenhouse effect** is the warming of the surface and lower atmosphere of Earth that happens when greenhouse gases in the air absorb and reradiate heat. Examples of greenhouse gases are CO₂ and water vapor. **Figure 4** shows how this process works.

The greenhouse effect is necessary to keep Earth's temperatures stable. However, Earth's global temperatures have been rising steadily for many decades. Most scientists think that this increase in temperatures is caused by an increase in CO₂. ➤ **Burning fossil fuels increases the amount of CO₂ in the atmosphere. Increases in atmospheric CO₂ may be responsible for an increase in global temperatures.**

Effects of Global Warming A continued increase in global temperatures has the potential to cause a number of serious environmental problems. For example, ice sheets over Antarctica and Greenland have already started to melt. If these ice sheets continue to melt, they could raise sea levels around the world. Coastal ecosystems would be destroyed. People who live along a coast could lose their homes. Global weather patterns would also be affected. For example, warmer oceans make hurricanes and typhoons more intense and could make such storms more common. Droughts could become more frequent, causing damage to crops. The equilibrium in ecosystems could be altered. Migration patterns of some birds have already changed.

➤ **Reading check** *How might the burning of fossil fuels affect climate?*



Source: Scripps Institute of Oceanography and National Oceanic & Atmospheric Administration.

Figure 4 The greenhouse effect is a natural process that keeps Earth warm.
➤ **How does the increase in CO₂ relate to global warming?**

acid rain precipitation that has a pH below normal and has an unusually high concentration of sulfuric or nitric acids, often as a result of chemical pollution of the air from sources such as automobile exhausts and the burning of fossil fuels

global warming a gradual increase in the average global temperature

greenhouse effect the warming of the surface and lower atmosphere of Earth that occurs when carbon dioxide, water vapor and other gases in the air absorb and reradiate infrared radiation

SciLINKS
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 Topic: Chemical
 Pollution
 Code: HX80272

Water Pollution

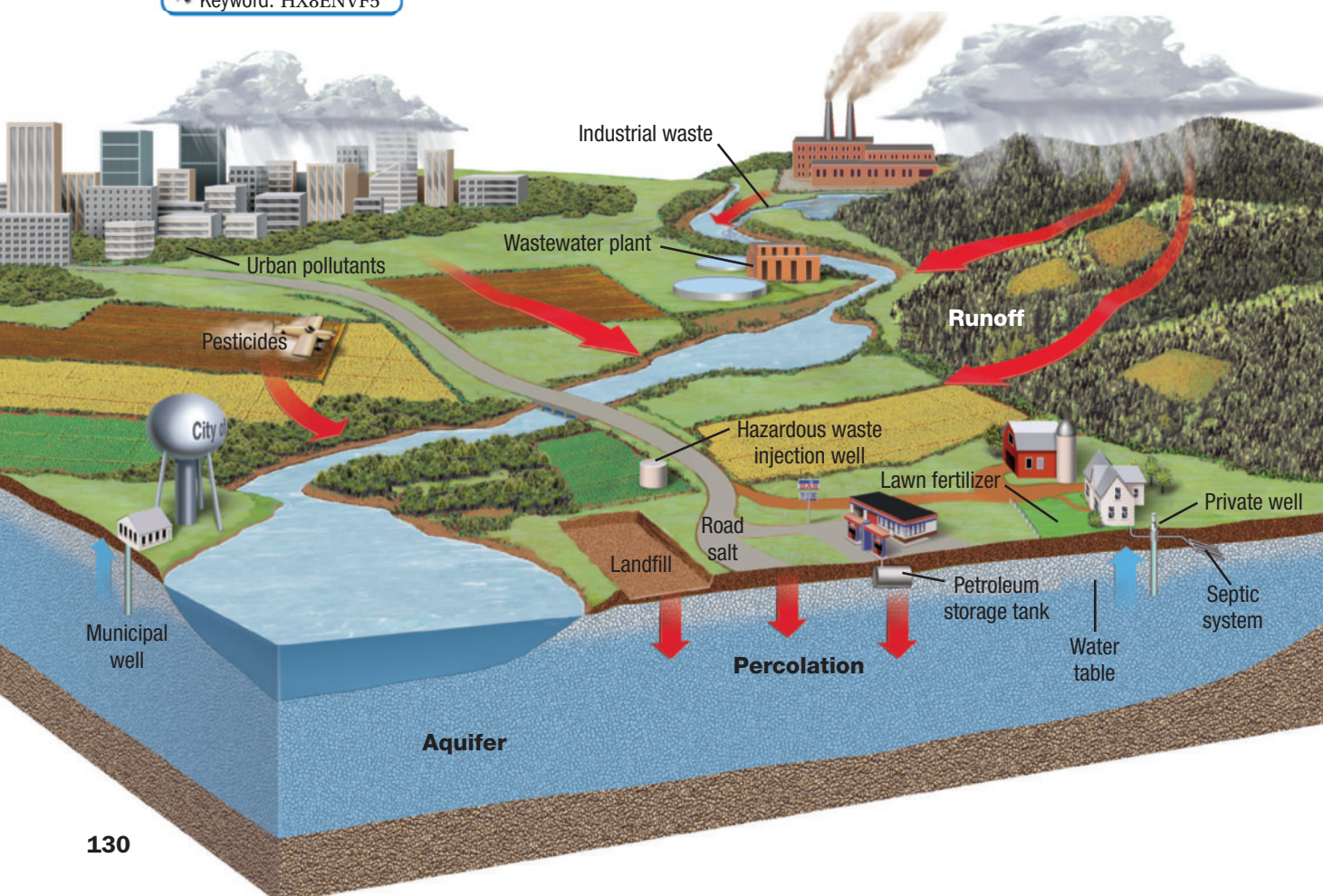
Every person needs 20–70 L (5–18 gal) of clean water each day to meet his or her drinking, washing, and sanitation needs. Unfortunately, many sources of water are polluted. **Figure 5** shows major sources of water pollution. ➤ **Water pollution can come from fertilizers and pesticides used in agriculture, livestock farms, industrial waste, oil runoff from roads, septic tanks, and unlined landfills.** Pollution enters groundwater when polluted surface water percolates down through the soil. Oil on roads can be washed into the ground by rain. Pesticides, fertilizers, and livestock waste seep into the ground in a similar way. Landfills and leaking underground septic tanks are also major sources of groundwater pollution.

When pollutants run off land and into rivers, both aquatic habitats and public water sources may be contaminated. For example, the pesticide, DDT, harmed many species, such as the bald eagle. The bald eagle was in danger of becoming extinct until the U.S. restricted the use of DDT in 1972. Pollution can also affect ecosystems. Fertilizers from farms, lawns, and golf courses can run off into a body of water, which increases the amount of nutrients in the water. An increase in some nutrients in a body of water can lead to an excessive growth of algae called a “bloom.” Algal blooms can deplete the dissolved oxygen in a body of water. Fish and other organisms then suffocate in the oxygen-depleted water.

Figure 5 Pollutants on Earth’s surface run off the land and into ground water and other water systems. ➤ **List the sources of water pollution that might occur in your neighborhood.**

➤ **Reading check** *List three sources of water pollution.*

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Soil Erosion

In this lab you will investigate factors that affect erosion.

Procedure

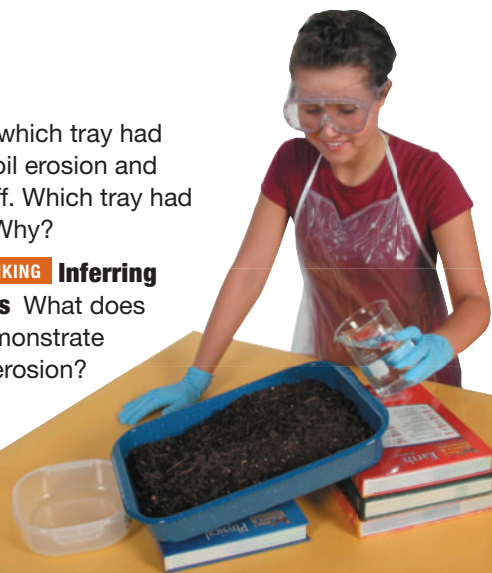
- 1 Fill **three trays**: one with **sod**, one with **topsoil**, and one with a type of **mulch**.
- 2 Place each tray at an angle on a “hill” of stacked **textbooks**. Place the same type of **large bowl** at the bottom of each tray to catch the runoff.
- 3 Pour **2 L of water** slowly and evenly on each tray to simulate heavy rainfall.
- 4 Use a **scale** to weigh the runoff of soil and water that collected in each bowl.

Analysis

1. **Determine** which tray had the most soil erosion and water runoff. Which tray had the least? Why?

2. **CRITICAL THINKING** **Inferring**

Conclusions What does this lab demonstrate about soil erosion?



Soil Damage

Fertile soil allows agriculture to supply the world with food. The United States is one of the most productive farming countries, largely because of its fertile soils. Fertile soil forms from rock that is broken down by weathering. Nutrients that make soil fertile come from the weathered rock as well as from bacteria, fungi and the remains of plants and animals. The processes that form just a few centimeters of fertile soil can take thousands of years. Without fertile soil, we cannot grow crops to feed ourselves or the livestock we depend on.

Soil Erosion The greatest threat to soil is soil erosion. **Erosion** is a process in which the materials of Earth’s surface are worn away and transported from one place to another by wind, gravity, or water.

➤ **Soil erosion destroys fertile soil that we need in order to produce food.**

Roots from plants and trees help hold soil together and protect it from erosion. When vegetation is removed, soil is left vulnerable to erosion. Many farming methods can lead to soil erosion. Plowing loosens the topsoil and removes plants that hold the soil in place. The topsoil can then be washed away by wind or rain.

Soil Conservation Sustainable agricultural practices can help conserve fertile soil. For example, *terracing* changes a steep field into a series of flat steps that stop gravity from eroding the soil. Planting a *cover crop*, such as soybeans, restores nutrients to the soil. *Crop rotation*, or planting a different crop every year, slows down the depletion of nutrients in the soil. In *contour plowing*, rows are plowed in curves along hills instead of in straight lines. The rows then act as a series of dams, which prevent water from eroding the soil.

➤ **Reading check** *How does erosion damage soil?*

erosion a process in which the materials of Earth’s surface are loosened, dissolved, or worn away and transported from one place to another by a natural agent, such as wind, water, ice, or gravity

READING TOOLBOX

Hypothesis or Theory? A lake in your state has had hundreds of dead fish wash up on shore. Write your own hypothesis that might explain why so many fish in the lake died.

Ecosystem Disruption

We share Earth with about 5 million to 15 million species. We depend on many of these species for fulfillment of our basic needs. We get food, clothing, medicines, and building material from many plants and animals. Yet as the human population has grown and affected every ecosystem, this wondrous diversity of life has suffered.

➤ **Ecosystem disruptions can result in loss of biodiversity, food supplies, potential cures for diseases, and the balance of ecosystems that supports all life on Earth.** We cannot avoid disrupting ecosystems as we try to meet the needs of a growing human population. But we can learn about how our actions affect the environment so that we can create ways to conserve it.

Habitat Destruction Over the last 50 years, about half of the world's tropical rain forests have been cut down or burned. The forests have been cleared for timber, pastureland, or farmland, as shown in **Figure 6**. This process of clearing forests is called **deforestation**. Many more thousands of square miles of forest will be destroyed this year. Some of the people who cut down the trees are poor farmers trying to make a living. The problem with deforestation is that as the rain forests and other habitats disappear, so do their inhabitants. In today's world, habitat destruction and damage cause more extinction and loss of biodiversity than any other human activities do.

Loss of Biodiversity Ecosystem disruption decreases the number of Earth's species. Biodiversity affects the stability of ecosystems and the sustainability of populations. **Biodiversity** is the variety of organisms in a given area. Every species plays an important role in the cycling of energy and nutrients in an ecosystem. Each species either depends on or is depended on by at least one other species. When a species disappears, a strand in a food web disappears. If a keystone species disappears, other species may also disappear. The species that disappears may be one that humans depend on.

There are many ways in which humans benefit from a variety of life forms on Earth. Humans have used a variety of organisms on Earth for food, clothing, shelter, and medicine. At least one-fourth of the medicines prescribed in the world are derived from plants. Fewer species of plants could mean fewer remedies for illnesses.

deforestation the process of clearing forests

biodiversity the variety of organisms in a given area, the genetic variation within a population, the variety of species in a community, or the variety of communities in an ecosystem

extinction the death of every member of a species

ACADEMIC VOCABULARY

sustain to maintain or keep in existence

Figure 6 This forest in Brazil was slashed and burned to provide land for cattle and crops. ➤ **How does deforestation decrease biodiversity?**





Figure 7 The zebra mussel (left) is an invasive species that has disrupted the ecosystems of the Great Lakes region. The red panda (right) is an endangered species because its habitat, located in China and Myanmar, is being disrupted. ➤ Name another example of an invasive species. Name three other endangered species.

Invasive Species Humans have disrupted ecosystems by intentionally and unintentionally introducing nonnative species. One example of an invasive species is the zebra mussel, shown in **Figure 7**. In the 1980s, the zebra mussel was unintentionally introduced to the Great Lakes by ships traveling from the Black and Caspian Seas. The zebra mussel disrupted the Great Lakes ecosystem, causing some species to struggle while others flourished. Zebra mussels have also had a negative impact on humans. Zebra mussels clog the pipes of water treatment facilities which costs the public millions of dollars a year.

Extinction Many species are on the edge of extinction. **Extinction** is the death of every member of a species. One species that is at risk of extinction is the red panda. A red panda is shown in **Figure 7**. When a species becomes extinct, we lose forever the knowledge and benefits that we might have gained from the species. For example, two anticancer drugs have been developed from the rosy periwinkle, a flower in Madagascar that is threatened by deforestation. If this flower becomes extinct, a possible source of new drugs is gone.

➤ **Reading Check** *How has the introduction of the zebra mussel into the Great Lakes affected humans?*

Section

2

Review

➤ KEY IDEAS

1. **Identify** the affects of air pollution.
2. **Explain** how the burning of fossil fuels, such as oil, might lead to climate change.
3. **Identify** five sources of water pollution.
4. **Explain** why soil erosion is a problem.

5. **List** four ways ecosystem disruption affects humans.

CRITICAL THINKING

6. **Evaluating Viewpoints** A classmate asserts that extinction is not a problem because everything goes extinct eventually. Explain how extinction can be both a natural process and a current problem for society.

USING SCIENCE GRAPHICS

7. **Predicting Patterns** Using the chart, “CO₂ and Global Temperature Trends, 1960–2005,” predict temperature and CO₂ levels for the year 2020. Describe how the temperature you predict would affect humans.

Environmental Solutions

Key Ideas	Key Terms	Why It Matters
<ul style="list-style-type: none"> ➤ How do conservation and restoration solve environmental issues? ➤ What are three ways that people can reduce the use of environmental resources? ➤ How can research and technology affect the environment? ➤ How do education and advocacy play a part in preserving the environment? ➤ Why is it important for societies to consider environmental impact when planning for the future? 	<p>recycling ecotourism</p>	<p>Everyone can play an important role in sustaining a healthy environment for all of us.</p>

Protecting the environment is critical to human well-being. With new technologies and the effort of individuals and governments, many environmental problems can be solved.

Conservation and Restoration

Two major techniques for dealing with environmental problems are conservation and restoration. ➤ **Conservation** involves protecting existing natural habitats. **Restoration** involves cleaning up and restoring damaged habitats. The best way to deal with environmental problems is to prevent them from happening. Conserving habitats prevents environmental issues that arise from ecosystem disruption. For example, parks and reserves protect a large area in which many species live.

Restoration reverses damage to ecosystems. Boston Harbor, shown in **Figure 8**, is one restoration success story. Since the colonial period, the city dumped sewage directly into the harbor. The buildup of waste caused outbreaks of disease. Beaches were closed. Most of the marine life disappeared and as a result, the shellfish industry shut down. To solve the problem, the city built a sewage-treatment complex. Since then, the harbor waters have cleared up. Plants and fish have returned, and beaches have been reopened.

➤ **Reading check** *What is the difference between restoration and conservation?*

Figure 8 Once considered one of the most polluted harbors in the world, Boston Harbor has been cleaned up as part of a restoration project.

➤ Name a restoration project or natural preserve in your state.





Recycled Paper

In this activity, you will learn how to recycle paper.

Procedure

- 1 Tear **two sheets of used paper** into small pieces.
- 2 Put the pieces in a **blender** with **1 L of water**. Cover and blend until the mixture is soupy.
- 3 Fill a square **pan** with **2–3 cm of water**. Place a **wire screen** in the pan.
- 4 Pour 250 mL of the paper mixture onto the screen and spread the mixture evenly.
- 5 Lift the screen and paper mixture out of the water.
- 6 Place the screen inside a section of **newspaper**. Close the newspaper and turn it over so that the screen is on top of the mixture.

- 7 Cover the newspaper with a **flat board** and press on the board to squeeze out the water.
- 8 Open the newspaper and let your paper dry overnight.

Analysis

1. **Evaluate** whether the paper you made is as strong as the paper that it was made from.
2. **CRITICAL THINKING Analyzing Methods** How might you improve your technique to produce stronger paper?

Reduce Resource Use

The impact of humanity on the environment depends on how many resources we use. We can decrease our impact by using fewer resources. ➤ We can reduce our use of resources, such as water and fossil fuels for energy. We can reuse goods rather than disposing of them. Furthermore, we can recycle waste to help protect the environment.

Reduce One of the best ways that you can help solve environmental problems is by reducing the amount of energy that you use and the amount of waste that you produce. You can use ceramic plates instead of a disposable paper plate. Low-flow toilets and shower heads can decrease the amount of water used.

Reuse The reuse of goods saves both money and resources. Many things are thrown away and wasted though they are still useful. Plastic bags and utensils can be used several times, rather than only once before disposal.

Recycle The process of reusing things instead of taking more resources from the environment is called **recycling**. Recycling existing products generally costs less than making new ones from raw materials does. For example, recycling aluminum uses about 95 percent less energy than mining and processing the aluminum from Earth does. Recycling also prevents pollution. For example, recycling motor oil keeps toxic substances out of landfills.

➤ **Reading Check** *What are three ways that you can reduce your use of resources?*

ACADEMIC VOCABULARY

impact the effect of one thing on another

recycling the process of recovering valuable or useful materials from waste or scrap



Technology

Advances in technology have led to the production of cars and the development of industry. Both of these processes have contributed to the problem of pollution. But, technology brings not only problems but also environmental solutions. ▶ **Research and technology can help protect our environment by providing cleaner energy sources, better ways to deal with waste, and improved methods for cleaning up pollution.**

Solar panels, shown in **Figure 9**, hybrid cars, and scrubbers are examples of advances in technology. Hybrid cars use a combination of electricity and gasoline as their source of energy. Hybrid cars designed to be fuel-efficient, burn less gasoline and release less pollution into the atmosphere than the average car. Scrubbers are devices that reduce harmful sulfur emissions from industrial smokestacks. Scrubbers have decreased emissions of sulfur dioxide, carbon monoxide, and soot by more than 30%!

Researching Solutions Researchers must determine the cause of an environmental problem before they can provide a solution to it. Researching such problems requires the use of scientific methods. Scientists make observations and collect data. After analyzing the data, a scientist may propose a solution to the environmental problem that was studied. Proposals should take into account the costs, risks, and benefits of implementing the solution. Mario Molina is a scientist who researched the effects of CFCs on the ozone layer of the atmosphere. He determined that CFCs damage the ozone layer, which protects us from the sun's harmful ultra-violet radiation. His research convinced the nations of the world to limit the use of CFCs.

Research by students can also help solve environmental problems. **Figure 9** shows students trying to find out why the dwarf wedge mussel is disappearing from rivers.

▶ **Reading Check** *How can fuel-efficient hybrid cars help solve environmental problems?*

Figure 9 Students at Keene High School in New Hampshire do field research on dwarf wedge mussels (left). Solar panels in California generate energy without producing pollution (right).

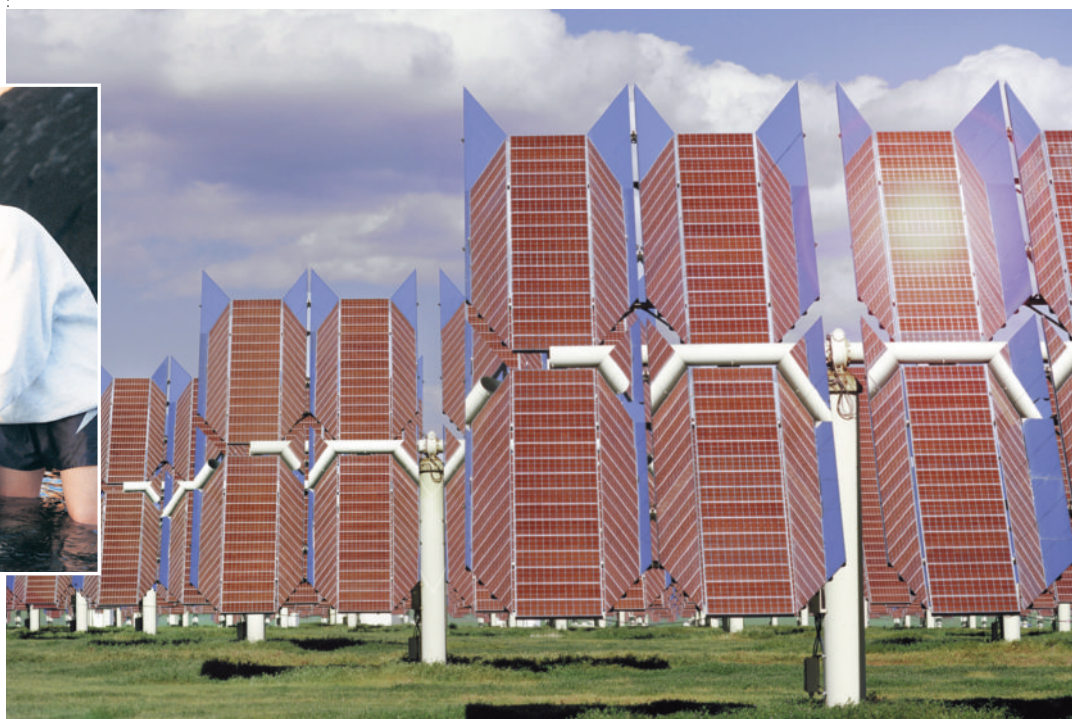




Figure 10 From a skybridge, ecotourists learn about the unique ecosystems at Monteverde Biological Cloud Forest Preserve in Costa Rica, without disturbing wildlife.

Environmental Awareness

Addressing environmental issues requires cooperation among conservation groups, individuals, and governments. Education and advocacy help more individuals take an active role in this process.

► **Education makes people more aware of environmental issues. Education also shows people how they can help address such issues. Expressing support, or *advocating*, for efforts to protect the environment can help get more people involved in these efforts.**

Advocacy Many environmental problems have been solved because of the efforts of those who advocate for a solution.

Conservation groups make efforts to educate people, protect land, and influence laws through advocacy. Some organizations work on an international level. Others work on local environmental problems. Some groups help farmers, ranchers, and other landowners ensure the long-term conservation of their land.

Individuals and the media also play an important role in raising awareness of environmental issues. With her 1962 book *Silent Spring*, biologist Rachel Carson made millions of people aware of the dangers of pesticides. Her efforts contributed to the restriction on the use of the dangerous pesticide DDT.

Education Educating the public about the environment helps gain public support for solving environmental issues. Environmental education can enrich people's experience of their world and empower them to care for it. Ecotourism is one way to educate the public about the environment. **Ecotourism** is a form of tourism that supports conservation of the environment. **Figure 10** shows ecotourists in Costa Rica. Ecotourists may learn about the particular environmental problems of an area. Often, an ecotourist is given an opportunity to help solve environmental problems as part of his or her tour.

► **Reading check** *How can advocacy and education help solve environmental problems?*

READING TOOLBOX

Venn Diagram Make a Venn diagram to help you compare the similarities and differences between advocacy and education relating to environmental science.

ecotourism a form of tourism that supports the conservation and sustainable development of ecologically unique areas



Figure 11 The Fresh Kills landfill (left) occupies 2,200 acres on Staten Island. To the right is the plan for the Fresh Kills of tomorrow. ➤ In what ways does your community plan to conserve or restore the environment?

Planning for the Future

What will our planet look like in 50 years? Will it still supply the basic needs and quality of life that we enjoy today, or will we lack the resources we need? ➤ **Careful planning for the future can help us avoid damaging the environment and can help us solve the environmental issues that we face.** If we want a safe, healthy, bright future, we need to actively aim for it. **Figure 11** shows how Staten Island is planning for the future by turning a landfill into a park.

Society can plan by noting the effects of certain activities, such as development and resource use. For example, if a builder wants to develop an area that is near an aquifer's recharge zone, the local government may evaluate the effects of development on the aquifer. After analyzing risks, costs, and benefits to the community, the government may choose to enforce limitations on the development. When governments plan for the future, they can protect resources for the community for years to come.

➤ **Reading check** *Why do we need to evaluate effects of development before following through with the development?*

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 Topic: Solving Environmental Problems
 Code: HX81424

Section

3

Review

➤ KEY IDEAS

- 1. Explain** how conservation might help an endangered species.
- 2. Describe** three ways you can reduce the use of environmental resources.
- 3. Describe** how research and technology affect the environment.

- 4. Explain** how education on the resources that we use can help preserve the environment.
- 5. Describe** how planning can prevent damage to the environment.

CRITICAL THINKING

- 6. Analyzing Methods** To join a global agreement to fight climate change, the United States must reduce CO₂ levels by 10%. What would be the positive and negative effects on society of such a reduction in CO₂?

METHODS OF SCIENCE

- 7. Predicting Outcomes** A land manager proposes planting shrubs to help restore land damaged by erosion. Describe a study or experiment that you could carry out to evaluate whether this proposal will work.

Why It Matters

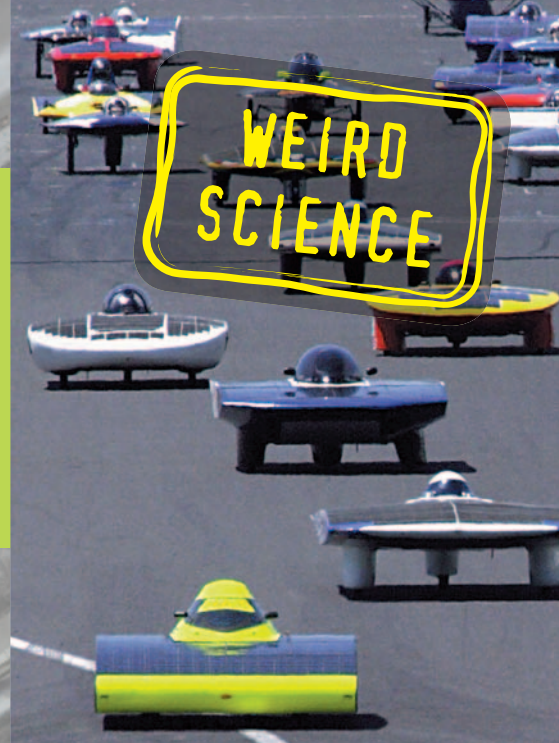
Cars of the Future

For many Americans, a car is a necessity. People rely on cars to get to work, to school, and to run errands. However, most cars are the main contributor of pollutants, such as CO₂, in the atmosphere. To help reduce the amount of pollutants released into the atmosphere, scientists have been developing cars that use nonpolluting forms of energy.

Different Forms of Energy

Scientists have developed many cars of the future that are more fuel efficient than other cars of today or that use nonpolluting forms of energy. The hybrid, a type of car that is becoming popular in the United States, uses electricity as well as gasoline. Some cars of the future run on only solar power! Solar-car races, as shown in the image above right, inspire advancements in car technology through friendly competitions. The FIA Alternative Energies Cup in Japan has solar cars compete in an eight-hour endurance race. Scientists have also developed cars that can run on ethanol and hydrogen. Some day, you may be riding in one of these cars.

Research Many technical universities have teams that compete in solar car races. Conduct Internet research and investigate some of the more successful teams. Create a Web site or poster supporting one of the teams you learn about.



Obvio!—Gas or Ethanol This fuel-efficient Brazilian minicar can run on either gas or ethanol. Ethanol produces less pollution than gas and is renewable. Ethanol is formed from biomass, such as corn or potatoes.



Toyota Fine-N Fuel Cell Hybrid (FCHV) The FCHV doesn't burn fossil fuels. It gets its energy from a fuel cell that produces chemical energy by combining oxygen and hydrogen. The best thing about the fuel cell is that it doesn't produce any pollution. The only byproduct of the fuel cell is water!

Chapter 6 Lab

Objectives

- Simulate an environmental condition in the laboratory.
- Measure the difference between treated and untreated seedlings.
- Analyze the effects of acidic conditions on plants.

Materials

- seeds (50)
- beaker (250 mL)
- mold inhibitor (20 mL)
- water, distilled
- paper towels
- solutions of various pH
- pencil, wax (or marker)
- bags, plastic, resealable
- metric ruler
- graph paper

Safety



Effects of Acid Rain on Seeds

Living things, such as salamander embryos, can be damaged by acid rain at certain times during their lives. In this lab, you will design an experiment to investigate the effects of acidic solutions on seeds. To do this, you will germinate seeds under various experimental conditions that you determine.

Preparation

1. **SCIENTIFIC METHODS State the Problem** How does acid rain affect plants?
2. **SCIENTIFIC METHODS Form a Hypothesis** Form a testable hypothesis that explains how a germinating plant might be affected by acid rain. Record your hypothesis.

Procedure

Design an Experiment

- 1 Design an experiment that tests your hypothesis and that uses the materials listed for this lab. Predict what will happen during your experiment if your hypothesis is supported.
- 2 Write a procedure for your experiment. Identify the variables that you will control, the experimental variables, and the responding variables. Construct any tables that you will need to record your data. Make a list of all of the safety precautions that you will take. Have your teacher approve your procedure before you begin.

Conduct Your Experiment

- 3 Put on safety goggles, gloves, and a lab apron.
- 4 **CAUTION: The mold inhibitor contains household bleach, which is a toxic chemical and a base.** Place your seeds in a 250 mL beaker, and slowly add enough mold inhibitor to cover the seeds. Soak the seeds for 10 minutes, and then pour the mold inhibitor into the proper waste container. Gently rinse the seeds with distilled water, and place them on clean paper towels.
- 5 **CAUTION: Solutions that have a pH below 7.0 are acids.** Carry out your experiment for 7–10 days. Make observations every 1–2 days, and note any changes. Record your observations each day in a data table, similar to the one shown.
- 6 Clean up your lab materials according to your teacher's instructions. Wash your hands before leaving the lab.

<i>Solution</i>	<i>Date</i>	<i>Observations</i>

Analyze and Conclude

- 1. Summarizing Results** Describe any changes in the look of your seeds during the experiment. Discuss seed type, average seed size, number of germinated seeds, and changes in seedling length.
- 2. Analyzing Results** Were there any differences between the solutions? Explain.
- 3. Analyzing Methods** What was the control group in your experiment?
- 4. Analyzing Data** Make graphs of your group's data. Plot seedling growth (in millimeters) on the y -axis. Plot number of days on the x -axis.
- 5. SCIENTIFIC METHODS Interpreting Data** How do acidic conditions appear to affect seeds?
- 6. Predicting Outcomes** How might acid rain affect the plants in an ecosystem?
- 7. SCIENTIFIC METHODS Critiquing Procedures** How could your experiment be improved?
- 8. SCIENTIFIC METHODS Formulating Scientific Questions** Write a new question about the effect of acid rain that could be explored with another investigation.

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Extensions

9. Inferring Relationships

Research to identify the parts of the United States that are most affected by acid rain. Explain why acid rain affects these areas more than it affects other areas.

- 10. Analyzing Methods** Describe how factories have changed to reduce the amount of acid rain.

Key Ideas

Key Terms

1 An Interconnected Planet

- Humans are a part of the environment and can affect the resilience of the environment.
- Renewable resources are natural resources that can be replaced at the same rate at which they are consumed.
- Nonrenewable resources are resources that form at a rate that is much slower than the rate at which they are consumed.
- Pollution and habitat destruction destroy the resources we need to live, such as the air we breathe, the water we drink, and the food we eat.

fossil fuel (126)



2 Environmental Issues

- Air pollution causes respiratory problems for people, results in acid rain, damages the ozone layer, and affects global temperature.
- Burning fossil fuels increases the amount of CO₂ in the atmosphere. Increases in atmospheric CO₂ may be responsible for an increase in global temperatures.
- Water pollution can come from fertilizers and pesticides used in agriculture and from livestock farms, industrial waste, oil runoff from roads, septic tanks, and unlined landfills.
- Soil erosion destroys fertile soil that we need in order to produce food.
- Ecosystem disruptions can result in loss of biodiversity, food supplies, potential cures for diseases, and the balance of ecosystems that supports all life on Earth.



acid rain (128)
 global warming (128)
 greenhouse effect (129)
 erosion (131)
 deforestation (132)
 biodiversity (132)
 extinction (133)

3 Environmental Solutions

- Conservation involves protecting existing natural habitats. Restoration involves cleaning up and restoring damaged habitats.
- We can reduce our use of natural resources, such as water and fossil fuels for energy. We can reuse goods rather than disposing of them. Furthermore, we can recycle waste to help protect the environment.
- Research and technology can help protect our environment by providing cleaner energy sources, better ways to deal with waste, and improved methods for cleaning up pollution.
- Education makes people more aware of environmental issues and of ways that they can help. Expressing support, or *advocating*, for efforts to protect the environment can help get more people involved.
- Careful planning for the future can help us avoid damaging the environment and solve environmental issues that we currently face.

recycling (135)
 ecotourism (137)



Chapter 6 Review

READING TOOLBOX

- Word Parts** Copy each of the following words: *biodiversity* and *extinction*. Write down other words that have the same word parts. Then, look in the dictionary for the definitions of the words.
- Concept Map** Make a concept map on how human activity affects climate. Try to use the following terms in your map: *greenhouse effect*, *carbon dioxide*, *greenhouse gases*, *global warming*, *CFCs*, *ozone layer*, *acid rain*, and *sulfur dioxide*.

Using Key Terms

Use each of the following terms in a separate sentence.

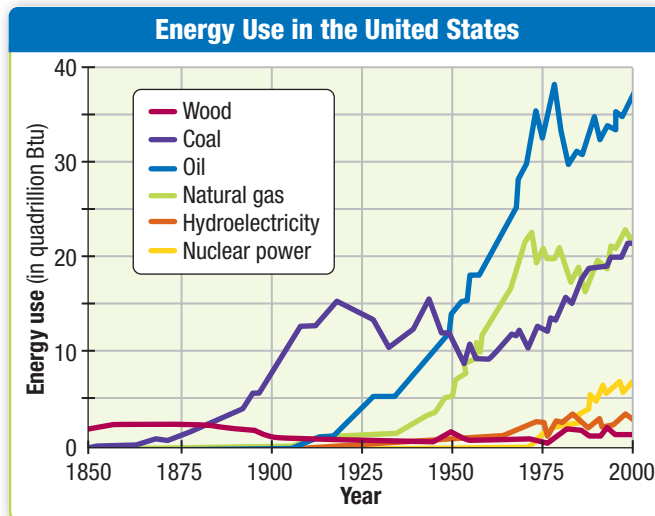
- fossil fuel*
- recycle*

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

- global warming* and *greenhouse effect*
- erosion* and *deforestation*

Understanding Key Ideas

Use the the figure to answer the following question(s).



- Which form of energy use has increased the most in the U.S. since 1850?

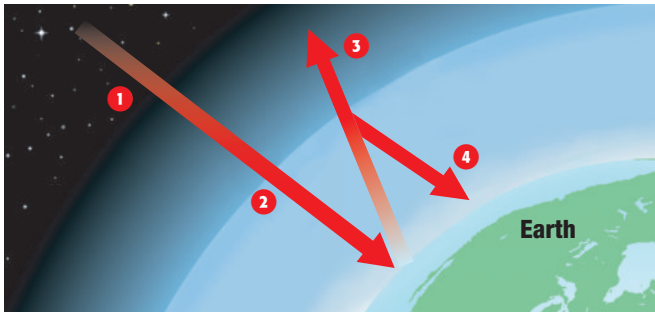
- Which of the following damages the ozone layer?
 - CO₂
 - SO₂
 - NO₃
 - CFCs
- Which of the following is not a source of water pollution?
 - CFCs
 - oil runoff
 - pesticides
 - industrial waste
- Which of the following is a result of ecosystem disruption?
 - acid rain
 - global warming
 - greenhouse effect
 - loss of biodiversity
- Which of the following is a technology used to harness a renewable resource?
 - benzene
 - hybrid cars
 - solar panels
 - smokestack scrubbers
- Rachel Carson's book *Silent Spring* educated readers about what environmental threat?
 - pesticide use
 - invasive species
 - CFC production
 - burning fossil fuels
- Which of the following is an example of conservation?
 - creating a nature preserve
 - cleaning up a polluted stream
 - planting trees on an eroding slope
 - reintroducing endangered species
- Which of the following is an example of planning for the future to avoid environmental damage?
 - creating a landfill
 - cleaning up an oil spill
 - mining aluminum from Earth's crust
 - evaluating potential effects of development

Explaining Key Ideas

- Describe** one way in which the environment affects human health.
- Explain** how increasing CO₂ in Earth's atmosphere might lead to climate change.
- Explain** the difference between conservation and restoration.

Using Science Graphics

Use the diagram to answer the following question(s).



18. Which arrow represents a flow of heat that will increase as atmospheric CO₂ rises?
- a. 1 c. 3
b. 2 d. 4
19. Which arrow represents a flow of heat that will decrease as atmospheric CO₂ rises?
- a. 1 c. 3
b. 2 d. 4

Critical Thinking

20. **Constructing Explanations** Fossil fuel burning and the clearing of forests each contribute large amounts of CO₂ to the atmosphere. How might deforestation lead to this release of CO₂?
21. **Proposing Solutions** Your state is experiencing a shortage of electrical power on hot summer days when many air conditioners are on. You are asked to propose measures that might solve this shortage problem without increasing electricity supplies. Propose one such measure, and explain how it would address the problem.
22. **Analyzing Information** What do environmental scientists mean by *interdependence*? Give an example of interdependence from this chapter.
23. **Analyzing Processes** Propose two steps that scientists might take to speed restoration of a river damaged by a major toxic spill.
24. **Predicting Outcomes** How would stopping all pesticide use likely affect rates of food production and incidence of diseases, such as malaria, that are spread by insects?
25. **Inferring Relationships** Describe how some species would be affected by global warming.

Connecting Key Ideas

26. **Analyzing Processes** Humans need clean, fresh water. Environmental scientists think that fresh water may become a limiting factor for human population growth. Explain how you could estimate Earth's carrying capacity for humans based on the availability of fresh water. What information would you need to make this estimate?

Alternative Assessment

27. **Field Trip Plan** Develop a lesson plan for a 30-minute class or field trip about one environmental issue that students in your class could do something about. Include the issue to be covered, an outline of points to discuss, and description of activities, location, or materials you would need.
28. **Waste Investigation** Find out where household waste goes in your community. How far is the waste taken from your home? Is the waste close to other homes or to important water sources for your area? Write a short summary of your findings.

Writing for Science

29. **Speech** Imagine that your town is holding a public hearing on whether to build a diesel bus depot next to your school. Use the library or the Internet to write a two-minute speech on why you support or oppose the project.
30. **Research** Obtain a list of the plants and animals that are endangered in your state. Find out where these species live, and mark the locations on a map of your state. Research the effects of habitat loss on species in your county or in surrounding areas.
31. **Proposal** Imagine you are a scientist who has been studying the subject of global warming. You have been asked by the President of the United States to write a recommendation for the president's environmental policy on the subject. The President has asked you to provide important facts that can be used to promote the proposed policies. Summarize your recommendations in a brief letter.

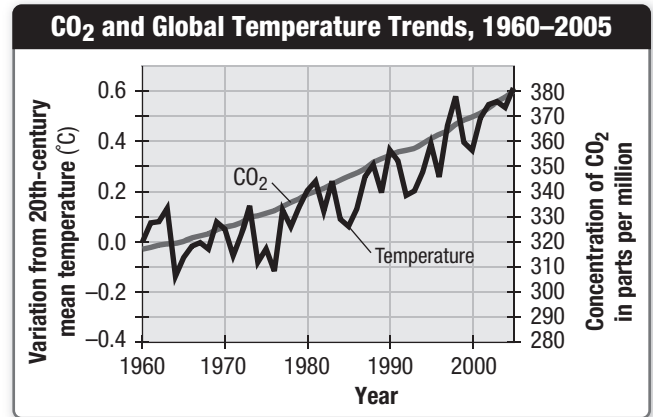
TEST TIP For a question involving experimental data, determine the constants, variables, and control before answering the questions.

Science Concepts

- What is the term for the natural ability of Earth's atmosphere to trap energy from the sun?
 - global warming
 - ozone depletion
 - greenhouse effect
 - biological magnification
- Which of the following terms means "liquid precipitation that has a low pH and that results from sulfur emissions reacting with water"?
 - acid rain
 - sulfuric acid
 - greenhouse gas
 - thermal pollution
- What does Earth's ozone layer shield Earth's inhabitants from?
 - solar heating
 - meteor impacts
 - ultraviolet rays
 - ozone depletion
- Which of the following describes the variety of species in an area?
 - biodiversity
 - species richness
 - species evenness
 - bioindicator species
- Which of the following is a renewable resource?
 - coal
 - trees
 - gasoline
 - natural gas
- Which of the following is a process in which materials of Earth's surface are worn away and transported from one place to another by wind, gravity, or water?
 - erosion
 - terracing
 - disruption
 - deforestation

Using Science Graphics

Use the graph to answer the following question(s).



Source: Scripps Institute of Oceanography and National & Atmospheric Administration.

- What is the term commonly used to describe the trend shown in this graph?
 - water pollution
 - global warming
 - ozone depletion
 - biodiversity crisis

Use the table to answer the following question(s).

	United States	Japan	Indonesia
Number of people per square mile	78	829	319
Garbage produced per person per year (kg)	720 kg	400 kg	43 kg

- Which country has the most people per square mile?
 - Japan
 - United States
 - Indonesia
 - Japan and Indonesia
- Which country produces the greatest amount of garbage per square mile?
 - Japan
 - United States
 - Indonesia
 - Japan and Indonesia

Math Skills

- Making Conversions** An oil tanker hit a coral reef and spilled 800,000 mL of oil into the ocean. If the oil spread evenly over 100 km², how many liters of oil does each square kilometer contain?

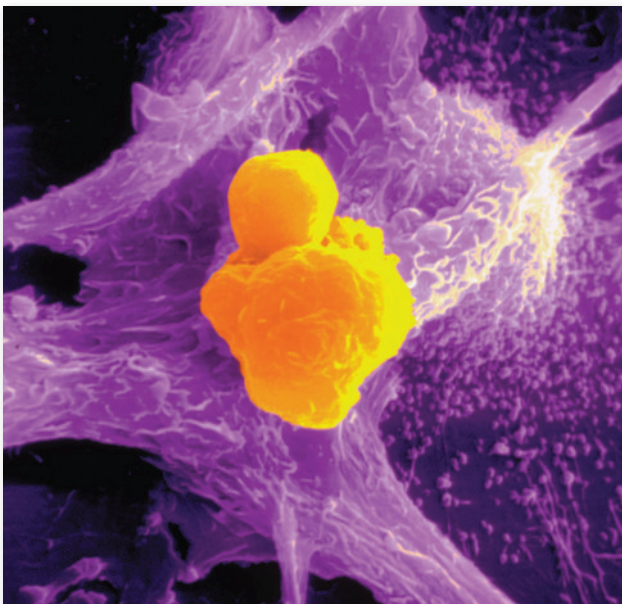
UNIT 3 Cells

7 Cell Structure

8 Cells and Their Environment

9 Photosynthesis and Cellular Respiration

10 Cell Growth and Division



Macrophage (purple) attack on a cancer cell (yellow)



Sex chromosomes of a human male: Y (left) and X (right)