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Advanced Science Program

United Arab Emirates Edition

مجموعات فخر الوطن وعام زايد

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GRADE 6 VOLUME 3

مجموعات فخر الوطن وعام زايد

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Student Resources Handbook

Science Content Background

Lesson 1

Ecosystems

Ecosystems and Biomes An ecosystem consists of all the living and nonliving things in an area. Examples of ecosystems include forests, deserts, grasslands, rivers, and coral reefs. Similar ecosystems in separated areas make up a biome. For example, the desert biome consists of deserts around the world. The ecosystems in a biome have similar climates and kinds of plants and animals.

Abiotic Factors The nonliving parts of an ecosystem are called abiotic factors. Abiotic factors provide many of the resources needed by organisms for their survival. They include sunlight, temperature, air, water, and the abiotic parts of soil. The abiotic portion of soil consists of particles of rock, sand, and clay. The biotic part of soil is called humus (HEW mus), which contains the decayed remains of various kinds of organic matter.

Biotic Factors The living, or biotic, factors of an ecosystem include all the living organisms in the ecosystem and the remains of dead organisms or parts of organisms. Both a living tree and its dead, decayed leaves are among the biotic factors in an ecosystem.

Habitats The area within an ecosystem that provides an organism with the biotic and abiotic factors it needs for survival is called the organism's habitat. Both plants and animals have habitats. A habitat can be large or small. A cricket's habitat, for example, might be a damp area under a log. The habitat of a cactus is a hot desert.

Populations and Communities A population consists of all the members of a particular species living in a given ecosystem. The number of organisms of a species living in a defined area, such as a square kilometer, is the population density of that species. Different populations within an ecosystem constitute a community.

Population Change Population sizes tend to change over time, sometimes growing, other times decreasing. These variations are due to various causes, such as climate changes, natural disasters, and the availability of food and habitats. Events such as forest fires can change animal populations rapidly. A 1995 forest fire in Northern California, for instance, killed about 98 percent of the area's mountain beavers.

Lesson 2

Relationships Within Ecosystems

Niches A habitat is usually shared by many species. A species has a particular niche within a habitat. An organism's niche can be thought of as its role in a habitat. For example, the niche of a bird or an insect in a forest habitat might include its ability to fly, eat nectar from blossoms, and spread pollen.

Competition Competition is the interactions between two or more organisms that must use the same abiotic or biotic factor at the same time, and limits population size. Competition between members of a species occurs in particular when that species becomes overpopulated. Animals are increasingly in competition with humans for food, water, and habitats because of human expansion into formerly wild areas.

Symbiosis Sometimes two species establish a long-term relationship that usually involves obtaining food or energy. This type of relationship is called symbiosis. There are three types of symbiosis: mutualism, commensalism, and parasitism. With mutualism, both species benefit. With commensalism, one species benefits while the other neither benefits nor is harmed. With parasitism, one species benefits and the other is harmed.

Mutualism

Lesson 3

Matter and Energy in Ecosystems

Matter Recycling The matter on Earth is constantly being recycled. For example, when a leaf drops to the ground, it is broken down by bacteria and fungi. The elements in the leaf are then returned to the soil and air to be reused. Matter cycles through ecosystems in different forms as organisms incorporate it into their tissues and later die and decompose. Matter can change form, but it cannot be created or destroyed.

Energy in Ecosystems Like matter, energy can be neither created nor destroyed. However, unlike matter, the energy in an ecosystem cannot be recycled or returned to its original source. Almost all energy used by Earth's organisms comes from the Sun. Plants use the energy in sunlight to make their own food—sugars. Plants are called producers. Animals are called *consumers* and get their energy by eating either plants or other animals.

The Movement of Energy in Ecosystems Energy moves through food chains and food webs. A food chain is a series of organisms, from a producer at the bottom through several consumers. Each organism in the chain gets eaten by the next-highest organism in the chain. A food web is a group of interconnected food chains. Most ecosystems contain many food chains combined into one large and complex food web.

Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

* Given adequate resources and an absence of disease or predators, populations of organisms in environments increase at rapid rates. Finite resources and other factors limit their growth.

* One of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods.

* The world contains a wide diversity of physical conditions, which creates a wide variety of environments: freshwater, marine, forest, desert, grassland, mountain and others. In any particular environment, the growth and survival of organisms depend on the physical conditions.

* In all environments, organisms with similar needs may compete with one another for limited resources, including food, space, water, air, and shelter.

Lesson 1
Ecosystems

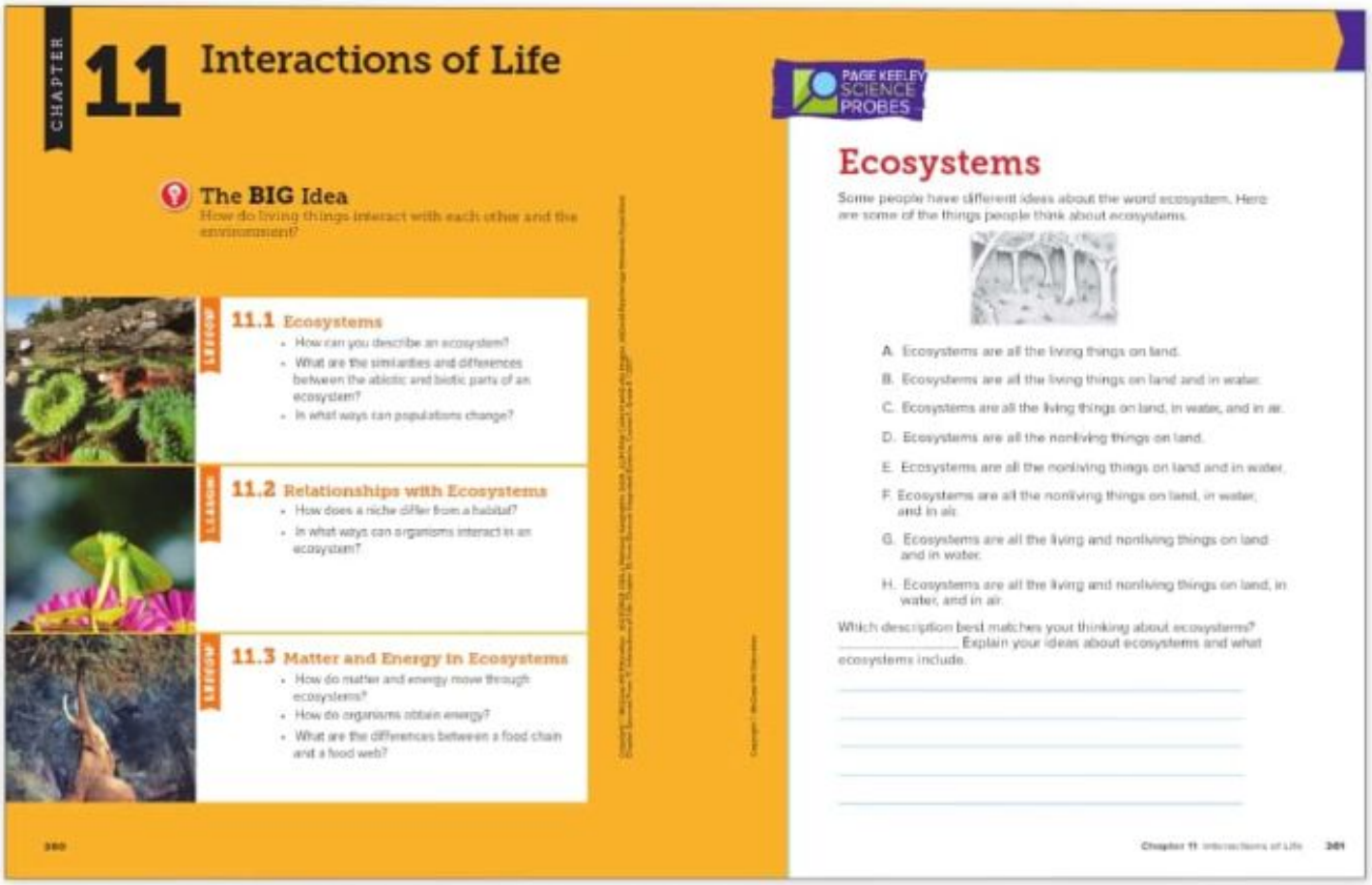
1. An ecosystem is all the interactions among the living and nonliving parts of the environment in a given area.
2. Both abiotic factors and biotic factors are parts of an ecosystem.
   - 2a. Abiotic factors include nonliving things such as sunlight, water, and air.
   - 2b. Biotic factors include all the living and once-living organisms in an ecosystem.
3. Populations can increase, decrease, move, and die out.

Lesson 2
Relatio nships Within Ecosystems

4. Ecosystems include habitats and niches.
   - 4a. A habitat is the place within an ecosystem that provides the resources an organism needs.
   - 4b. A niche is the way an organism interacts with the biotic and abiotic factors in its environment to meet its needs.
5. Relationships exist between organisms in ecosystems.
   - 5a. Organisms rely on each other for food and other resources.
   - 5b. Organisms compete with each other for resources.
   - 5c. Organisms cooperate with each other to obtain resources.

Lesson 3
Matter and Energy in Ecosystems

6. Matter cycles through ecosystems. Energy is transferred from one organism to another organism.
7. Organisms obtain energy from sunlight or chemicals in the environment or by eating other organisms.
8. A food chain shows a series of feeding relationships that follows the path of energy through an ecosystem. A food web shows the interactions among several food chains within an ecosystem.



CHAPTER 11 Interactions of Life

The BIG Idea
How do living things interact with each other and the environment?

LESSON 11.1 Ecosystems
- How can you describe an ecosystem?
- What are the similarities and differences between the abiotic and biotic parts of an ecosystem?
- In what ways can populations change?

LESSON 11.2 Relationships with Ecosystems
- How does a niche differ from a habitat?
- In what ways can organisms interact in an ecosystem?

LESSON 11.3 Matter and Energy in Ecosystems
- How do matter and energy move through ecosystems?
- How do organisms obtain energy?
- What are the differences between a food chain and a food web?

PAGE KEELEY SCIENCE PROBES

Ecosystems

Some people have different ideas about the word ecosystem. Here are some of the things people think about ecosystems.

A. Ecosystems are all the living things on land.
B. Ecosystems are all the living things on land and in water.
C. Ecosystems are all the living things on land, in water, and in air.
D. Ecosystems are all the nonliving things on land.
E. Ecosystems are all the nonliving things on land and in water.
F. Ecosystems are all the nonliving things on land, in water, and in air.
G. Ecosystems are all the living and nonliving things on land and in water.
H. Ecosystems are all the living and nonliving things on land, in water, and in air.

Which description best matches your thinking about ecosystems? _____ Explain your ideas about ecosystems and what ecosystems include.

How do living things interact with each other and the environment?

The BIG Idea

There a re no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

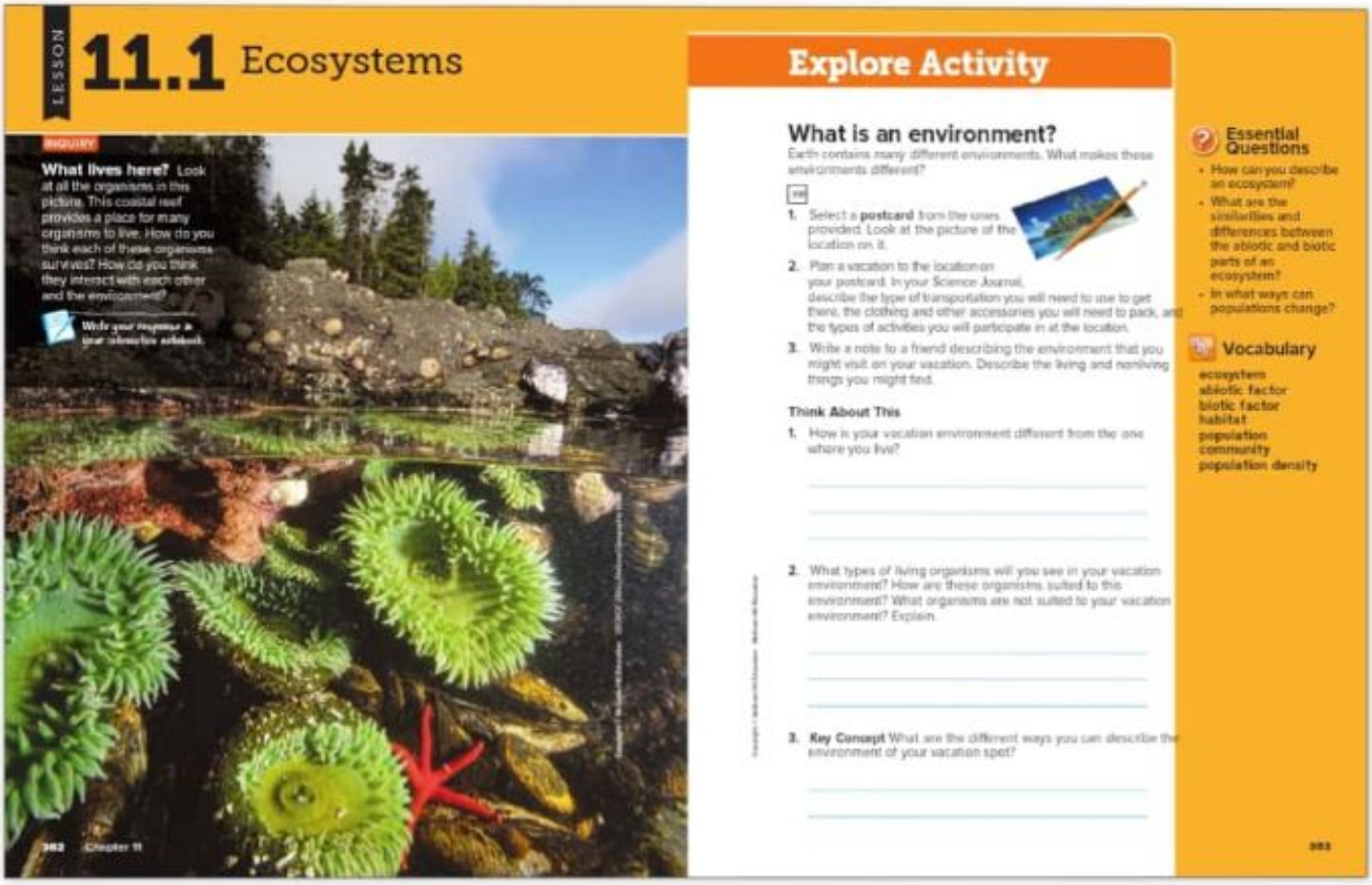
Guiding Questions

AL Are all environments the same?	*Use this question to define* environment *and initiate a general discussion about the many different types of environments on Earth.*
OL What living and nonliving things make up your environment?	*Use this question to create a distinction between the living and nonliving things in environments and to emphasize that different environments might have different living things.*
BL What do living things need from the environment in order to survive?	*Students may respond that animals need to breathe, take in water, and consume food. Begin a discussion on how an organism's survival depends on the interactions that occur within an environment.*

PAGE KEELEY SCIENCE PROBES

Ecosystems

Answers to the Page Keeley Science Probe can be found in the Teacher's Edition of the *Activity Lab Workbook*.


LESSON 11.1 Ecosystems

INQUIRY

What lives here? Look at all the organisms in this picture. This coastal reef provides a place for many organisms to live. How do you think each of these organisms survives? How do you think they interact with each other and the environment?

Write your response in your interactive notebook.

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Explore Activity

What is an environment?

Earth contains many different environments. What makes these environments different?

1. Select a **postcard** from the ones provided. Look at the picture of the location on it.
2. Plan a vacation to the location on your postcard. In your Science Journal, describe the type of transportation you will need to use to get there, the clothing and other accessories you will need to pack, and the types of activities you will participate in at the location.
3. Write a note to a friend describing the environment that you might visit on your vacation. Describe the living and nonliving things you might find.

Think About This

1. How is your vacation environment different from the one where you live?

2. What types of living organisms will you see in your vacation environment? How are these organisms suited to this environment? What organisms are not suited to your vacation environment? Explain.

3. **Key Concept** What are the different ways you can describe the environment of your vacation spot?

Essential Questions

- How can you describe an ecosystem?
- What are the similarities and differences between the abiotic and biotic parts of an ecosystem?
- In what ways can populations change?

Vocabulary

ecosystem
abiotic factor
biotic factor
habitat
population
community
population density

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INQUIRY

About the Photo **What lives here?** Wherever on Earth there is water and food, life abounds. The shallow water in the photo is drenched in sunlight, the energy source that forms the basis of almost all food webs.

Guiding Questions

OL How do you think each of the organisms in a coastal reef survives?	*Students should recognize that the survival of organisms depends on the living and nonliving things around them.*
OL Why do the anemones live near the surface of the water?	*The anemones depend on light for food.*
BL How do you think anemones interact with each other and the environment?	*Algae and saltwater plants use sunlight to make their own energy-rich foods: sugars. This energy is passed to plant-eating animals and then to animals that eat other animals. The anemone is a filter feeder that consumes tiny plants and animals that float in the water.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Apply a Term to a Broader Context

1. Write the term *population density* on chart paper or the board.
2. Explain that *population density* is the number of individuals of a species living in a defined area. As the lesson material explains, when the population density of an area is too high, living conditions deteriorate for the organisms in that area. Resources become scarce and diseases may spread more easily.
3. Introduce the term *carrying capacity*, the maximum population that a habitat can support over an extended period of time. Do students think that Earth's carrying capacity for the human species has been reached? Introduce opinions from population study experts, commonly found in scientific journals or educational Web sites. Ask students if they agree or disagree with these opinions.

ExploreActivity

What is an environment?

Prep: *10 min* **Class:** *10 min*

Purpose
To observe pictures of an ecosystem and infer information about the environment.

Materials
Students: postcards (actual postcards, or postcards made from pictures of ecosystems with blank backs for writing)

Before You Begin
Acquire different postcards that show different environments, such as mountains, oceans, forest, tropical island, snowy, etc. Make sure the pictures show enough of the environment so that students will be able to determine details about plant and animal life, as well as the nonliving features. Postcards also could be prepared by printing up postcard-sized pictures of different ecosystem environments.

Guide the Investigation

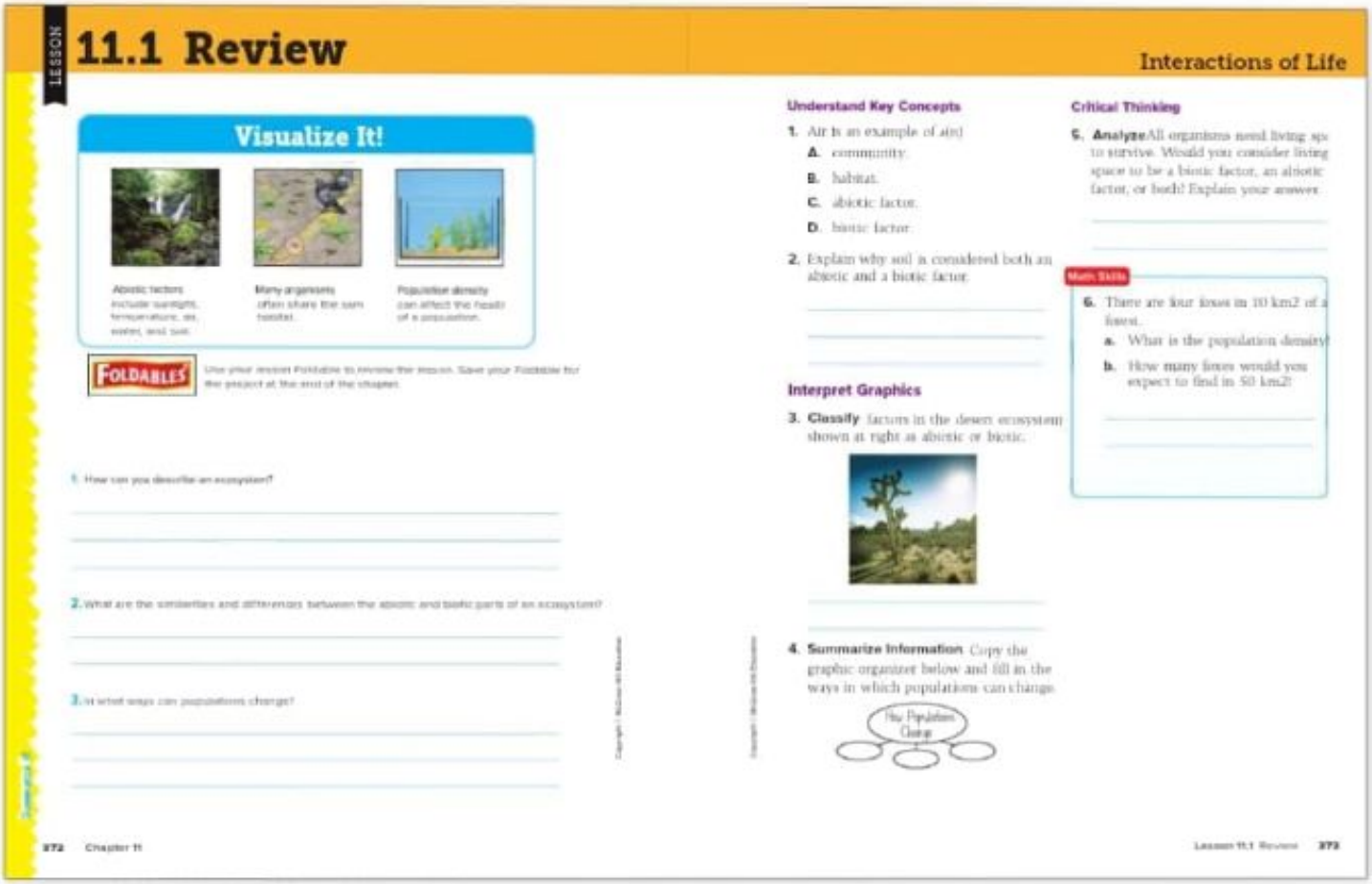
- Tell students they are going to plan a vacation to an exotic location, as if they had won a prize on a game show.
- Allow students to choose a postcard and have them complete the lab. Encourage them to be imaginative. Allow them to use research tools, if they wish, to learn more about the location they will "visit."

Think About This

1. Answers will vary. Students should compare and contrast this environment with the local environment where they live.
2. Answers will vary. Students should provide examples of plants and animals that live in the environment and explain why they think these organisms are suited to live there. They should also provide examples of organisms that would not survive in this environment.
3. **Key Concept** The ecosystem can be described in terms of living and nonliving things. Living things include the plants and animals that inhabit the environment. Nonliving things include the soil, water, air, and temperature.

Extension
Have students draw or find examples of some pictures they will take on their vacation to show friends back home. Have them write captions for the pictures that describe the characteristics of the environment shown.

Teacher Notes



LESSON

11.1 Review

Interactions of Life

Visualize It!

Abiotic factors include sunlight, temperature, air, water, and soil.

Many organisms often share the same habitat.

Population density can affect the health of a population.

FOLDABLES

1. How can you describe an ecosystem?

2. What are the similarities and differences between the abiotic and biotic parts of an ecosystem?

3. In what ways can populations change?

Understand Key Concepts

1. Air is an example of a(n)
   A. community.
   B. habitat.
   C. abiotic factor.
   D. biotic factor.

2. Explain why soil is considered both an abiotic and a biotic factor.

Interpret Graphics

3. **Classify** factors in the desert ecosystem shown at right as abiotic or biotic.

4. **Summarize Information** Copy the graphic organizer below and fill in the ways in which populations can change.

How Populations Change

Critical Thinking

5. **Analyze** All organisms need living space to survive. Would you consider living space to be a biotic factor, an abiotic factor, or both? Explain your answer.

Math Skills

6. There are four foxes in 10 km2 of a forest.
   a. What is the population density?
   b. How many foxes would you expect to find in 50 km2?

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Lesson 11.1 Review 373

Understand Key Concepts

1. **C.** abiotic factor.

2. Biotic factors include both living and once-living organisms. The biotic portion of soil includes living organisms—such as bacteria—and humus, which is composed of decayed organisms. Abiotic factors in soil include minerals and particles of rock, clay, and sand.

Interpret Graphics

3. Biotic: cacti, other plants (students might also mention algae, bacteria); abiotic: air, light, sand (some students might mention water)

4. increase, decrease, move

Critical Thinking

5. Accept reasonable answers. Sample answer: Either or both, depending on the organism's requirements. A bird might require living space in a tree (biotic factor). A plant might require enough space away from other plants to get enough sunlight and air to grow to full size (abiotic factors).

Math Skills

6. a. $\frac{4 \text{ foxes}}{10 \text{ km}^2} = \frac{4}{10} = \frac{0.4 \text{ foxes}}{\text{km}^2}$

   b. $\frac{0.4 \text{ foxes}}{\text{km}^2} \times 50 \text{ km}^2 = 20 \text{ foxes}$

LESSON

11.2 Relationships Within Ecosystems

INQUIRY

What's it doing? This praying mantis has captured a grasshopper for its next meal. The mantis and the grasshopper have a feeding relationship, just one way that organisms in an ecosystem interact with one another. What other ways can you think of for organisms to interact?

Write your response in your science notebook.

Explore Activity

How do organisms help plants grow?

Different organisms often rely on other organisms to survive. One such relationship exists between types of fungi and plants. The fungi live on the roots of plants and help them obtain water and minerals. In return, the plants supply the fungi with nutrients.

1. Examine the photograph of plant roots. The roots on the right have had a beneficial fungus added to them. The roots on the left were grown in sterilized soil. Record your observations in your Science Journal.

Think About This

1. What difference do you note in the plant roots grown with a fungus added to the soil compared to the plant roots grown in sterile soil?
2. Which plants do you think might grow larger or faster?
3. **Key Concept** How do you think the relationship between these organisms helps them use the resources in their environment?

Essential Questions

- How does a niche differ from a habitat?
- In what ways can organisms interact in an ecosystem?

Vocabulary

niche
competition
overpopulation
predation
symbiosis
mutualism
commensalism
parasitism

INQUIRY

About the Photo **What's it doing?** Praying mantises are predatory and feed on a variety of insects, including moths, crickets, grasshoppers, and flies. They are colored to blend with their environment, thus making them less easily seen by their prey.

Guiding Questions

AL	What is the relationship between the praying mantis and the grasshopper that it captured?	*They have a feeding relationship. Use this question to point out the ecological significance of relationships, that is, the interaction of organisms with each other.*
OL	In this feeding relationship, what is the praying mantis? What is the grasshopper?	*Use this question to explore predator-prey relationships. The praying mantis is the predator, and the grasshopper is the prey. In another situation, the praying mantis could be the prey of some other organism.*
BL	What other ways do organisms in ecosystems interact?	*Use this question to explore other kinds of relationships in ecosystems: they feed together in groups, they mate, parents protect young, they compete for resources.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Deriving a Definition

1. Write the words *compete* and *competition* on chart paper or the board. Have students identify each word's part of speech. *Compete is a verb. Competition is a noun.*
2. Tell students that, when an organism competes with another organism, it is trying to get something that both organisms need. **Ask: What do you think two organisms might compete for in an environment?** *sample answer: water, food, shelter, mates*

3. Point out the word *compete* in *competition*. **Ask: What do you think the word competition means?** *Sample answer: The act of trying to get something or the interactions between organisms that need the same things.*
4. Have students record the accepted definition for competition in their Science Journals.

Teacher Notes

ExploreActivity

How do organisms help plants grow?

Prep: *none* **Class:** *10 min*

Purpose

To infer the benefits of the symbiotic relationship between fungi and plants.

Before You Begin

Have students scan the lesson and briefly look at the pictures and definitions under symbiosis. Ask students to think about any examples they know in which two different organisms work together.

Guide the Investigation

Make sure students understand the difference in the way the plants in the photograph were grown. Ask them to compare the plants and describe any and all differences they note in all parts of the plants.

Think About This

1. The plant roots grown with fungi are longer and more extensive than the plant roots grown in sterile soil.
2. Answer should indicate that the plant with fungi will grow larger or faster. Possible answers include: the longer roots might enable the plants to obtain more water and nutrients; the plants might be better supported and might be able to grow larger and taller.
3. **Key Concept** The plant is helped as the fungi increase its ability to obtain water and minerals in the soil. The fungus is helped because as the plant grows larger, it becomes a good source of nutrients.

Extension

Many species around the world form relationships with other species. To introduce students to the idea of organisms benefiting from each other, you can discuss the practice of keeping pets. Pets get food, shelter, and protection from humans, while humans get companionship and, some think, have fewer health problems. Be sure to point out that humans choose to form relationships with pets, unlike the relationship between fungi and plants where no choice is made.

Symbiosis

Have students read about symbiosis. Then use the Guiding Questions, Word Origin, and Visual Literacy to reinforce students' understanding.

Guiding Questions

AL What is symbiosis?	*Symbiosis is a close, long-term relationship between two species that usually involves obtaining food or energy.*
OL In what ways can organisms interact in an ecosystem?	*Organisms can rely on each other for food or other resources, compete with each other for resources, or cooperate within an ecosystem.*
BL In which types of symbiosis is neither organism harmed?	*In mutualism and commensalism neither organism is harmed. Use this question to initiate a discussion about the three types of symbiosis.*

Word Origin

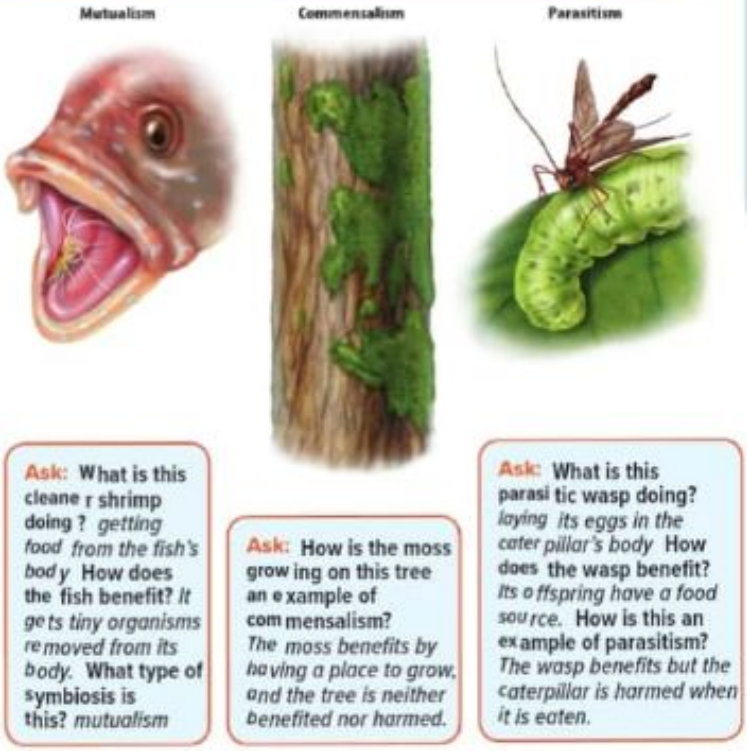
symbiosis

Ask: **How does knowing the meaning of its Greek origin help you remember the meaning of *symbiosis*?** *The Greek origin means "living together" and organisms live together in symbiosis.*

Visual Literacy: Figure 13

Use **Figure 13** shown below to reinforce students' understanding of the three types of symbiosis.

Ask: **What are the three types of symbiosis?** *mutualism, commensalism, parasitism*



Ask: **What is this cleaner shrimp doing?** *getting food from the fish's body* **How does the fish benefit?** *It gets tiny organisms removed from its body.* **What type of symbiosis is this?** *mutualism*

Ask: **How is the moss growing on this tree an example of commensalism?** *The moss benefits by having a place to grow, and the tree is neither benefited nor harmed.*

Ask: **What is this parasitic wasp doing?** *laying its eggs in the caterpillar's body* **How does the wasp benefit?** *Its offspring have a food source.* **How is this an example of parasitism?** *The wasp benefits but the caterpillar is harmed when it is eaten.*

Differentiated Instruction

AL **Predation and Symbiosis** Have pairs of students create a concept map that compares predation and the three types of symbiosis. Encourage them to illustrate their concept maps with drawings or photos.

BL **Symbiosis Examples** Have pairs of students choose one type of symbiosis and find more examples of species that have this relationship with another species. Encourage them to create a presentation with visuals to share with the class.

Teacher Toolbox

Teacher Demo

Humans and Habitats Display photos of areas in your community or other communities where houses or businesses are being built, trees are being cut down, roads are being built, or land is being cultivated for crops. Have students discuss how the changes affect resources for humans and other organisms.

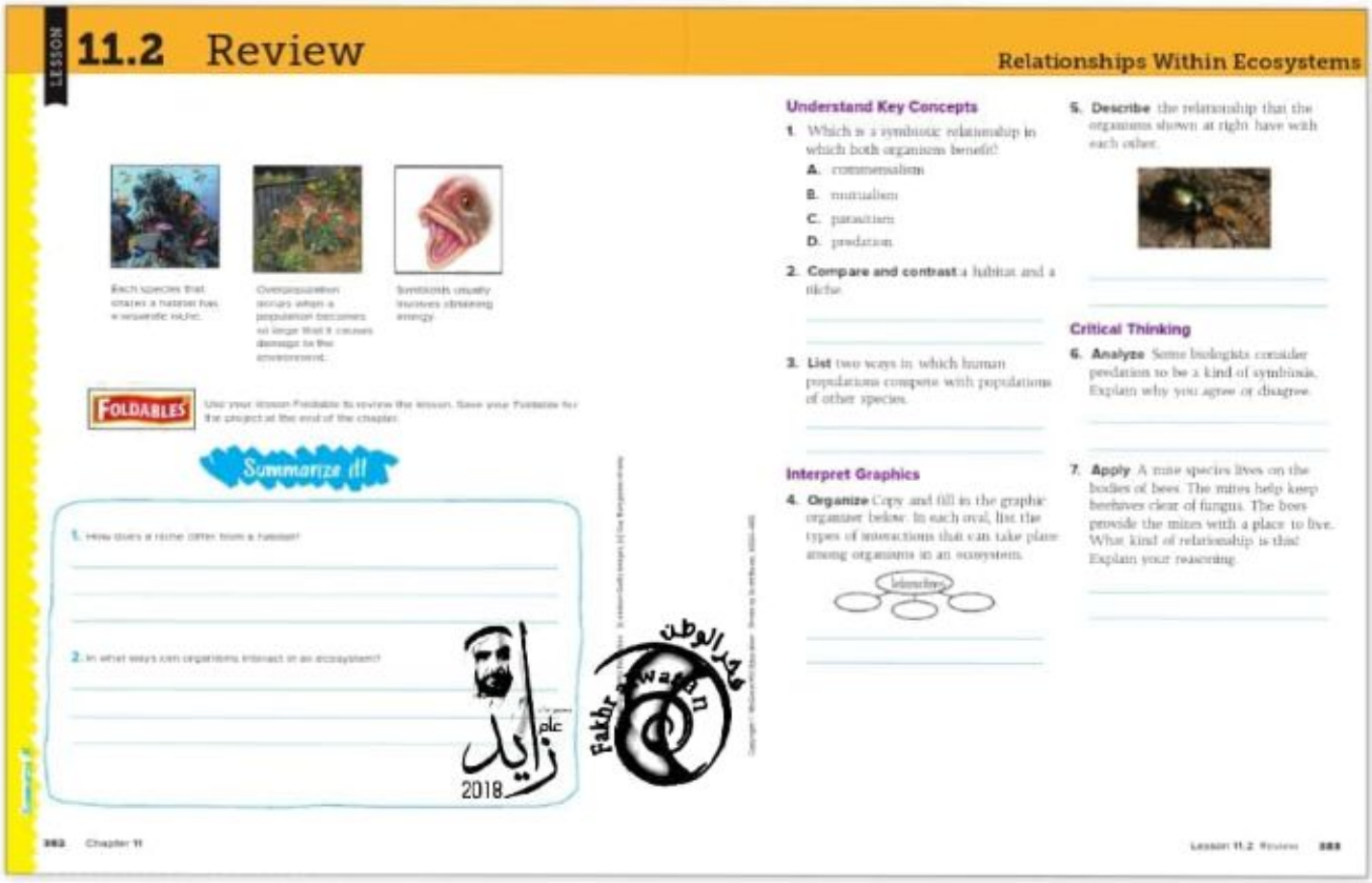
Fun Fact

Tick Saliva Ticks are arthropods that attach to the skin of people, dogs, and other animals. Once attached, these parasites suck blood from their hosts. Chemicals in their saliva help keep their hosts' blood from clotting, make blood vessels widen, and prevent the hosts from feeling pain where the ticks are attached.

Reading Strategy

Summarizing Have students summarize the sections on these pages. Then tell them to share their summaries and discuss both positive aspects and the aspects of each summary that could be improved.

FOLDABLES For help creating this Foldable and additional Foldables® ideas, use the **Foldables Handbook** in the back of this book.



LESSON 11.2 Review

Relationships Within Ecosystems

Each species that shares a habitat has a separate niche.

Overpopulation occurs when a population becomes so large that it causes damage to the environment.

Symbiosis usually involves obtaining energy.

FOLDABLES Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

Summarize it!

1. How does a niche differ from a habitat?

2. In what ways can organisms interact in an ecosystem?

Understand Key Concepts

1. Which is a symbiotic relationship in which both organisms benefit?
   A. commensalism
   B. mutualism
   C. parasitism
   D. predation
2. **Compare and contrast** a habitat and a niche.
3. **List** two ways in which human populations compete with populations of other species.

Interpret Graphics

4. **Organize** Copy and fill in the graphic organizer below. In each oval, list the types of interactions that can take place among organisms in an ecosystem.

Interactions

5. **Describe** the relationship that the organisms shown at right have with each other.

Critical Thinking

6. **Analyze** Some biologists consider predation to be a kind of symbiosis. Explain why you agree or disagree.
7. **Apply** A mite species lives on the bodies of bees. The mites help keep beehives clear of fungus. The bees provide the mites with a place to live. What kind of relationship is this? Explain your reasoning.

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Lesson 11.2 Review 383

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Niches
- Competition
- Competing with Humans
- Predation

Understand Key Concepts

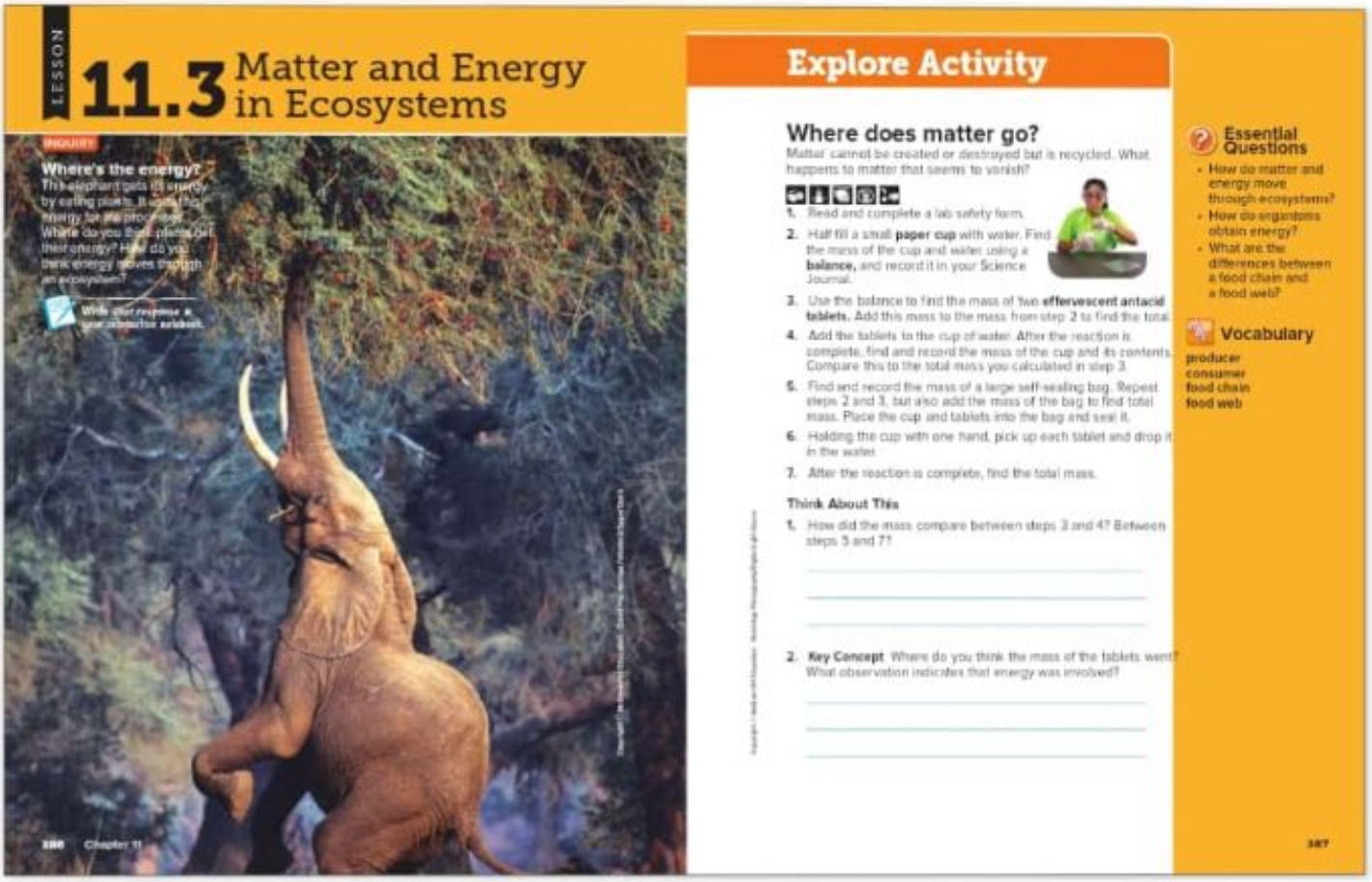
1. **B.** mutualism
2. Answers will vary. Sample answer: A habitat is where an organism lives; it provides the organism with resources it needs. A niche includes where the organism lives plus how it interacts with the biotic and abiotic factors to survive—how it obtains food and finds shelter, for example.
3. Answers will vary. Sample answers: competition for food, living space, water, and clean air.

Interpret Graphics

4. Competition, predation, symbiosis
5. The relationship is one of predation. The bird is the predator, and the insect is the prey.

Critical Thinking

6. Answers will vary. Sample answer: Disagree. Predation is a lot like parasitism. One organism gets food by harming another. However, the relationship is not long-term. Conversely: Agree. The two organisms have a close relationship that involves the exchange of energy, and it ends when the prey animal is killed.
7. Answers will vary. Sample answer: The relationship is mutualism, which is a type of symbiosis. Both organisms benefit in a long-term relationship.



INQUIRY

About the Photo **Where's the energy?** The elephant in the photo gets energy by eating plants. Animals need energy to carry out life processes. Use the questions below to discuss how energy moves through an ecosystem.

Guiding Questions

AL	Where do you think plants get their energy?	*possible answers: from the soil, the Sun, or the atmosphere*
OL	What is the animal reaching for with its trunk? Why?	*It is reaching for part of the plant, which it will eat to obtain energy.*
BL	What would happen to the elephant if all the plants in this area were destroyed by bacteria?	*Unless the elephant could travel to locate an alternate food source, the elephant could not survive because it could not obtain energy.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Use Prefixes and Suffixes to Understand Word Meaning

1. Write *produce* on the board.
2. Circle *pro* and explain: *This prefix means "forward."*
3. Circle *duce*, and explain: *This word part means "to lead."*
4. Write *producer* on the board.
5. Circle *er*, and explain: *This suffix means "one who."*
6. **Ask: What does *producer* mean?** *"one who leads forward, or brings forth"*
7. Repeat with consumer. Students will determine that *consumer* means *"one who (or that) eats or takes in."*

ExploreActivity

Where does matter go?

Prep: *10 min* **Class:** *15 min*

Purpose
To observe how matter seems to disappear, but actually changes form.

Materials
Student: 2 paper cups, 4 effervescent antacid tablets, balance scale, large self-sealing plastic bag, water

Before You Begin
Be sure to zero out the mass of the cups. It is also helpful to use as small an amount of water as is necessary to cause the reaction that will completely dissolve the tablets. This will help maximize the amount of mass of the tablets compared to the water and materials as a whole—and make it easier to measure the "disappearance" of the mass of the tablets.

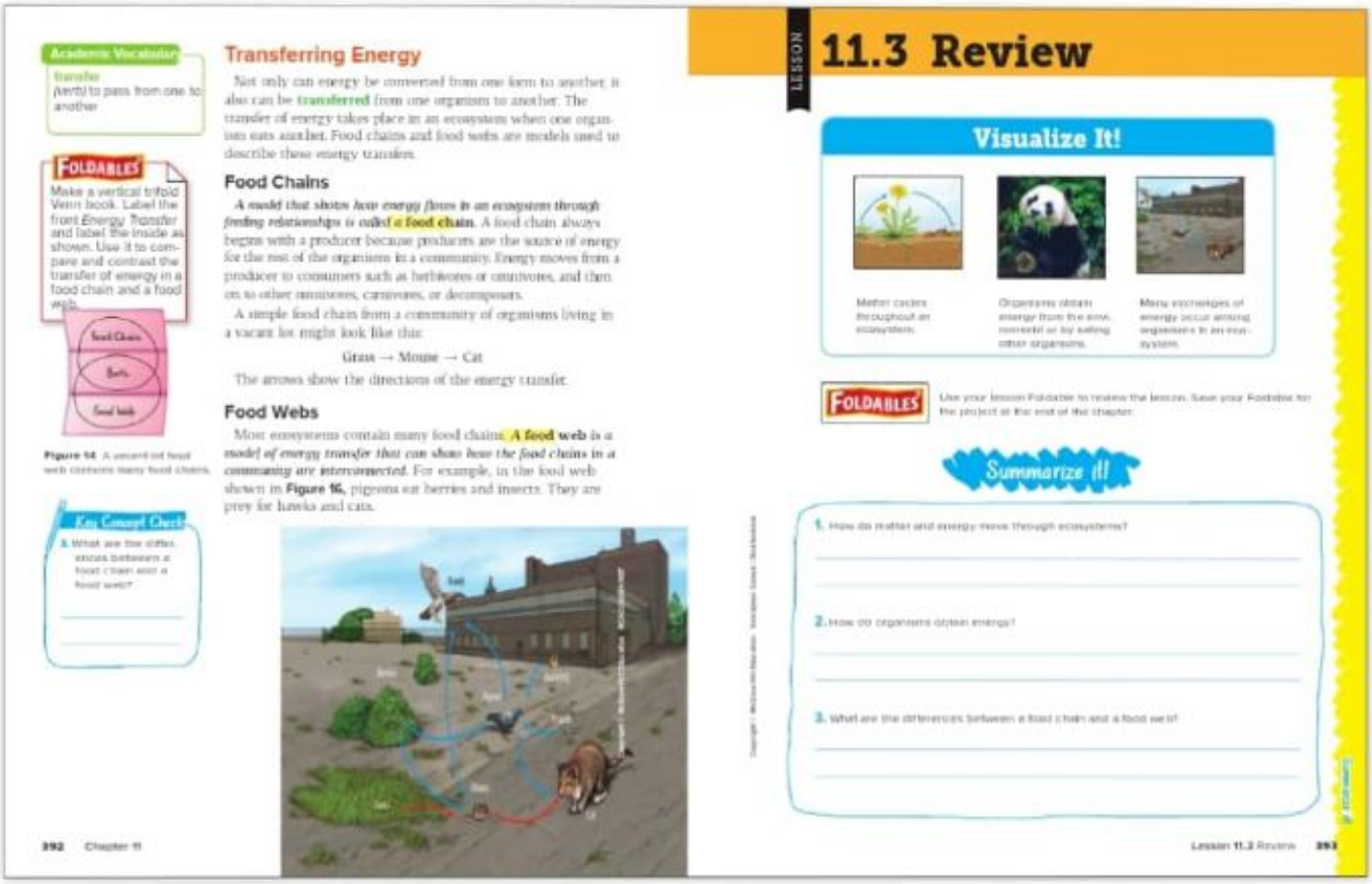
Guide the Investigation

- Read and check students' lab safety forms.
- Take care to keep the materials separate from each other before you are ready for the reaction to occur.
- Because the bag must be completely sealed in order to capture the gas as the tablets change state from solid to gas, students might want to practice adding the tablets to the water and then quickly sealing the bag as the reaction begins.
- ⚠ Caution students not to drink the antacid solution. Make certain the solutions are disposed of properly when the lab is completed. The liquid can be poured down a sink.
- **Troubleshooting** Make certain the plastic bag is large enough to contain the gas produced from the reaction.

Think About This

1. Students should note that the mass decreased between steps 3 and 4—mass of the reactants and products was not equal. Students should also note that the mass of the reactants and the products should be equal between steps 5 and 7.
2. **Key Concept** The mass of the tablets changed form into gas, but was not lost in the second trial. The motion and activity of bubbling indicates that some energy is involved.

Teacher Notes



Transferring Energy

Food Chains / Food Webs

Use the scaffolded questions below to guide students in understanding how food chains and food webs are made up of producers and consumers that transfer energy.

Guiding Questions

AL	What is a food chain?	*A food chain is a simple model of energy transfer from a producer to one or more consumers.*
OL	Why does a food chain always begin with a producer?	*It begins with a producer because producers are the energy source for the rest of the organisms in the food chain.*
OL	What are the differences between a food chain and a food web?	*A food chain shows a series of feeding relationships that follow the path of energy through an ecosystem. A food web shows several interacting food chains within an ecosystem.*

Academic Vocabulary

transfer

Ask: **What does *transfer* mean?** *to pass from one to another*

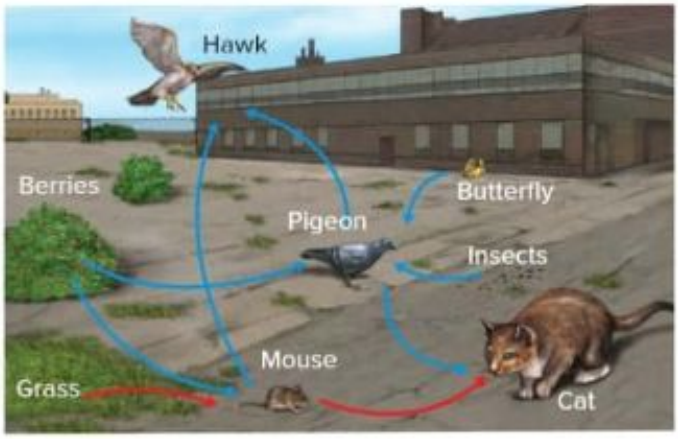
Ask: **What is transferred in a food chain?** *energy*

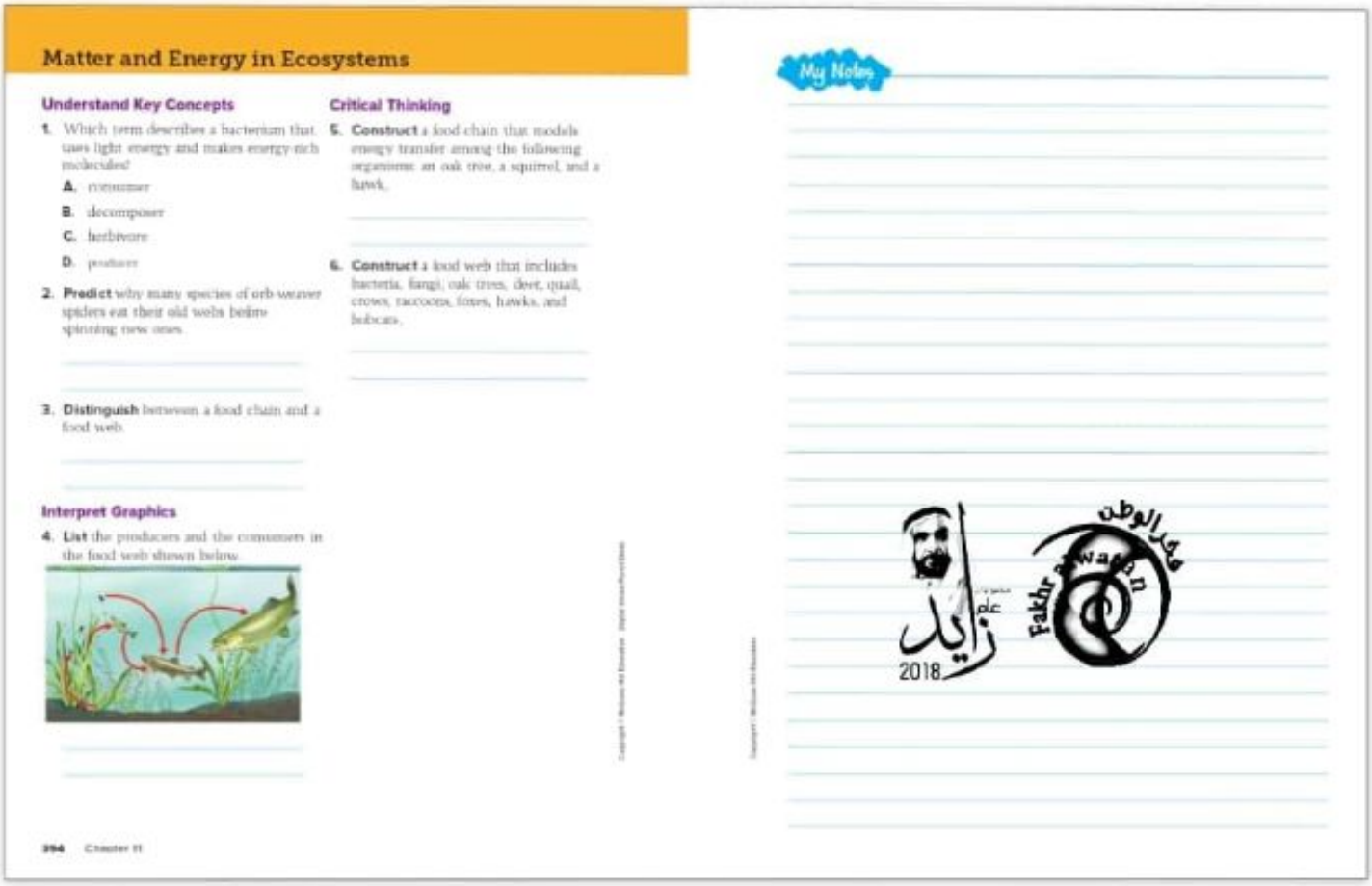
Visual Literacy: Figure 16

Use **Figure 16** to guide students in understanding the interconnection of food webs in a community.

Ask: **What is shown in this diagram?** *a food web that contains many food chains*

Ask: **Why do the grass, mouse, and cat represent a simple food chain?** *The mouse (a consumer) eats the grass (a producer); the mouse obtains energy from the grass. Then the cat (another consumer) eats the mouse; the cat obtains energy from the mouse.*





Matter and Energy in Ecosystems

Understand Key Concepts

1. Which term describes a bacterium that uses light energy and makes energy-rich molecules?
   A. consumer
   B. decomposer
   C. herbivore
   D. producer
2. **Predict** why many species of orb-weaver spiders eat their old webs before spinning new ones.
3. **Distinguish** between a food chain and a food web.

Interpret Graphics

4. **List** the producers and the consumers in the food web shown below.

Critical Thinking

5. **Construct** a food chain that models energy transfer among the following organisms: an oak tree, a squirrel, and a hawk.
6. **Construct** a food web that includes bacteria, fungi, oak trees, deer, quail, crows, raccoons, foxes, hawks, and bobcats.

My Notes

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Understand Key Concepts

1. **D.** producer
2. They eat their old webs as a way of recycling the matter the web is made of and retrieving the energy stored in the chemical bonds of the web materials.
3. A food chain shows one path of energy through an ecosystem. A food web shows several interacting pathways of energy through an ecosystem.

Interpret Graphics

4. Producers include plants, and consumers include insects and fish.

Critical Thinking

5. Oak tree → squirrel → hawk
6. Student answers should show: oak trees as producers that provide food for deer, quail, crows, raccoons; deer as food for bobcats; quail as food for bobcats, foxes, raccoons, crows; crows as food for hawks; raccoons as food for bobcats, hawks; bacteria and fungi as decomposers that feed on the dead bodies of any or all the other organisms.

CHAPTER

11 Study Guide

The BIG Idea

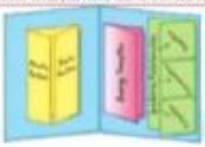
Organisms depend on one another and on their environment for food, shelter, living space, and other needs. The nonliving parts of the environment—including sunlight, water, air, and soil nutrients—determine what kinds of organisms can live in a given area and how many organisms can live there.

Key Concepts Summary	Vocabulary
11.1: Ecosystems • An **ecosystem** is all the interactions among the living and nonliving parts of the environment in a given area. • Both **abiotic factors** and **biotic factors** are parts of an ecosystem. Abiotic factors include nonliving things such as sunlight, water, and air. Biotic factors include all the living and once-living organisms in an ecosystem. • **Populations** can increase, decrease, move, and die out.	ecosystem abiotic factor biotic factor habitat population community population density
11.2: Relationships Within Ecosystems • A habitat is the place within an ecosystem that provides the resources an organism needs. A **niche** is the way an organism interacts with the biotic and abiotic factors in its environment to meet its needs. • Organisms rely on each other for food and other resources, compete with each other for resources, and cooperate with each other to obtain resources.	niche competition overpopulation predation symbiosis mutualism commensalism parasitism
11.3: Matter and Energy in Ecosystems • Matter cycles through ecosystems. Energy transfers from one organism to another in ecosystems. • Organisms obtain energy from eating it or chemicals in the environment or by eating other organisms. • A **food chain** shows a series of feeding relationships that follows the path of energy through an ecosystem. **food web** shows the interaction among several food chains within an ecosystem.	producer consumer food chain food web

FOLDABLES

Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.



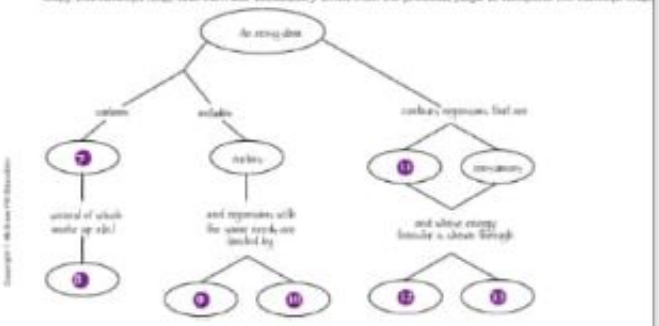
Use Vocabulary

Write the vocabulary term that best matches each phrase.

1. provides an organism with the abiotic and biotic factors needed for life
2. a number of individuals of a species living in the same area at the same time
3. a relationship in which one organism hunts another for food
4. a close relationship between two organisms in which one organism benefits and the other is harmed
5. an organism that can convert energy from sunlight into chemical energy
6. an organism that cannot make its own food

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.



Key Concepts Summary

Study Strategy: Whole/Part Relationships

Divide the class into small groups. Explain that each group is to create a diagram that explains the relationships within ecosystems.

1. Have each group choose an ecosystem at random from a container that you've prepared with names of different ecosystems labeled on pieces of paper.
2. Provide chart paper and markers for each group. Provide an opportunity for each group to use the Internet to obtain images as needed or desired for their diagrams.
3. Encourage students to be creative, yet accurate, when creating diagrams that show relationships within their ecosystems.
4. Create a "museum walk." Display all the charts. Have a spokesperson from each group explain the group's ecosystem diagram as the class moves from one diagram to another.
5. Allow students an opportunity to ask questions.

Vocabulary

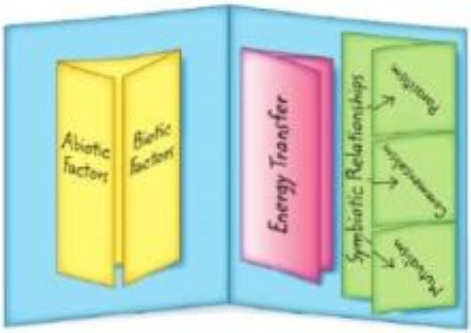
Study Strategy: Making Connections

Draw the following chart on the board or chart paper:

Vocabulary	How It Applies

1. Have students copy the chart in their Science Journals.
2. Haves students review the chapter lessons and write all vocabulary terms in the Vocabulary column. Students should then explain how each term applies to ecosystems.
3. Students may add other terms from the chapter as needed.
4. Organize students into pairs. Have each student pair review their charts and add to or clarify information on their vocabulary charts.
5. Quickly review the charts as a class to clarify any misconceptions concerning how the terms presented in the chapters apply to ecosystems.

FOLDABLES Chapter Project



Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

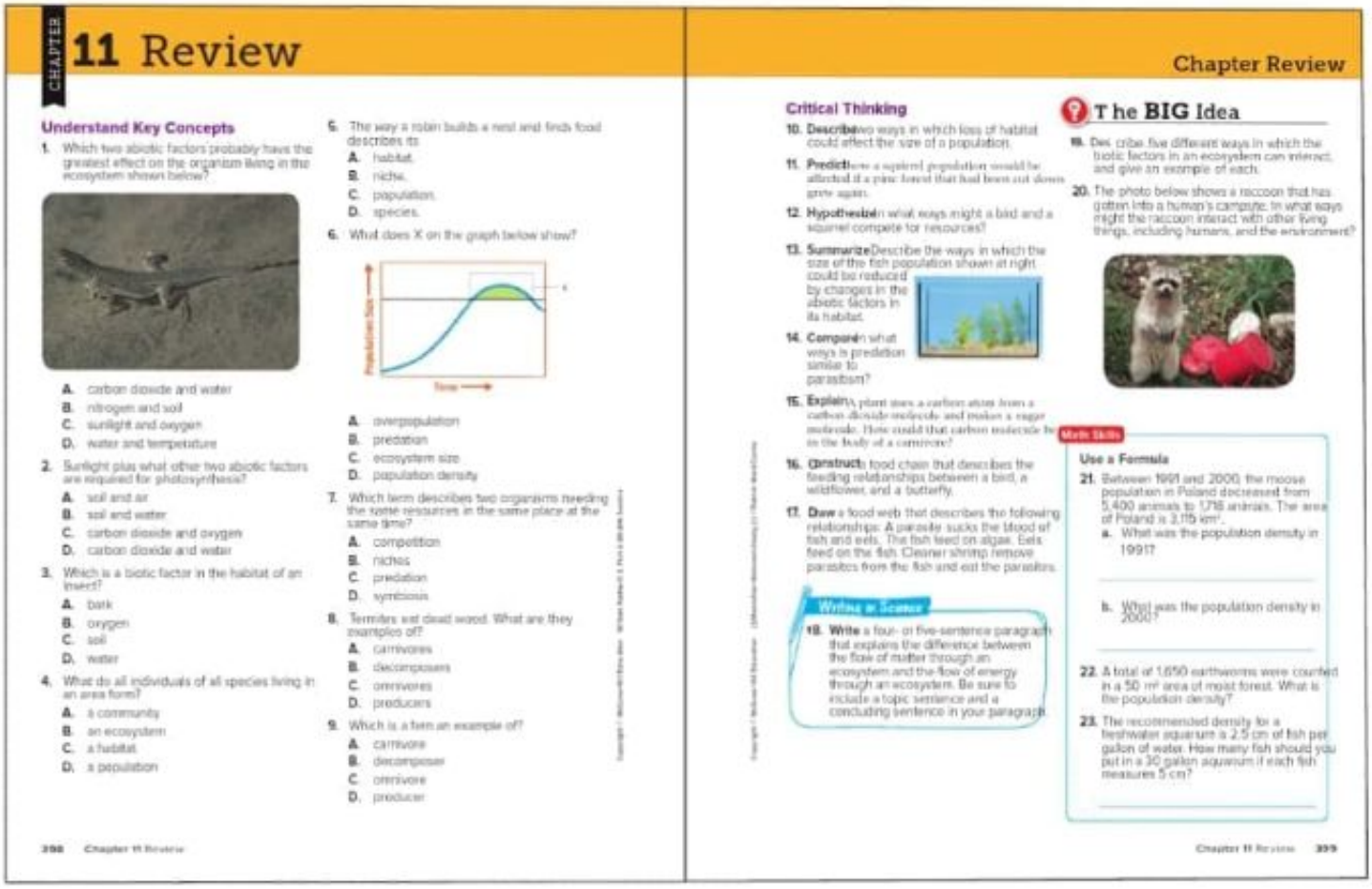
Teacher Notes

Use Vocabulary

1. Habitat
2. Population
3. Predation
4. Parasitism
5. Producer
6. Consumer

Link Vocabulary and Key Concepts

7. Populations
8. Community
9. 10. Limiting factors/competition
11. Producers
12. 13. Food chains/food webs



CHAPTER 11 Review

Chapter Review

Understand Key Concepts

1. Which two abiotic factors probably have the greatest effect on the organism living in the ecosystem shown below?

A. carbon dioxide and water
B. nitrogen and soil
C. sunlight and oxygen
D. water and temperature

2. Sunlight plus what other two abiotic factors are required for photosynthesis?
A. soil and air
B. soil and water
C. carbon dioxide and oxygen
D. carbon dioxide and water

3. Which is a biotic factor in the habitat of an insect?
A. bark
B. oxygen
C. soil
D. water

4. What do all individuals of all species living in an area form?
A. a community
B. an ecosystem
C. a habitat
D. a population

5. The way a robin builds a nest and finds food describes its
A. habitat.
B. niche.
C. population.
D. species.

6. What does X on the graph below show?

A. overpopulation
B. predation
C. ecosystem size
D. population density

7. Which term describes two organisms needing the same resources in the same place at the same time?
A. competition
B. niches
C. predation
D. symbiosis

8. Termites eat dead wood. What are they examples of?
A. carnivores
B. decomposers
C. omnivores
D. producers

9. Which is a term an example of?
A. carnivore
B. decomposer
C. omnivore
D. producer

Critical Thinking

10. **Describe** two ways in which loss of habitat could affect the size of a population.

11. **Predict** how a squirrel population would be affected if a pine forest that had been cut down grew again.

12. **Hypothesize** in what ways might a bird and a squirrel compete for resources?

13. **Summarize** Describe the ways in which the size of the fish population shown at right could be reduced by changes in the abiotic factors in its habitat.

14. **Compare** in what ways is predation similar to parasitism?

15. **Explain** A plant uses a carbon atom from a carbon dioxide molecule and makes a sugar molecule. How could that carbon molecule be in the body of a carnivore?

16. **Construct** a food chain that describes the feeding relationships between a bird, a wildflower, and a butterfly.

17. **Draw** a food web that describes the following relationships: A parasite sucks the blood of fish and eels. The fish feed on algae. Eels feed on the fish. Cleaner shrimp remove parasites from the fish and eat the parasites.

Writing in Science

18. **Write** a four- or five-sentence paragraph that explains the difference between the flow of matter through an ecosystem and the flow of energy through an ecosystem. Be sure to include a topic sentence and a concluding sentence in your paragraph.

The BIG Idea

19. Describe five different ways in which the biotic factors in an ecosystem can interact, and give an example of each.

20. The photo below shows a raccoon that has gotten into a human's campsite. In what ways might the raccoon interact with other living things, including humans, and the environment?

Math Skills

Use a Formula

21. Between 1991 and 2000, the moose population in Poland decreased from 5,400 animals to 1,716 animals. The area of Poland is 3,115 km².
a. What was the population density in 1991?

b. What was the population density in 2000?

22. A total of 1,650 earthworms were counted in a 50 m² area of moist forest. What is the population density?

23. The recommended density for a freshwater aquarium is 2.5 cm of fish per gallon of water. How many fish should you put in a 30 gallon aquarium if each fish measures 5 cm?

Understand Key Concepts

1 D. water and temperature
2 D. carbon dioxide and water
3 A. bark
4 A. a community
5 B. niche.
6 A. overpopulation
7 A. competition
8 B. decomposers
9 D. producer

Critical Thinking

10 Fewer places to live would force the individuals in the population to live closer together, therefore increasing population density. With fewer places to live, some individuals might move out of the area, reducing the population's size.

11 An increase in the number of trees would offer more habitat for squirrels. The population could increase.

12 Accept reasonable answers. Sample answer: They might compete for nesting space in a tree. They might compete for food if both species eat seeds or acorns.

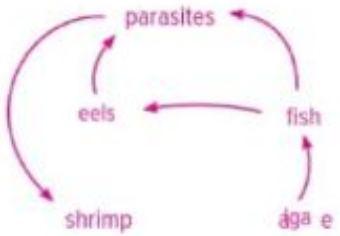
13 Accept reasonable answers. Sample answer: A decrease in rainfall could drop water levels and cause some fish to dry out. More sunlight could cause more plants to grow so small fish had more food.

14 In both relationships, one organism feeds on another. The organism that feeds benefits, but the organism that is fed upon is harmed.

15 Accept reasonable answers. Plant could be eaten by an herbivore, the herbivore eaten by a carnivore.

16 Wildflower → butterfly → bird

17 Food web drawings will vary. Sample answer:



Writing in Science

18 Accept reasonable answers. Sample answer: Matter and energy both move through ecosystems. Energy flows in one direction, from sunlight to producers to consumers to decomposers. Matter flows in the same direction as energy. However, matter is recycled by decomposers and can go through the cycle again and again.

The BIG Idea

19 Accept reasonable answers. Student answers should include descriptions of competition, predation, and three types of symbiosis (mutualism, commensalism, and parasitism).

20 Answers will vary. Sample answers: The raccoon might eat the human's food or sleep near their camp. The raccoon, a consumer, eats other organisms as food, competes against other raccoons, defends itself against predators, and depends on abiotic factors in its environment, such as water, to survive.

Math Skills

Use a Formula

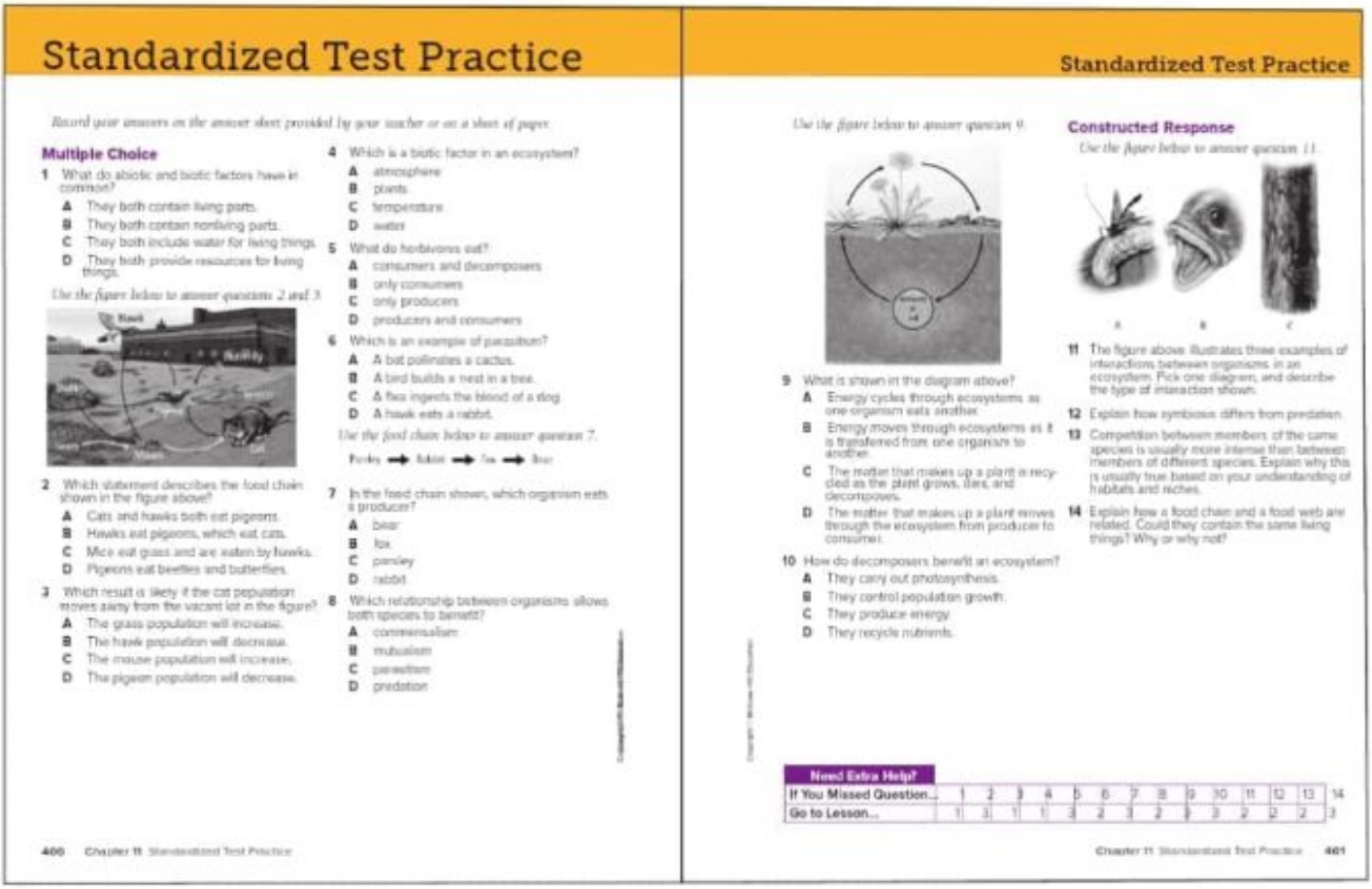
21. a. $\frac{5{,}400 \text{ moose}}{3{,}115 \text{ km}^2} = \frac{1.734 \text{ moose}}{\text{km}^2}$

b. $\frac{1{,}718 \text{ moose}}{3{,}115 \text{ km}^2} = \frac{0.5515 \text{ moose}}{\text{km}^2}$

22. $\frac{1{,}650 \text{ earthworms}}{50 \text{ m}^2} = \frac{33 \text{ earthworms}}{\text{m}^2}$

23. Each fish would require 2 gallons of water, so there could be 15 fish in the 30-gallon aquarium.

Teacher Notes



Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice

1 What do abiotic and biotic factors have in common?
- A They both contain living parts.
- B They both contain nonliving parts.
- C They both include water for living things.
- D They both provide resources for living things.

Use the figure below to answer questions 2 and 3.

2 Which statement describes the food chain shown in the figure above?
- A Cats and hawks both eat pigeons.
- B Hawks eat pigeons, which eat cats.
- C Mice eat grass and are eaten by hawks.
- D Pigeons eat beetles and butterflies.

3 Which result is likely if the cat population moves away from the vacant lot in the figure?
- A The grass population will increase.
- B The hawk population will decrease.
- C The mouse population will increase.
- D The pigeon population will decrease.

4 Which is a biotic factor in an ecosystem?
- A atmosphere
- B plants
- C temperature
- D water

5 What do herbivores eat?
- A consumers and decomposers
- B only consumers
- C only producers
- D producers and consumers

6 Which is an example of parasitism?
- A A bat pollinates a cactus.
- B A bird builds a nest in a tree.
- C A flea ingests the blood of a dog.
- D A hawk eats a rabbit.

Use the food chain below to answer question 7.

Parsley → Rabbit → Fox → Bear

7 In the food chain shown, which organism eats a producer?
- A bear
- B fox
- C parsley
- D rabbit

8 Which relationship between organisms allows both species to benefit?
- A commensalism
- B mutualism
- C parasitism
- D predation

Use the figure below to answer question 9.

9 What is shown in the diagram above?
- A Energy cycles through ecosystems as one organism eats another.
- B Energy moves through ecosystems as it is transferred from one organism to another.
- C The matter that makes up a plant is recycled as the plant grows, dies, and decomposes.
- D The matter that makes up a plant moves through the ecosystem from producer to consumer.

10 How do decomposers benefit an ecosystem?
- A They carry out photosynthesis.
- B They control population growth.
- C They produce energy.
- D They recycle nutrients.

Constructed Response

Use the figure below to answer question 11.

A B C

11 The figure above illustrates three examples of interactions between organisms in an ecosystem. Pick one diagram, and describe the type of interaction shown.

12 Explain how symbiosis differs from predation.

13 Competition between members of the same species is usually more intense than between members of different species. Explain why this is usually true, based on your understanding of habitats and niches.

14 Explain how a food chain and a food web are related. Could they contain the same living things? Why or why not?

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	3	1	1	3	2	3	2	3	3	2	2	2	3

Multiple Choice

1 **D—Correct.** A, B, C—Both abiotic and biotic factors provide resources for living things. A is incorrect because abiotic factors are nonliving. B is incorrect because biotic factors are living, and C is incorrect because water is an abiotic factor only.

2 **C—Correct.** A, B, D—A food chain begins with a producer and shows the transfer of energy to consumers. A and D describe parts of food webs but lack producers and are not linear. B is not supported by the figure; pigeons do not eat cats.

3 **C—Correct.** A, B, D—Without cats the mouse population is likely to increase. A is incorrect because an increase in the mouse population will reduce the grass population. B is incorrect because the hawk population may increase as more mice will be available to eat; that is, hawks will have less competition from cats for food. D is incorrect because the pigeon population is more likely to increase since cats will not be eating them.

4 **B—Correct.** A, C, D—Plants are living things. Atmosphere, temperature, and water are nonliving (abiotic) factors.

5 **C—Correct.** A, B, D—Herbivores eat plants, which are producers. They do not eat consumers.

6 **C—Correct.** A, B, D—A describes mutualism. B describes commensalism. D describes predation.

7 **D—Correct.** A, B, C—Parsley is a producer, and the rabbit eats parsley. The fox and the bear eat other consumers.

8 **B—Correct.** A, C, D—In commensalism, one species benefits, and the other is unaffected. In parasitism and predation, one species is harmed.

9 **C—Correct.** A, B, D—A and B describe energy moving from organism to organism, but only one kind of organism (a plant) is shown. D is not supported by the figure because only a producer is shown.

10 **D—Correct.** A, B, C—Decomposers recycle nutrients. They do not carry out photosynthesis, control population growth, or produce energy.

Constructed Response

11 The figure shows (A) parasitism, (B) mutualism, and (C) commensalism. The wasp is a parasite because it ultimately harms the caterpillar when the wasp's larvae chew their way out of the caterpillar's body. The cleaner shrimp remove tiny organisms from the fish's body, which benefits both the shrimp and the fish. The moss benefits from having a niche on the tree while not harming the tree.

12 In parasitism, the parasite lives off the host, but does not kill it. In contrast, a predator lives off of prey, and actually kills it for food.

13 Two species cannot inhabit the same niche although they can share a habitat. Thus, species in the same niche would compete for exactly the same resources which would make competition between members of a single species occupying the same niche more intense.

14 A food chain is part of a food web. The food web can show many food chains and how they are interrelated. Because one is part of the other, a food chain can have some of the same organisms as a food web.

Answer Key

Question	Answer
1	D
2	C
3	C
4	B
5	C
6	C
7	D
8	B
9	C
10	D
11	See extended answer.
12	See extended answer.
13	See extended answer.
14	See extended answer.

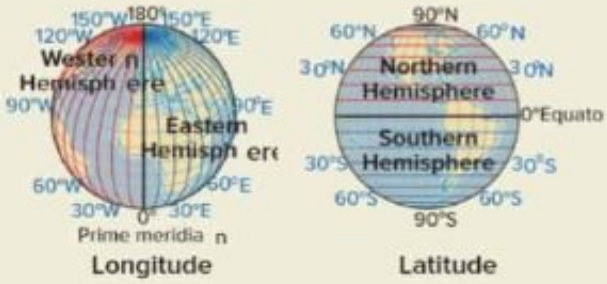
Science Content Background

Lesson 1

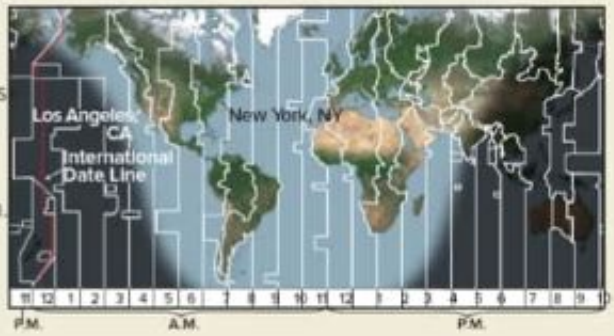
Maps

Longitude Degrees of longitude are represented by vertical lines (running from pole to pole) on maps or globes and make up one-half of the grid system used to pinpoint locations on Earth's surface. The reference point for degrees of longitude is the prime meridian (0°). In 1884, the location of the prime meridian was established as passing through the center of a telescope housed at what was then the Observatory of Greenwich in Greenwich, England.

Latitude Degrees of latitude are represented as horizontal lines on maps and globes. Together, degrees of longitude and latitude make up the grid system used to precisely locate positions on Earth. The reference point for degrees of latitude is the equator (0°). Unlike lines of longitude, lines of latitude are parallel. Because Earth is spherical, it can be divided into 360°. So, the distance covered by one degree of latitude is calculated by dividing the circumference of Earth (about 40,000 km) by 360. The distance between each degree of latitude is equal to approximately 111 km.



Time Zones Earth is divided into 24 time zones. This is because it takes about 24 hours for Earth to complete one rotation on its axis. Greenwich Mean Time (GMT) begins at the prime meridian. The width of a time zone is 15° of longitude. (360° divided by 24 hours equals 15° per hour.) For every 15° of longitude a person moves west of the prime meridian, the time changes by one hour ahead of GMT. For every 15° of longitude a person moves east of the prime meridian, the time changes by one hour behind GMT. Because lines of longitude are not parallel and get closer to each other as they near the poles, the distance in kilometers between time zones is not constant. At the North and South Poles, where all degrees of longitude meet, a person can cross over all 24 times zones in seconds.

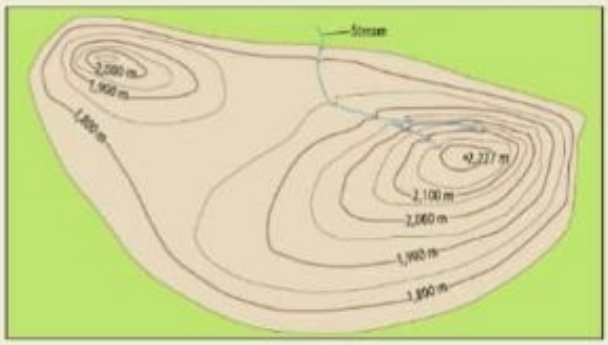


Map Projections Cylindrical projections produce a grid in which lines of latitude are parallel. Lines of longitude remain perpendicular to lines of latitude. But, unlike a globe, the lines of longitude are parallel to each other. Because direction can be tracked in a straight path on cylindrical projections, they are often used to make navigational maps for ships and planes. Conical projections produce accurate representations of small areas of Earth's surface. For this reason, conical projections are often used to make maps that focus on a smaller area, such as a road map.

Lesson 2

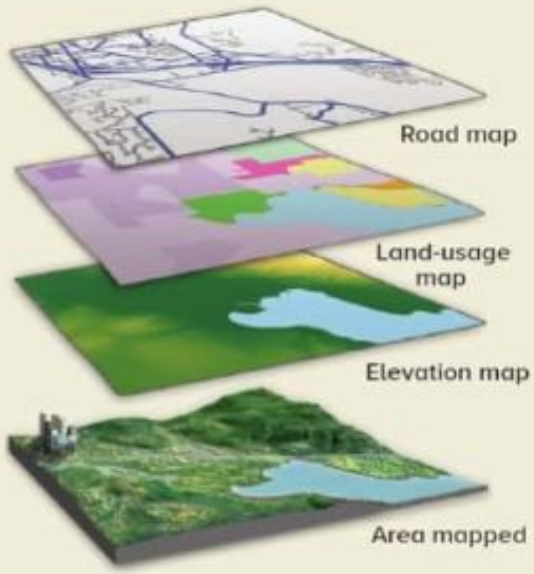
Technology and Mapmaking

Reading Topographic Maps Contour lines on the map are lines that connect points of equal evaluation. Not every contour line will have the elevation it represents marked on it. Only certain contour lines, called index contours, will be labeled with elevation. Index contours give the reader a reference point from which to begin reading the map. The elevation difference between contour lines is not universal. The contour interval, or the elevation difference between contour lines that are next to each other, differs from one map to another. In order to read a topographic map, a person must know what the contour interval is for that map. This allows the reader to determine the elevation represented by each contour line on the map.



Geologic Maps Geologic maps show geologic formations, such as types of rock, faults, and folds. They are usually printed over a regular map that shows roads and other features to help the reader become oriented correctly. The regular map is printed in light colors so the geological features can be seen clearly.

Geographic Information Systems (GIS) GIS can be used to find patterns, such as the location and magnitude of earthquake activity. GIS maps can also show quantities of things, such as the number of doctors per 1,000 people in an area. Information like this helps people determine whether the needs of a community are being met. Like remote sensing, GIS maps can also show changes to an area over time, such as changes in land use over time.



Remote Sensing Remote-sensing techniques have enabled scientists to learn more about the topography of the ocean floor as well as more about ocean circulation, algal blooms, particularly red tides, and changes in sea level.

Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

*American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

*Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure, and make things.

*A model of something is similar to but not exactly like, the thing being modeled. Some models are physically similar to what they are representing, but others are not.

*Geometric figures, number sequences, graphs, diagrams, sketches, number lines, maps, and oral and written descriptions can be used to represent objects, events, and processes in the real world.

Lesson 1 Maps

1 Maps contain information such as legends with identifying symbols, and latitude and longitude to determine location.

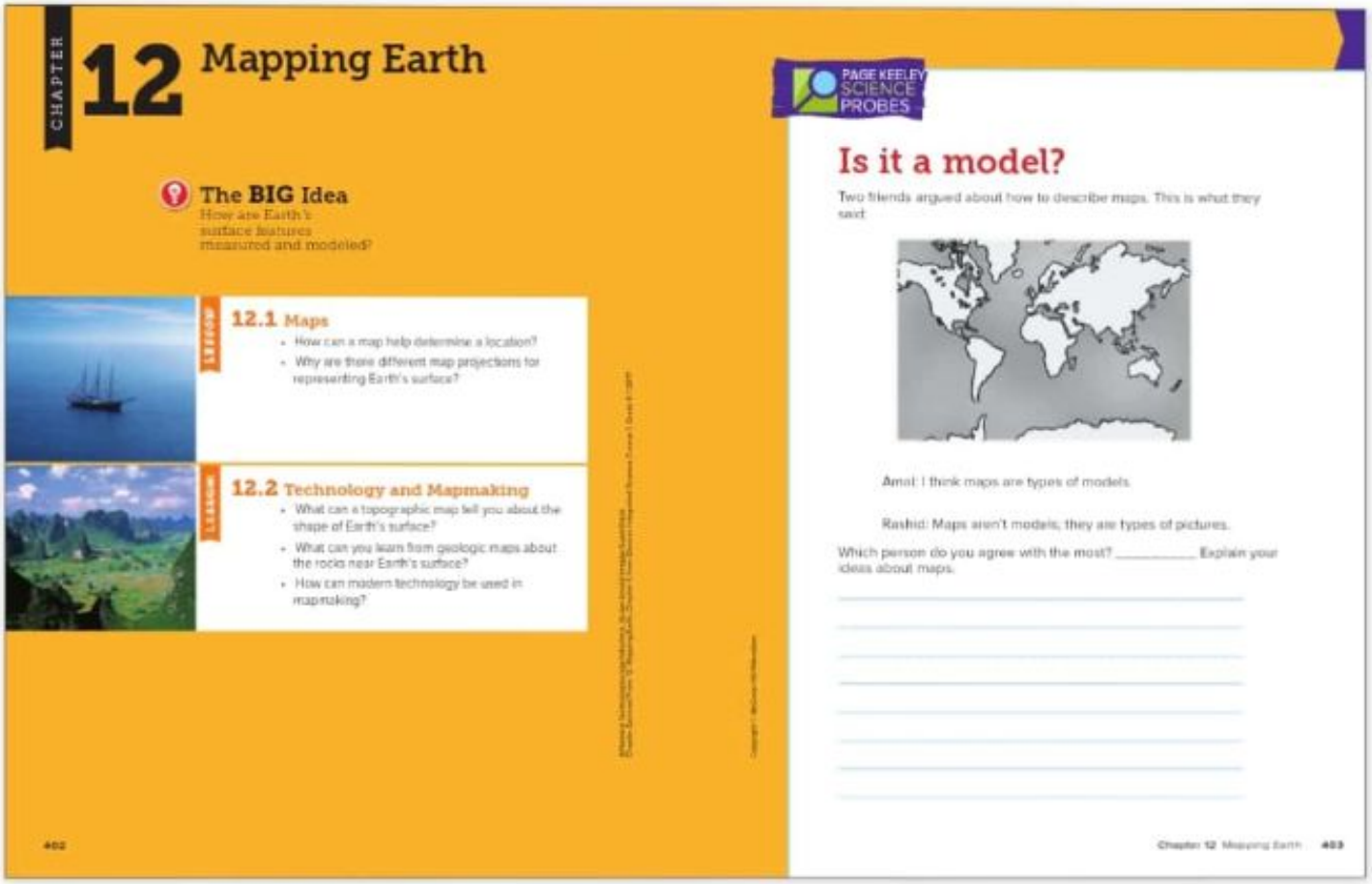
2 Map projections distort Earth's features.

Lesson 2 Technology and Mapmaking

5 GPS, remote sensing, and GIS are used to check locations, take aerial photographs and images, and layer items to produce more accurate maps.

3 Topographic maps show elevation through contour lines.

4 Geologic maps contain information about rocks such as rock types, rock age, and faults.



How are Earth's surface features measured and modeled?

The BIG Idea

There are no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL	What is a map?	*This question enables students to start thinking about maps, which are two-dimensional models. Most students might describe a map as a piece of paper or drawing that helps them get from one point to another.*
OL	Find the hook-shaped body of water near the left edge of the small map. Where is this water body on the large map?	*If they look carefully enough, students should be able to see that the hook-shaped body of water on the small map is directly to the right of the top of the smaller map on the larger map.*
BL	Why do the parts of these maps that show the same area look different?	*Some students will realize that the maps look different because they are at different scales and use different colors to show surface features. Some students might realize that the maps were made at different times.*

PAGE KEELEY SCIENCE PROBES Is it a model?

Answers to the Page Keeley Science Probe can be found in the Teacher's Edition of the *Activity Lab Workbook*.

Get Ready to Read

What do you think?

Use this anticipation guide to gauge students' background knowledge and preconceptions about maps and mapmaking. At the end of the chapter, ask students to read and evaluate their earlier responses. Students should be encouraged to change any of their responses.

Anticipation Set for Lesson 1

1. **Maps help determine locations on Earth.**

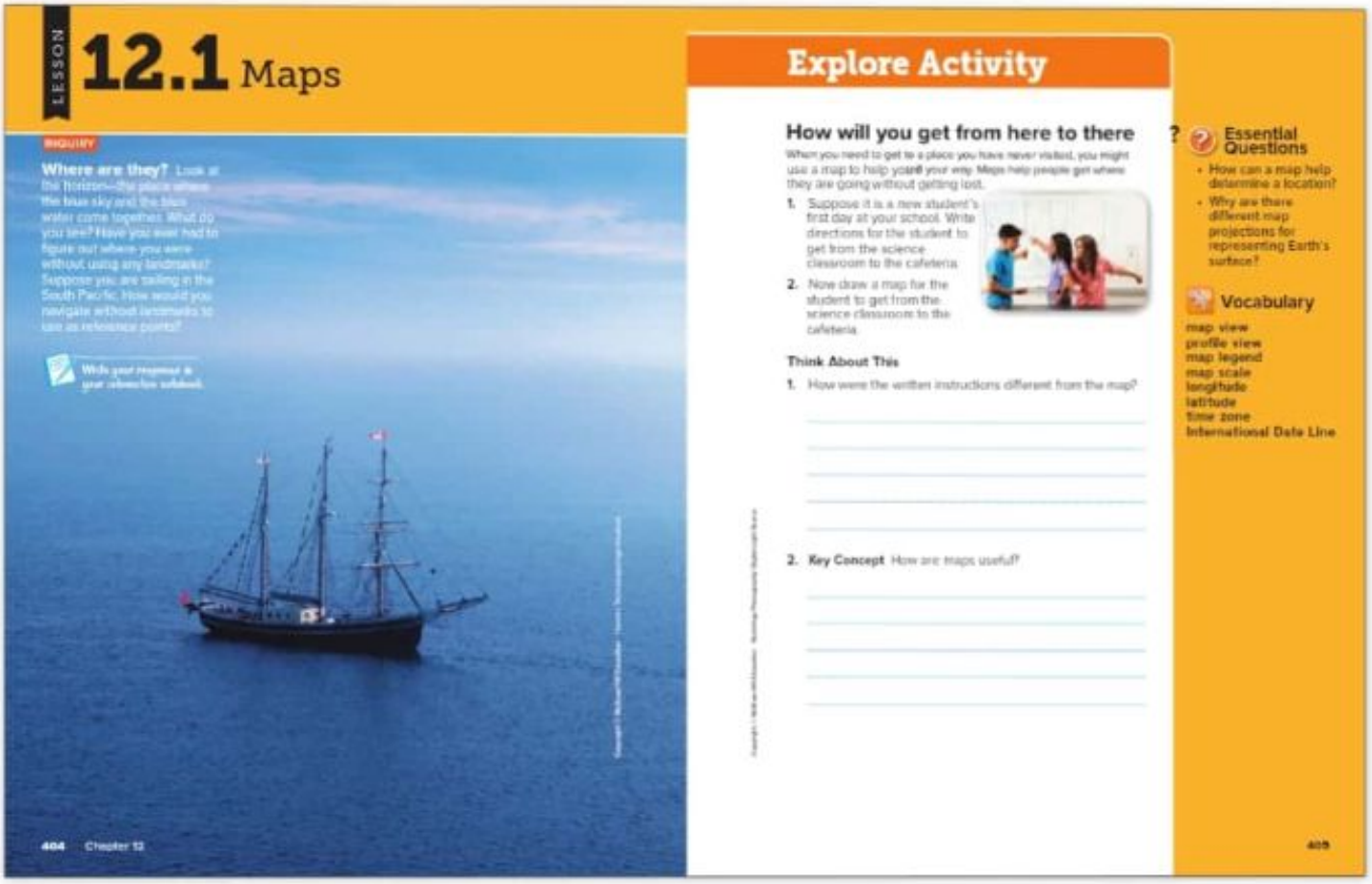
   Agree. A map is a flat model of Earth.

2. **All Earth models are spherical.**

   Disagree. Maps model Earth in two dimensions.

3. **World maps are drawn accurately for every location.**

   Disagree. Each type of map projection has some area of distortion.



INQUIRY

About the Photo **Where are they?** Make an analogy between the photo and navigating without landmarks and the popular swimming pool game *Marco Polo*. In this game, one person closes his or her eyes and tries to find other people who swim around him or her. The person with the closed eyes calls out "Marco" and the other swimmers respond with "Polo." The person calling out "Marco" must navigate using sound, rather than sight.

Guiding Questions

AL **Have you ever played the swimming pool game *Marco Polo*? Describe the game.**	*Allow one or two volunteers to describe the game and how it's played.*
OL **How is playing the game *Marco Polo* like navigating a sailboat without using landmarks?**	*From their experience with* Marco Polo *and similar games, students should be able to conclude that navigation is difficult, yet possible, without being able to see landmarks.*
BL **List ways that the sailboat's crew might find their way around the South Pacific.**	*Accept all reasonable answers. Some students should be able to conclude that today sailors can use compasses, the Sun, GPS devices, or other tools to navigate on the open ocean.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

Upon completion of this lesson, students should understand and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Form Operational Definitions

1. Have students pair up and observe each other from both the front and the side.
2. **Ask: Which view of your partner is a profile view?** *the view from the side*
3. Tell students that frontal views are also called plan views. In the case of a map, such a view is called a map view.
4. **Ask: What is a map view?** *a view of a part of Earth as if one were looking down on the area*

ExploreActivity

How will you get from here to there?

Prep: *0 min* **Class:** *15 min*

Purpose
To determine the usefulness of maps by comparing written directions to find a location using a map.

Materials
Student: pencil, paper; **Optional:** metric ruler

Before You Begin
Make sure students understand that a map is a model that shows an area as if it were viewed from above.

Guide the Investigation

- Before students begin the lab, ask them to consider the following question: **What information does the new student need to successfully arrive at the cafeteria?**
- While students do not need to worry about an exact scale, explain that the maps should be drawn as accurately as possible.

Think About This

1. Sample answer: The instructions depend on written language. Images on the map would be easier to use. Visual learners would prefer a map; auditory learners might prefer a written/spoken instruction guide. Kinesthetic learners might follow the route with a finger on a map.
2. **Key Concept** Sample answer: Maps are useful because they can help a person find his or her way in an unfamiliar place.

Teacher Notes

Map Projections

As students read this page, have them make and complete the Foldables® suggested on the page. Have students use what they have read, the notes in the Foldables®, and **Figure 7** to answer the Guiding Questions below.

Guiding Questions

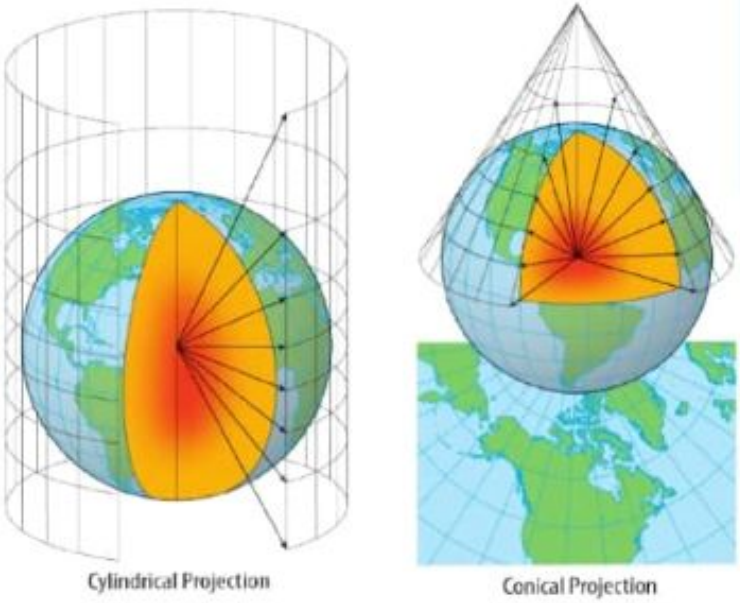
AL **Where are maps made from cylindrical and conical projections most accurate?**	*The maps are most accurate in places where the cylinder or cone onto which the map will be made touches the globe.*
OL **What are the advantages and disadvantages of cylindrical projections and conical projections?**	*Cylindrical projections are accurate at the center of the map (equator) while areas at the poles are enlarged. Conical projections are accurate where the cone touches the globe, but distortions occur everywhere else.*
BL **What types of areas might be accurately mapped using conical projections?**	*Conical projections can be used for making accurate maps of specific regions, such as a continent or a country.*

Visual Literacy: Figure 7

Use **Figure 7** to discuss the two types of projections presented here. Clarify for students that they should answer the questions according to the locations of the cylinder and the cone as shown in the figure.

Ask: **Describe the relationship between the lines of longitude on each projection.** *On the cylindrical projection, lines of longitude are parallel to each other. On the conical projection, lines of longitude meet at the top of the cone.*

Ask: **Why does this happen?** *The lines drawn on a map using these projections reflect the shape of cylinders and cones that are slit open and flattened. A cylinder opened this way becomes a rectangle, so both longitude and latitude lines are perpendicular. When a cone is split open the resulting shape is curved, so the longitude lines converge at the pole.*



Cylindrical Projection

Conical Projection

Differentiated Instruction

Understanding Time Zones and Map Projections
Divide the class into small groups. Give students copies of cylindrical projections that include Antarctica. Write the following questions on slips of paper. Ask ELL students questions that stress terms. Ask AL students questions that stress skills. Ask BL students critical thinking questions. Samples of each are below. Have each group answer the questions directly on their maps.

AL Ask: **Where is the International Date Line?** *180° from the prime meridian* **How many hours difference is there between New York City and the western edge of Africa?** *4*

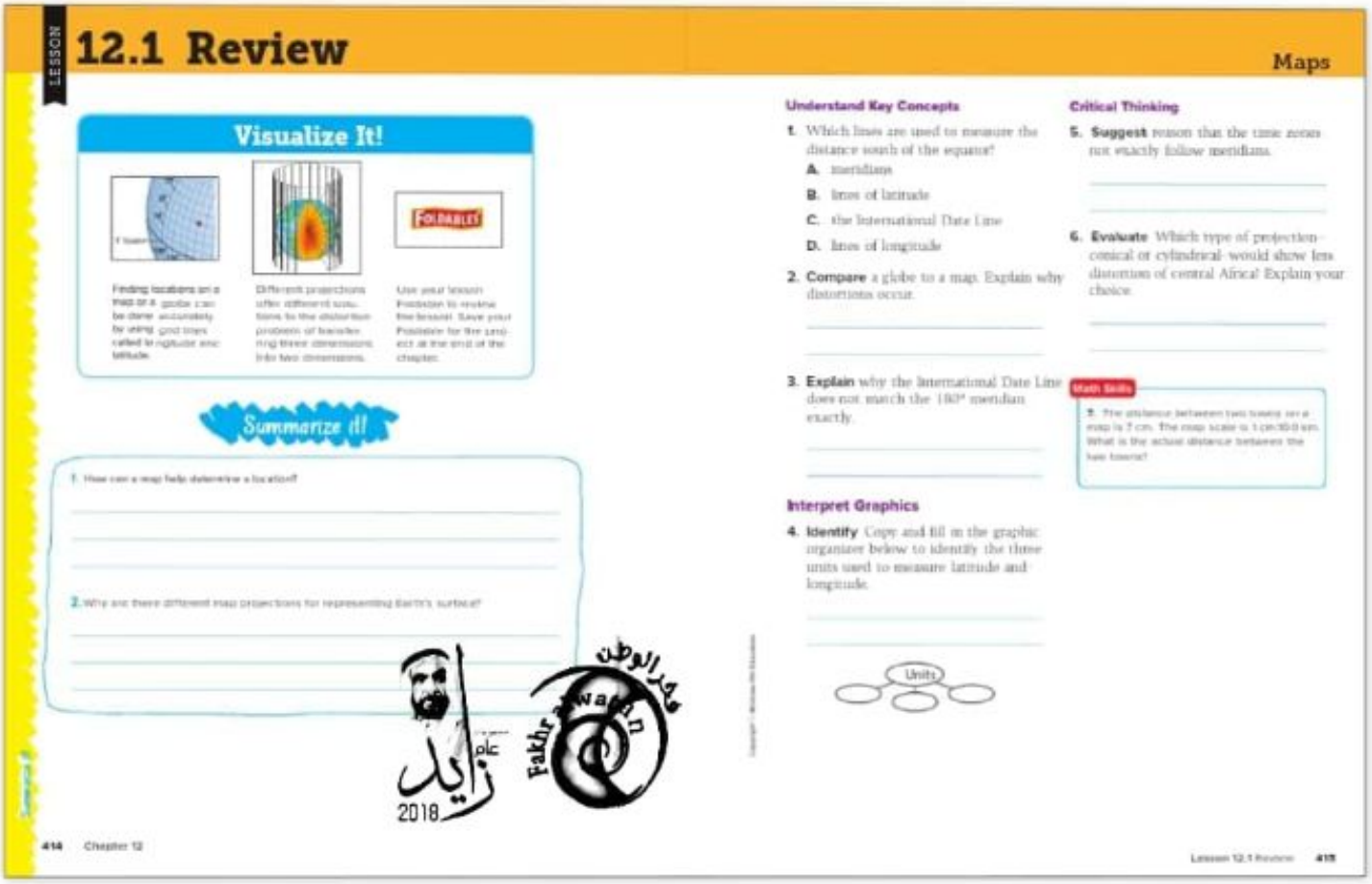
BL Ask: **What is the large landmass along the bottom of the projection and why is it so large?** *Antarctica; it is highly distorted because of its geographical location at the South Pole. Projections distort areas where the shape of the paper does not touch the globe.*

Teacher Toolbox

Fun Fact
Time and Time Again! Because of its location at the South Pole, Antarctica technically has 24 time zones! However, scientists and others who live and work in Antarctica often use GMT, or Greenwich Mean Time, to tell time on this frozen continent.

Real-World Science
Daylight Saving Time Daylight saving time (DST) occurs when clocks are set ahead one hour for a certain period of time. Most states in the United States observe daylight saving time and *spring forward!* (or set their clocks ahead) on the second Sunday in March. Then, on the first Sunday in November, they *fall back!* (or set their clocks back an hour). Not all states switch to DST; plus, states that occupy more than one time zone may use DST in one part of the state but not in another.

FOLDABLES For help creating this Foldable and additional Foldables® ideas, use the **Foldables Handbook** in the back of this book.



Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: Which Key Concept does each image relate to?**

FOLDABLES Review students' folded books. Check students' definitions of cylindrical and conical projections and the notes under each heading.

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Understanding Maps
- Reading Maps
- Plotting Locations
- Map Projections

Understand Key Concepts

1. **B.** Lines of latitude

2. A globe is a three-dimensional model of Earth. A map is a two-dimensional model. Globes have less distortion because they more accurately represent Earth's three dimensions. Maps are distorted because they are a flat representation of a sphere.

3. In order to keep island groups in the same time zones the International Date Line goes around them.

Interpret Graphics

4. Degrees; minutes; seconds

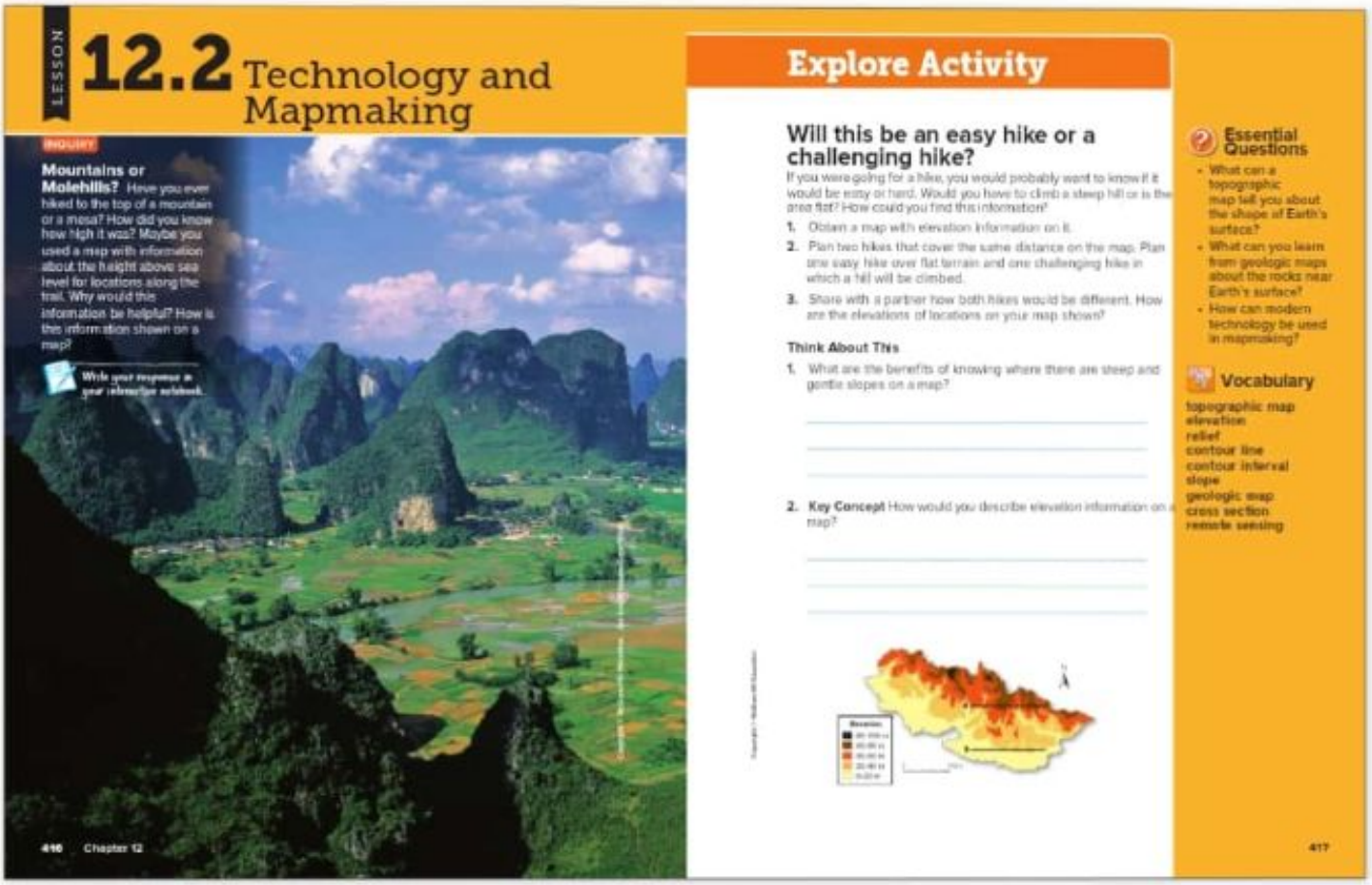
Critical Thinking

5. Political boundaries might cross a meridian. To keep states or countries within the same time zone, the time zone boundaries go around them.

6. A cylindrical projection would have a small distortion because central Africa is near the equator, where these projections are most accurate. A conical projection would need to specifically focus on central Africa to be accurate.

Math Skills

7. 700 km



INQUIRY

About the Photo **Mountains or Molehills?** This photo shows a series of plant-covered rocks jutting up from the surrounding land. Over time, eroding forces wore away softer rocks and left these more resistant rocks standing. As students observe the photograph, ask the questions below.

Guiding Questions

AL	Have you ever been told that you were making a mountain out of a molehill? What does this saying mean?	*A molehill is much, much smaller than a mountain. Making a mountain out of a molehill means that a person is making too big of a deal about something, or making something worse than it is.*
OL	Are these jutting rock structures mountains or hills?	*Accept any answer that students can justify. Some students might use the buildings near the center hill to estimate the height of the rock structures. Relative to a typical mountain range, these structures are hills. However, relative to the fields along the river, the rock structures might appear as mountains to an observer on the ground.*
BL	How could you show both the hills and the flat fields on the same map? Remember that a map is a two-dimensional model of Earth's surface.	*Some students might know that a topographic map can be used to show the elevation and relief of an area. Student answers might also reflect use of a profile map.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

Upon completing this lesson, students should understand the Key Concepts and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary

Matching

1. Write each vocabulary word on a separate index card. Draw a simple diagram that explains or shows what is meant by each word on another set of index cards.
2. Ask for volunteers to match each word with its correct picture. Some of the matching might be accomplished by luck or by the process of elimination.
3. Display the correctly matched cards somewhere in the room where students can refer to them as you teach this lesson.
4. Students might make individual sets of cards for personal use.

ExploreActivity

Will this be an easy hike or a challenging hike?

Prep: *10 min* **Class:** *20 min*

Purpose
To explore elevation using a map.

Material
map with elevation information on it

Before You Begin
Ask students to look at the maps in **Lesson 1** and see if they can tell where the hills and mountains are from these maps. Then have them consider the usefulness of knowing such information.

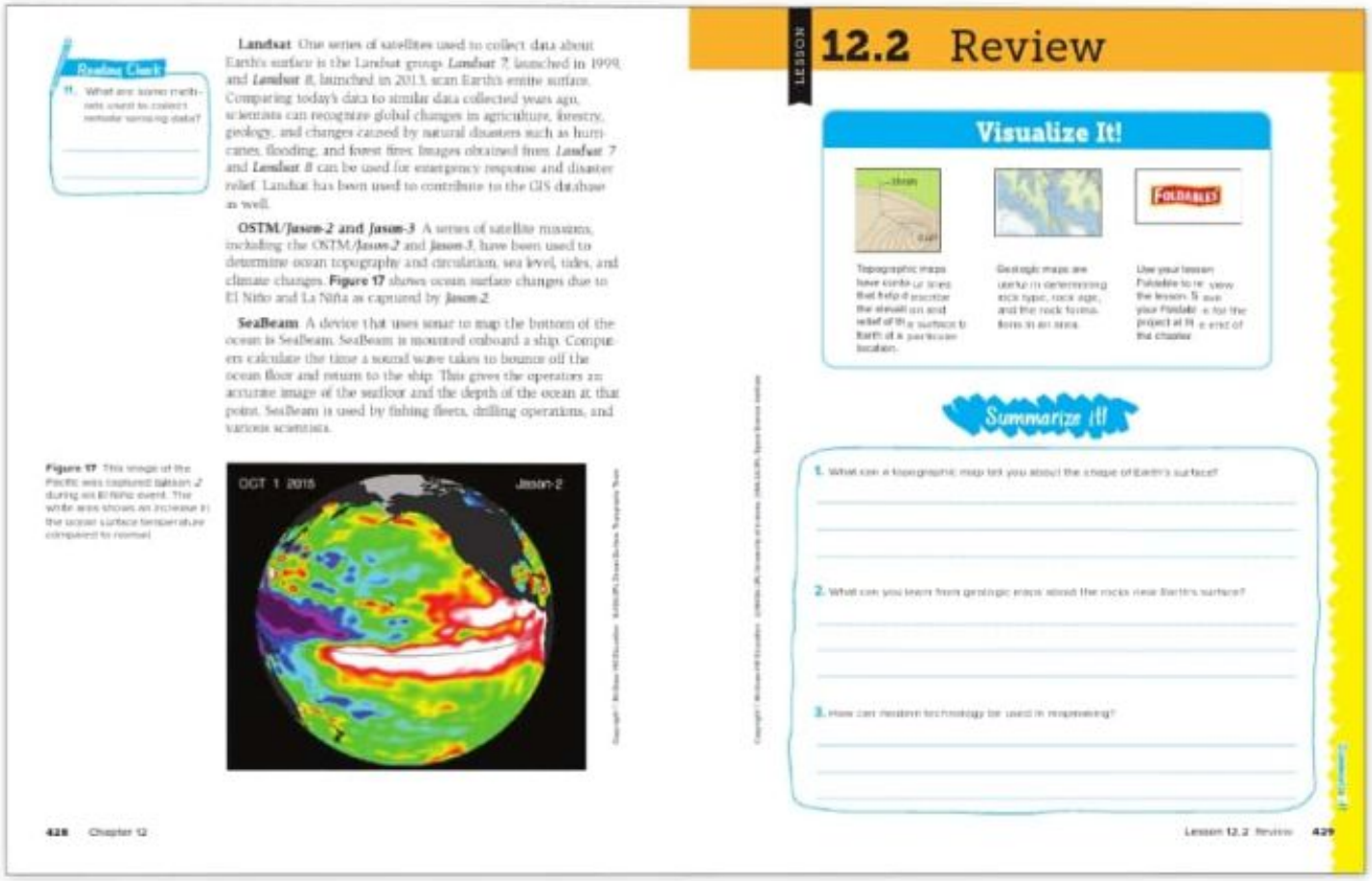
Guide the Investigation

- Tell students they will be planning two hikes—one easy hike and one challenging hike.
- Ask students what would make a hike easy or challenging.

Think About This

1. Potential answers: One can find the easiest way to travel through an area. One can determine the best areas to build roads or houses.
2. **Key Concept** Any way of showing three-dimensional characteristics on a two-dimensional surface are acceptable. Answers might include shading, lines, colors, or a combination of these.

Teacher Notes



Reading Check

11. What are some methods used to collect remote sensing data?

Landsat One series of satellites used to collect data about Earth's surface is the Landsat group. *Landsat 7*, launched in 1999, and *Landsat 8*, launched in 2013, scan Earth's entire surface. Comparing today's data to similar data collected years ago, scientists can recognize global changes in agriculture, forestry, geology, and changes caused by natural disasters such as hurricanes, flooding, and forest fires. Images obtained from *Landsat 7* and *Landsat 8* can be used for emergency response and disaster relief. Landsat has been used to contribute to the GIS database as well.

OSTM/*Jason-2* and *Jason-3* A series of satellite missions, including the OSTM/*Jason-2* and *Jason-3*, have been used to determine ocean topography and circulation, sea level, tides, and climate changes. **Figure 17** shows ocean surface changes due to El Niño and La Niña as captured by *Jason-2*.

SeaBeam A device that uses sonar to map the bottom of the ocean is SeaBeam. SeaBeam is mounted onboard a ship. Computers calculate the time a sound wave takes to bounce off the ocean floor and return to the ship. This gives the operators an accurate image of the seafloor and the depth of the ocean at that point. SeaBeam is used by fishing fleets, drilling operations, and various scientists.

Figure 17 This image of the Pacific was captured by *Jason-2* during an El Niño event. The white area shows an increase in the ocean surface temperature compared to normal.

428 Chapter 12

LESSON

12.2 Review

Visualize It!

Topographic maps have contour lines that help describe the elevation and relief of the surface of Earth at a particular location.

Geologic maps are useful in determining rock type, rock age, and the rock formations in an area.

Use your lesson Foldable to review the lesson. Save your Foldable for the project at the end of the chapter.

Summarize It!

1. What can a topographic map tell you about the shape of Earth's surface?

2. What can you learn from geologic maps about the rocks near Earth's surface?

3. How can remote technology be used in mapmaking?

Lesson 12.2 Review 429

OSTM/*Jason-2 and Jason-3*

Landsat and OSTM/*Jason-2* and *Jason-3* are just a few of the many satellites used in remote sensing. After students have read the first two paragraphs on the page, ask the questions below.

Guiding Questions

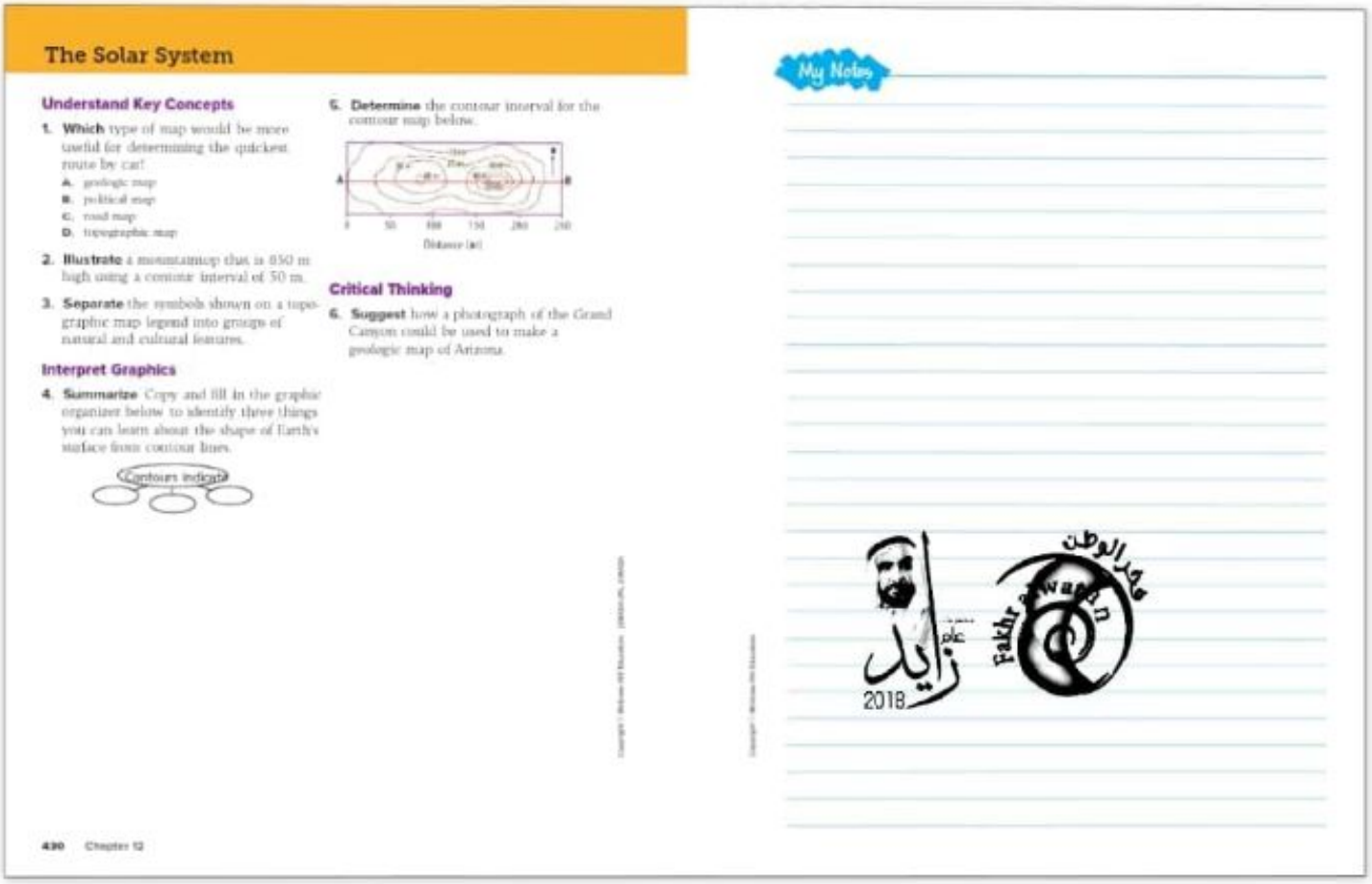
AL	What types of data are collected by Landsat instruments?	*Landsat collects data about the land, the coastlines, and the wetlands, and data that are used in GIS.*
OL	How is Landsat data different from the data collected by OSTM/*Jason-2* and *Jason-3*?	*The OSTM/Jason-2 and Jason-3 satellites primarily collect data about Earth's oceans and climate.*
BL	Which satellite—*Landsat* or OSTM/*Jason-2* and *Jason-3*—would be used to collect data on changing farmlands? Which satellite might be used in the fishing industry?	*Landsat; OSTM/Jason-2 and Jason-3*

SeaBeam

SeaBeam is a device that uses sonar to map ocean depths. After students have read the paragraph about this remote sensing tool, ask the questions below.

Guiding Questions

AL	Based on the information in the paragraph, what do you think sonar is?	*Sonar is a remote sensing tool in which sound waves are used to calculate depth to the ocean floor.*
OL	What are some methods used to collect remote sensing data?	*Satellites and sonar are two tools that are used to collect remote sensing data.*
BL	Sound travels in clear salt water at about 1,500 m/s. If it takes a sound wave a total of 3 s to leave the boat and return, how deep is the water?	*2,250 m*



Summarize It!

The information needed to complete this graphic organizer can be found in the following sections:

- Types of Maps
- Making Maps Today

Understand Key Concepts

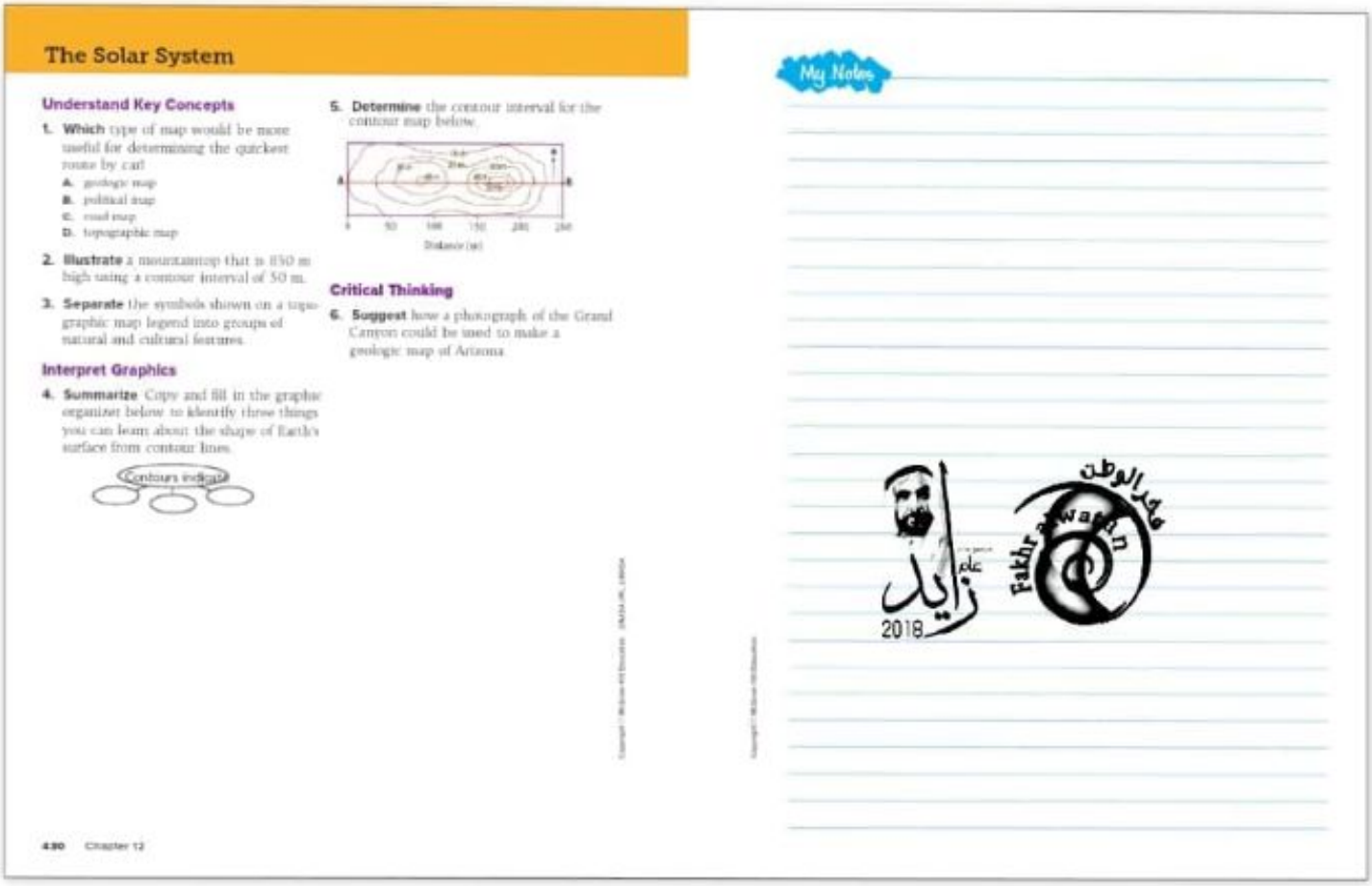
1. **C.** Road map
2. The mountaintop should have a point labeled 850 m. It should be surrounded by concentric circles of contour lines. The index contours should be numbered to reflect the 50-m contour interval.
3. Natural features include streams, lakes, mountains, and forests. Cultural features include human-made structures such as roads, railroads, bridges, and trails.

Interpret Graphics

4. Slope, elevation, relief
5. 10 m

Critical Thinking

6. The photograph could be used to identify thicknesses and layers of rock. This photo, along with data on the particular rock types in the layers, could be translated into a geologic map of the canyon.



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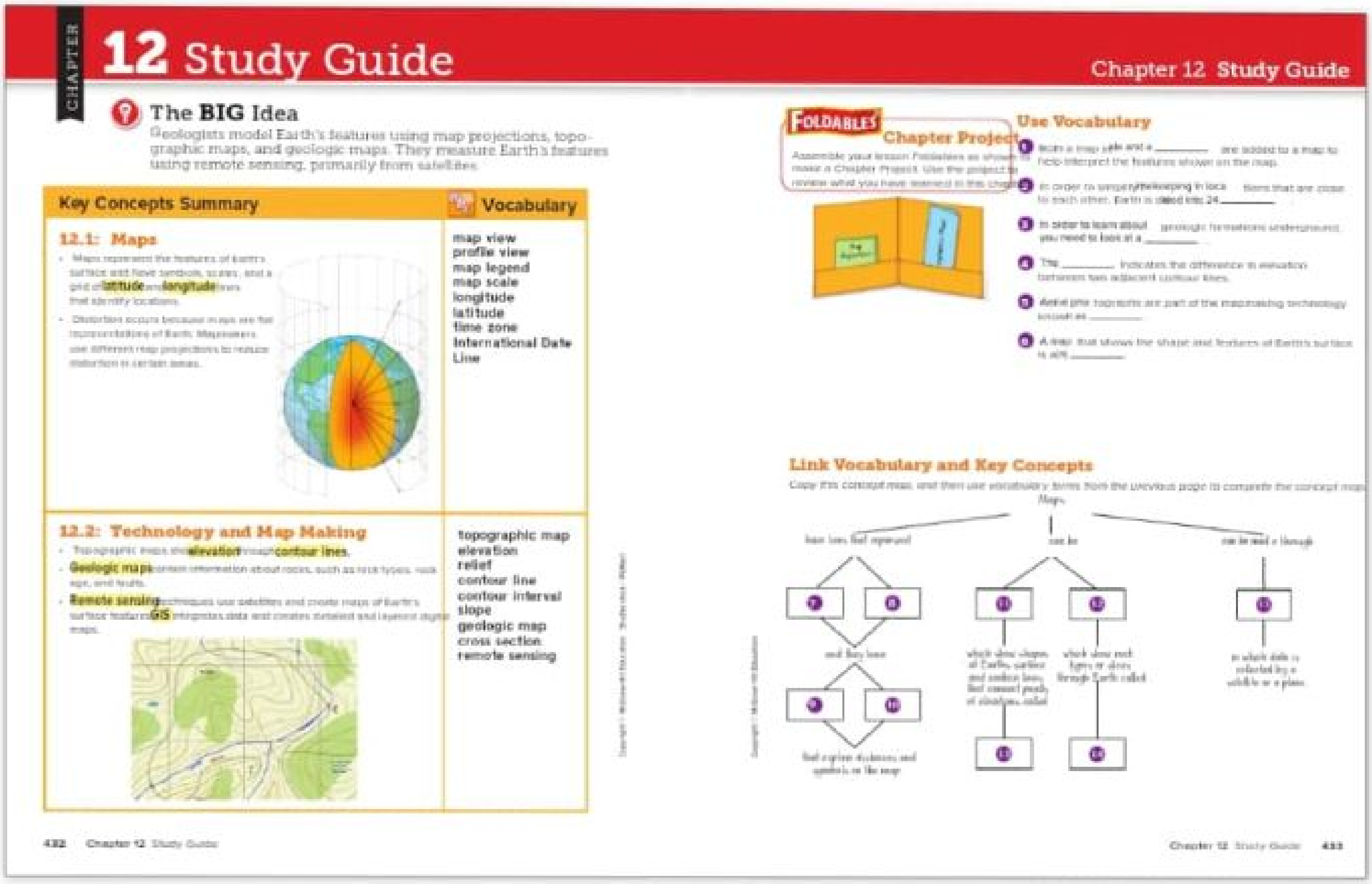
CHAPTER 12 Study Guide

Chapter 12 Study Guide

The BIG Idea

Geologists model Earth's features using map projections, topographic maps, and geologic maps. They measure Earth's features using remote sensing, primarily from satellites.

Key Concepts Summary | Vocabulary

12.1: Maps

map view
profile view
map legend
map scale
longitude
latitude
time zone
International Date Line

12.2: Technology and Map Making

topographic map
elevation
relief
contour line
contour interval
slope
geologic map
cross section
remote sensing

FOLDABLES Chapter Project

Use Vocabulary

Link Vocabulary and Key Concepts

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Chapter 12 Study Guide 433

Key Concepts Summary

Study Strategy: Visualize the Concept

Explain to students that in this chapter they learned that maps are tools used to visually represent Earth. Looking at different maps is a good way to review the concepts they've learned.

1. Assign each student one of the Key Concept statements on this page. Instruct each student to find an image, such as a map, that represents the idea in his or her assigned statement. Permit students to use the Internet or other library resources to find their images.
2. In their Science Journals, each student should include the following information: the assigned Key Concept statement, the source of the image, a brief description of the image, and an explanation of why the image represents that statement. If possible, students should also include a copy of their images in their Science Journals.
3. Have students present their images to the class. Allow the class to discuss each image.

Example:

Key Concept	Where I found my map	Description of my map	Why my map represents the Key Concept

Vocabulary

Study Strategy: Name That Term

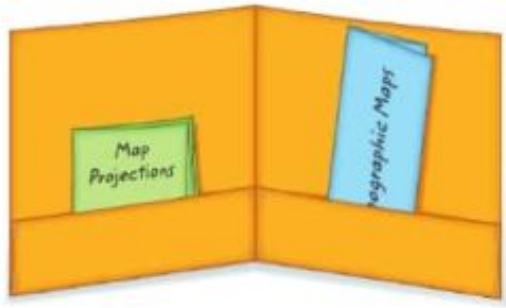
Remind students that learning all the vocabulary terms is one way to study the major concepts of the chapter. This game will help students review chapter vocabulary.

1. Write vocabulary terms on note cards, and pass the cards out to students. You may repeat terms more than once.
2. Have students write words or short phrases that can be used to describe or explain the term on the note card. See the example below.
3. Students should then take turns reading their descriptive words or phrases aloud while the rest of the class tries to determine which vocabulary term the student is describing.

Example:

topographic map
picture of landscape
elevation
relief
contour lines

FOLDABLES® Chapter Project



Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

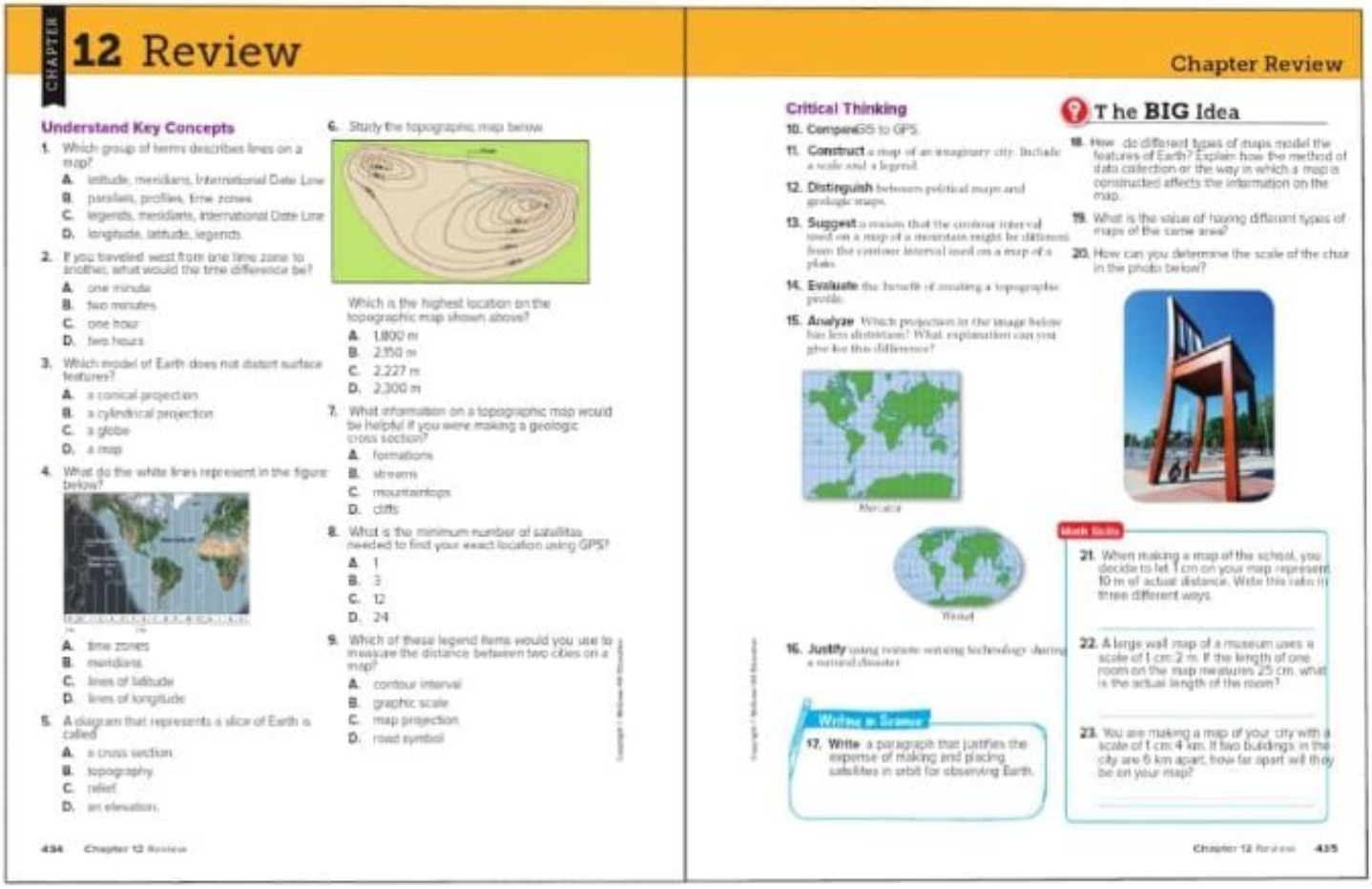
Teacher Notes

Use Vocabulary

1. Map legend
2. Time zones
3. Geologic map
4. Contour interval
5. Remote sensing
6. Topographic map

Link Vocabulary and Key Concepts

7. Latitude
8. Longitude
9. Map scale
10. Map legend
11. Topographic
12. Geologic
13. Contour lines
14. Cross sections
15. Remote sensing



CHAPTER 12 Review

Understand Key Concepts

1. Which group of terms describes lines on a map?
   A. latitude, meridians, International Date Line
   B. parallels, profiles, time zones
   C. legends, meridians, International Date Line
   D. longitude, latitude, legends
2. If you traveled west from one time zone to another, what would the time difference be?
   A. one minute
   B. two minutes
   C. one hour
   D. two hours
3. Which model of Earth does not distort surface features?
   A. a conical projection
   B. a cylindrical projection
   C. a globe
   D. a map
4. What do the white lines represent in the figure below?
   A. time zones
   B. meridians
   C. lines of latitude
   D. lines of longitude
5. A diagram that represents a slice of Earth is called
   A. a cross section
   B. topography
   C. relief
   D. an elevation
6. Study the topographic map below.
   Which is the highest location on the topographic map shown above?
   A. 1,800 m
   B. 2,150 m
   C. 2,227 m
   D. 2,300 m
7. What information on a topographic map would be helpful if you were making a geologic cross section?
   A. formations
   B. streams
   C. mountaintops
   D. cliffs
8. What is the minimum number of satellites needed to find your exact location using GPS?
   A. 1
   B. 3
   C. 12
   D. 24
9. Which of these legend items would you use to measure the distance between two cities on a map?
   A. contour interval
   B. graphic scale
   C. map projection
   D. road symbol

434 Chapter 12 Review

Chapter Review

Critical Thinking

10. Compare GIS to GPS.
11. Construct a map of an imaginary city. Include a scale and a legend.
12. Distinguish between political maps and geologic maps.
13. Suggest a reason that the contour interval used on a map of a mountain might be different from the contour interval used on a map of a plain.
14. Evaluate the benefit of creating a topographic profile.
15. Analyze Which projection in the image below has less distortion? What explanation can you give for this difference?

Mercator

Winkel

16. Justify using remote sensing technology during a natural disaster.

Writing in Science

17. Write a paragraph that justifies the expense of making and placing satellites in orbit for observing Earth.

The BIG Idea

18. How do different types of maps model the features of Earth? Explain how the method of data collection or the way in which a map is constructed affects the information on the map.
19. What is the value of having different types of maps of the same area?
20. How can you determine the scale of the chair in the photo below?

Math Skills

21. When making a map of the school, you decide to let 1 cm on your map represent 10 m of actual distance. Write this ratio in three different ways.
22. A large wall map of a museum uses a scale of 1 cm : 2 m. If the length of one room on the map measures 25 cm, what is the actual length of the room?
23. You are making a map of your city with a scale of 1 cm : 4 km. If two buildings in the city are 6 km apart, how far apart will they be on your map?

Chapter 12 Review 435

Understand Key Concepts

1 A. latitude, meridians, International Date Line
2 C. one hour
3 C. a globe
4 A. time zones
5 A. a cross section.
6 C. 2,227 m
7 A. formations
8 B. 3
9 B. graphic scale

Critical Thinking

10 GPS is a series of satellites used to pinpoint a location on Earth. GIS might use GPS and other satellite data to accurately map Earth, or to create simulation programs.

11 Student answers should include one type of scale that is included in the legend along with other features.

12 Political maps have artificial boundaries and use color to identify countries, states, or other political regions. Geologic maps use actual rock formations to determine boundaries between them. Colors indicate the age of each rock or formation.

13 Mountain slopes are steeper and the gradient will change more rapidly than on a gentle slope or a flat plain. The contour interval for a plain will be smaller than the contour interval for mountainous terrain.

14 A topographic profile could be useful in such things as planning a hike, determining a watershed, or deciding where to construct a building.

15 The Winkle projection has curved longitude lines, which reduces distortion at the poles, unlike the Mercator projection.

16 Remote sensing of areas affected by hurricanes, earthquakes, or volcanic eruptions can be made faster than on-site examinations, cover more area in a short amount of time, and can show changes such as flooding or damage to roads that would limit access.

Writing in Science

17 Students' answers might include multiple uses of satellites, reduction in time for data collection, better access to remote areas, and accuracy of sensors.

The BIG Idea

18 Sample answer: Topographic maps use contour lines to indicate elevation and symbols to indicate human-made objects. Geologic maps use colors to indicate rocks and rock layers or surface features such as mountains. GIS combine a selection of data from various databases to create a map. Depending on the type of map, different information is used. Satellite and aerial photography and sonar can also be used in making the different kinds of maps.

19 Different maps show different information. Topographic maps show elevation and relief of the surface, while geologic maps show information about what's below the surface. Road maps show only roads and other useful travel information. Political maps focus on boundaries between countries, states, or counties.

20 You could compare the dimensions of the chair to those of a real chair. Students also might compare the size of an average person to that of the chair.

Math Skills

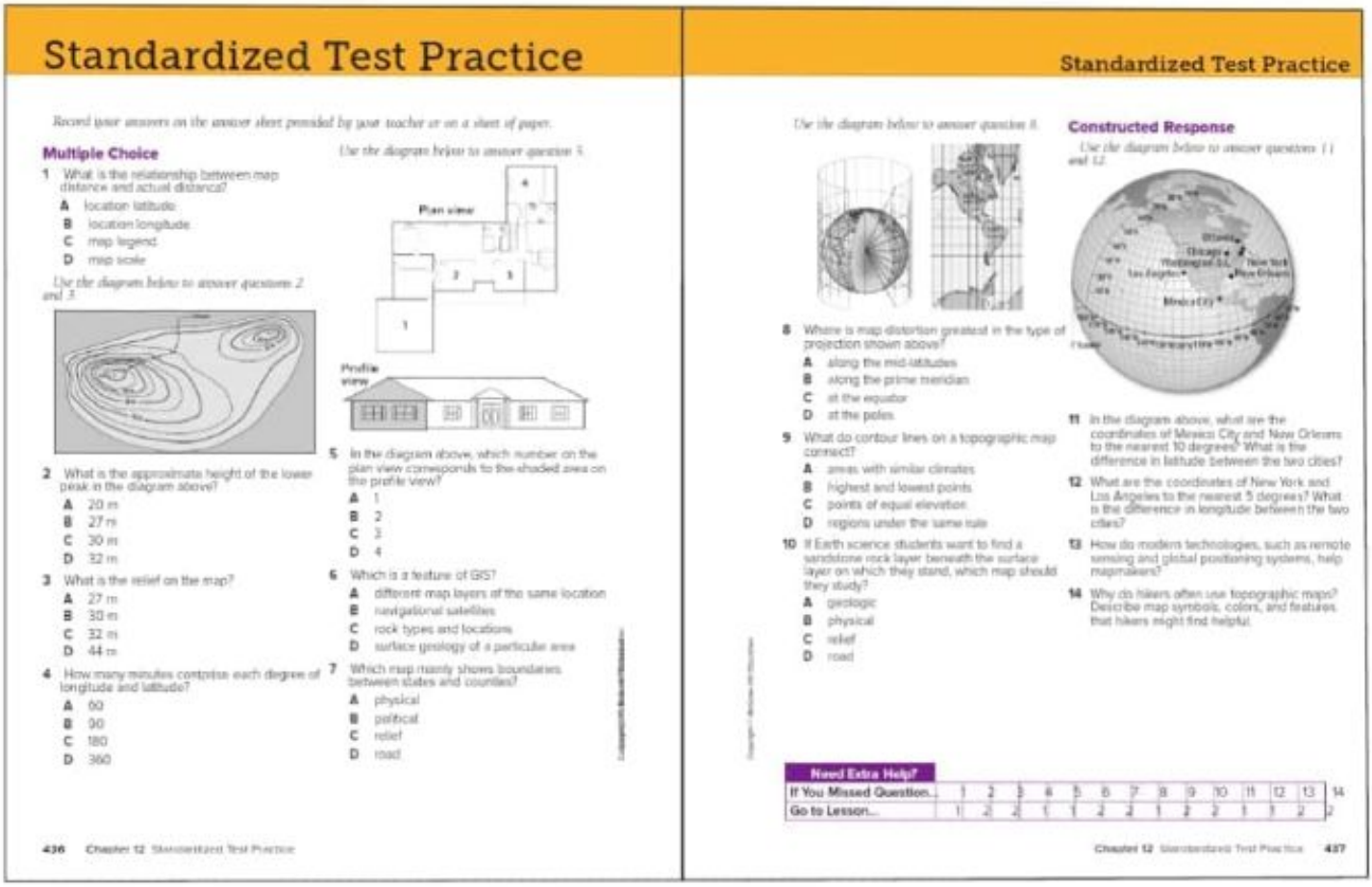
Ratio Scale

21 1 cm to 10 m; 1 cm:10 m; 1 cm/10 m

22 $\frac{1\text{ cm}}{25\text{ cm}} = \frac{2\text{ m}}{X}$ $X = 50$ m

23 $\frac{1\text{ cm}}{X} = \frac{4\text{ km}}{6\text{ km}}$ $X = 1.5$ cm

Teacher Notes



Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice

1 What is the relationship between map distance and actual distance?
A location latitude
B location longitude
C map legend
D map scale

Use the diagram below to answer questions 2 and 3.

2 What is the approximate height of the lower peak in the diagram above?
A 20 m
B 27 m
C 30 m
D 32 m

3 What is the relief on the map?
A 27 m
B 30 m
C 32 m
D 44 m

4 How many minutes comprise each degree of longitude and latitude?
A 60
B 90
C 180
D 360

Use the diagram below to answer question 5.

Plan view

Profile view

5 In the diagram above, which number on the plan view corresponds to the shaded area on the profile view?
A 1
B 2
C 3
D 4

6 Which is a feature of GIS?
A different map layers of the same location
B navigational satellites
C rock types and locations
D surface geology of a particular area

7 Which map mainly shows boundaries between states and counties?
A physical
B political
C relief
D road

436 Chapter 12 Standardized Test Practice

Standardized Test Practice

Use the diagram below to answer question 8.

8 Where is map distortion greatest in the type of projection shown above?
A along the mid-latitudes
B along the prime meridian
C at the equator
D at the poles

9 What do contour lines on a topographic map connect?
A areas with similar climates
B highest and lowest points
C points of equal elevation
D regions under the same rule

10 If Earth science students want to find a sandstone rock layer beneath the surface layer on which they stand, which map should they study?
A geologic
B physical
C relief
D road

Constructed Response

Use the diagram below to answer questions 11 and 12.

11 In the diagram above, what are the coordinates of Mexico City and New Orleans to the nearest 10 degrees? What is the difference in latitude between the two cities?

12 What are the coordinates of New York and Los Angeles to the nearest 5 degrees? What is the difference in longitude between the two cities?

13 How do modern technologies, such as remote sensing and global positioning systems, help mapmakers?

14 Why do hikers often use topographic maps? Describe map symbols, colors, and features that hikers might find helpful.

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	2	2	1	1	2	2	1	2	2	1	1	2	2

Chapter 12 Standardized Test Practice 437

Multiple Choice

1 **D—Correct.** A, B, C—Map scales, such as 1 cm = 1 km, show the relationship between a distance on the map and the corresponding actual distance on the ground.

2 **B—Correct.** A, C, D—The lower peak is located just past the 25 m contour line, which indicates that the peak is 27 m high.

3 **D—Correct.** A, B, C—Relief is the difference between the elevations of the highest and lowest points in an area. The relief of the area featured on the map is 44 m − 0 m = 44 m.

4 **A—Correct.** B, C, D—To help scientists identify the exact location of a place that does not fall on an imaginary line of latitude or longitude, each degree is divided into 60 minutes and each minute, into 60 seconds.

5 **A—Correct.** B, C, D— A map or a plan view looks down on an object, while a profile view looks from the side. The shaded area on the profile view is the first-story room to the left, or number 1 on the plan view.

6 **A—Correct.** B, C, D—Using a compilation of satellite and scanner information, as well as aerial photographs, GIS creates digital maps of different layers of the same location. Similar to the layers of a cake, the map layers can be stacked. Various layers can provide information on land usage, elevation, roads, streams and lakes, or the type of soil on the ground.

7 **B—Correct.** A, C, D— Political maps show the boundaries between countries, states, counties, or townships. The boundaries can be shown as a variety of solid or dashed lines.

8 **D—Correct.** A, B, C—In cylindrical projection maps, shapes near the equator are very accurately represented; however, shapes near the poles are enlarged.

9 **C—Correct.** A, B, D—Contour lines on a topographic map connect points with equal elevation.

10 **A—Correct.** B, C, D—Geologic maps show the surface geology of a particular area, including rock types, their ages, and fault locations. Geologic cross-sections (drawn from information gathered by drilling, studying earthquake waves, and looking at cliffs) diagram virtual vertical slices of rocks below the surface, revealing layers such as sandstone.

Constructed Response

11 Mexico City is 20°N, 100°W. New Orleans is 30°N, 90°W. The difference in latitude is 10°.

12 New York City is 40°N, 75°W. Los Angeles is 35°N, 120°W. The difference in longitude is 45°.

13 Answers will vary. Computer systems, global positioning, and remote sensing all can assist mapmakers. Computer systems can store data and create images of data for maps. Global positioning is the use of 24 GPS satellites circling Earth to locate any position on Earth accurately with a GPS receiver. GPS can help make maps more exact. Remote sensing is the use of oceanic, aerial, and satellite sensors, such as sonar radar, to measure features on Earth's surface and ocean depths. Data from remote sensors can be stored and analyzed in computer systems.

14 Answers should include: Topographic maps use contour lines to show relief and elevation of Earth's surface. Hikers can use topographic maps to determine the best route to a destination. The steepness of a slope can be determined by the spacing of contour lines. Lines that are close together indicate steep slopes, which hikers may want to avoid. Downward-pointing V-shaped contours indicate a ridge, while upward-pointing V-shapes indicate drainage and stream valleys. Trails, roads, and directions that appear on maps can help a hiker access an area. Contour colors indicate land (brown) or water (blue). Green colors indicate vegetation such as forests or woods. Human structures are indicated in black or pink.

Answer Key

Question	Answer
1	D
2	B
3	D
4	A
5	A
6	A
7	B
8	D
9	C
10	A
11	See extended answer
12	See extended answer
13	See extended answer
14	See extended answer

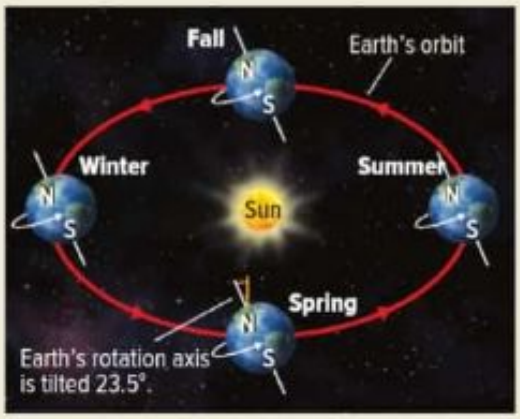
Science Content Background

Lesson 1

The Sun-Earth-Moon System

Earth's Orbit Around the Sun The Sun contains more than 99 percent of the solar system's mass. It exerts a huge gravitational pull, causing other solar system objects to revolve around it. Earth follows an elliptical orbit around the Sun. The distance between Earth and the Sun varies slightly, but the average is 150 million km or 1 astronomical unit (AU).

Earth's Tilt and Seasons Earth is tilted on its axis at an angle of 23.5°. As Earth revolves around the Sun, the direction of the tilt does not change. It always points in the same direction. When the North Pole is tilted toward the Sun, the Sun's rays are at higher angles, daytime is longer, and the northern hemisphere has summer. When the North Pole is tilted away from the Sun, the Sun's rays are at lower angles, daytime is shorter, and the northern hemisphere has winter.



Earth's Moon The Moon rotates on its axis at the same rate it revolves around Earth. The Moon completes its path around Earth every 27.3 days. Because of the equal rotation and revolution cycles, the same side of the Moon always faces Earth. The source of the Moon's illumination is the reflection of the sunlight. The percentage of the Moon that is visible from Earth changes as the Moon's position changes during its revolution around Earth.

Tides Tides are daily changes in water levels of Earth's oceans and other larger bodies of water caused by the position of Earth and the gravitational pull of the Moon and the Sun. High tides and low tides occur every 12.5 hours. High tides occur when the gravitational pull is greatest, when the Moon, Earth, and the Sun are in a straight line. Low tides occur between high tides. Spring tides are tides that occur when the range in water level between low and high tides is the greatest: when the Sun, the Moon, and Earth are aligned. Neap tides occur when the range in water level between low and high tides is the least: when the Sun, the Moon, and Earth are at right angles.

Eclipses When the Moon, Earth, and the Sun align, an eclipse can occur. A solar eclipse occurs when the Moon passes between Earth and the Sun and the Moon's shadow falls on a part of Earth. This can happen only during a new moon. A lunar eclipse occurs when Earth's shadow falls on the Moon. This can happen only during a full moon.

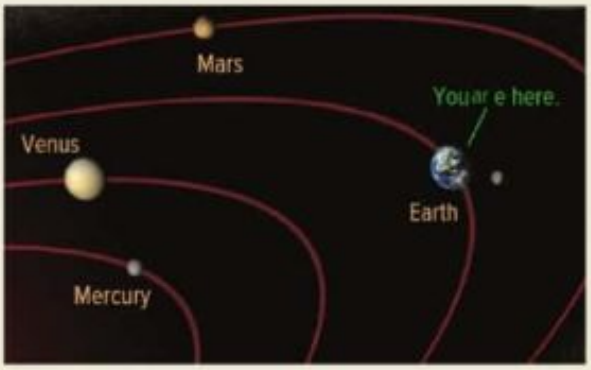
Science Content Backgroun

Lesson 2

The Solar System

Solar System Formation The solar system formed 4.5 billion years ago, as gravity pulled together a cloud of dust and gas. The cloud became denser, smaller, and hotter and began to spin. The Sun formed at its hot, dense center. As the cloud rotated, it flattened into a disk. Other objects, such as planets, formed as leftover dust and gas clumped together.

Planets and Other Objects A planet is a massive, spherical object that orbits the Sun and has no other large objects in its orbital path. The solar system contains eight planets. As shown below, Mercury, Venus, Earth, and Mars are the small, rocky inner planets. Jupiter, Saturn, Uranus, and Neptune are the large, gaseous outer planets. Other solar system objects include dwarf planets, moons, asteroids, comets, and meteoroids.



Lesson 3

Stars, Galaxies, and the Universe

Star Light Nuclear reactions in a star's core release energy and emit light. Star light can range on the color spectrum from red to blue. Red stars are the coolest stars; blue stars are the hottest.

The Sun The Sun is a yellow star. It is the closest star to Earth and is larger and more massive than 90 percent of other stars. The Sun has been shining for around 5 billion years. It is a solitary star, not part of a binary- or multiple-star system.

Galaxies The Sun and planets are part of the Milky Way galaxy. A galaxy is a collection of stars, gases, and dust held together by gravity. The Milky Way is a spiral galaxy. It is part of a larger cluster of 30 galaxies called the Local Group. Clusters and superclusters of galaxies also are pulled together by gravity.

The Universe The universe formed 13–14 billion years ago. The universe continues to expand today. It contains visible light and matter as well as invisible matter, known as dark matter. Matter in the universe is recycled as stars form and explode.

Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

*Things near Earth fall to the ground unless something holds them up.

*Earth's gravity pulls any object on or near Earth toward it without touching it.

*The Sun can be seen only in the daytime, but the Moon can be seen sometimes at night and sometimes during the day. The Sun, the Moon, and stars all appear to move across the sky.

*Earth is one of several planets that orbit the Sun, and the Moon orbits around Earth.

*There are more stars in the sky than anyone can easily count, but they are not scattered evenly, and they are not all the same in brightness or color.

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

Lesson 1

The Sun-Earth-Moon System

1 Earth has seasons because it is tilted as it revolves around the Sun.

2 The Moon's position in relation to Earth and the Sun causes waxing and waning moon phases. The Moon's gravity is largely responsible for tides. As the Moon orbits Earth, it causes eclipses.

3 A solar eclipse occurs when the Moon moves between Earth and the Sun and the Moon's shadow covers part of Earth. A lunar eclipse occurs when the Moon moves into then out of Earth's shadow.

Lesson 2

The Solar System

4 Gravity affected how the solar system and objects within it formed, and it continues to affect how solar system objects orbit the Sun.

5 The solar system contains the Sun, planets, dwarf planets, asteroids, comets, meteoroids, moons, and other objects.

6 Earth is the third planet from the Sun and the only planet known to have large amounts of liquid water at its surface.

Lesson 3

Stars, Galaxies, and the Universe

7 A star is a large sphere of hydrogen gas hot enough for nuclear reactions to occur in its core.

8 The Sun is a yellow star and is more massive than 90 percent of stars.

9 Earth orbits the Sun, which is located in the Milky Way galaxy.

10 The universe contains billions of galaxies, which are grouped into clusters and superclusters.

CHAPTER 13 Earth in Space

The BIG Idea
Where is Earth in the universe, and how is Earth related to other objects in the universe?

LESSON 13.1 The Sun-Earth-Moon System
- What causes seasons on Earth?
- How does the Moon affect Earth?
- How do solar and lunar eclipses differ?

LESSON 13.2 The Solar System
- How does gravity influence the shape and the motion of objects in the solar system?
- What objects are in the solar system?
- How does Earth compare with other objects in the solar system?

LESSON 13.3 Stars, Galaxies, and the Universe
- What are stars?
- How does the Sun compare to other stars?
- Where is Earth located in the universe?
- How is the universe structured?

PAGE KEELEY SCIENCE PROBES

Seasons

Six friends wondered why it is hot in the summer and cold in the winter. This is what they said:

Ibrahim: I think Earth is closer to the Sun in the summertime.

Ahmed: I think the Sun gives off more heat in the summertime.

Ismail: I think Earth rotates toward the Sun in the summertime.

Eiman: I think Earth tilts toward the Sun in summer and away from the Sun in winter.

Asma: I think the sunlight that hits Earth is spread out more in the summertime.

Usama: I don't think it is any of the things you described. I think it is something else.

Which friend do you agree with the most? _____ Explain why you agree with that friend.

Whe re is Earth in the universe, and how is Earth related to other obje cts in the universe?

The BIG Idea

There a re no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL	What's the address of your school? Be as specific as possible.	*Most students may be able to give the street, street number, and city or town of your school. They might also include a zip code and the country.*
OL	Now suppose you had to give the school's address to an extraterrestrial being. What would you say?	*To the address above, students should add Earth's location in the solar system, which is the third planet from the Sun.*
BL	How would you give the school's address in the universe?	*Students' addresses should include the street, street number, city, town, zip code and country followed by Earth's position in the solar system, the solar system's place in the Milky Way, and the Milky Way's place in the universe.*

PAGE KEELEY SCIENCE PROBES

Seasons

Answers to the Page Keeley Science Probe can be found in the Teacher's Edition of the *Activity Lab Workbook*.

Get Ready to Read

What do you think?

Use this anticipation guide to gauge students' background knowledge and preconceptions about Earth movements and the planet's place in space. At the end of each lesson, ask students to read and evaluate their earlier responses. Students should be encouraged to change any of their responses.

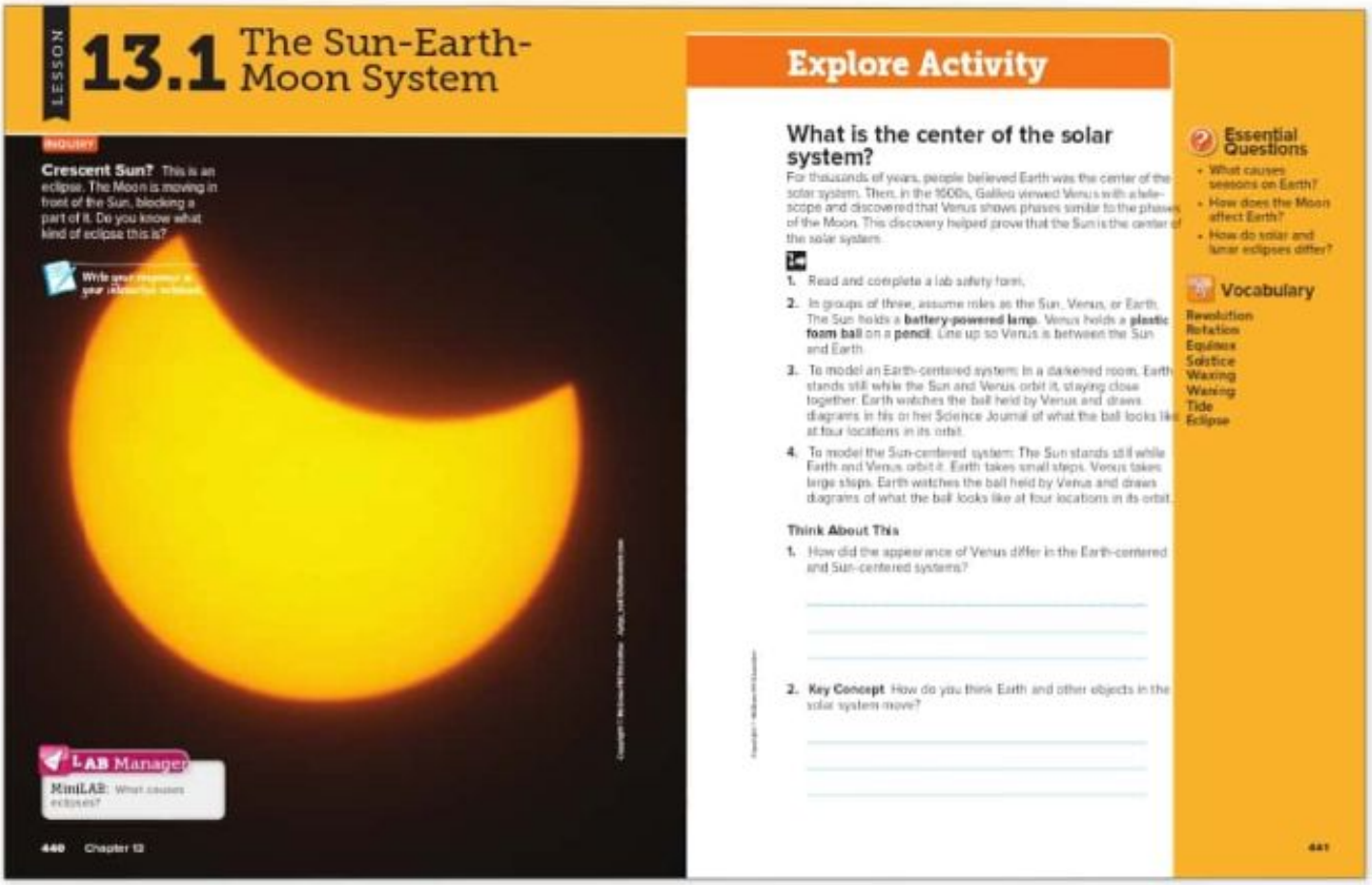
Anticipation Set for Lesson 1

1. **Seasons are caused by the changing distance between Earth and the Sun.**

   Disagree. Seasons are caused by the tilt of Earth on its axis as it revolves around the Sun.

2. **The Moon has a dark side upon which the Sun never shines.**

   Disagree. All parts of the Moon, including the side facing away from Earth, experience two weeks of sunlight each month.



INQUIRY

About the Photo **Crescent Sun?** Students probably are familiar with a crescent-shaped Moon but not a crescent-shaped Sun! The Sun appears to have this shape because of a partial solar eclipse. A solar eclipse occurs when the Moon passes between Earth and the Sun and the Moon's shadow reaches Earth's surface, causing the Moon to appear to cover the Sun. Solar eclipses can be partial or total. During a total solar eclipse, the Moon blocks the entire Sun. Read the text in the blue box, then ask the first scaffolded question.

Guiding Questions

AL	Why does the Sun have this shape?	*Students should be able to explain that an object is blocking a part of the Sun from the viewer.*
OL	An eclipse is the movement of one space object into the shadow of another. Do you know what kind of eclipse this is?	*Some students will know that the photograph shows a solar eclipse.*
BL	Use this photo to infer where Earth is relative to the Moon and the Sun during a solar eclipse.	*Earth is in the Moon's shadow, opposite the Sun. Have students compare this photo to the drawing of the solar eclipse shown in* ***Figure 10*** *to understand the positions of Earth, the Sun, and the Moon during a solar eclipse.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Compare and Contrast

pairs *rotation* and *revolution*, *equinox* and *solstice*, and *waxing* and *waning* on chart paper. Have students take turns reading the definition of each term aloud and write it next to the appropriate word.

Ask: How are *rotation* and *revolution* alike? How are they different? *Rotation and revolution are movements of objects in space. Rotation is the spin of an object on its axis. Revolution is the movement of one object around another.*

Ask: Compare and contrast *equinox* and *solstice*. *Equinox and solstice are related to the angle of the Sun's rays hitting Earth's*

surface. They mark the beginning of a season on Earth. A solstice marks the start of summer or winter. An equinox marks the start of spring or fall.

Ask: Compare and contrast *waxing* and *waning* as they apply to Earth's moon. *Waxing and waning both describe the change in the portion of lit surface of the Moon that can be seen from Earth. Waxing is when the amount of the Moon's lit surface that is visible from Earth increases. Waning is when the amount of the Moon's lit surface that is visible from Earth decreases.*

Teacher Notes

ExploreActivity

What is the center of the solar system?

Prep: *5 min* **Class:** *20 min*

Purpose

To demonstrate that the Sun is the center of the solar system and that Earth and Venus move around the Sun.

Materials

Student: 1 battery-powered lamp, 1 foam ball, 1 pencil

Before You Begin

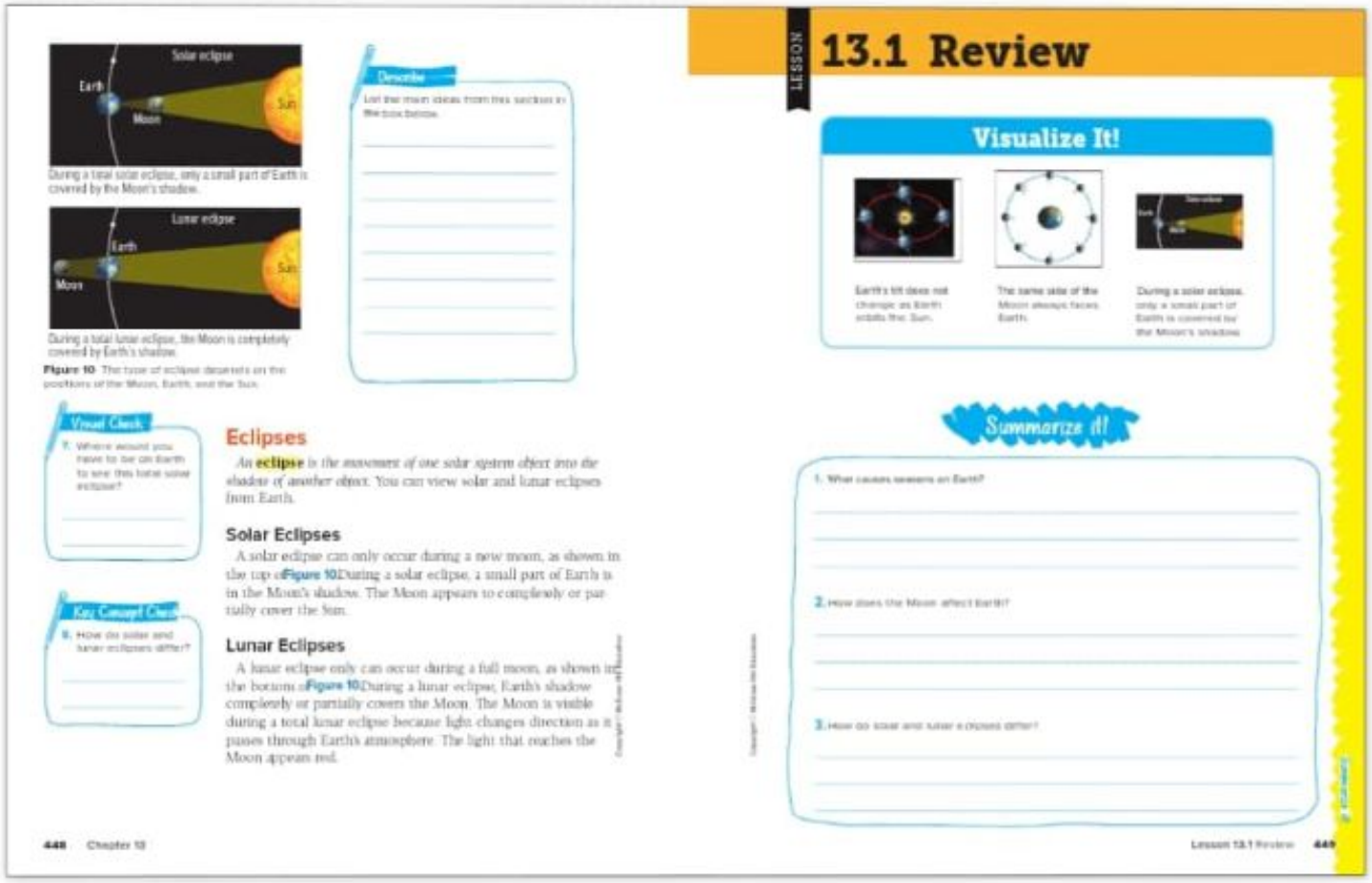
Explain that Venus orbits the Sun once every 225 Earth days while Earth orbits the Sun once every 365 days. Then ask why Venus moves faster than Earth in the Sun-centered system. Students should be able to conclude that the closer an object is to the Sun, the faster it revolves.

Guide the Investigation

- **Troubleshooting:** Before you begin, make sure the light sources are bright enough. The darker you can make the room and the more spread-out the groups can be, the easier it will be for students to observe the phases.
- In the Earth-centered system, it doesn't matter how fast the Sun and Venus move, but the Sun and Venus should be fairly close all the time. This is how Venus appears in the sky—close to the Sun. In the Sun-centered system, Venus should move around the Sun faster than Earth. Venus still appears close to the Sun, but sometimes on one side and sometimes on the other.

Think About This

1. In the Earth-centered model, Venus will be "new" if the two planets and the Sun are all in a line and "crescent-shaped" otherwise. Students should understand that only in the Sun-centered model does Venus show the entire range of phases: full, gibbous, new, just like the Moon.
2. Earth and most other objects in the solar system orbit the Sun.



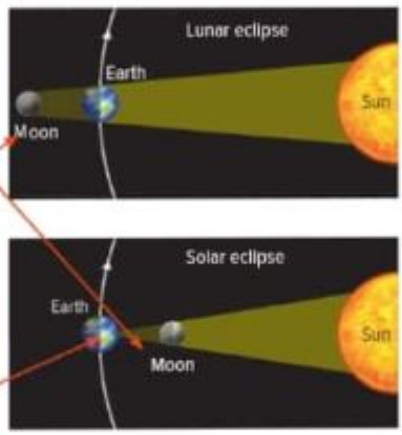
Eclipses

Solar Eclipses / Lunar Eclipses

An eclipse is the movement of one object into the shadow of another. Movements of Earth and the Moon as they revolve around the Sun can produce solar and lunar eclipses.

Visual Literacy: Figure 10

Ask: How do solar and lunar eclipses differ? *During a lunar eclipse, the Moon is in Earth's shadow. During a solar eclipse, the Moon blocks all or some of the Sun's light but only a small location on Earth is covered by the shadow.*



Ask: Where would you have to be on Earth to see this total solar eclipse? *within the area of Moon's shadow*

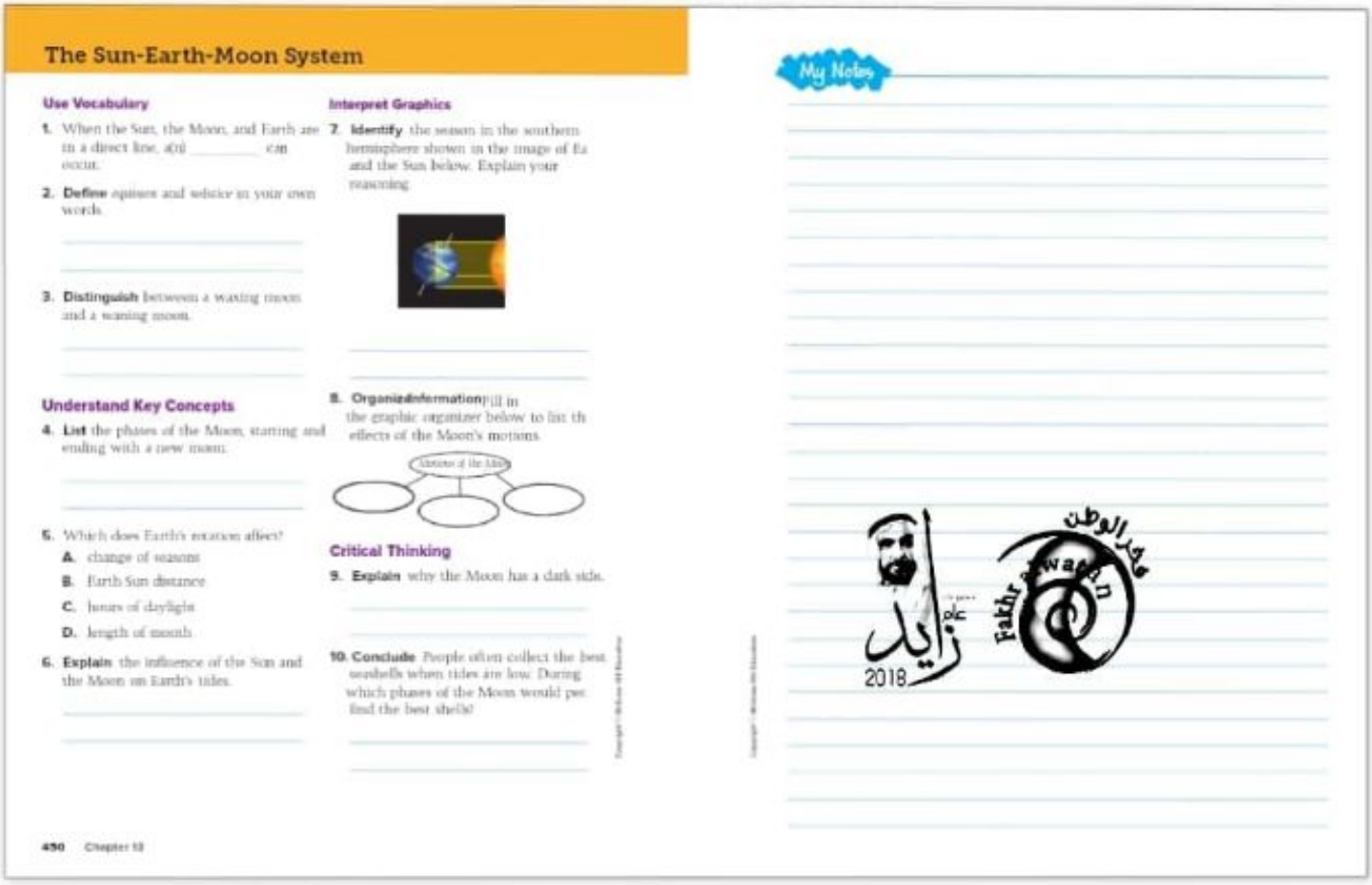
Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: To which Key Concept does each image relate?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Earth and the Universe
- Motions of Earth
- Earth's Tilt and Seasons
- Earth's Moon
- Tides
- Eclipses


The Sun-Earth-Moon System

Use Vocabulary

1. When the Sun, the Moon, and Earth are in a direct line, a(n) _____ can occur.
2. **Define** equinox and solstice in your own words.
3. **Distinguish** between a waxing moon and a waning moon.

Understand Key Concepts

4. **List** the phases of the Moon, starting and ending with a new moon.
5. Which does Earth's rotation affect?
   A. change of seasons
   B. Earth-Sun distance
   C. hours of daylight
   D. length of month
6. **Explain** the influence of the Sun and the Moon on Earth's tides.

Interpret Graphics

7. **Identify** the season in the southern hemisphere shown in the image of Ea and the Sun below. Explain your reasoning.

8. **Organize Information** Fill in the graphic organizer below to list th effects of the Moon's motions.

Critical Thinking

9. **Explain** why the Moon has a dark side.
10. **Conclude** People often collect the best seashells when tides are low. During which phases of the Moon would peo find the best shells?

My Notes

450 Chapter 13

Use Vocabulary

1. Eclipse
2. Sample answer: An equinox is a day that has an equal amount of light hours and dark hours. A solstice is a day when the Earth is tilted toward or away from the Sun and has either the greatest or fewest number of daylight hours.
3. Sample answer: More of the Moon's lit side becomes visible from Earth as the Moon is waxing, and less of the Moon's lit side becomes visible from Earth as the Moon is waning.

Understand Key Concepts

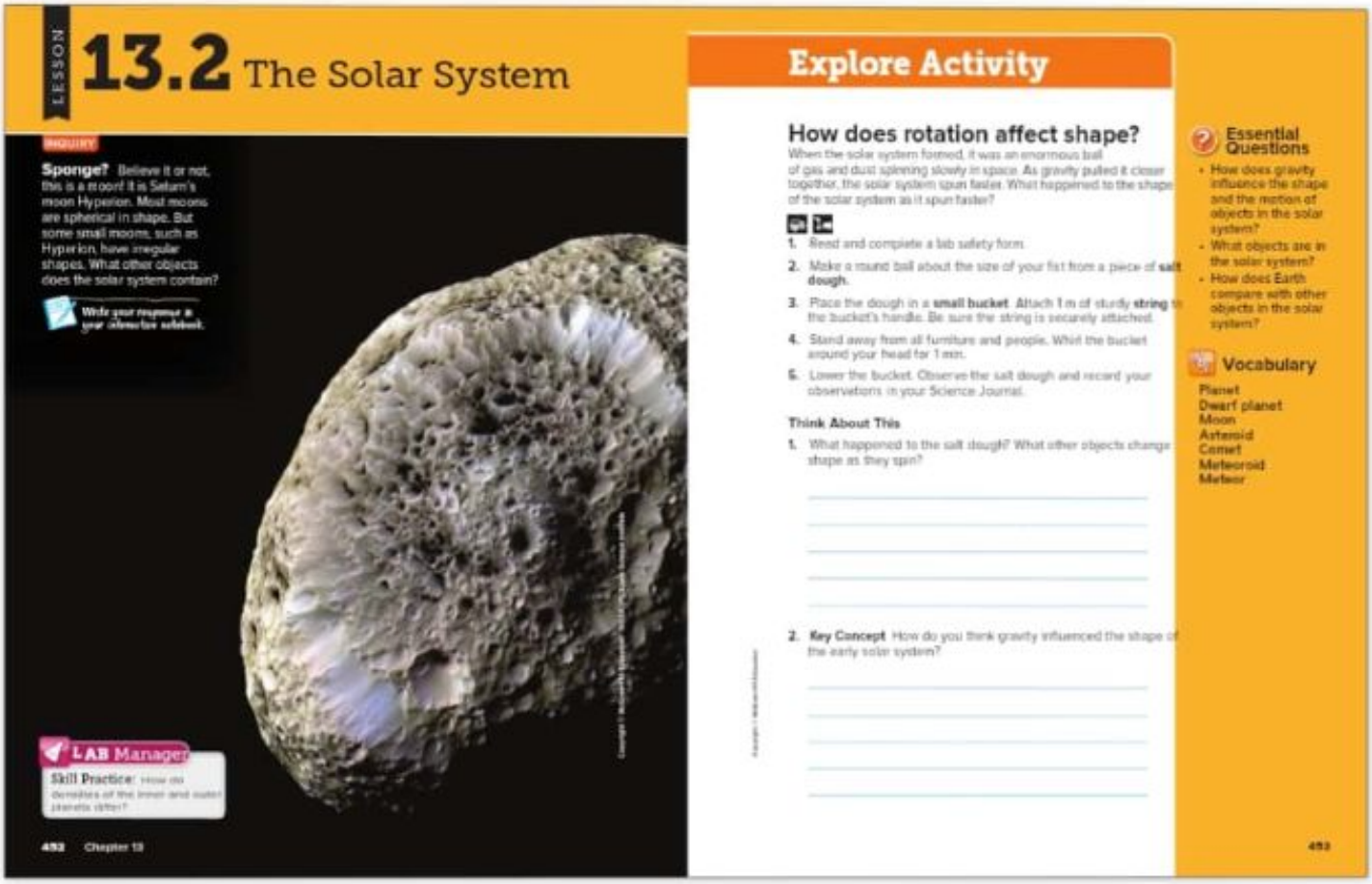
4. New moon – waxing crescent – first quarter – waxing gibbous – full moon – waning gibbous – last quarter – waning crescent – new moon
5. **C.** Hours of daylight
6. The Sun and the Moon both influence the tides on Earth because of their gravitational pull on Earth. The Moon has more of an effect because it is so much closer to Earth than the Sun.

Interpret Graphics

7. It is winter in the southern hemisphere. Earth's southern hemisphere is tilted away from the Sun, and the sunlight strikes the area at a lower angle.
8. Phases of the Moon, changes in tides, eclipses (in any order)

Critical Thinking

9. One side of the Moon is always lit (the side facing the Sun), and one side is always dark (the side facing away from the Sun). But one side is not always dark because the Moon rotates as it revolves around Earth. Different portions of the Moon are lit at different times, this is why we see phases of the Moon.
10. The highest and lowest tides occur during full and new moon phases.



INQUIRY

About the Photo Hyperion is one of nearly 150 known moons in our solar system. Unlike the Moon, Hyperion's odd shape and spongy-looking surface are likely related to its low density. Flybys of Hyperion suggest that other objects in space repeatedly collided with this moon, causing its surface to compress and form numerous sharp-walled craters. Before students read the figure caption about this moon of Saturn, ask the first scaffolded question below. After they read the caption, ask the remaining questions.

Guiding Questions

AL	What do you think this space object is?	*Accept all reasonable responses.*
OL	How does this moon of Saturn compare to our own Moon? How is it different?	*Both moons orbit a larger body called a planet. Both have cratered surfaces. Unlike Earth's Moon, which is spherical, Hyperion has an irregular shape.*
BL	What other objects does the solar system contain?	*Students likely will name planets and perhaps the Sun. Other objects in our solar system include dwarf planets, asteroids, comets, and meteoroids.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Words with Multiple Meanings

1. Write the terms meteor and meteoroid on the board or chart paper. If necessary, remind students that a suffix is added to the end of a word and changes the word's meaning. **Ask: What is the suffix of the word meteoroid? –***oid* **Ask: What are some other words that end with –oid?** Answers will vary, but may include science and math terms such as diploid, haploid, trapezoid, rhomboid, and spheroid.

2. **Ask: What do you think the suffix –oid means?** Most students should be able to infer that the suffix –oid means similar to or resembling the [specified object]. **Ask: Using only this information, what can you say about meteoroids?** *Meteoroids are objects in space that are similar to meteors.*

ExploreActivity

How does rotation affect shape?

Prep: *5 min* **Class:** *20 min*

Purpose
To demonstrate that rotation causes objects to flatten.

Materials
Student: salt dough, small bucket, string

Before You Begin

- Make the salt dough firm enough to hold its shape but soft enough to provide dramatic results. Dough that is too stiff will not significantly deform.
- Cut the string into 1-m lengths.
- Demonstrate how the solar nebula spun faster as it collapsed. Have a student sit on a rotating stool with arms outstretched, holding a weight in each hand. Give a gentle spin and have the student pull his or her arms in.
- As an alternative to this lab, consider placing a handful of flour in a small pile at the bottom of the bucket. Twist the string and release the bucket so it rotates upright like a top. The flour pile will spread out, modeling the flattening protoplanetary disk.

Guide the Investigation

- ⚠ Be sure the strings are firmly attached to the buckets and that students hold the string tightly. Also, be sure all students stand far enough apart so that no one is hit by the spinning objects.

Think About This

1. The salt dough should have flattened somewhat. Some examples of other objects that flatten when spinning include pizza dough spun by a baker and a skirt that flies outward as the person wearing it spins in a circle.
2. Gravity pulled the cloud of gas and dust together. As this continued, the gas and dust got hotter and denser and eventually formed a star. Gravity caused the solar system to form a ball, but spinning caused it to flatten. Students later will learn that gravity caused objects with enough mass to become nearly spherical as well.

Teacher Notes

Key Concept Check

5. How do the inner and outer planets differ?

Outer Planets

The four outermost planets, shown in Table 2, formed from gases and other materials that escaped from the region closest to the Sun. They are often called the gas giants. They are larger than the inner planets, they rotate more quickly, and they each have rings. Except for Saturn's rings, the rings are barely visible. Each outer planet also has many moons. Scientists suspect each has a small, rocky core. These planets do not have solid surfaces. They have thick atmospheres of hydrogen and helium.

Table 2 The outer planets are made are not entirely of gas and ice.

Table 2 The Outer Planets

Jupiter Though it is made mostly of hydrogen and helium, Jupiter contains more mass than the rest of the planets combined. Jupiter revolves around the Sun at a distance of 5 AU. It has the fastest rotation of any planet—a day lasts just 10 Earth hours. Jupiter's clouds swirl with various colors because they contain small amounts of sulfur and phosphorus. Jupiter has strong weather systems.	
Saturn Saturn is the second-largest planet. At 9.5 AU from the Sun, it is nearly twice as far from the Sun as Jupiter, but its makeup is similar. Saturn has thousands of thin rings made of billions of pieces of ice ranging in size from pebbles to boulders. Saturn's clouds form bands and spots, but it is hard to see them. Saturn's hazy upper atmosphere hides its colorful lower layers.	
Uranus Uranus orbits the Sun at a distance of nearly 20 AU. Uranus is tilted so much that its axis sometimes points directly toward the Sun. The planet is a bluish-green color because of a small amount of methane in its atmosphere. Scientists suspect that a layer of icy liquid water, ammonia, and other compounds lies deep below Uranus's thick atmosphere.	
Neptune At 30 AU, Neptune is so far away that it cannot be seen from Earth without a telescope. Neptune's makeup is similar to that of Uranus, although it has more methane in its atmosphere and is deeper blue in color. Neptune has the fastest winds of any planet, recorded at over 1,000 km/h. The spots on its surface are hurricane-like storms, which do not last long.	

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LESSON 13.2 Review

Visualize It!

The solar system includes planets, moons, asteroids, comets, and many other objects.

Jupiter contains more mass than the rest of the planets combined.

Saturn's rings are made of billions of pieces of ice.

Summarize it!

1. How does gravity influence the shape and the motion of objects in the solar system?

2. What objects are in the solar system?

3. How does Earth compare with other objects in the solar system?

Lesson 13.2 Review 459

Outer Planets

After students read about the outer planets, assess their understanding by asking the following scaffolded questions.

Guiding Questions

AL	What are the outer planets, in the correct order from the Sun?	*Jupiter, Saturn, Uranus, and Neptune*
OL	How do the inner and outer planets differ?	*The inner planets are smaller than the outer planets. They are made of rock and metals, while the outer planets are mostly gases. The inner planets have fewer moons and rotate more slowly than the outer planets. The inner planets also have no rings, but most outer planets do. The outer planets also take longer to orbit the Sun than the inner planets do.*
BL	What features might scientists expect to find on other outer planets? Contrast these to Pluto's features.	*Scientists might expect to find large, fast-rotating, but slower orbiting, gaseous planets. Similar to the inner planets, Pluto is small and rocky, has no rings, and few moons.*

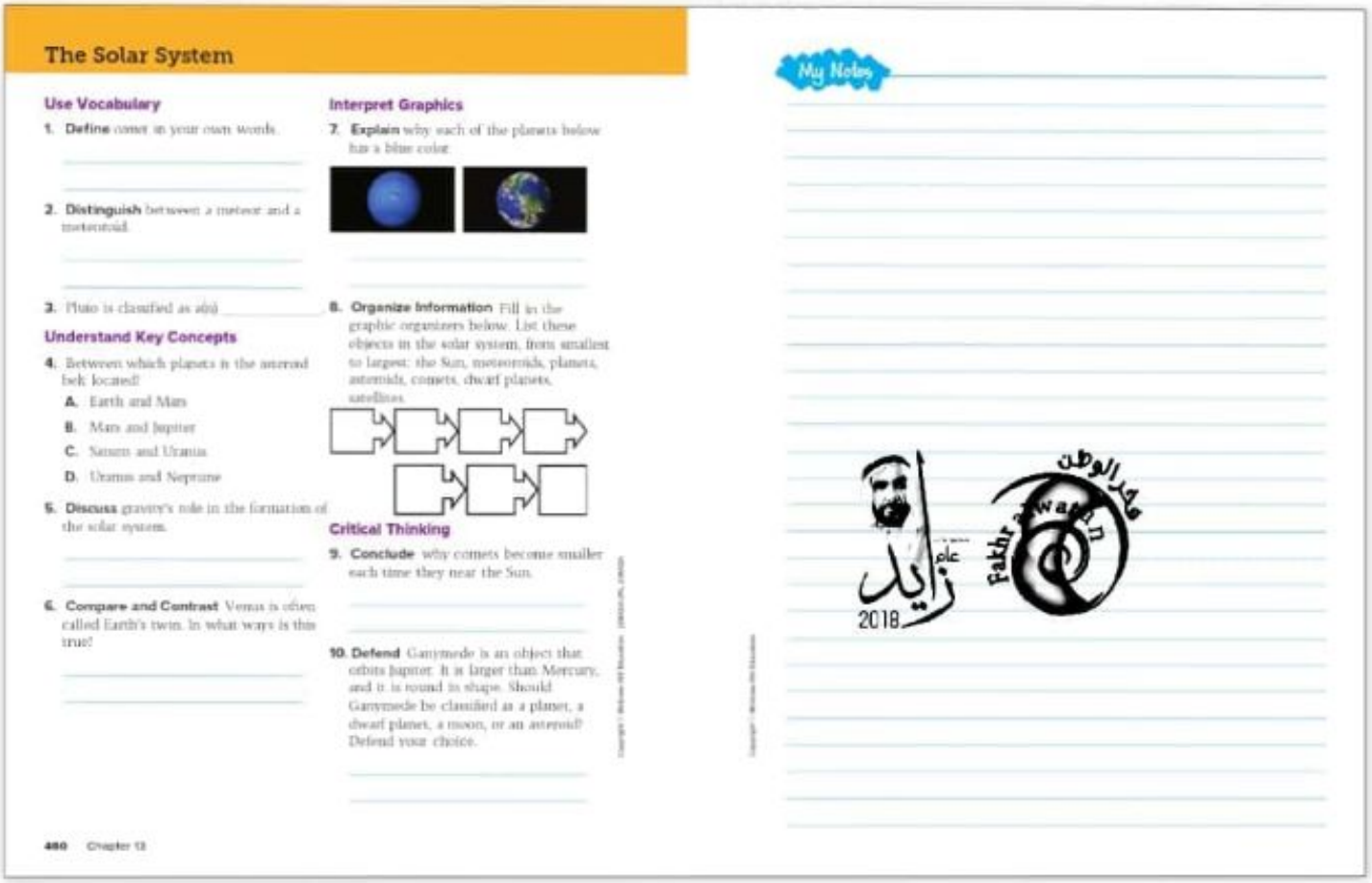
Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: To which Key Concept does each image relate?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- The Solar System
- Inner Planets



The Solar System

Use Vocabulary

1. **Define** comet in your own words.

2. **Distinguish** between a meteor and a meteoroid.

3. Pluto is classified as a(n) _____.

Understand Key Concepts

4. Between which planets is the asteroid belt located?
   A. Earth and Mars
   B. Mars and Jupiter
   C. Saturn and Uranus
   D. Uranus and Neptune

5. **Discuss** gravity's role in the formation of the solar system.

6. **Compare and Contrast** Venus is often called Earth's twin. In what ways is this true?

Interpret Graphics

7. **Explain** why each of the planets below has a blue color.

8. **Organize Information** Fill in the graphic organizers below. List these objects in the solar system, from smallest to largest: the Sun, meteoroids, planets, asteroids, comets, dwarf planets, satellites.

Critical Thinking

9. **Conclude** why comets become smaller each time they near the Sun.

10. **Defend** Ganymede is an object that orbits Jupiter. It is larger than Mercury, and it is round in shape. Should Ganymede be classified as a planet, a dwarf planet, a moon, or an asteroid? Defend your choice.

My Notes

Use Vocabulary

1. Answers will vary but should convey that a comet is a small, icy body that orbits the Sun and develops a tail when it is near the Sun.
2. A meteoroid is a small bit of debris that moves through the solar system. A meteor is a meteoroid that burns up as it enters Earth's atmosphere.
3. Dwarf planet

Understand Key Concepts

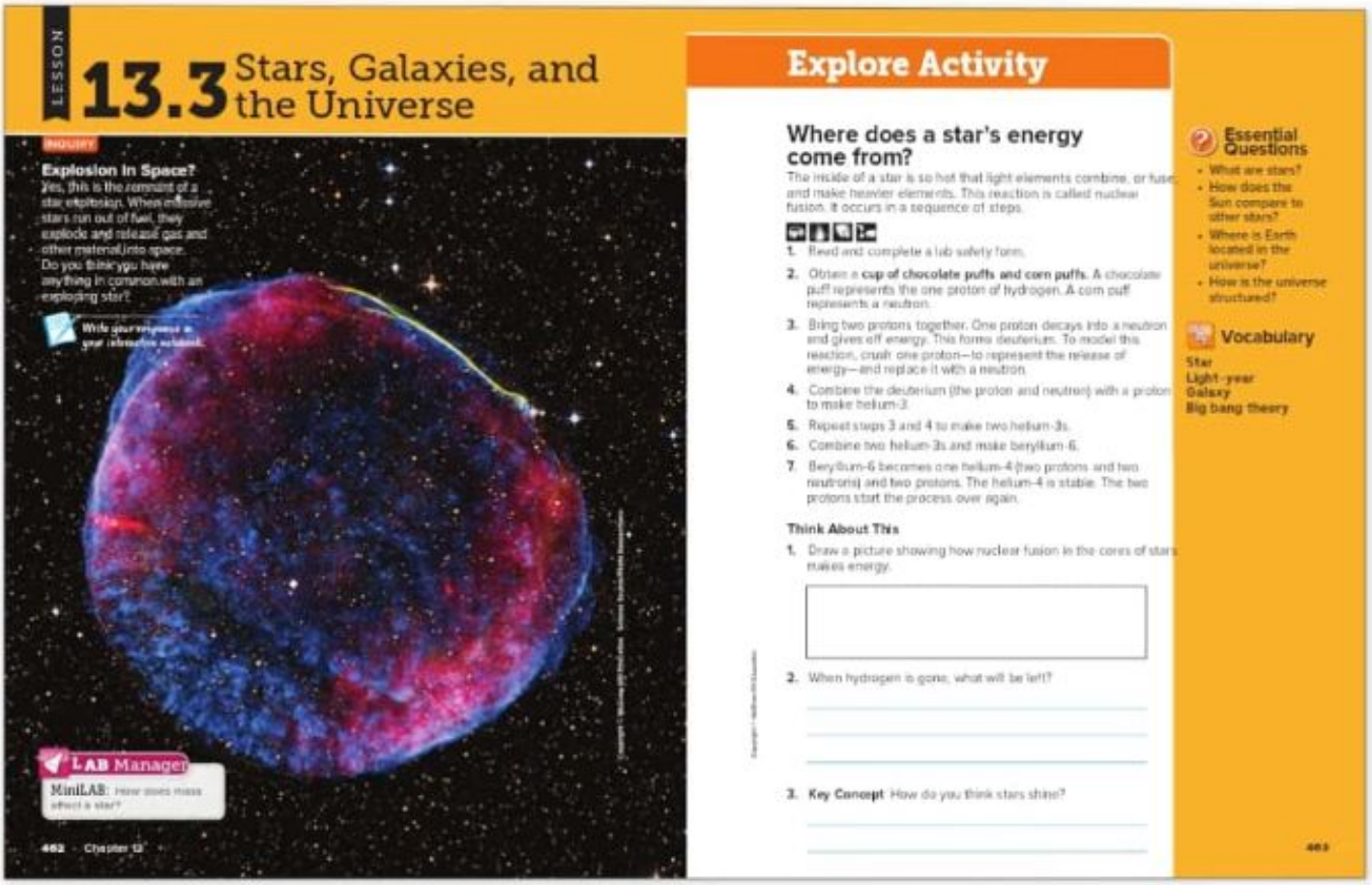
4. B. Mars and Jupiter
5. Gravity caused a cloud of dust and gas to contract, forming the Sun. Gravity caused the original ball-shaped system to flatten into a disk shape. Gravitational attraction also caused the gas and dust orbiting the Sun to clump and form objects that orbit the Sun.
6. Both Venus and Earth are about the same size and have about the same composition. However, Venus is hotter than Earth, rotates very slowly, and is entirely covered by clouds.

Interpret Graphics

7. Neptune, the planet on the left, is blue because of the methane in its atmosphere. Earth, the planet on the right, is blue because of the large amount of liquid water on its surface.
8. Meteoroids → comets or asteroids → asteroids or comets → satellites → dwarf planets → planets → the Sun

Critical Thinking

9. Comets are made of ice. On each revolution of the Sun, the comet becomes smaller as some of the ice melts.
10. Ganymede is a moon because it orbits something other than the Sun.



INQUIRY

About the Photo **Explosion in Space?** The explosion of the star that produced this galactic remnant lit up Earth's sky in the year 1006. This remnant, which is about 60 light-years across, still glows 7,000 light-years from Earth. Scientists think that the glowing mass of gases and dust represents the remains of a white dwarf star. A white dwarf forms as a star exhausts its nuclear fuel. Near the end of its nuclear burning stage, such a star expels most of its outer material and only the hot core of the star remains. Before students read the figure caption about this supernova remnant, ask the first two Guiding Questions below. After they read the caption, ask the remaining question.

Guiding Questions

AL What do you think this is?

Accept all reasonable answers at this point. Some students will be able to state that this mass has something to do with stars or galaxies.

OL What do you think makes stars explode?

Some students might know that a supernova occurs when a star exhausts its fuel.

BL Do you think you have anything in common with an exploding star?

Most students likely will say no. However, guide students to conclude that, like all matter, matter in stars is recycled. Scientists have determined most of the elements in the human body were originally made in stars. Students will learn more about recycled stellar matter at the end of this lesson.

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary
Words with Multiple Meanings

1. Write the term *light-year* on the board or on chart paper.
2. **Ask: What do you think this word means?** *Answers will vary. Some students likely will state that the term is related to time or distance.* Explain that a *light-year* is a unit of distance and is the distance that light travels in one year.
3. Tell students that one light-year equals 9.46 trillion km. Write this number out, or have students attempt to write it out, so that they can get a sense of its magnitude. *946,000,000,000,000 km*

ExploreActivity

Where does a star's energy come from?

Prep: *10 min* **Class:** *20 min*

Purpose
To model the fusion process that goes on inside most (main-sequence) stars.

Materials
Student: 1 cup of cereal puffs with more chocolate puffs than corn puffs
Alternate: small balls of two colors of clay can be used instead of cereal

Before You Begin
Discuss how the nucleus of an element is made of protons and neutrons. Make labeled drawings showing hydrogen-1 (one proton), deuterium (one proton and one neutron), helium-3 (two protons and one neutron), helium-4 (two protons and two neutrons), and beryllium-6 (four protons and two neutrons). Draw protons and neutrons in different colors.

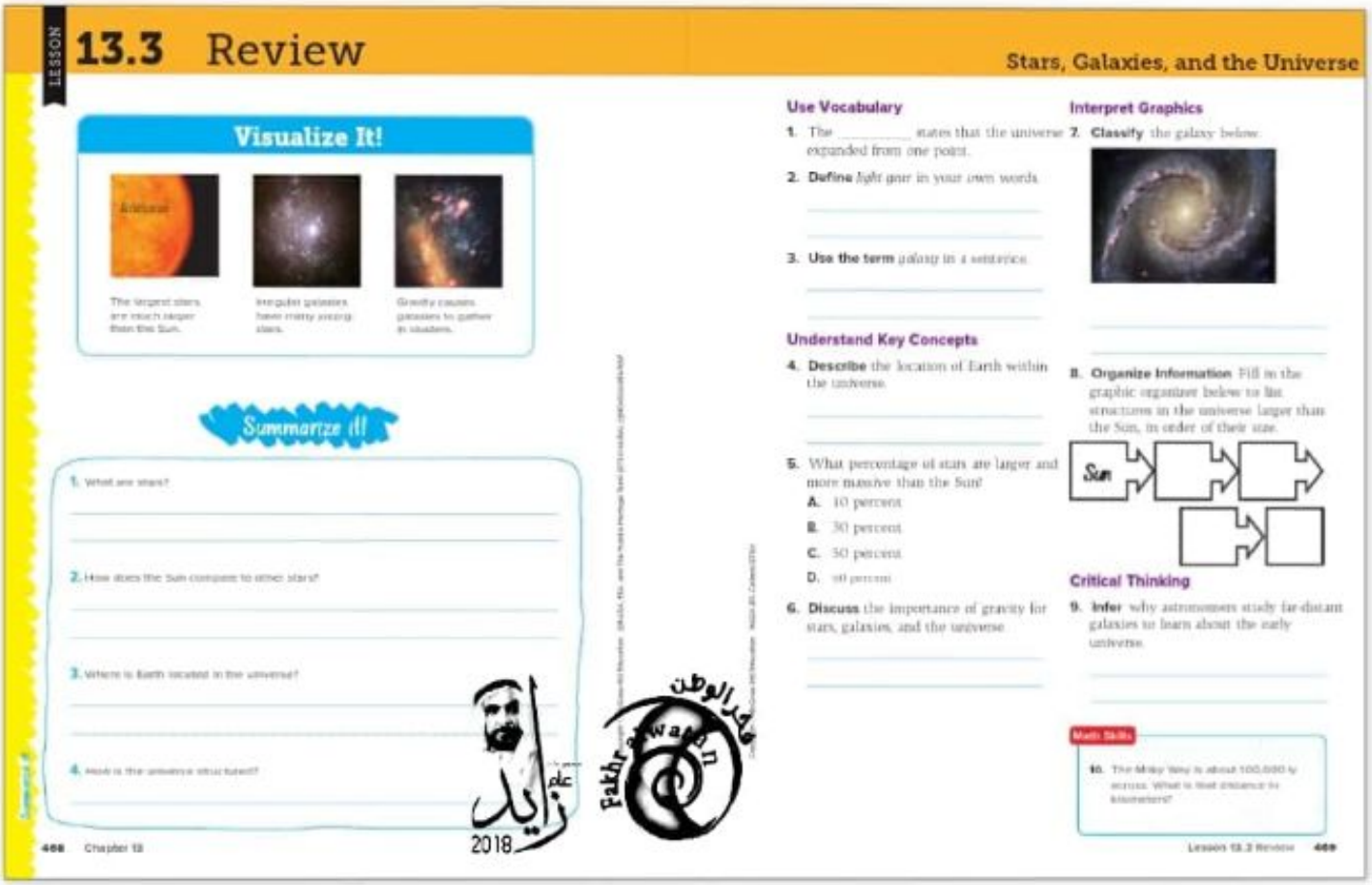
Guide the Investigation

- ⚠ Remind students not to eat the puffs.
- **Troubleshooting** Encourage students to keep their workspaces orderly by not dumping all the puffs out of the cup at once.
- Have students count the number of protons that enter the reaction, the number of protons and neutrons that come out, and the amount of energy released.

Think About This

1. Drawings should reflect the steps the students followed in this lab.
2. Hydrogen forms helium in the steps described in this lab. Helium is a stable product. It will remain in the star when most of the hydrogen is gone.
3. The Sun and other stars shine because of nuclear fusion in their cores. In nuclear fusion, heavy elements form from the combination of lighter elements. This process releases energy.

Teacher Notes



LESSON 13.3 Review

Stars, Galaxies, and the Universe

Visualize It!

Summarize it!

1. What are stars?
2. How does the Sun compare to other stars?
3. Where is Earth located in the universe?
4. How is the universe structured?

Use Vocabulary

1. The _____ states that the universe expanded from one point.
2. **Define** *light year* in your own words.
3. **Use the term** *galaxy* in a sentence.

Understand Key Concepts

4. **Describe** the location of Earth within the universe.
5. What percentage of stars are larger and more massive than the Sun?
   A. 10 percent
   B. 30 percent
   C. 50 percent
   D. 90 percent
6. **Discuss** the importance of gravity for stars, galaxies, and the universe.

Interpret Graphics

7. **Classify** the galaxy below.
8. **Organize Information** Fill in the graphic organizer below to list structures in the universe larger than the Sun, in order of their size.

Sun

Critical Thinking

9. **Infer** why astronomers study far-distant galaxies to learn about the early universe.

Math Skills

10. The Milky Way is about 100,000 ly across. What is that distance in kilometers?

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Lesson 13.3 Review 469

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: To which Key Concept does each image relate?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Stars
- Galaxies
- The Universe

Use Vocabulary

1. The Big Bang theory
2. Answers will vary but should convey that a light-year is a measure of distance and that one light-year is the distance light travels in a year.
3. Sample answer: Earth is located in a spiral galaxy called the Milky Way galaxy.

Understand Key Concepts

4. Sample answer: Earth is part of the solar system, which is part of the Milky Way, which is part of the Local Cluster, which is part of the Local Supercluster.
5. A. 10 percent
6. Stars form when the pull of gravity causes clouds of gas and dust to collapse and get hotter and denser. Gravity causes stars to group together into galaxies, clusters, and superclusters. Gravity is the force that will determine the ultimate fate of the universe.

Interpret Graphics

7. This is a spiral galaxy.
8. Sun → solar system → Milky Way → Local Group → Local Supercluster

Critical Thinking

9. They study distant galaxies to learn what the early universe was like because light takes time to travel. Looking at light from very distant objects is like looking far back in time.

Math Skills

10. 100,000 ly × 9,460,000,000,000 km/ 1.0 ly = 946,000,000,000,000,000 km

CHAPTER

13 Study Guide

The BIG Idea

The Moon orbits Earth as Earth orbits the Sun. The Sun is at the center of the solar system. The solar system is part of the Milky Way, one of billions of galaxies in the universe.

Key Concepts Summary	Vocabulary
13.1: The Sun-Earth-Moon System • Earth has seasons because it is tilted as it revolves around the Sun. • The Moon's position in relation to Earth and the Sun causes **waxing** and **waning** moon phases. The Moon's gravitational pull is largely responsible for **tides**. As the Moon orbits Earth, it causes **eclipses**. • A solar eclipse occurs when the Moon moves between Earth and the Sun and the Moon's shadow covers part of Earth. A lunar eclipse occurs as the Moon passes through Earth's shadow.	revolution rotation equinox solstice waxing waning tide eclipse
13.2: The Solar System • Gravity affected how the solar system and objects within it formed, and it continues to affect how solar system objects orbit the Sun. • The solar system contains the Sun, **planets, dwarf planets, asteroids, comets, meteoroids, moons,** and other objects. • Earth is the third planet from the Sun and the only planet known to have large amounts of liquid water on its surface.	planet dwarf planet moon asteroid comet meteoroid meteor
13.3: Stars, Galaxies, and the Universe • A **star** is a large sphere of hydrogen gas hot enough for nuclear reactions to occur in its core. • The Sun is a yellow star and is more massive than 90 percent of other stars. • Earth orbits the Sun, which is located in the Milky Way **galaxy**. • The universe contains billions of galaxies, which are grouped into clusters and superclusters.	star light-year galaxy big bang theory

FOLDABLES **Chapter Project**

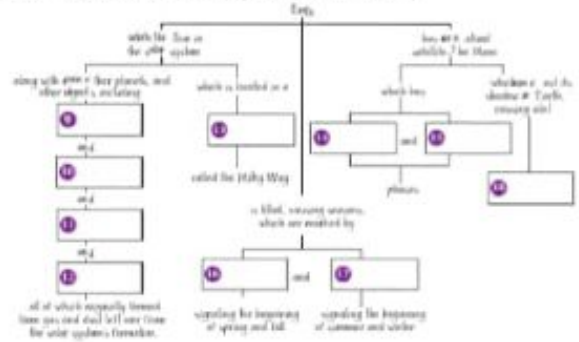
Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. Compare Earth's rotation and revolution.
2. As the Moon appears to get smaller, its phases are _____.
3. As the Moon appears to get larger, its phases are _____.
4. Distinguish between a solstice and an equinox.
5. Define the terms meteoroid and meteor.
6. A collection of stars, gas and dust is a _____.
7. When the Moon moves between Earth and the Sun, a(n) _____ can occur.
8. Define the word stars.

Link Vocabulary and Key Concepts

Use vocabulary terms from the previous page to complete the concept map.



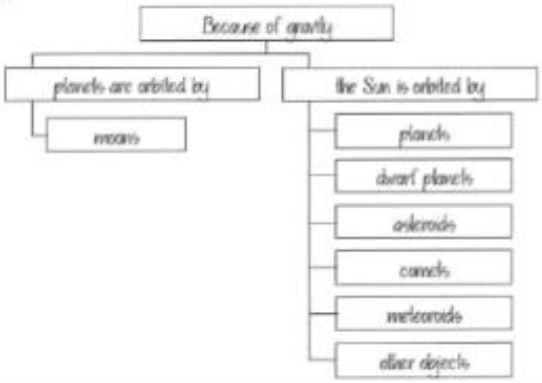
Key Concepts Summary

Study Strategy: Concept Maps

Concept maps are extremely useful study aids. Key Concepts Summary statements can be used to make a concept map.

1. Have students read over the Key Concept Summary statements.
2. Instruct students to draw a concept map in their Science Journals using the information in one or more of the Key Concept statements. A sample concept map is shown below.

Example:



Vocabulary

Study Strategy: Finding Relationships

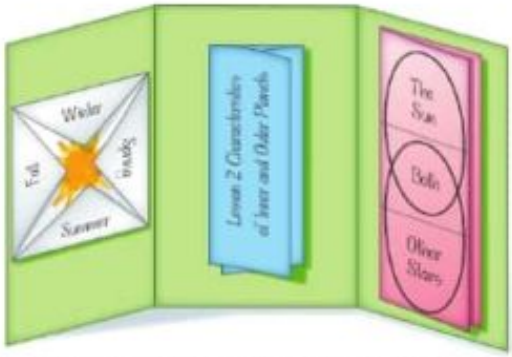
Tell students that the terms in this chapter relate to one another in many different ways. For example, two different terms might share the same root, have similar meanings, or describe different parts of a solar system.

1. Place all the vocabulary terms on slips of paper in a bowl.
2. Have students or student pairs draw two terms from the bowl.
3. Instruct students to write a sentence using both terms. The sentences should highlight a relationship between the terms.
4. Have students share their sentences with the rest of the class.

Example:

The tilt of Earth on its axis and the revolution of Earth around the Sun—the star at the center of the solar system—causes the seasons.

FOLDABLES® Chapter Project



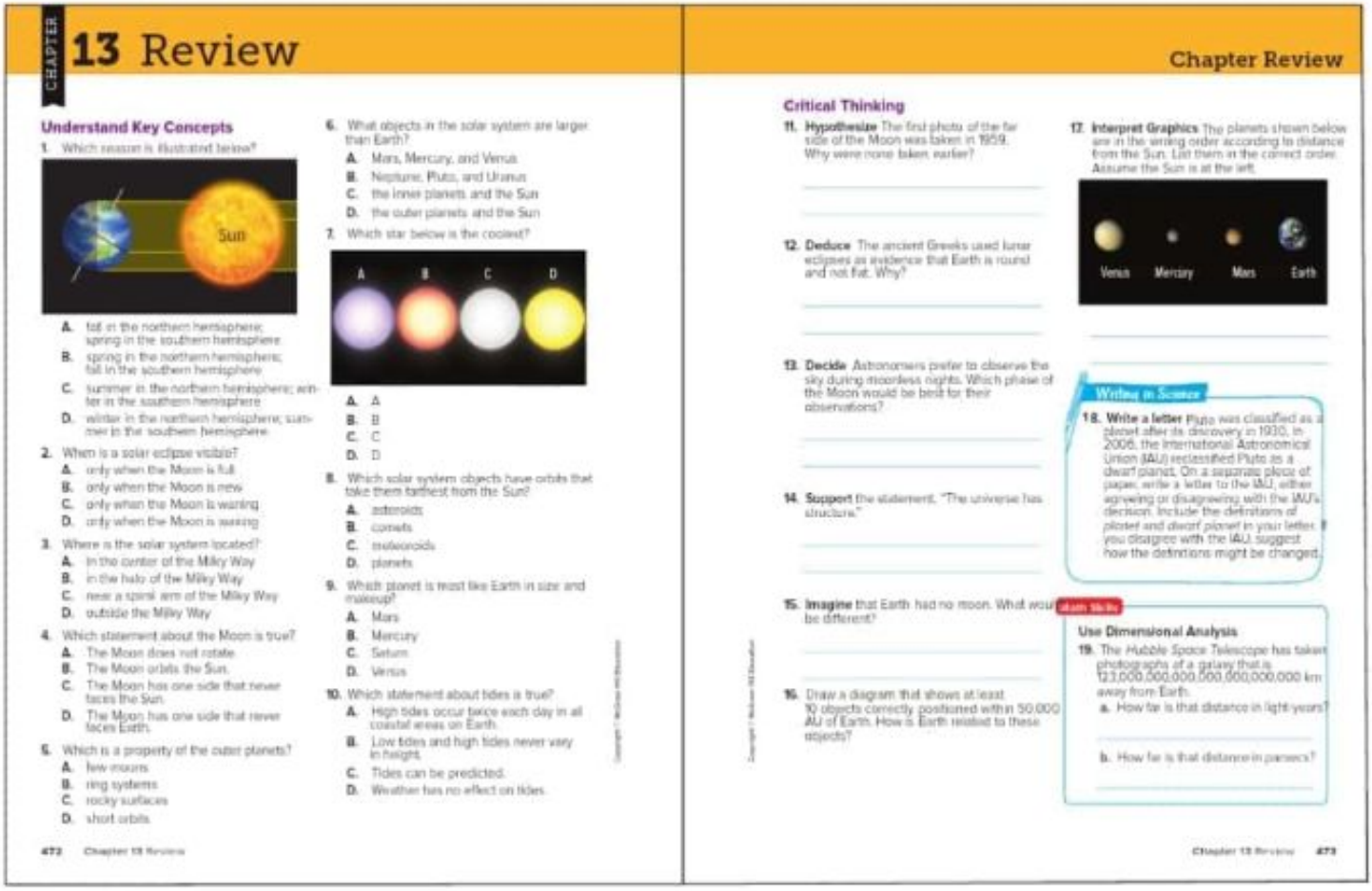
Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class discuss the way in which the Foldables® is organized.

Teacher Notes

Use Vocabulary

1. Both are movements of Earth. Earth rotates, or spins, on its axis once about every 24 hours. This causes day and night. Earth revolves around the Sun. This takes approximately 365 days, one year.
2. Waning
3. Waxing
4. Both are times in Earth's orbit when the tilt of Earth's axis in relation to the Sun is at an extreme. A solstice is the point in Earth's orbit when Earth is tilted the most toward or away from the Sun. This is the start of winter or summer. An equinox is the point in Earth's orbit when the axis is pointed neither toward nor away from the Sun. This is the start of spring or fall.
5. A meteoroid is a piece of debris in the solar system. A meteor is a meteoroid burning up as it enters Earth's atmosphere producing a streak of light.
6. Galaxy
7. Solar eclipse
8. Tides are the periodic rise and fall of the surface of the water in the oceans or other large bodies of water on Earth in response to gravitational pull of the Moon and the Sun.



CHAPTER 13 Review

Understand Key Concepts

1. Which season is illustrated below?

A. fall in the northern hemisphere; spring in the southern hemisphere
B. spring in the northern hemisphere; fall in the southern hemisphere
C. summer in the northern hemisphere; winter in the southern hemisphere
D. winter in the northern hemisphere; summer in the southern hemisphere

2. When is a solar eclipse visible?
A. only when the Moon is full
B. only when the Moon is new
C. only when the Moon is waning
D. only when the Moon is waxing

3. Where is the solar system located?
A. in the center of the Milky Way
B. in the halo of the Milky Way
C. near a spiral arm of the Milky Way
D. outside the Milky Way

4. Which statement about the Moon is true?
A. The Moon does not rotate.
B. The Moon orbits the Sun.
C. The Moon has one side that never faces the Sun.
D. The Moon has one side that never faces Earth.

5. Which is a property of the outer planets?
A. few moons
B. ring systems
C. rocky surfaces
D. short orbits

6. What objects in the solar system are larger than Earth?
A. Mars, Mercury, and Venus
B. Neptune, Pluto, and Uranus
C. the inner planets and the Sun
D. the outer planets and the Sun

7. Which star below is the coolest?

A. A
B. B
C. C
D. D

8. Which solar system objects have orbits that take them farthest from the Sun?
A. asteroids
B. comets
C. meteoroids
D. planets

9. Which planet is most like Earth in size and makeup?
A. Mars
B. Mercury
C. Saturn
D. Venus

10. Which statement about tides is true?
A. High tides occur twice each day in all coastal areas on Earth.
B. Low tides and high tides never vary in height.
C. Tides can be predicted.
D. Weather has no effect on tides.

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Chapter Review

Critical Thinking

11. **Hypothesize** The first photo of the far side of the Moon was taken in 1959. Why were none taken earlier?

12. **Deduce** The ancient Greeks used lunar eclipses as evidence that Earth is round and not flat. Why?

13. **Decide** Astronomers prefer to observe the sky during moonless nights. Which phase of the Moon would be best for their observations?

14. **Support** the statement, "The universe has structure."

15. **Imagine** that Earth had no moon. What would be different?

16. Draw a diagram that shows at least 10 objects correctly positioned within 50,000 AU of Earth. How is Earth related to these objects?

17. **Interpret Graphics** The planets shown below are in the wrong order according to distance from the Sun. List them in the correct order. Assume the Sun is at the left.

Writing in Science

18. **Write a letter** Pluto was classified as a planet after its discovery in 1930. In 2006, the International Astronomical Union (IAU) reclassified Pluto as a dwarf planet. On a separate piece of paper, write a letter to the IAU, either agreeing or disagreeing with the IAU's decision. Include the definitions of *planet* and *dwarf planet* in your letter. If you disagree with the IAU, suggest how the definitions might be changed.

Math Skills

Use Dimensional Analysis

19. The *Hubble Space Telescope* has taken photographs of a galaxy that is 123,000,000,000,000,000,000,000 km away from Earth.
a. How far is that distance in light-years?
b. How far is that distance in parsecs?

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Link Vocabulary and Key Concepts

9, 10, 11, 12 Dwarf planets, asteroids, comets, meteoroids (in any order)

13 Spiral galaxy

14, 15 Waxing, waning (in any order)

16 Equinox

17 Solstice

18 Solar eclipse

Understand Key Concepts

1 C. summer in the northern hemisphere; winter in the southern hemisphere

2 B. only when the Moon is new

3 C. near a spiral arm of the Milky Way

4 D. The Moon has one side that never faces Earth.

5 B. ring systems

6 D. the outer planets and the Sun

7 B. (the red star)

8 B. comets

9 D. Venus

10 C. Tides can be predicted.

Critical Thinking

11 None were taken earlier because the Moon orbits Earth in the same amount of time it takes to make one revolution. Therefore, one side of the Moon is never seen from Earth. The photo was taken by a camera on a space probe orbiting the Moon.

12 During a lunar eclipse, Earth's shadow is always round. Only a round object—not a flat object—can have a round shadow.

13 The Moon will not be visible at any time during the night when the phase is new.

14 Matter is not randomly distributed. Galaxies are grouped into clusters, clusters of galaxies are grouped into superclusters, and even superclusters form patterns in space.

15 Without a moon, tides would not be as extreme—and likely not very noticeable—because only the Sun's gravitational pull would influence them. There would be no moonlight or moon phases in the night sky. There would be no eclipses.

16 Drawings will differ but should be similar to the drawings and photos of the solar system in this book. Earth is related to these objects because it is a member of the solar system, just like the other objects. It is in orbit around the Sun, like many of the objects in the solar system, and the Moon is in orbit around Earth. Like Mercury, Venus, and Mars, Earth is an inner planet. It has a rocky body and an iron core like the other inner planets but unlike the outer planets—Jupiter, Saturn, Uranus, and Neptune. Meteoroids sometimes enter Earth's atmosphere, becoming meteors and occasionally impacting Earth's surface as meteorites. Earth is unique because it is the only body known to have large amounts of water on its surface and an atmosphere that includes oxygen. It also is the only body where life is known to exist.

17 Mercury, Venus, Earth, Mars

Writing in Science

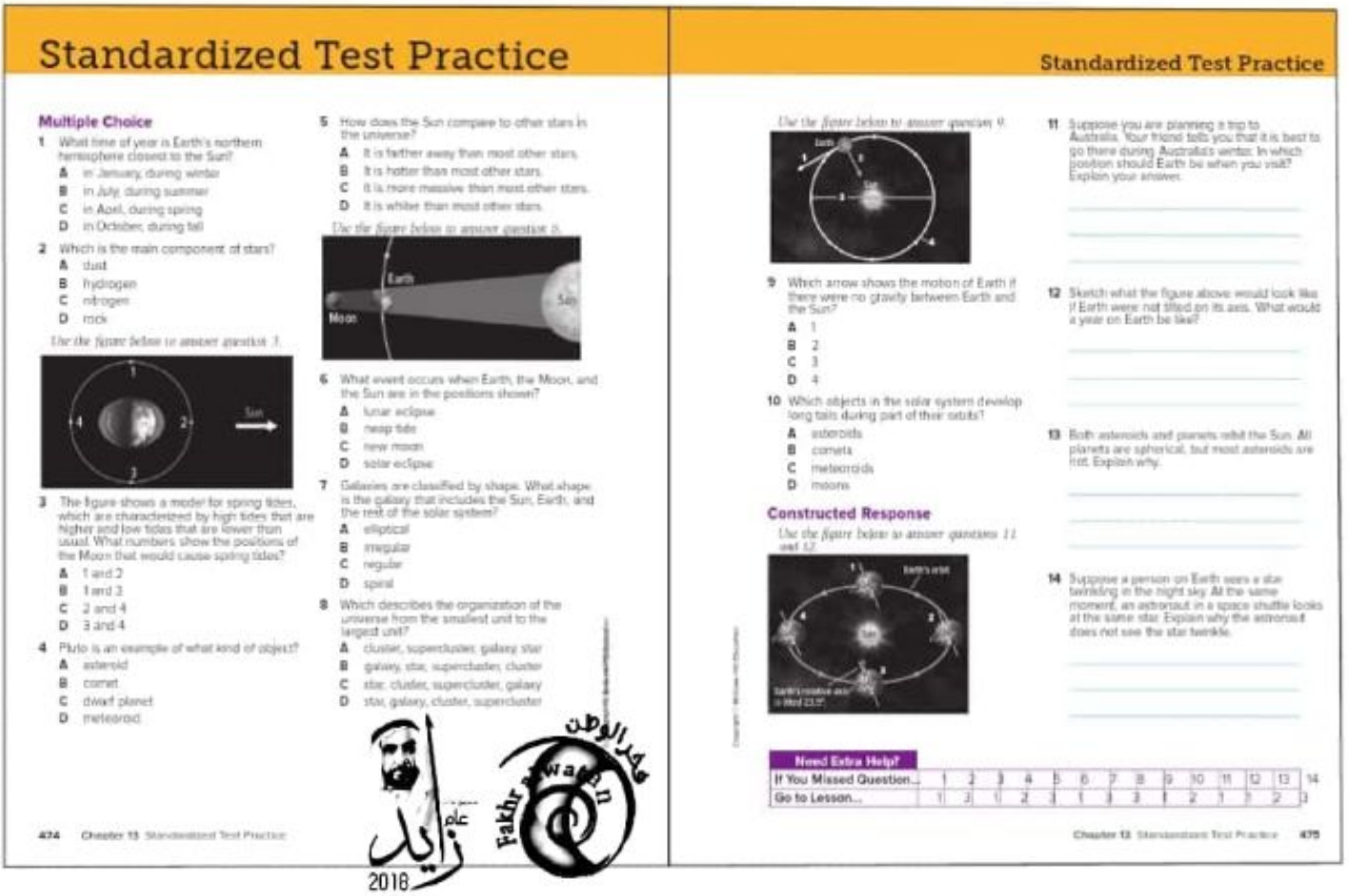
18 Answers will vary but should include definitions of *planet*—a body that orbits the Sun and is massive enough to be spherical and to have cleared its orbital path of other objects of similar size, and *dwarf planet*—a body that is massive enough to be spherical but not massive enough to have cleared its orbital path of other objects of similar size.

Math Skills

Use Dimensional Analysis

19. a. 123,000,000,000,000,000,000,000 km × 1 ly/9,460,000,000,000 km = 13,000,000,000 ly

b. 123,000,000,000,000,000,000,000 km × 1 ly/9,460,000,000,000 km • 1 pc/3.26 ly = 4,000,000,000 pc (with sig. figs)



Standardized Test Practice

Multiple Choice

1 What time of year is Earth's northern hemisphere closest to the Sun?
A in January, during winter
B in July, during summer
C in April, during spring
D in October, during fall

2 Which is the main component of stars?
A dust
B hydrogen
C nitrogen
D rock

Use the figure below to answer question 3.

3 The figure shows a model for spring tides, which are characterized by high tides that are higher and low tides that are lower than usual. What numbers show the positions of the Moon that would cause spring tides?
A 1 and 2
B 1 and 3
C 2 and 4
D 3 and 4

4 Pluto is an example of what kind of object?
A asteroid
B comet
C dwarf planet
D meteoroid

5 How does the Sun compare to other stars in the universe?
A It is farther away than most other stars.
B It is hotter than most other stars.
C It is more massive than most other stars.
D It is whiter than most other stars.

Use the figure below to answer question 6.

6 What event occurs when Earth, the Moon, and the Sun are in the positions shown?
A lunar eclipse
B neap tide
C new moon
D solar eclipse

7 Galaxies are classified by shape. What shape is the galaxy that includes the Sun, Earth, and the rest of the solar system?
A elliptical
B irregular
C regular
D spiral

8 Which describes the organization of the universe from the smallest unit to the largest unit?
A cluster, supercluster, galaxy, star
B galaxy, star, supercluster, cluster
C star, cluster, supercluster, galaxy
D star, galaxy, cluster, supercluster

Use the figure below to answer question 9.

9 Which arrow shows the motion of Earth if there were no gravity between Earth and the Sun?
A 1
B 2
C 3
D 4

10 Which objects in the solar system develop long tails during part of their orbits?
A asteroids
B comets
C meteoroids
D moons

Constructed Response

Use the figure below to answer questions 11 and 12.

11 Suppose you are planning a trip to Australia. Your friend tells you that it is best to go there during Australia's winter. In which position should Earth be when you visit? Explain your answer.

12 Sketch what the figure above would look like if Earth were not tilted on its axis. What would a year on Earth be like?

13 Both asteroids and planets orbit the Sun. All planets are spherical, but most asteroids are not. Explain why.

14 Suppose a person on Earth sees a star twinkling in the night sky. At the same moment, an astronaut in a space shuttle looks at the same star. Explain why the astronaut does not see the star twinkle.

Need Extra Help?														
If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	3	1	2	3	1	3	3	1	2	1	2	3	

Multiple Choice

1 A—Correct. Though it is winter, the Earth's orbital path takes it closest to the Sun. B is incorrect because in July Earth is farthest from the Sun. C and D put Earth at distances between its closest and farthest points from the Sun.

2 B—Correct. A, C, and D are incorrect because stars do not contain very much, if any, of these materials.

3 C—Correct. A, B, and D are incorrect because the Moon must be in line with Earth and the Sun to cause spring tides. In these choices, the Moon is at right angles with Earth and the Sun in at least one position listed.

4 C—Correct. A is incorrect because Pluto is not in the asteroid belt and it is larger than asteroids. B is incorrect because Pluto does not travel close to the Sun and does not develop a long tail. D is incorrect because meteoroids are very tiny and Pluto is very large in comparison.

5 C—Correct. A is incorrect because the Sun is the closest star to Earth. B is incorrect because the Sun is in the middle of the temperature range of stars. D is incorrect because the Sun is a yellow star.

6 A—Correct. B is incorrect because the Moon, Earth, and the Sun form a right angle during neap tides. C and D are incorrect because the Moon has to be between Earth and the Sun during a new moon or during a solar eclipse.

7 D—Correct. A and B are incorrect because the Milky Way is a spiral galaxy, not an elliptical or an irregular galaxy. C is incorrect because "regular" is not a type of galaxy.

8 D—Correct. A is incorrect because galaxies and stars are smaller than clusters or superclusters. B is incorrect because stars are smaller than galaxies and clusters are smaller than superclusters. C is incorrect because galaxies are smaller than clusters or superclusters.

9 A—Correct. B is incorrect because the arrow shows the direction of the gravitational pull of the Sun. C is incorrect because the arrow shows the distance between the Sun and part of Earth's orbit. D is incorrect because the arrow shows Earth's orbit. Earth orbits the Sun because of the gravitational force between Earth and the Sun.

10 B—Correct. A, C, and D are incorrect because none of them develop long tails during part of their orbits.

Constructed Response

11 Earth should be in position 2 when I visit. Australia is in the southern hemisphere. When Earth is in position 2, the southern hemisphere is tilted away from the Sun and is therefore experiencing winter.

12 Students' answers should include a sketch of Earth in four positions around the Sun. In each position, Earth's axis should be pointing straight up and down. Students' answers should also include the following description: Earth will not have seasons. Every month of the year will have similar weather.

13 Planets have much more mass than asteroids do. Therefore, planets exert a larger gravitational force. This larger force pulls the material forming the planets into spherical shapes. Asteroids do not have a large enough gravitational force to pull the material forming them into spheres.

14 People on Earth see stars twinkle because the light from the stars is bent in different directions as it travels through Earth's atmosphere. The astronaut on the Space Shuttle is outside of Earth's atmosphere so the light that the astronaut sees is not bent and the stars do not appear to twinkle.

Answer Key

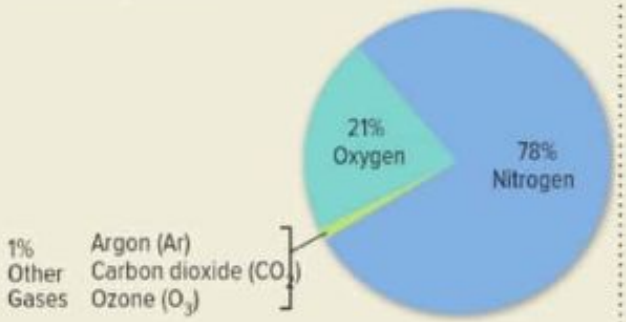
Question	Answer
1	A
2	B
3	C
4	C
5	C
6	A
7	D
8	D
9	A
10	B
11	See extended answer.
12	See extended answer.
13	See extended answer.
14	See extended answer.

Science Content Background

Lesson 1

Earth Systems

The Atmosphere Earth's atmosphere is critical to life on Earth. It contains the gases needed by many organisms to survive, including oxygen and carbon dioxide. A layer of ozone in the stratosphere protects the biosphere from harmful ultraviolet radiation from the Sun. Also, thermal energy trapped by the atmosphere helps regulate Earth's surface temperature, making life on Earth possible.

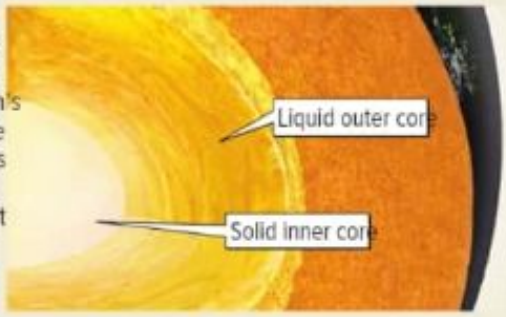


The Hydrosphere and the Cryosphere The hydrosphere consists of all of the water on Earth, which is found at Earth's surface in oceans, lakes, and rivers, as well as underground and in the atmosphere. Water exists as a solid, a liquid, and a gas on Earth. Water is solid in glaciers and polar ice caps, and it is gas (water vapor) in the atmosphere. Liquid water exists on and below Earth's surface. About 97 percent of water on Earth is salt water, and the remaining 3 percent is freshwater. Only 1 percent of freshwater is at Earth's surface in lakes, rivers, and streams. The majority of freshwater—79 percent—is stored in glaciers and ice caps. About 20 percent is groundwater.

Materials in the Geosphere The geosphere consists of minerals, rocks, soil, and metals. Minerals are naturally occurring inorganic solids that have crystal structures and definite chemical compositions. "Inorganic" means that minerals are not biologic in origin.

Rocks Rocks are made of minerals and other materials, including organic matter. Rocks are classified into three main categories—igneous, metamorphic, and sedimentary. These categories are based on how the rocks form. Igneous rock forms when magma or lava cools. Metamorphic rock forms when high temperatures and pressure change existing rock into new rock. Metamorphic rock can form from igneous rock, sedimentary rock, or other metamorphic rock. Sedimentary rock forms when layers of sediment are compressed and cemented together.

Structure Earth's structure consists of three main layers—the crust, the mantle, and the core. Compared to the other layers, the crust is thin. Oceanic crust is usually 5–10 km thick. Continental crust is 35–70 km thick. The mantle extends from the bottom of the crust and is about 2,900 km thick. The outer and inner core together are about 3,500 km thick. The layers of Earth are often compared to the layers of a hard-boiled egg or a peach. Each has a thin outer layer, comparable to Earth's crust; a middle layer, like the mantle; and an inner layer, similar to the core.



Lesson 2

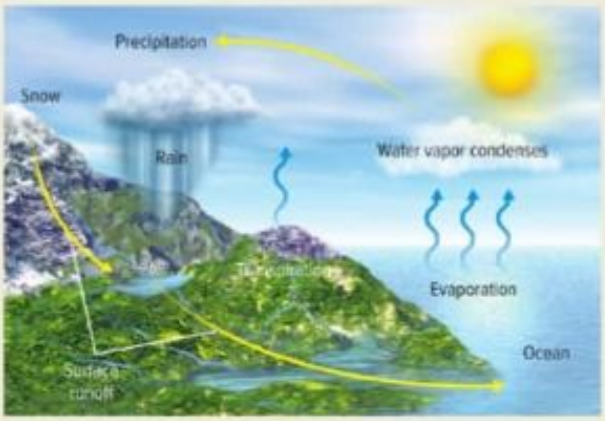
Interactions of Earth's Systems

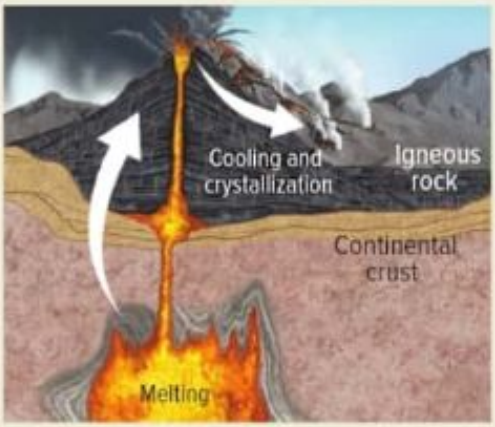
The Water Cycle Rates of evaporation and precipitation vary from one location to another. But globally, the amount of water evaporated from Earth's surface is about equal to the amount of water that falls back to Earth as precipitation. It takes about 10 days for a water molecule that has been evaporated to fall back to Earth's surface.

Evaporation and Transpiration Factors that affect rates of evaporation include temperature and wind. The higher the temperature of water, the faster the evaporation rate. Increased wind speed also leads to an increase in evaporation rates. Transpiration rates are also affected by several factors including air temperature, wind, relative humidity, and the type of plant. Increased temperature and wind lead to increased transpiration rates. Increased relative humidity leads to decreased transpiration rates. Different types of plants transpire at different rates. For example, desert plants, such as cacti, transpire less than other types of plants in order to help conserve water in dry conditions.

Changes in the Atmosphere One example of an interaction between the geosphere and the atmosphere is the rain-shadow effect. *Orographic lifting* is the term used to describe the rising of air due to contact with an elevated barrier, such as a mountain. The windward sides of mountains usually have high levels of precipitation. The leeward sides of mountains, under the influence of a rain-shadow, are usually deserts. The Great Basin Desert in the western United States was created by the rain-shadow effect.

The Rock Cycle The rock cycle connects processes at Earth's surface with those in Earth's interior. Weathering and erosion break rocks at Earth's surface into sediment. When layers of sediment are deposited on top of each other, enough pressure is eventually applied to the bottom layers that the sediment changes to sedimentary rock. If sedimentary rock is exposed to the extreme temperatures and pressure in Earth's interior, it will eventually become metamorphic rock. The term *metamorphosis* means "to change physical form or structure." When igneous, metamorphic, or sedimentary rock are subjected to intense heat and pressure, each can change into a new metamorphic rock.





Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

*"The world contains a wide diversity of physical conditions, which creates a wide variety of environments: freshwater, marine, forest, desert, grassland, mountain, and others. In any particular environment, the growth and survival of organisms depends on the physical conditions."

*"Earth is mostly rock. Three-fourths of Earth's surface is covered by a relatively thin layer of water (some of it frozen) and the entire planet is surrounded by a relatively thin layer of air."

*"When liquid water disappears, it turns into a gas (vapor) in the air. It can reappear as a liquid when cooled and then as a solid if cooled below the freezing point of water. Clouds and fog are made of tiny droplets or frozen crystals of water."

*"Rock is composed of different combinations of minerals. Smaller rocks come from the breakage and weathering of bedrock and larger rocks. Soil is made partly from weathered rock and partly from plant remains, and it also contains many living organisms."

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

Lesson 1
Earth Systems

1 The atmosphere has a layered structure that includes the troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere. It is made of nitrogen, oxygen, and trace gases.

2 Water is found on Earth in oceans, lakes, rivers, and as ice and groundwater. Small amounts of water are also found within the atmosphere and the biosphere.

3 Earth is made up of the biosphere, the atmosphere, the hydrosphere, the cryosphere, and the geosphere.

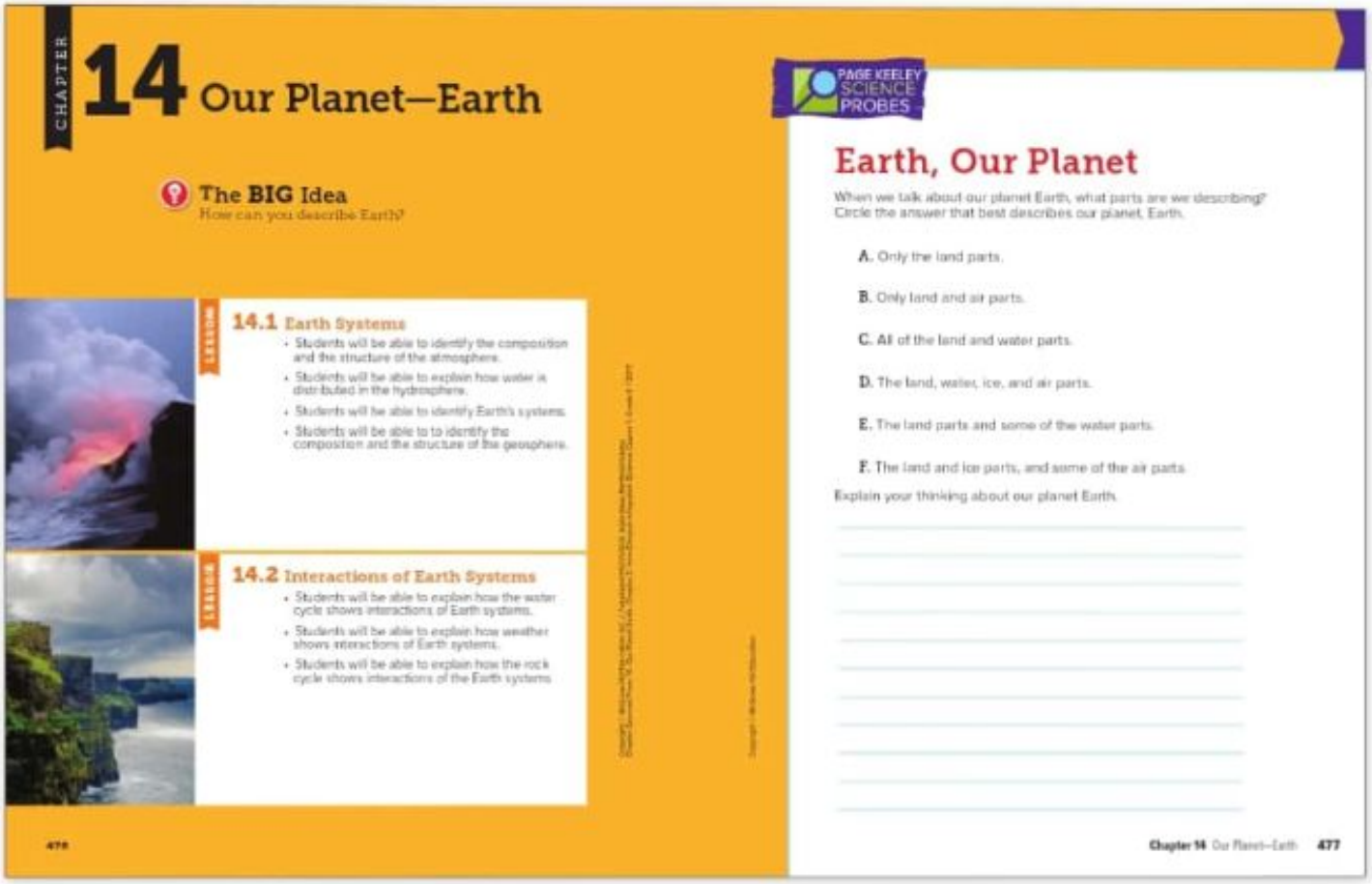
4 The geosphere is made of soil, metal, and rock. It has a layered structure that includes the crust, the mantle, and the core.

Lesson 2
Interactions of Earth Systems

5 The water cycle shows how water moves between reservoirs of the hydrosphere, the atmosphere, the geosphere, and the biosphere.

6 Weather and climate are influenced by transfers of water and energy among the atmosphere, the geosphere, and the hydrosphere.

7 Rocks continually change form as they move through the rock cycle. Processes such as weathering and erosion are examples of interactions among the Earth systems.


CHAPTER 14 Our Planet—Earth

The BIG Idea
How can you describe Earth?

14.1 Earth Systems
- Students will be able to identify the composition and the structure of the atmosphere.
- Students will be able to explain how water is distributed in the hydrosphere.
- Students will be able to identify Earth's systems.
- Students will be able to to identify the composition and the structure of the geosphere.

14.2 Interactions of Earth Systems
- Students will be able to explain how the water cycle shows interactions of Earth systems.
- Students will be able to explain how weather shows interactions of Earth systems.
- Students will be able to explain how the rock cycle shows interactions of the Earth systems.

PAGE KEELEY SCIENCE PROBES

Earth, Our Planet

When we talk about our planet Earth, what parts are we describing? Circle the answer that best describes our planet, Earth.

A. Only the land parts.

B. Only land and air parts.

C. All of the land and water parts.

D. The land, water, ice, and air parts.

E. The land parts and some of the water parts.

F. The land and ice parts, and some of the air parts.

Explain your thinking about our planet Earth.

Chapter 14 Our Planet—Earth 477

How can you describe Earth?

The BIG Idea

There are no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL How is life on Earth linked to water at Earth's surface and oxygen in Earth's atmosphere?

Use this question to get students thinking about Earth's different systems and how they are linked. Students should recall that all living organisms need water to survive. Many organisms, including animals, need oxygen to survive as well.

OL What are some features that make Earth different from other planets in our solar system?

Use this question to get students thinking about Earth's different systems and their characteristics. Possible answer: Earth is the only planet that has life as we know it. Earth's atmosphere contains oxygen. The temperatures on Earth are not as extreme as they are on other planets. Earth has liquid water. Earth has a solid surface.

BL Give one example of how water at Earth's surface is linked to the atmosphere.

Students should recall interactions between the hydrosphere and the atmosphere as part of the water cycle. Possible answer: Water at Earth's surface evaporates into the atmosphere. It later condenses and forms clouds.

PAGE KEELEY SCIENCE PROBES

Earth, Our Planet

Answers to the Page Keeley Science Probe can be found in the Teacher's Edition of the *Activity Lab Workbook*.

LESSON

14.1 Earth Systems

INQUIRY

A Hot Mix? Earth is made of more than soil, minerals, and melted rocks flowing out of volcanoes. What other parts of Earth do you see in the photo? How do these parts interact?

Write your response in your interactive notebook.

478 Chapter 14

Explore Activity

How can you describe Earth?

When you look out the window, you might see wispy white clouds, birds in the trees, and rolling hills in the distance. All these things are part of Earth. What else makes up Earth?

Procedure

1. Read and complete a lab safety form.
2. With your partner, brainstorm a list of words that describe Earth. Limit the list to 20 words. Be creative! Record the list in your Science Journal.
3. Use **markers** to rewrite your list of words using different colors and letter shapes. Use **scissors** to cut out each word.
4. Group the words that you think relate to each other. Use a **glue stick** to fix the words to a piece of **colored paper**.

Think About This

1. What words did you use to describe Earth?
2. How did your list compare to those of other students?
3. What things do you think make up Earth?

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Learning Outcomes

- Students will be able to identify the composition and the structure of the atmosphere.
- Students will be able to explain how water is distributed in the hydrosphere.
- Students will be able to identify Earth's systems.
- Students will be able to to identify the composition and the structure of the geosphere.

Vocabulary

biosphere
atmosphere
hydrosphere
groundwater
geosphere
mineral
rock

INQUIRY

A Hot Mix? About the Photo The photo shows the interaction between the geosphere, the hydrosphere, and the atmosphere. Hot, molten lava that has erupted from Earth's interior is oozing into the ocean, creating steam as the water heats up. The lava will eventually harden and form igneous rock. Have students think about how a volcanic eruption might affect the biosphere and the atmosphere.

Guiding Questions

AL Describe Earth's water system.	*Possible answers: Most of the water on Earth is salt water in the oceans. Freshwater is found in rivers and lakes and is stored in ice, including glaciers. Some water is in the atmosphere in a gaseous state.*
OL Where did the lava in the photo come from? How might the interior of Earth differ from conditions at Earth's surface?	*Possible answers: The lava came from Earth's interior. Temperatures in Earth's interior are hot enough to melt rock. But at Earth's surface, where temperatures are lower, rock is solid.*
BL Give an example of an interaction between any two of Earth's systems.	*Answers will vary. Students might point out the interaction between the hydrosphere and the atmosphere, which leads to weather; or the interaction between the biosphere and the atmosphere, in which organisms exchange gases, such as oxygen and carbon dioxide.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Prefixes and Root Words

1. Have students look up meaning of the root *sphere*. Sphere means *"globe" or "ball."*
2. Have students look up the definition of each of the following prefixes: *bio-, atmos-, hydro-, geo-*. Bio- *means life,* atmos- *means "vapor,"* hydro- *means "water," and* geo- *means "earth" or "ground."*
3. Have students write their own definitions for the terms *biosphere, atmosphere, hydrosphere,* and *geosphere* in their Science Journals. *Answers will vary but should be based on the meanings of the prefixes and word root.* Have students compare their definitions to those provided in the text as they read Lesson 1.

ExploreActivity

How can you describe Earth?

Prep: *15 min* **Class:** *20 min*

Purpose
To recognize that Earth is a complex system made of different sub-systems.

Materials
colored markers, scissors, glue stick, colored cardboard or stiff paper, plain white paper, examples of word clouds

Before You Begin

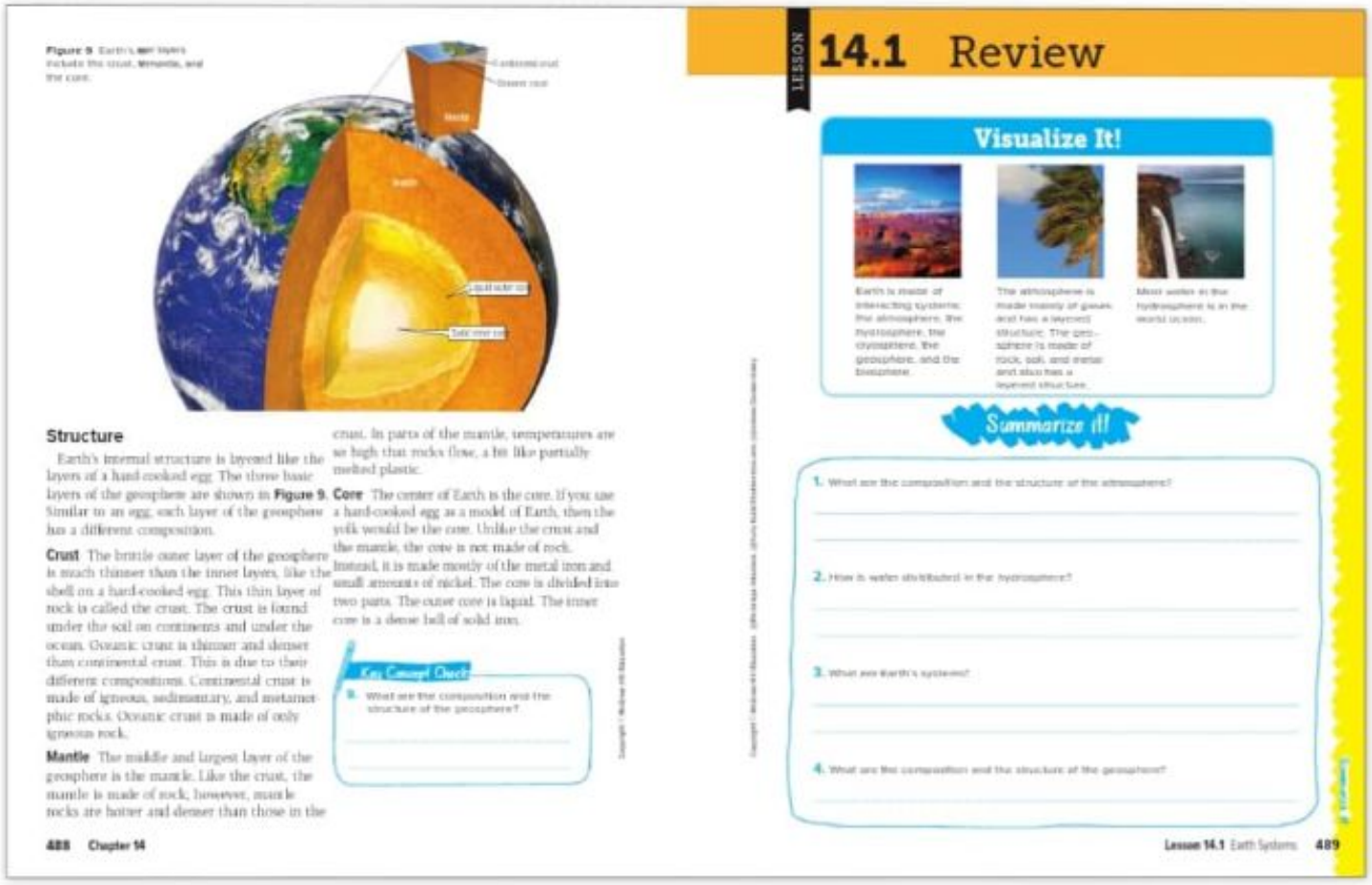
- Provide each group of students with a piece of colored cardboard, a glue stick, and several sheets of plain white paper.
- Explain the concept of a Wordle©. A Wordle is a "word cloud" in which words from a given text are grouped together. Show students several examples. To create your own Wordle, go to http://www.wordle.net. Some words in a Wordle are written in different colors or sizes based on how frequently they appear in a given piece of writing. Students do not need to reflect the frequency of usage of each word in their word clouds.

Guide the Investigation
Stress that there is no right way or wrong way to assemble a word cloud. Encourage students to be creative and inventive with their word cloud designs.

Think About This

1. Sample answer: water, air, round, rocks, planet, people, trees, mountains
2. Answers will vary. Students might find that each group used similar words to describe Earth. Some words that were not used by all groups might provide opportunities for discussion.
3. Sample Answer: Earth is made of living things, air, water, soil, and rocks.

Teacher Notes



LESSON 14.1 Review

Visualize It!

Summarize it!

1. What are the composition and the structure of the atmosphere?
2. How is water distributed in the hydrosphere?
3. What are Earth's systems?
4. What are the composition and the structure of the geosphere?

Structure

Earth's internal structure is layered like the layers of a hard-cooked egg. The three basic layers of the geosphere are shown in **Figure 9**. Similar to an egg, each layer of the geosphere has a different composition.

Crust The brittle outer layer of the geosphere is much thinner than the inner layers, like the shell on a hard-cooked egg. This thin layer of rock is called the crust. The crust is found under the soil on continents and under the ocean. Oceanic crust is thinner and denser than continental crust. This is due to their different compositions. Continental crust is made of igneous, sedimentary, and metamorphic rocks. Oceanic crust is made of only igneous rock.

Mantle The middle and largest layer of the geosphere is the mantle. Like the crust, the mantle is made of rock; however, mantle rocks are hotter and denser than those in the crust. In parts of the mantle, temperatures are so high that rocks flow, a bit like partially melted plastic.

Core The center of Earth is the core. If you use a hard-cooked egg as a model of Earth, then the yolk would be the core. Unlike the crust and the mantle, the core is not made of rock. Instead, it is made mostly of the metal iron and small amounts of nickel. The core is divided into two parts. The outer core is liquid. The inner core is a dense ball of solid iron.

Key Concept Check

1. What are the composition and the structure of the geosphere?

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Lesson 14.1 Earth Systems 489

Structure

The three basic layers of the geosphere are the crust, the mantle, and the core. While the crust and mantle are made of rock, the core is made of iron and nickel. The outer core is liquid and the inner core is solid iron and nickel. The text compares the layers of Earth's internal structure to the layers of a hard cooked egg. Complete the Teacher Demo using a hard-cooked egg to help students visualize the layers. **Ask: What other analogies can you make about layers in the geosphere?** *Possible answers: a peach, which has a thin outer skin, a fleshy layer, and a pit in the center*

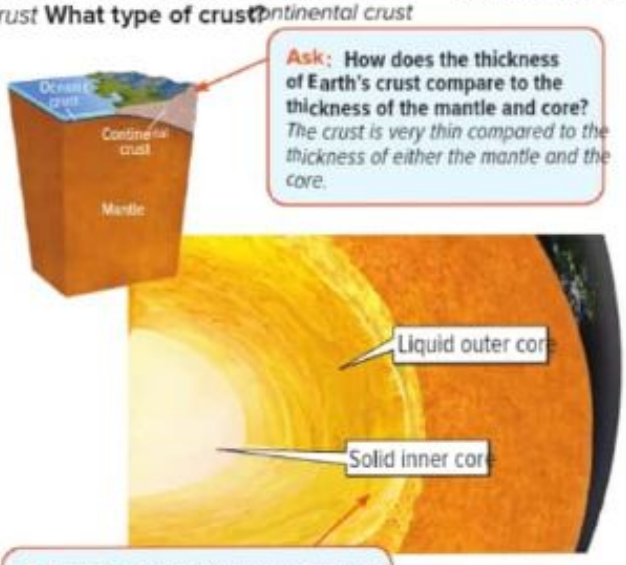
Guiding Questions

AL	**What is the difference between the crust and the mantle?**	*The mantle material is hotter and denser than the rocks of the crust.*
	Key Concept Check: What are the composition and the structure of the geosphere?	*The crust is solid and is made of rock, including igneous, sedimentary, and metamorphic rock. The mantle is made of partially melted rock. In parts of the mantle, rocks flow like melted plastic due to high temperature. The core is made of iron and nickel. The outer core is liquid, and the inner core is solid.*
BL	**Infer how the layers of the geosphere formed.**	*They resulted from their different densities. As Earth formed, the denser materials sank, and the less dense material rose.*

Visual Literacy: Structure of the Geosphere

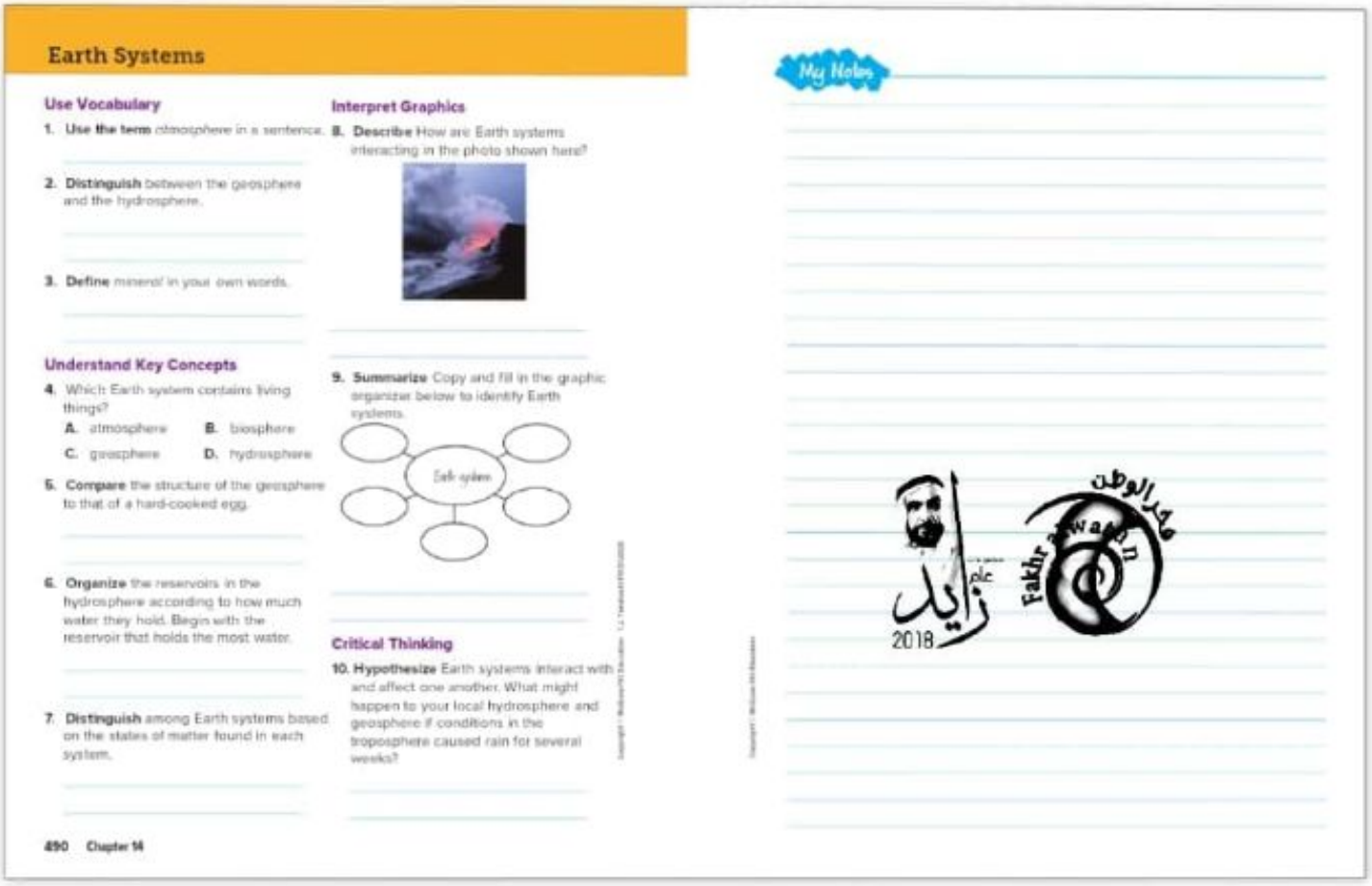
Figure 9 shows the layers of the geosphere. Relate material from the figure to students' lives.

Ask: When you are standing on the ground outside your house, which layer of the geosphere are you standing on? What type of crust? *continental crust*



Ask: How does the thickness of Earth's crust compare to the thickness of the mantle and core? *The crust is very thin compared to the thickness of either the mantle and the core.*

Ask: What is the difference between the outer core and the inner core? *The outer core is liquid and the inner core is solid.*



Earth Systems

Use Vocabulary

1. **Use the term** atmosphere in a sentence.
2. **Distinguish** between the geosphere and the hydrosphere.
3. **Define** mineral in your own words.

Understand Key Concepts

4. Which Earth system contains living things?
   A. atmosphere B. biosphere
   C. geosphere D. hydrosphere
5. **Compare** the structure of the geosphere to that of a hard-cooked egg.
6. **Organize** the reservoirs in the hydrosphere according to how much water they hold. Begin with the reservoir that holds the most water.
7. **Distinguish** among Earth systems based on the states of matter found in each system.

Interpret Graphics

8. **Describe** How are Earth systems interacting in the photo shown here?

9. **Summarize** Copy and fill in the graphic organizer below to identify Earth systems.

Earth system

Critical Thinking

10. **Hypothesize** Earth systems interact with and affect one another. What might happen to your local hydrosphere and geosphere if conditions in the troposphere caused rain for several weeks?

My Notes

2018

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Use Vocabulary

1 Sample answer: The hot air balloon floated up through the atmosphere.

2 The geosphere is the solid Earth system made mostly of rock, and the hydrosphere is the system that contains Earth's water.

3 Sample answer: A mineral is a solid that has a crystal structure, is inorganic, has a set composition, and forms naturally.

Understand Key Concepts

4 B. biosphere

5 Sample answer: The geosphere is layered like a hard-cooked egg. The crust of the geosphere is like the shell of the egg. The mantle is like the egg white. The core is like the yolk.

6 The reservoirs listed from largest to smallest are: the ocean, ice, groundwater, lakes, and rivers.

7 Sample answer: The atmosphere is composed mainly of gases, the hydrosphere is composed mainly of liquid, the geosphere is composed mainly of solids, and the biosphere is composed of solids and liquids.

Interpret Graphics

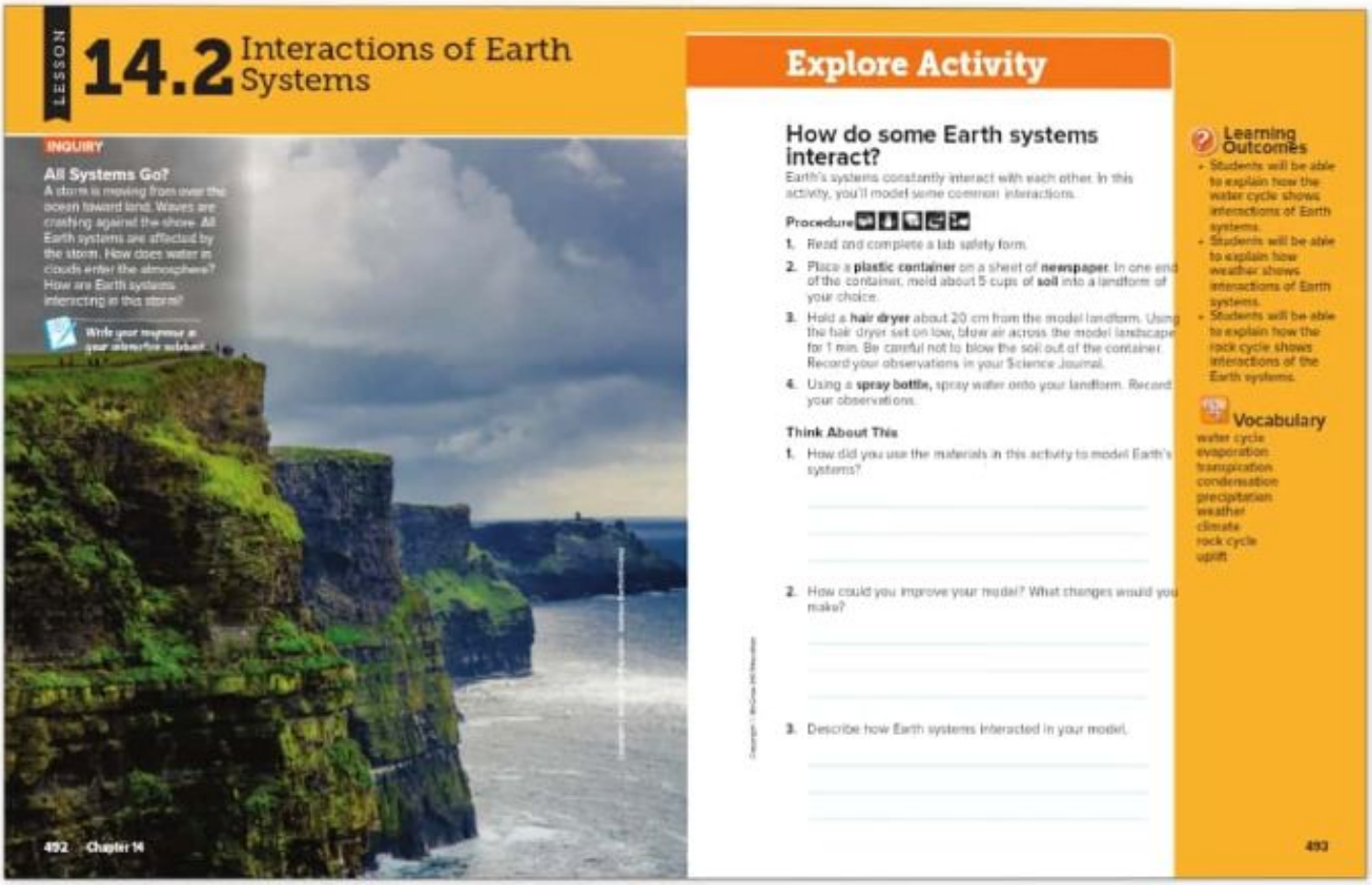
8 Lava from the geosphere is flowing into the ocean, which is part of the hydrosphere. The hot lava causes steam to form when it comes into contact with the ocean water, and the steam (water vapor) is released into the atmosphere. The ocean waves crash against the rocks, causing weathering and erosion.

9 Geosphere, hydrosphere, atmosphere, biosphere

Critical Thinking

10 Sample answer: Rivers and streams might overflow their banks and cause widespread flooding. The heavy rains could increase soil erosion and might lead to mudslides.

Desalination This feature can be found in the *Activity Lab Workbook*.


LESSON

14.2 Interactions of Earth Systems

INQUIRY

All Systems Go?
A storm is moving from over the ocean toward land. Waves are crashing against the shore. All Earth systems are affected by the storm. How does water in clouds enter the atmosphere? How are Earth systems interacting in this storm?

Write your response in your interactive notebook.

492 Chapter 14

Explore Activity

How do some Earth systems interact?

Earth's systems constantly interact with each other. In this activity, you'll model some common interactions.

Procedure

1. Read and complete a lab safety form.
2. Place a **plastic container** on a sheet of **newspaper**. In one end of the container, mold about 5 cups of **soil** into a landform of your choice.
3. Hold a **hair dryer** about 20 cm from the model landform. Using the hair dryer set on low, blow air across the model landscape for 1 min. Be careful not to blow the soil out of the container. Record your observations in your Science Journal.
4. Using a **spray bottle**, spray water onto your landform. Record your observations.

Think About This

1. How did you use the materials in this activity to model Earth's systems?
2. How could you improve your model? What changes would you make?
3. Describe how Earth systems interacted in your model.

Learning Outcomes

- Students will be able to explain how the water cycle shows interactions of Earth systems.
- Students will be able to explain how weather shows interactions of Earth systems.
- Students will be able to explain how the rock cycle shows interactions of the Earth systems.

Vocabulary

water cycle
evaporation
transpiration
condensation
precipitation
weather
climate
rock cycle
uplift

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INQUIRY

About the Photo **All Systems Go?** The photo can be used to start a discussion on how Earth's systems interact. In the photo, the interaction between the systems includes the waves hitting the cliffs (hydrosphere and geosphere), the clouds, which were formed with water from the hydrosphere (atmosphere and hydrosphere), the rain from the storm will provide water for plants and other organisms (hydrosphere, atmosphere, biosphere) and cause some soil erosion (hydrosphere, atmosphere, geosphere), and the plants are growing in the soil on top of and along the cliff (biosphere and geosphere).

Guiding Questions

AL	Which two Earth systems interact and form the clouds in the sky?	*The two systems are the hydrosphere and the atmosphere. Students might recall that clouds form when water from Earth's surface evaporates and then condenses in the atmosphere.*
OL	How do the waves from the hydrosphere interact with the cliffs from the geosphere?	*Possible answers: The waves will cause the rocks that make up the cliff to erode.*
BL	How does the storm interact with the biosphere?	*Possible answers: The rain will provide water for plants and other organisms. If the storm is severe, it might damage or destroy habitats.*

LAB Manager

All the labs for this lesson can be found in the *Acitivity Lab Handbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Prior Knowledge

Students might be familiar with many of the vocabulary terms in this lesson.

1. Make several sets of index cards. For each term, write just the definition on an index card. Then make another index card with just the term written on the card.
2. Group students in small groups. Set up stations around the room for each group.
3. At each station, arrange the cards with the terms in rows so that there is enough room above each card for the definition card.
4. Have students match the definition cards with each term.
5. Review the answers with students.

ExploreActivity

How do some Earth systems interact?

Prep: *10 min* **Class:** *20 min*

Purpose
To model erosion, an interaction between the hydrosphere, atmosphere, and geosphere.

Materials
plastic shoe box, newspaper, five cups of soil, 100 mL beaker, water, hairdryer, spray bottle

Before You Begin

- Place the materials in a central location. Open a bag of soil and place a cup nearby.
- Tell students to scoop around five cups of soil into their plastic containers.

Guide the Investigation

- For best results, set the hairdryer on low. Suggest that students experiment with the height and distance at which to hold the dryer to obtain a steady breeze across the model landform.
- ⚠ Students should wear their safety goggles during this activity. Blowing soil might get into eyes. Take care not to trip over the cord for the dryer or any extension cords you might use. Taping the cord to the floor may help prevent tripping. Keep water away from the dryer.

Think About This

1. The fan represented the atmosphere. The water in the spray bottle represented the hydrosphere. The soil represented the geosphere.
2. Sample answer: I could compact the soil or add vegetation to help prevent erosion. Or I could insert sticks to simulate trees or structures.
3. **Key Concept** The wind from the atmosphere blew the soil; the rain from the hydrosphere washed away some soil.

Teacher Notes

Academic Vocabulary

process
(noun) a natural phenomenon marked by gradual changes that lead toward a particular result

Weathering and Erosion

Rocks on Earth's surface are exposed to the atmosphere, the hydrosphere, and the biosphere. Glaciers, wind, and rain, along with the activities of some organisms, break down rocks into sediment. This **process** is called weathering. In **Figure 14**, weathering is shown in the mountains, where uplift has exposed rocks. Weathering of rocks into sediments is often accompanied by erosion. Erosion occurs when the sediments are carried by agents of erosion—water, wind, or glaciers—to new locations.

Deposition

Eventually, agents of erosion lose their energy and slow down or stop. When this occurs, eroded sediments are deposited, or laid down, in new places. Deposition forms layers of sediment. Over time, more and more layers are deposited.

Reading Check

1. How does compaction occur?

Compaction and Cementation

As more layers of sediment are deposited, their weight pushes down on underlying layers. The deeper layers are compacted. Minerals dissolved in surrounding water crystallize between grains of sediment and cement the sediments together. Compaction and cementation produce sedimentary rocks.

High Temperatures and Pressure

Metamorphic rocks form when rocks are subjected to high temperatures and pressure. This usually occurs far beneath Earth's surface. Igneous, sedimentary, and even metamorphic rocks can become new metamorphic rocks. Then, uplift can bring the rocks to the surface. There, the rocks are broken down and continue moving through the rock cycle.

Most interactions between the geosphere, the hydrosphere, and the atmosphere occur on Earth's surface. The atmosphere and hydrosphere alter rocks in the geosphere, and the geosphere in turn alters the other Earth systems. For example, energy from the Sun reaches Earth. The energy is reflected by Earth's surface and heats the atmosphere.

These are just a few examples of different interactions among Earth's systems. You have read about four different Earth systems in this chapter. But as **Figure 15** shows, the systems interact and function together as one unified system—planet Earth.

FOLDABLES

Key Concept Check

6. How do Earth systems interact in the rock cycle?

Figure 15 Earth is a unified system made of four interacting subsystems.

Weathering and Erosion, Deposition, Compaction and Cementation

Weathering occurs when rocks at Earth's surface are broken down into smaller pieces. Weathering is caused by water, ice, wind, and plants and animals. Erosion is the process of moving weathered rock from one location to another. Erosion is caused by water, glaciers, wind, and gravity. Deposition, compaction, and cementation are processes that continue the rock cycle and lead to the formation of sedimentary rock.

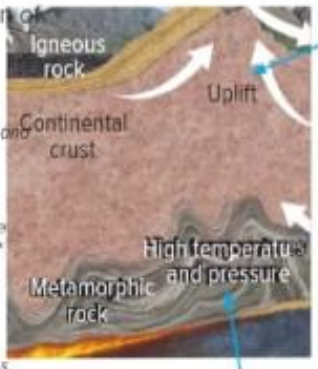
Guiding Questions

AL	What factors can cause weathering?	*The movement of glaciers (ice), wind, and water, and the activities of some organisms can cause weathering.*
	Reading Check How does compaction occur?	*Compaction occurs when more and more layers of sediment are deposited on top of existing layers. The deeper layers are compacted as the weight of the overlying sediment presses down.*
BL	How is weathering a part of the rock cycle?	*Weathering breaks down rocks and forms sediment, which in turn forms sedimentary rock.*
BL	Suppose you are able to look at a cross section of layers of sediment. Which layer was deposited first?	*The bottom layer was deposited first. More layers of sediment were deposited on top of the first layer.*

Academic Vocabulary

process

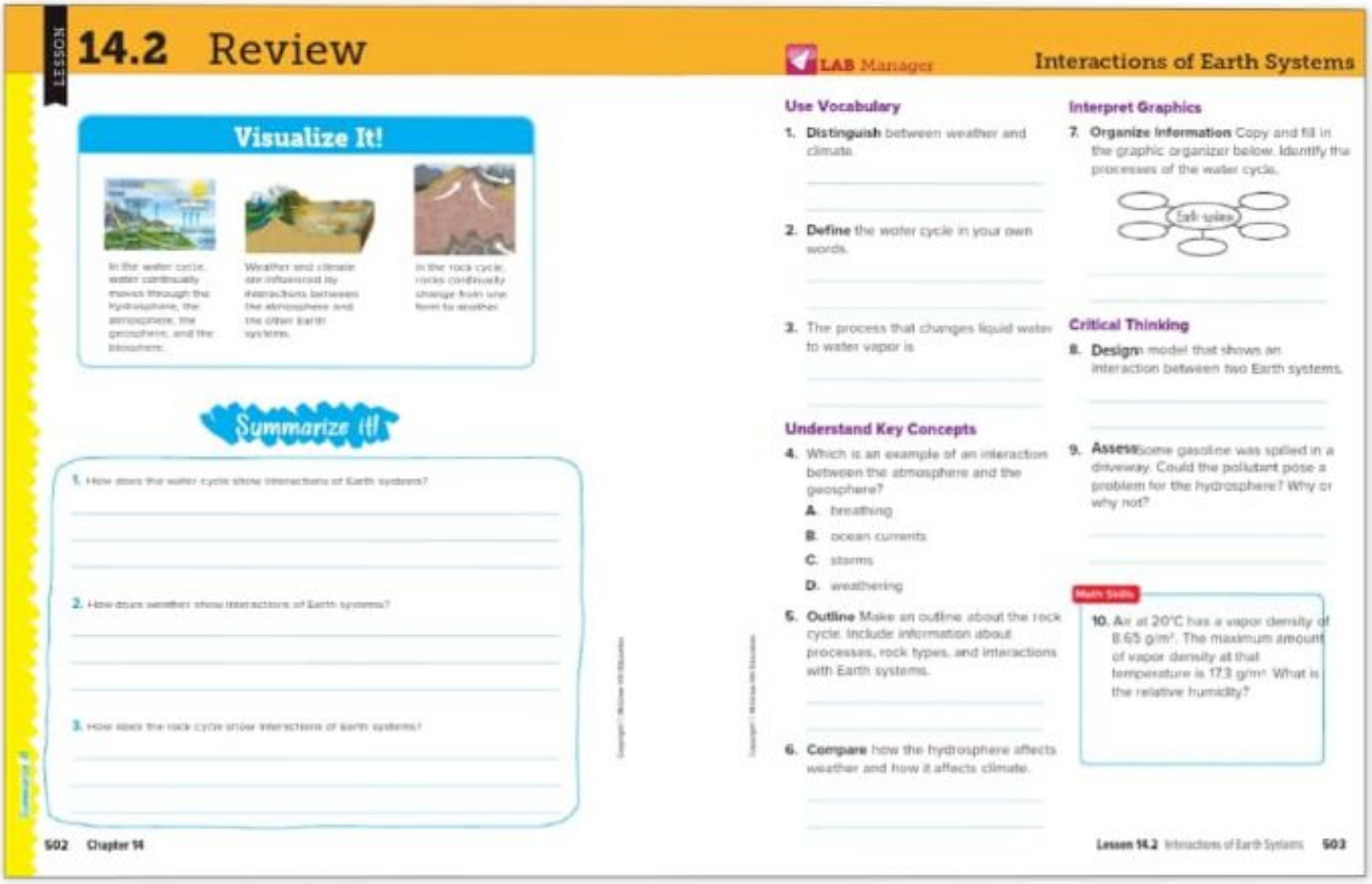
Students will likely be familiar with this term. **Ask: What are some other examples of processes that occur in Earth's systems?** *Possible answers: evaporation, condensation, transpiration, crystallization, or erosion*



Ask: How does metamorphic rock reach Earth's surface? *through the process of uplift*

Ask: How does metamorphic rock form? *Metamorphic rock forms when high temperatures and pressure act on and change sedimentary, igneous, or other metamorphic rocks.*

Ask: How do weathering and erosion change rocks? *Weathering breaks rocks into smaller pieces, and erosion moves the pieces from one location to another.*



LESSON 14.2 Review

Visualize It!

In the water cycle, water continually moves through the hydrosphere, the atmosphere, the geosphere, and the biosphere.

Weather and climate are influenced by interactions between the atmosphere and the other Earth systems.

In the rock cycle, rocks continually change from one form to another.

Summarize it!

1. How does the water cycle show interactions of Earth systems?

2. How does weather show interactions of Earth systems?

3. How does the rock cycle show interactions of Earth systems?

LAB Manager Interactions of Earth Systems

Use Vocabulary

1. **Distinguish** between weather and climate.

2. **Define** the water cycle in your own words.

3. The process that changes liquid water to water vapor is

Understand Key Concepts

4. Which is an example of an interaction between the atmosphere and the geosphere?
   A. breathing
   B. ocean currents
   C. storms
   D. weathering

5. **Outline** Make an outline about the rock cycle. Include information about processes, rock types, and interactions with Earth systems.

6. **Compare** how the hydrosphere affects weather and how it affects climate.

Interpret Graphics

7. **Organize Information** Copy and fill in the graphic organizer below. Identify the processes of the water cycle.

Earth system

Critical Thinking

8. **Design** model that shows an interaction between two Earth systems.

9. **Assess** Some gasoline was spilled in a driveway. Could the pollutant pose a problem for the hydrosphere? Why or why not?

Math Skills

10. Air at 20°C has a vapor density of 8.65 g/m³. The maximum amount of vapor density at that temperature is 17.3 g/m³. What is the relative humidity?

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Lesson 14.2 Interactions of Earth Systems 503

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: Which Key Concept does each image relate to?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- The Water Cycle
- Changes in the Atmosphere
- The Rock Cycle

Use Vocabulary

1. Weather is the state of the atmosphere at a particular time and place, and climate is the average weather over several decades.
2. Sample answer: The water cycle shows how water moves through different Earth systems.
3. evaporation

Understand Key Concepts

4. **D.** weathering
5. Outlines should include information about the processes of the rock cycle, the three main rock types, and interactions with Earth systems. Outline heads might be similar to those in the text.
6. The hydrosphere provides the water for cloud formation and precipitation. The hydrosphere can also affect air masses. Surface currents in the ocean transfer thermal energy, modifying the climates of coastal regions.

Interpret Graphics

7. In any order, the processes of the water cycle are evaporation, condensation, precipitation, transpiration, and respiration.

Critical Thinking

8. A model might be a terrarium that includes plants, soil, air, and water.
9. Sample answer: Yes, it could pose a problem if rain washed the gasoline into a nearby lake or river, or if the gasoline soaked into the ground and polluted groundwater.

Math Skills

10. RH = 8.65/17.3 = 0.50 × 100 = 50%

CHAPTER

14 Study Guide

The BIG Idea

Earth is a unified system that can be modeled by dividing it into four interacting subsystems: the biosphere, the atmosphere, the hydrosphere, and the geosphere.

Key Concepts Summary

14.1 Earth Systems

- Earth is made of the **biosphere**, the **atmosphere**, the **hydrosphere**, and the **geosphere**.
- The atmosphere has a layered structure that includes the troposphere, the stratosphere, the mesosphere, the thermosphere, and the exosphere. It is made of nitrogen, oxygen, and other gases.
- Water is found on Earth in oceans, lakes, rivers, and as ice and **groundwater**. Small amounts of water are also found within the atmosphere and the biosphere.
- The geosphere is made of soil, metal, and **rock**. It has a layered structure that includes the crust, the mantle, and the core.

14.2 Interactions of Earth Systems

- The **water cycle** shows how water moves between reservoirs of the hydrosphere, the atmosphere, the geosphere, and the biosphere.
- **Weather** and **climate** are influenced by transfers of water and energy among the atmosphere, the geosphere, and the hydrosphere.
- Rocks continually change form as they move through the **rock cycle**. Processes such as weathering and erosion are examples of interactions among Earth systems.

Vocabulary

biosphere
atmosphere
hydrosphere
groundwater
geosphere
mineral
rock

water cycle
evaporation
transpiration
condensation
precipitation
weather
climate
rock cycle
uplift

FOLDABLES

Chapter Project

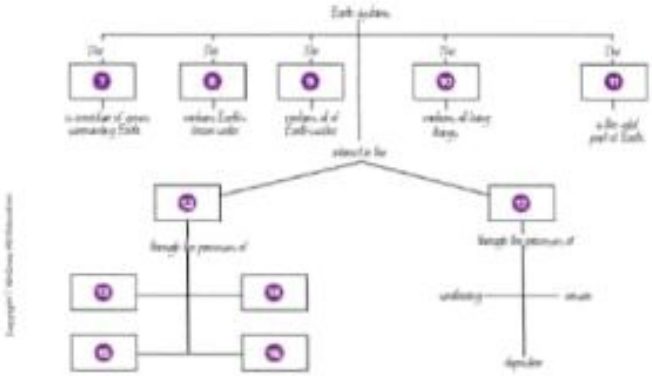
Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. The Earth system containing all living things is the _____.
2. Use the term mineral in a sentence.
3. Distinguish between rocks and minerals.
4. Conditions in the atmosphere at a given time and place are called _____.
5. Define the word uplift in your own words.
6. Distinguish between condensation and precipitation.

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.



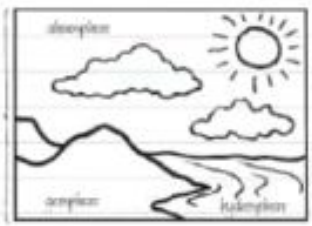
Key Concepts Summary

Study Strategy: Draw It

Students who are visual learners rather than verbal learners will benefit from using drawings to represent the meaning of key concept statements. Give visual learners in your class the following instructions.

1. Assign each student one of the sentences from the Key Concepts Summary.
2. Instruct students to draw a picture that represents the meaning of the sentence. Underneath the drawing, students should write the sentence.
3. Have students share their drawings with the class. If possible, make copies of all the student drawings and give them to students to use as a study guide.

Example:



Earth is made up of the biosphere, the atmosphere, the hydrosphere, and the geosphere.

Vocabulary

Study Strategy: Word Roots

Learning word roots will help students remember the meanings of difficult vocabulary terms. In addition, it will help students infer the meanings of other related terms. Give students the following instruct

1. Have students create a chart like the one below in their Science Journals.
2. Instruct students to use a dictionary to find the roots (also called etymology) of the chapter's vocabulary terms. Demonstrate to students where this information can be found in a dictionary entry
3. If time allows, have students find other English words that share common roots with the chapter's vocabulary terms.

Example:

Term	Word Part	Root
biosphere	bio	Greek bios, meaning 'life'
	sphere	Greek sphaira, meaning 'ball'
transpiration	trans	
	spira	
	tion	

FOLDABLES

Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class critique and discuss the way in which students have organized their Foldables®.

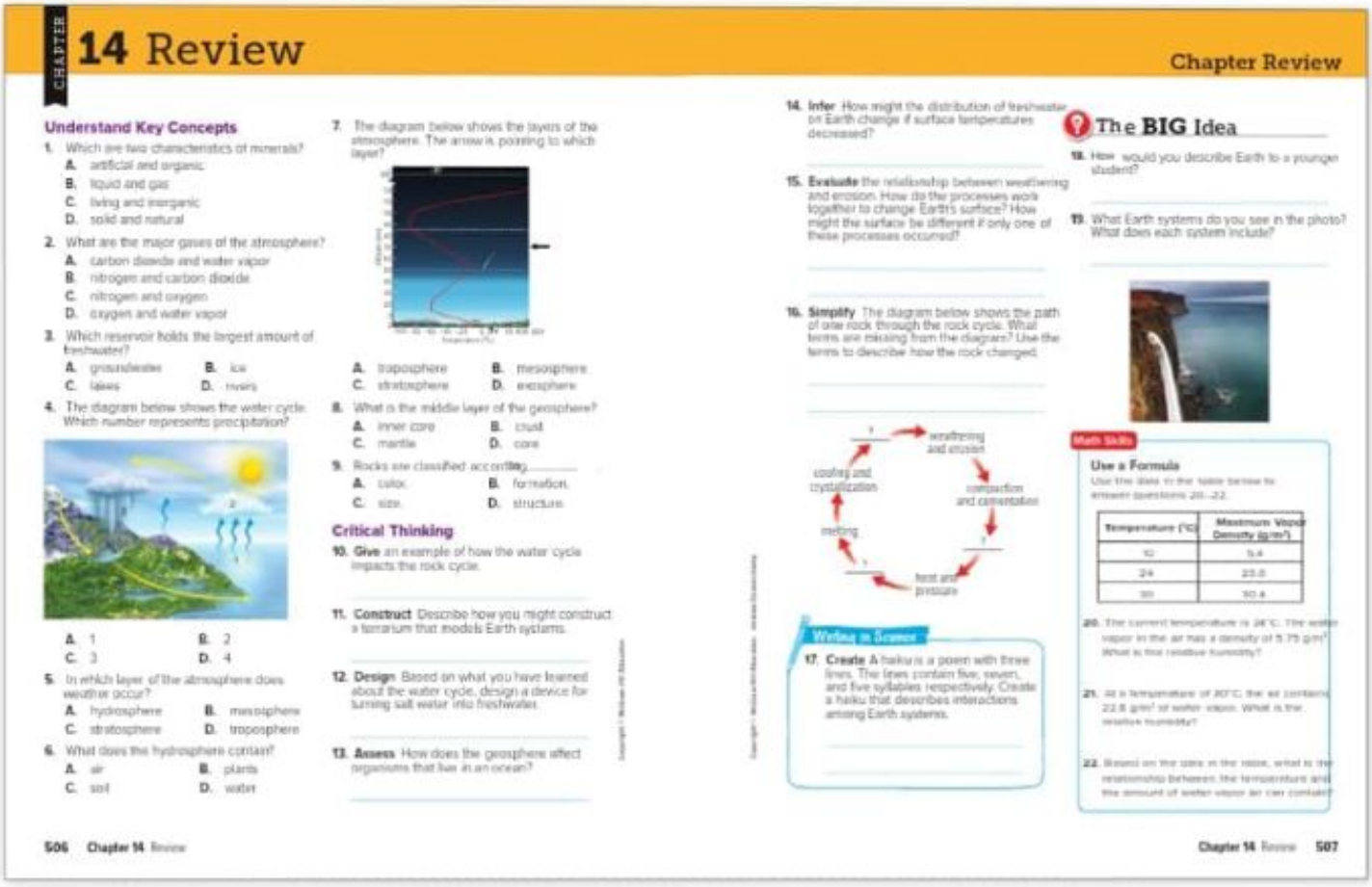
Use Vocabulary

1. Biosphere
2. Sample answer: Rocks are made of minerals.
3. Rocks are naturally occurring solids composed of minerals, rock fragments, and organic matter or glass. Minerals are naturally occurring, inorganic solids that have crystal structures and definite chemical compositions.
4. Weather
5. Sample answer: Uplift is the process that moves Earth materials to higher elevations.
6. Condensation occurs when a gas changes into a liquid. Precipitation occurs when water falls from clouds to Earth's surface.

Link Vocabulary and Key Concepts

7. Atmosphere
8. Hydrosphere
9. Biosphere
10. Geosphere
11. Water cycle
12 13 14 15 Evaporation/transpiration/ condensation/precipitation
16. Rock cycle

Teacher Notes



CHAPTER 14 Review

Chapter Review

Understand Key Concepts

1. Which are two characteristics of minerals?
   A. artificial and organic
   B. liquid and gas
   C. living and inorganic
   D. solid and natural
2. What are the major gases of the atmosphere?
   A. carbon dioxide and water vapor
   B. nitrogen and carbon dioxide
   C. nitrogen and oxygen
   D. oxygen and water vapor
3. Which reservoir holds the largest amount of freshwater?
   A. groundwater B. ice
   C. lakes D. rivers
4. The diagram below shows the water cycle. Which number represents precipitation?

   A. 1 B. 2
   C. 3 D. 4
5. In which layer of the atmosphere does weather occur?
   A. hydrosphere B. mesosphere
   C. stratosphere D. troposphere
6. What does the hydrosphere contain?
   A. air B. plants
   C. soil D. water
7. The diagram below shows the layers of the atmosphere. The arrow is pointing to which layer?

   A. troposphere B. mesosphere
   C. stratosphere D. exosphere
8. What is the middle layer of the geosphere?
   A. inner core B. crust
   C. mantle D. core
9. Rocks are classified according to _____.
   A. color B. formation
   C. size D. structure

Critical Thinking

10. **Give** an example of how the water cycle impacts the rock cycle.
11. **Construct** Describe how you might construct a terrarium that models Earth systems.
12. **Design** Based on what you have learned about the water cycle, design a device for turning salt water into freshwater.
13. **Assess** How does the geosphere affect organisms that live in an ocean?
14. **Infer** How might the distribution of freshwater on Earth change if surface temperatures decreased?
15. **Evaluate** the relationship between weathering and erosion. How do the processes work together to change Earth's surface? How might the surface be different if only one of these processes occurred?
16. **Simplify** The diagram below shows the path of one rock through the rock cycle. What terms are missing from the diagram? Use the terms to describe how the rock changed.

   weathering and erosion
   compaction and cementation
   heat and pressure
   melting
   cooling and crystallization

Writing in Science

17. **Create** A haiku is a poem with three lines. The lines contain five, seven, and five syllables respectively. Create a haiku that describes interactions among Earth systems.

The BIG Idea

18. How would you describe Earth to a younger student?
19. What Earth systems do you see in the photo? What does each system include?

Math Skills

Use a Formula

Use the data in the table below to answer questions 20–22.

Temperature (°C)	Maximum Vapor Density (g/m³)
10	9.4
24	23.0
30	30.4

20. The current temperature is 24°C. The water vapor in the air has a density of 5.75 g/m³. What is the relative humidity?
21. At a temperature of 30°C, the air contains 22.8 g/m³ of water vapor. What is the relative humidity?
22. Based on the data in the table, what is the relationship between the temperature and the amount of water vapor air can contain?

Understand Key Concepts

1 D. solid and natural
2 C. nitrogen and oxygen
3 B. ice
4 C. 3
5 D. troposphere
6 D. water
7 B. mesosphere
8 C. mantle
9 B. formation

Critical Thinking

10 Sample answer: The water cycle impacts the rock cycle through precipitation, which contributes to weathering and erosion.

11 The terrarium should include materials that represent each Earth system, such as rocks, soil, plants, water, air, and a cover to allow water to evaporate and condense, remaining within the terrarium. The rocks and soil would represent the geosphere, the plants would represent the biosphere, the water would represent the hydrosphere, and the air would represent the atmosphere. Students might include adding a heat/light source to represent the sun, which would contribute to evaporation of the water. They might include an animal to represent the biosphere and include respiration. Students might describe how the "systems" in their terrarium would interact. Interactions should be consistent with content presented in the chapter.

12 A device for turning salt water into freshwater could be based on evaporation and condensation. The set-up could include a pot of boiling salt water and a slanted lid with a trough on the low side for collecting the condensed freshwater.

13 Sample answer: Dissolved minerals from the geosphere make ocean water salty, which marine organisms need to survive.

14 Sample answer: Cooler temperature might increase the size of glaciers and ice caps, reducing the amount of freshwater in other reservoirs.

15 Sample answer: Weathering and erosion work together to break down rocks and carry sediment to new locations. Over time, they can carve canyons and valleys or wear away tall mountains. If only one of these processes occurred, rocks would not be broken down into smaller pieces or sediment would remain in one place if it was not eroded by wind, ice, or water.

16 The missing terms, clockwise starting at the top: igneous rock, sedimentary rock, and metamorphic rock. Sample answer: An igneous rock is weathered and eroded. The sediment undergoes compaction and cementation and forms a sedimentary rock. The sedimentary rock is subjected to heat and pressure and forms a metamorphic rock. The metamorphic rock melts, forming magma. The magma cools and crystallizes, forming an igneous rock.

Writing in Science

17 Haikus will vary, but should include the correct number of lines and syllables. They should also include information about interactions among Earth systems.

The BIG Idea

18 Sample answer: Earth is a large system divided into smaller, interacting systems that include air, water, living things, and rocks and soil.

19 The photograph shows Earth's atmosphere, hydrosphere and geosphere. Students might identify vegetation on the landmasses as part of the biosphere. The atmosphere includes air and water vapor that surround Earth. The hydrosphere includes all of Earth's water. The geosphere includes the solid part of Earth. And the biosphere includes all living things on Earth.

Math Skills

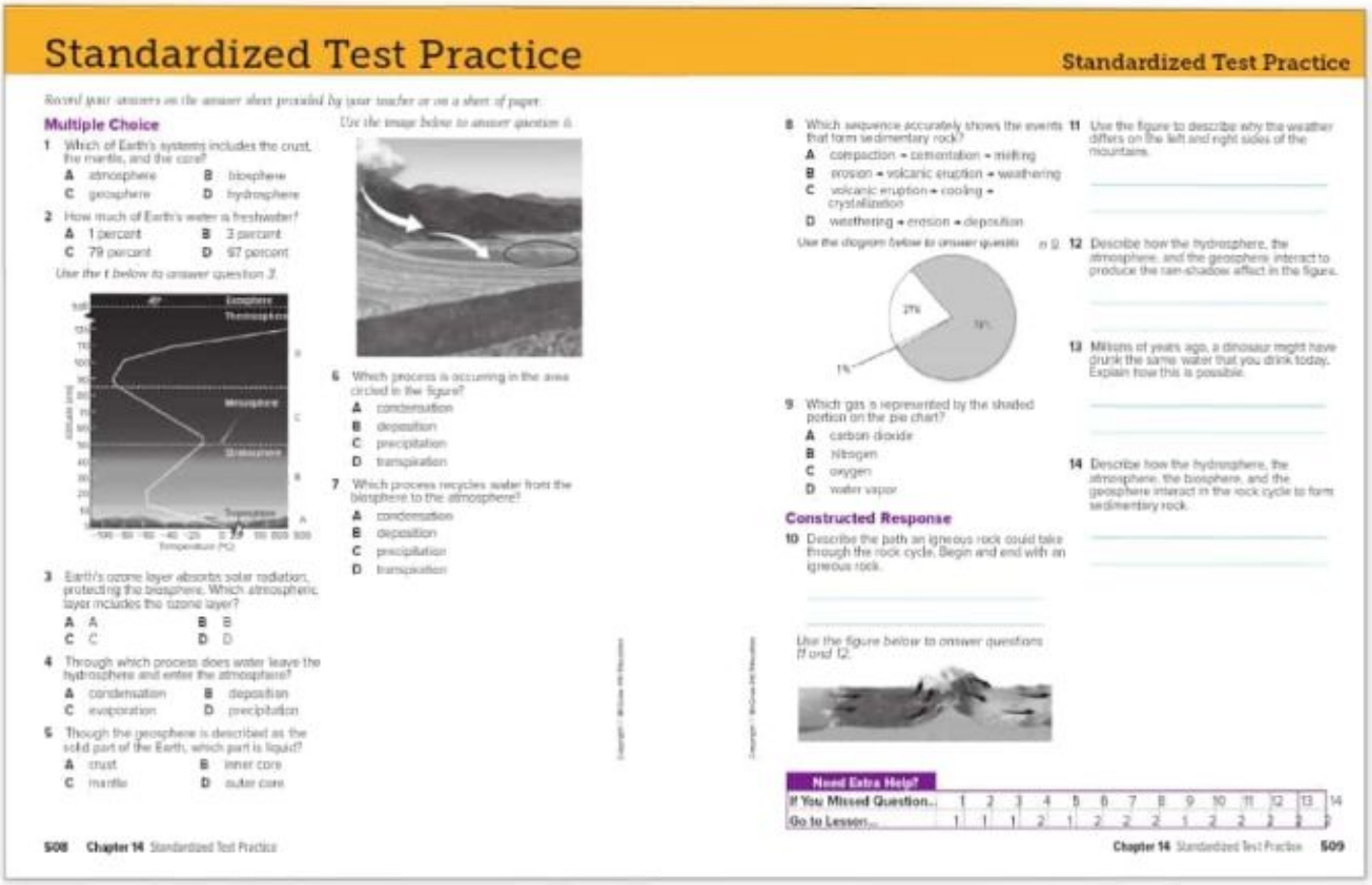
Use a Formula

20. $RH = \frac{5.75}{23.0} = 0.25 \times 100 = 25\%$

21. $RH = \frac{22.8}{30.4} = 0.75 \times 100 = 75\%$

22. The higher the temperature, the more water vapor the air can contain.

Teacher Notes



Standardized Test Practice

Standardized Test Practice

Record your answers on the answer sheet provided by your teacher or on a sheet of paper.

Multiple Choice

1 Which of Earth's systems includes the crust, the mantle, and the core?
A atmosphere B biosphere
C geosphere D hydrosphere

2 How much of Earth's water is freshwater?
A 1 percent B 3 percent
C 79 percent D 97 percent

Use the t below to answer question 3.

3 Earth's ozone layer absorbs solar radiation, protecting the biosphere. Which atmospheric layer includes the ozone layer?
A A B B
C C D D

4 Through which process does water leave the hydrosphere and enter the atmosphere?
A condensation B deposition
C evaporation D precipitation

5 Though the geosphere is described as the solid part of the Earth, which part is liquid?
A crust B inner core
C mantle D outer core

Use the image below to answer question 6.

6 Which process is occurring in the area circled in the figure?
A condensation
B deposition
C precipitation
D transpiration

7 Which process recycles water from the biosphere to the atmosphere?
A condensation
B deposition
C precipitation
D transpiration

8 Which sequence accurately shows the events that form sedimentary rock?
A compaction → cementation → melting
B erosion → volcanic eruption → weathering
C volcanic eruption → cooling → crystallization
D weathering → erosion → deposition

Use the diagram below to answer question 9.

9 Which gas is represented by the shaded portion on the pie chart?
A carbon dioxide
B nitrogen
C oxygen
D water vapor

Constructed Response

10 Describe the path an igneous rock could take through the rock cycle. Begin and end with an igneous rock.

Use the figure below to answer questions 11 and 12.

11 Use the figure to describe why the weather differs on the left and right sides of the mountains.

12 Describe how the hydrosphere, the atmosphere, and the geosphere interact to produce the rain-shadow effect in the figure.

13 Millions of years ago, a dinosaur might have drunk the same water that you drink today. Explain how this is possible.

14 Describe how the hydrosphere, the atmosphere, the biosphere, and the geosphere interact in the rock cycle to form sedimentary rock.

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	1	1	2	1	2	2	2	1	2	2	2	2	2

508 Chapter 14 Standardized Test Practice

Chapter 14 Standardized Test Practice 509

Multiple Choice

1 **C—Correct.** A, B, and D are Earth's other systems and do not include the crust, mantle, and core.

2 **B—Correct.** A is the amount of freshwater available on Earth's surface. C is the amount of freshwater in glaciers and ice caps. D is the amount of ocean salt water.

3 **B—Correct.** A, C, and D are atmospheric layers that do not contain a layer of ozone.

4 **C—Correct.** Water "leaves" the hydrosphere by evaporation, and the water vapor produced becomes part of the atmosphere. A, B, and D are other processes that occur within the hydrosphere and atmosphere.

5 **D—Correct.** A, B, and C are parts of the geosphere that are solid. The crust and inner core are solid. Rocks in the mantle flow because they are so hot, but they are considered a solid.

6 **B—Correct.** A, C, and D are not processes of the rock cycle and are not shown in the diagram.

7 **D—Correct.** A, B, and C are other processes in the water cycle and do not involve living things.

8 **D—Correct.** A and B are sequences that do not occur in nature. C describes a sequence that forms ignous rock.

9 **B—Correct.** A, C and D are gases that make up much less than 78 percent of Earth's atmosphere.

Constructed Response

10 An igneous rock is uplifted to Earth's surface, where it weathers and produces sediment. The sediment is compacted and cemented together, forming sedimentary rock. The sedimentary rock is subducted. Deep below Earth's surface, the sedimentary rock is subjected to high temperatures and pressure and forms a metamorphic rock. The metamorphic rock is subjected to higher temperatures and melts, forming magma. If the magma cools below Earth's surface, it will crystallize and form an igneous rock. If the molten rock erupts as lava, the lava will cool and crystallize at Earth's surface and form an igneous rock.

11 Moist air comes off the ocean and cools as it moves up over the coastal mountains. The cooled air drops precipitation on the left side of the mountains. The air, now dry, continues on to the right side of the mountains, causing a dry climate.

12 Water evaporates from the surface of the hydrosphere, adding moisture to the atmosphere. The air cools as it travels over the mountains of the geosphere. The moisture condenses, forming precipitation on the windward side of the mountain (geosphere). The dry air creates the rainshadow effect as it moves down the leeward side of the mountain.

13 The amount of water on Earth does not change but cycles continuously through the water cycle. Therefore, the water that was on Earth during times of the dinosaurs is the same water on Earth today.

14 Water and ice (hydrosphere and cryosphere), wind (atmosphere), and plants and animals (biosphere), break down rocks (geosphere) into sediment through weathering. Erosion occurs when water and ice (hydrosphere) and/or wind (atmosphere) carry sediment to new locations. Deposition forms layers of sediment. The weight of sediment layers compacts them. Minerals from surrounding water crystallize in the sediment and cement the layers together, producing new sedimentary rocks.

Answer Key

Question	Answer
1	C
2	B
3	B
4	C
5	D
6	B
7	D
8	D
9	B
10	See extended answer.
11	See extended answer.
12	See extended answer.
13	See extended answer.
14	See extended answer.

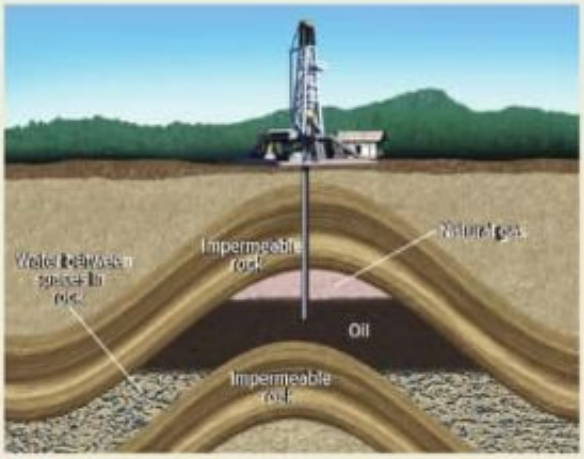
Science Content Background

Lesson 1

Energy Resources

Sources of Energy Energy is used for electricity, transportation, and a variety of other human needs. Energy sources can be nonrenewable or renewable. Nonrenewable resources are used faster than they can be replaced by natural processes within a human time scale. Renewable resources can be replaced in a relatively short amount of time.

Fossil Fuel Formation Coal, oil, and natural gas are nonrenewable energy resources called fossil fuels. Fossil fuels form underground, as heat and pressure change the chemical composition of the remains of prehistoric organisms. Oil and gas deposits are found in areas of folded rock, beneath impermeable rock layers.



Advantages and Disadvantages of Fossil Fuels Fossil fuels are easy to transport, relatively inexpensive to produce, and can be easily burned in power plants to make electricity. However, burning fossil fuels contributes to pollution and global warming.

Lesson 2

Renewable Energy Resources

Sun, Wind, and Water Renewable energy can be obtained from the Sun, wind, and moving water. Solar energy can be captured directly to heat water and homes, and converted to electricity by photovoltaic cells. Turbines can be turned by wind to generate electricity. Turbines also can be turned by moving water, such as rivers or tides, to generate hydroelectric power.

Geothermal and Biomass Energy Geothermal and biomass energy are used to heat homes and generate electricity. Geothermal energy is thermal energy from Earth's interior. Biomass energy is energy released by burning wood or other organic materials. Ethanol and biodiesel are examples of biomass fuels that are used to power vehicles.

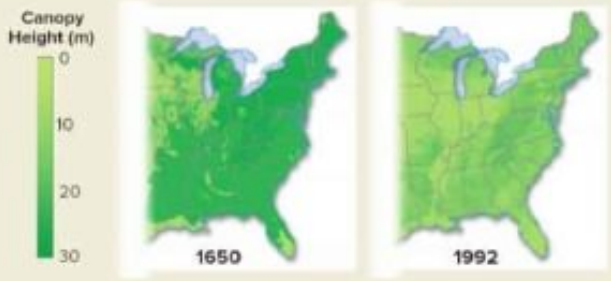
Advantages and Disadvantages of Renewable Resources Renewable resources can be used indefinitely. They also produce less pollution than fossil fuels. However, the use of renewable resources can be costly and is often limited to certain areas, so widespread use is difficult to achieve.

Lesson 3

Land Resources

Land as a Resource Land itself is a resource. It provides space for living, soil for growing crops and trees, and minerals for mining.

Forests and Agricultural Lands Resources from forests and agricultural lands are harvested to make products for people to use. Trees from forests provide fuel, paper products, and wood products. Crops from agricultural lands provide food or biomass energy. As populations grow, forests might be cut down to clear land for development and agriculture. In the past, forests in the eastern United States were cut down to make room for other land uses. Since the 1920s much of these forests have regrown, but the canopies have not yet reached the heights they had before cutting, nearly 100 years ago.



Mineral Resources Metallic and nonmetallic mineral resources are mined from the land. For example, the rock bauxite is mined to obtain aluminum. Quartz is mined for use in the manufacture of computer chips. Sand and gravel are mined and used for roads and construction materials.

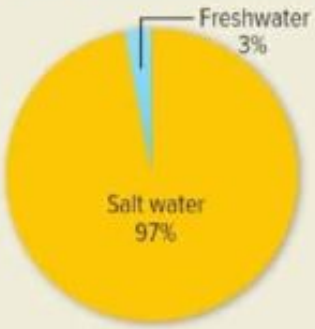
Managing Land Resources Crops and trees are renewable land resources. Minerals are considered nonrenewable. The misuse of land resources can cause deforestation and pollution. However, proper management of lands can protect habitats and still provide resources for people to use.

Lesson 4

Air and Water Resources

Water Supplies Earth's water is 97 percent salt water and only 3 percent freshwater. Of that 3 percent freshwater, only about 0.9 percent is available for human uses, such as electricity production, agriculture, industry, home use, and recreation.

Water Distribution on Earth



Importance of Air and Water Air and water are necessary for life. Polluted air and water can harm human health and the health of ecosystems. Compounds in the air can react and produce smog or acid precipitation. Smog can irritate respiratory systems. Acid precipitation can damage lakes and trees. Fertilizers, insecticides, and other chemicals can run off and pollute water. Developments in technology and stricter laws since 1972 have helped reduce air and water pollution.

Strand Map

Required Background Knowledge

To understand the Key Concepts of this chapter, students should have the following background knowledge:

*People need water, food, air, waste removal, and a particular range of temperatures in their environment, just as other animals do.

*Different ways of obtaining, transforming, and distributing energy have different environmental consequences.

*Some people try to reduce the amount of fuels they use in order to conserve resources, reduce pollution, or save money.

*People burn fuels such as wood, oil, coal, or natural gas or use electricity to cook their food and warm their houses.

* American Association for the Advancement of Science. (1993). Benchmarks for Science Literacy. New York: Oxford University Press.

Lesson 1
Energy Resources

1 Nonrenewable resources include fossil fuels and uranium, which is used for nuclear energy.

2 Nonrenewable energy resources are widely available and easy to convert to energy. However, using these resources can cause pollution and habitat disruption. Safety concerns also are an issue.

3 People can conserve energy to help manage these resources.

Lesson 2
Renewable Energy Resources

4 Renewable energy resources include solar energy, wind energy, water energy, geothermal energy, and biomass energy.

5 Renewable resources cause little or no pollution. However, some types of renewable energy are costly or limited to certain areas.

6 Individuals can help educate others about renewable resources.

Lesson 3
Land Resources

7 Land is considered a resource because it is used by living beings to meet their needs for food, shelter, and other things.

8 Some land resources are renewable, while others are not.

9 Individuals can recycle and compost to help conserve land resources.

Lesson 4
Air and Water Resources

10 Most living things cannot survive without clean air and water.

11 Individuals can make their homes and schools more energy efficient.

Identifying Misconception

Energy Transformations

Find Out What Students Think

Students may think that...

... power plants create energy. Students might not realize that power plants transform energy from one form to another. For example, a coal plant transforms the chemical energy stored in the coal to electric energy. A wind farm transforms the kinetic energy of the wind into electric energy. As the wind blows, it turns turbines that are connected to generators. Magnets in the generators spin, inducing an electric current.

Discussion

Ask: Where does electricity come from? Let students form small discussion groups. After a set time limit, have students present their answers and supporting evidence. If students simply state that electricity comes from power plants, ask them to describe how the power plants get the energy to produce electricity.

Promote Understanding

Activity Have students perform this activity to model how a generator transforms the energy of motion, called kinetic energy, into electric energy.

1. Form small student groups. Provide each group with a film canister, a spool of thin copper wire, a small LED light, transparent tape, and two strong magnets. Make sure one of the magnets can fit inside the film canister.
2. Show students how to make the model of a generator.
   - Wind the copper wire about 100 times around the circumference of the film canister.
   - Tape the wire onto the canister.
   - Make sure the two ends of the wire are sticking out, and attach them to the LED light.
   - Place one magnet inside the canister.
   - Wave the other magnet below the canister to make the magnet inside move.
   - As the inner magnet moves, the LED light should flicker on and off.
3. Have each group make and test a model generator.
4. **Ask:** How is energy being transformed in the model generator? **The kinetic energy from your hand that is moving the magnets is being converted to electric energy. As you move the magnets, the wires cross the magnetic field between the magnets. This induces an electric current that lights up the bulb.**
5. Tell students that generators are used to produce electricity in all types of power plants. **Ask:** How is energy transformed as water flows over a turbine and the turbine spins a generator in a hydroelectric power plant? **Kinetic energy from the water moves the turbine. The kinetic energy from the spinning turbine is transformed into electric energy within the generator.**

Energy Vampires

Find Out What Students Think

Students may think that...

... appliances do not use power when they are turned off. In fact, microwaves, televisions, and computers consume energy anytime they are plugged in, even if they are turned off. Appliances that remain on "standby," such as computers, televisions, and DVD players, drain the most power. On average, about 5 percent of all energy used in a household each year is lost in this way as "vampire energy."

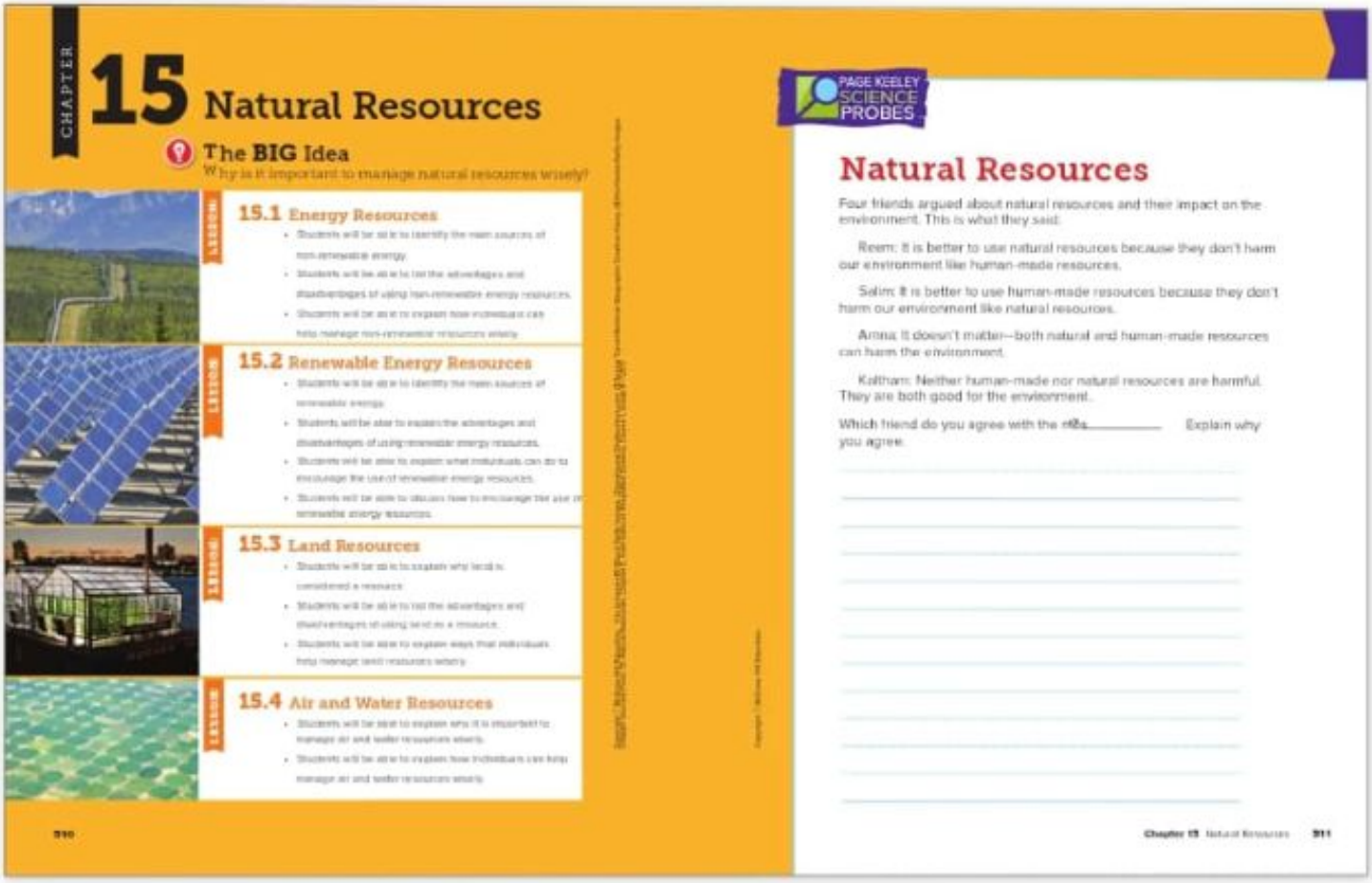
Discussion

Ask: What can you do at home to save electricity? Let students form small discussion groups. After a set time limit, have students present their answers and supporting evidence. Students are likely to mention turning out lights when they are not in a room or reducing their use of entertainment devices. Some students might know that unplugging computers, television sets, and other appliances can also save electricity. Plugging appliances into power strips, and then turning the power strips off, also can eliminate vampire energy.

Promote Understanding

Activity Have students perform this simple activity to investigate vampire energy.

1. Set up a television and DVD player at the front of the room.
2. Show students that you are plugging the TV and DVD player into an electrical outlet. Do not turn either one on.
3. **Ask:** Does anything happen to the TV or DVD player to show that they are consuming energy? **Both are likely to display standby lights. The DVD player might display a clock. Often, parts of the appliance even feel warm to the touch.**
4. Have a volunteer turn on the TV and the DVD using remote controls. Then have the volunteer switch the devices off.
5. Show students a power strip. Plug the TV and the DVD into the power strip, and turn the power strip off.
6. **Ask:** Do you see anything that shows that either device is consuming energy? **The devices should be off, with no standby lights or clocks displayed, so students should infer that the devices are no longer consuming energy.**
7. Have a volunteer try to turn on the TV and the DVD using remote controls. The devices should remain off.
8. **Ask:** How can a power strip help you save energy at home? **Power strips stop devices from using energy when they are turned off.**



Natu ral Resources

The BIG Idea

There a re no right or wrong answers to these questions. Write studentgenerated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

AL Name at least five natural resources you use every day.	*Answers will vary, but might include soil, water, air, land, solar energy, gasoline and other fuels, natural gas, coal, and certain metals, among others.*
OL Which resources could you live without?	*Again, answers will vary, but students should find—perhaps with some leading questions— that they need all of the natural resources they listed, either directly or indirectly.*
OL Which of the resources listed do you think are plentiful? Which do you think are limited?	*Some students likely will know that some resources, including many metals, water, and air, are relatively plentiful, but should be used wisely and recycled appropriately. Other resources, such as natural gas, oil, and coal, are limited, or nonrenewable.*
BL Why is it important to manage all resources wisely?	*Students should infer that even though some resources are plentiful, they are not necessarily evenly distributed over Earth and/or can be polluted and therefore become unusable.*

PAGE KEELEY SCIENCE PROBES

Natural Resources

Answers to the Page Keeley Science Probe can be found in the Teacher's Edition of the *Activity Lab Workbook*.

LESSON

15.1 Energy Resources

INQUIRY

What do these panels do? The Trans-Alaska Pipeline System carries oil more than 1,200 km from beneath Prudhoe Bay, Alaska, to the port city of Valdez, Alaska. How might the pipeline's construction and operation affect the habitats and the organisms living along it? How do getting and using fossil fuels impact the environment?

Write your response in your interactive notebook.

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Explore Activity

How do you use energy resources?

In the United States today, the energy used for most daily activities is easily available at the flip of a switch or the push of a button. How do you use energy in your daily activities?

1. Design a three-column data chart in your Science Journal. Title the columns *Activity*, *Type of Energy Used*, and *Amount of Time*.
2. Record every instance that you use energy during a 24 hr period.
3. Total your usage of the different forms of energy, and record them in your Science Journal.

Think About This

1. How many times did you use each type of energy?
2. Compare and contrast your usage with that of other members of your class.
3. Are there instances of energy use when you could have conserved energy? Explain how you would do it.

Learning Outcomes

- Students will be able to identify the main sources of non-renewable energy.
- Students will be able to list the advantages and disadvantages of using non-renewable energy resources.
- Students will be able to explain how individuals can help manage non-renewable resources wisely.

Vocabulary

nonrenewable resource
renewable resource
nuclear energy
reclamation

513

INQUIRY

About the Photo **What's in the pipeline?** There are three major types of pipelines—solid pipelines, liquid pipelines, and gas pipelines. The Trans-Alaska Pipeline System is a liquid pipeline that has used gravity, pressure, and pumps to move more than 15 billion barrels of oil from Prudhoe Bay to Valdez since 1977. Provide students with a map of Alaska and have them locate these two points. Then, before they read the caption, have students guess what they think might be transported through this pipeline. After they read the caption, have them answer both the Guiding Questions below and the questions posed in the caption.

Guiding Questions

AL How do you think oil moves through this 1,200-km system of pipes?	*Students should be able to infer that gravity, pressure, and pumps move the liquid through the pipeline.*
OL What is oil?	*Most students should know that oil is a fossil fuel. Some students might also know that oil, along with natural gas, formed millions of years ago from the remains of ancient organisms.*
BL Is oil a renewable or nonrenewable resource? Explain your answer.	*Because it takes millions of years to form, oil is considered a nonrenewable resource. In other words, it is being used faster than it can be replaced. Students will learn more about renewable and nonrenewable resources in this chapter.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Compare and Contrast

1. Write the words renewable and nonrenewable on chart paper or on the board. Align the terms so that the prefix non– is isolated from the rest of the word, as shown below.

   Nonrenewable

   renewable

2. **Ask: What does the prefix *non-* mean?** Non- *means "not, without, or the opposite of."* **If a renewable resource is one that can be replaced, what is a nonrenewable resource?** *A nonrenewable resource is one that cannot be replaced once it is used up.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

ExploreActivity

How do you use energy resources?

Prep: *1 min* **Class:** *20 min*

Purpose
To record personal energy use throughout a day, analyze the usage, and identify any instances where energy could have been conserved.

Before You Begin
Turn off the classroom lights and any other items using an energy source before students enter the room. If asked about the lack of lights, act as if everything is normal.

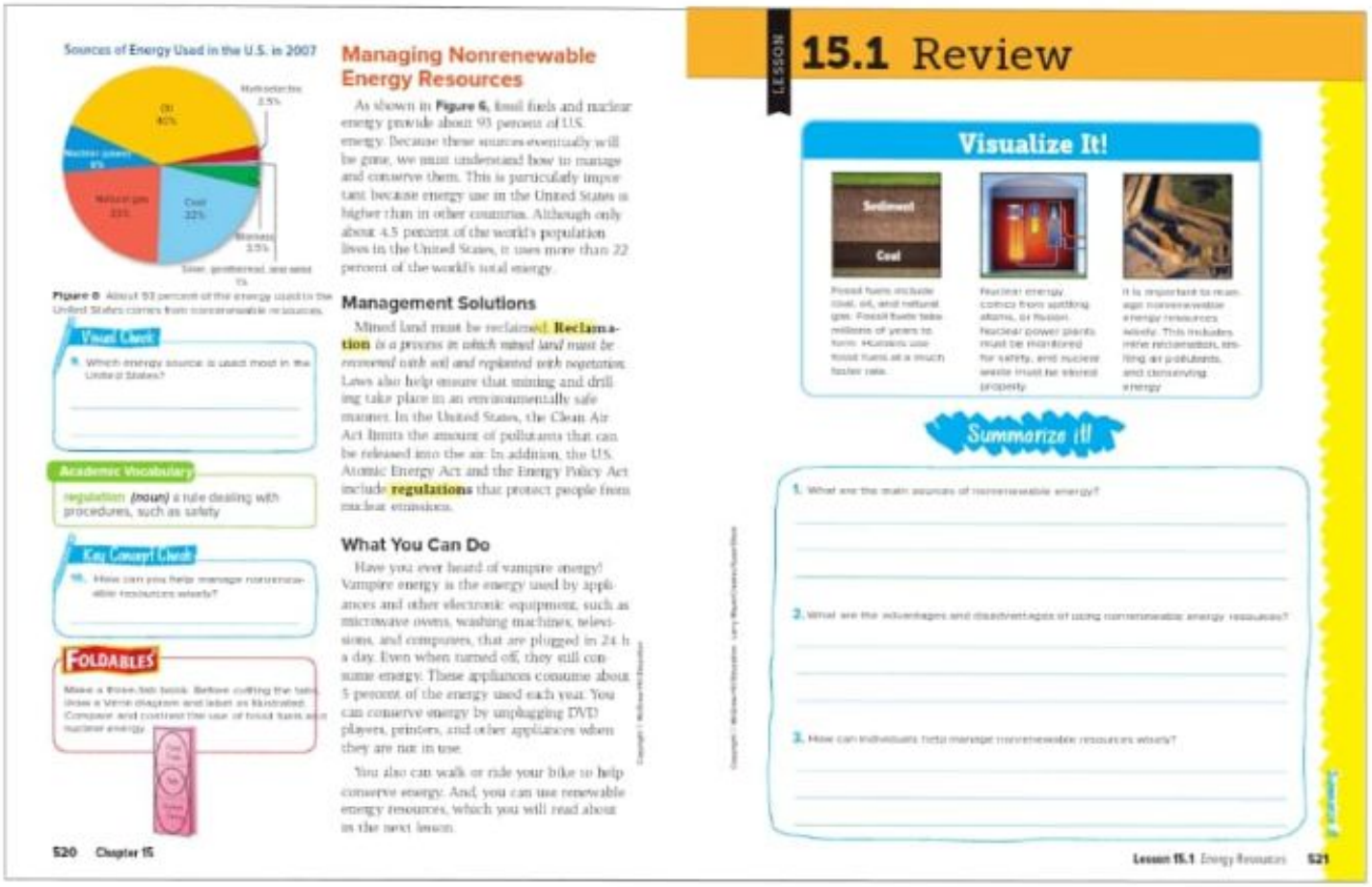
Guide the Investigation
Use the darkened, quiet room as a lead-in to a discussion of the use of electric energy. Then, explain what happens when a switch is flipped to its *On* position.

Think About This

1. Answers will vary, but should accurately reflect the data collected.
2. Sample answer: Some of us use more electric energy watching television than others do, but the amount of lighting used varies depending on household size and other factors.
3. Sample answers: I could have conserved fossil fuels by walking or riding my bike to school instead of being driven. I could have turned off lights that I was not using.

Extension
Have students make the same type of chart for another day when they are attempting to decrease their use of energy. Then compare the two charts.

Teacher Notes



Managing Nonrenewable Energy Resources

The graph in **Figure 6** shows that most of the energy used in the United States comes from nonrenewable resources. After students have read the page, ask the Guiding Questions and review the Academic Vocabulary below.

Guiding Questions

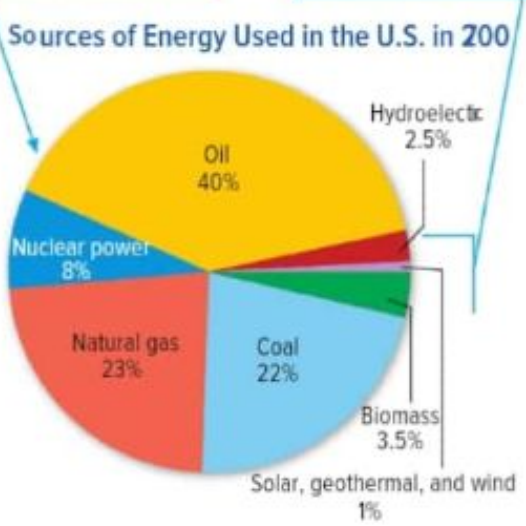
AL About how much energy do people in the United States use compared to people in other countries?	*People in the United States use 22 percent of the world's total energy output.*
Key Concept Check: How can you help manage nonrenewable resources wisely?	*Sample answer: I can conserve energy by walking or riding my bike to nearby places. I can turn off lights when they are not being used. I also can unplug some appliances when they are not being used.*
BL Why do you think the energy loss from appliances in the passive or standby mode is called vampire energy?	*In books and movies, vampires are creatures that drain people's blood to stay alive. Vampire energy is energy that is often unknowingly "drained" from electric outlets when appliances are not turned on or are not being used.*

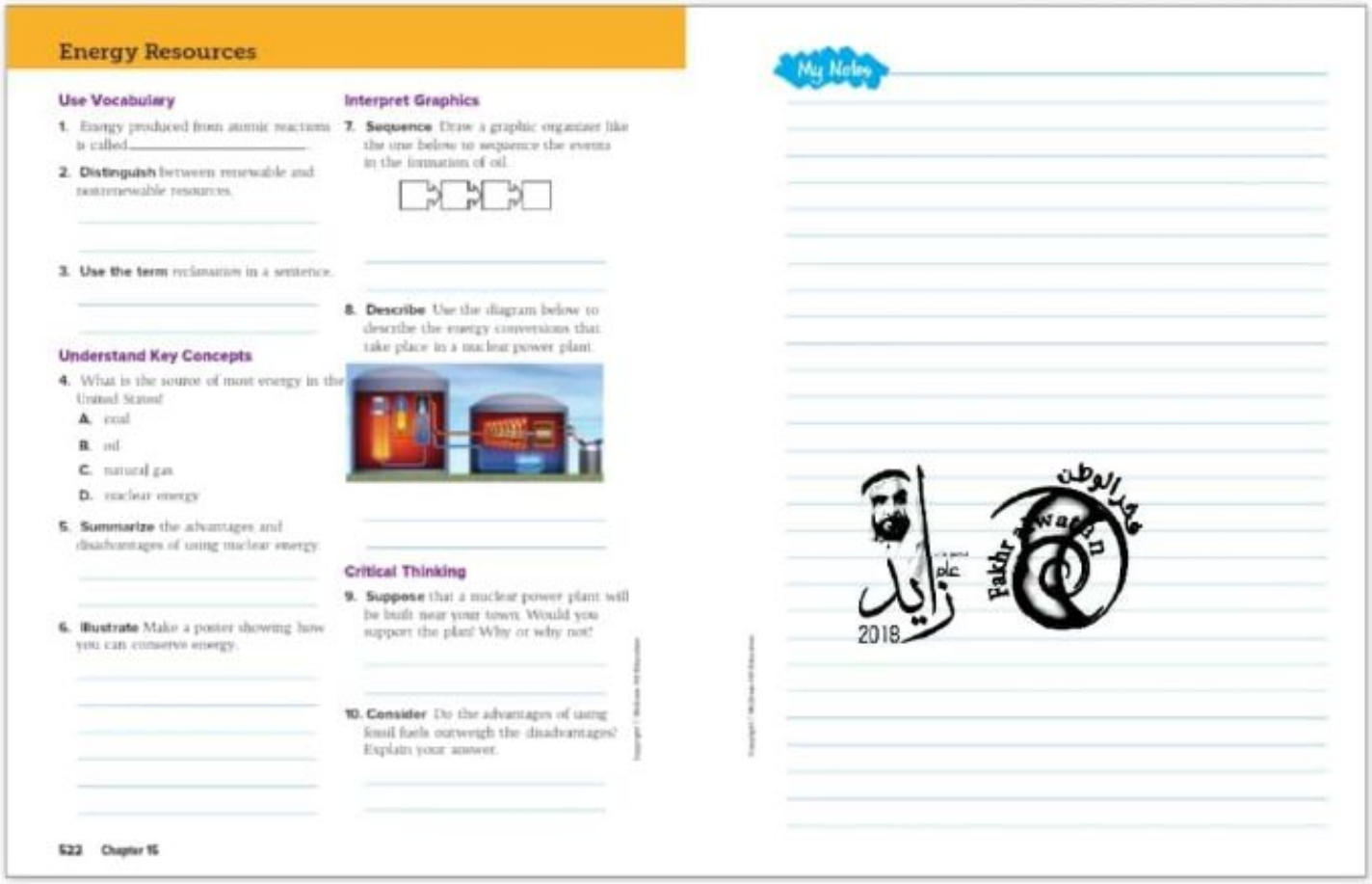
Visual Literacy: Figure 6

Ask a volunteer to add up the values in the circle graph. Then explain that each part of the graph is a percentage of the whole, or 100 percent. Then have students use the graph to answer the questions below.

Ask: Which energy source is used most in the United States? Visual Check Answer: *oil*

Ask: What percentage of the energy used in 2007 was provided by renewable resources? *7 percent*





Energy Resources

Use Vocabulary

1. Energy produced from atomic reactions is called _____.
2. **Distinguish** between renewable and nonrenewable resources.
3. **Use the term** reclamation in a sentence.

Understand Key Concepts

4. What is the source of most energy in the United States?
   A. coal
   B. oil
   C. natural gas
   D. nuclear energy
5. **Summarize** the advantages and disadvantages of using nuclear energy.
6. **Illustrate** Make a poster showing how you can conserve energy.

Interpret Graphics

7. **Sequence** Draw a graphic organizer like the one below to sequence the events in the formation of oil.
8. **Describe** Use the diagram below to describe the energy conversions that take place in a nuclear power plant.

Critical Thinking

9. **Suppose** that a nuclear power plant will be built near your town. Would you support the plant? Why or why not?
10. **Consider** Do the advantages of using fossil fuels outweigh the disadvantages? Explain your answer.

My Notes

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Use Vocabulary

1. Nuclear energy
2. Renewable resources can be replenished by natural processes in a relatively short amount of time. Nonrenewable resources are those that are being used up faster than they can be replaced by natural processes.
3. Sample answer: The process of reclamation has turned an old strip mine into an area covered with grass and trees.

Understand Key Concepts

4. **B.** oil
5. Advantages: usually nonpolluting, produces large amounts of energy from a relatively small amount of fuel. Disadvantages: uses a nonrenewable resource; has the potential for nuclear meltdown, produces toxic waste materials.
6. Posters will vary but should include energy conservation methods such as using renewable energy resources, riding a bike rather than driving, or turning off or unplugging appliances when not in use.

Interpret Graphics

7. Marine organisms die and fall to the ocean floor. The remains are buried by sediment. Bacteria decompose the organic matter. Heat and pressure compress the materials and change them to oil.
8. Energy from splitting atoms produces thermal energy. This energy heats water and forms steam. Steam converts the potential energy in the turbines to kinetic energy. The generator converts kinetic energy into electric.

Critical Thinking

9. Answers will vary. Students should give reasons for their support for or opposition to the plan.
10. Sample answer: I do not think the advantages outweigh the disadvantages. Burning fossil fuels pollutes the environment. Plus, fossil fuels are nonrenewable and will eventually run out, so we should decrease our dependence on them.

LESSON

15.2 Renewable Energy Resources

What do these panels do? These solar panels convert energy from the Sun into electrical energy. What are some of the advantages of using energy from the Sun? What are some of the disadvantages?

Write your response in your interactive notebook.

Explore Activity

How can renewable energy sources generate energy in your home?

Renewable energy technologies can contribute to reducing our dependence on fossil fuels.

1. Review the table below. It shows how much energy, in Watt-hours, it takes to run certain appliances.
2. In one hour, a typical bicycle generator generates 200 W-h of electric energy; a small solar panel generates 150 W-h; and small wind turbines typically generate 100 W-h. Complete the table by calculating the time it would take for each alternative form of energy to generate the electricity needed to run each appliance for 1 h.

Hint: Use the following equation to solve for the time used by each energy source:

$$\text{(Time used by energy source)} = \frac{\text{(Time to use appliance)} \times \text{(Energy used per hour by appliance)}}{\text{(Energy produced per hour by energy source)}}$$

Think About This

1. Which appliance required the longest energy-generating time from the alternative energy sources? Why?

2. What issues would you have to consider when using solar or wind energy to generate electricity in your home?

Appliance	Energy Used Per Hour	Time on (Hr.)	Time for Solar Panel	Time for Wind Turbine
Desktop computer	75 W-h			
Hair dryer	1000 W-h			
Television	200 W-h			

Learning Outcomes

- Students will be able to identify the main sources of renewable energy.
- Students will be able to explain the advantages and disadvantages of using renewable energy resources.
- Students will be able to explain what individuals can do to encourage the use of renewable energy resources.

Vocabulary

solar energy
wind farm
hydroelectric power
geothermal energy
biomass energy

525

INQUIRY

About the Photo **What do these panels do?** The more than 72,000 solar panels at Nellis Air Force Base comprise the largest solar voltaic system in America. The array, which contains nearly 6 million solar cells, is expected to supply more than 25 percent of the total power used by the 12,000 or so people who live on the base. Before students read the caption, ask the first Guided Question below. After students read the caption, ask the remaining questions.

Guiding Questions

AL	What do you think these panels do?	*Most students likely will recognize the panels as being solar panels that collect energy from the Sun and change it into electricity.*
OL	What are some of the advantages and disadvantages of using energy from the Sun?	*Advantages include its availability and the fact that it does not pollute. Disadvantages include that less energy is produced on cloudy days and none is produced at night; solar cells are expensive compared to other energy sources; and solar panels must be large to produce large amounts of energy.*
BL	Point out Nellis Air Force base on a physio-graphic map of the United States. Why do you think the Air Force chose this particular base for the solar array?	*The base, which is near Las Vegas, Nevada, is located in a sunny desert. Deserts are regions that usually have many hours of sunshine almost every day of every month.*

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Recognize Word Parts

Have students examine the terms *hydroelecvgtric, geothermal,* and *biomass* for any familiar word parts. *Students most likely will recognize* hydro-, geo-, therm-, and bio-. **Ask: Based on their word parts, what do you think the terms *hydroelectric, geothermal,* and *biomass* mean?** *Sample answers:* Hydro- *means water;* hydroelectric *refers to power generated using water.* Geo- *means earth and* therm- *refers to heat.* Geothermal *means heat from Earth.* Bio- *refers to life;* biomass *is organic material.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

ExploreActivity

How can renewable energy sources generate energy in your home?

Prep: *5 min* **Class:** *20 min*

Purpose
To calculate the time it would take for renewable sources of energy to generate enough electricity to run various household appliances for one hour.

Before You Begin
As a class, discuss the pros and cons of generating electricity using an electricitygenerating bicycle, a solar panel, and a wind turbine.

Guide the Investigation
Allow students to use their calculators, if necessary, for this activity. To calculate the time from each type of energy, refer to the following sample:

For Television

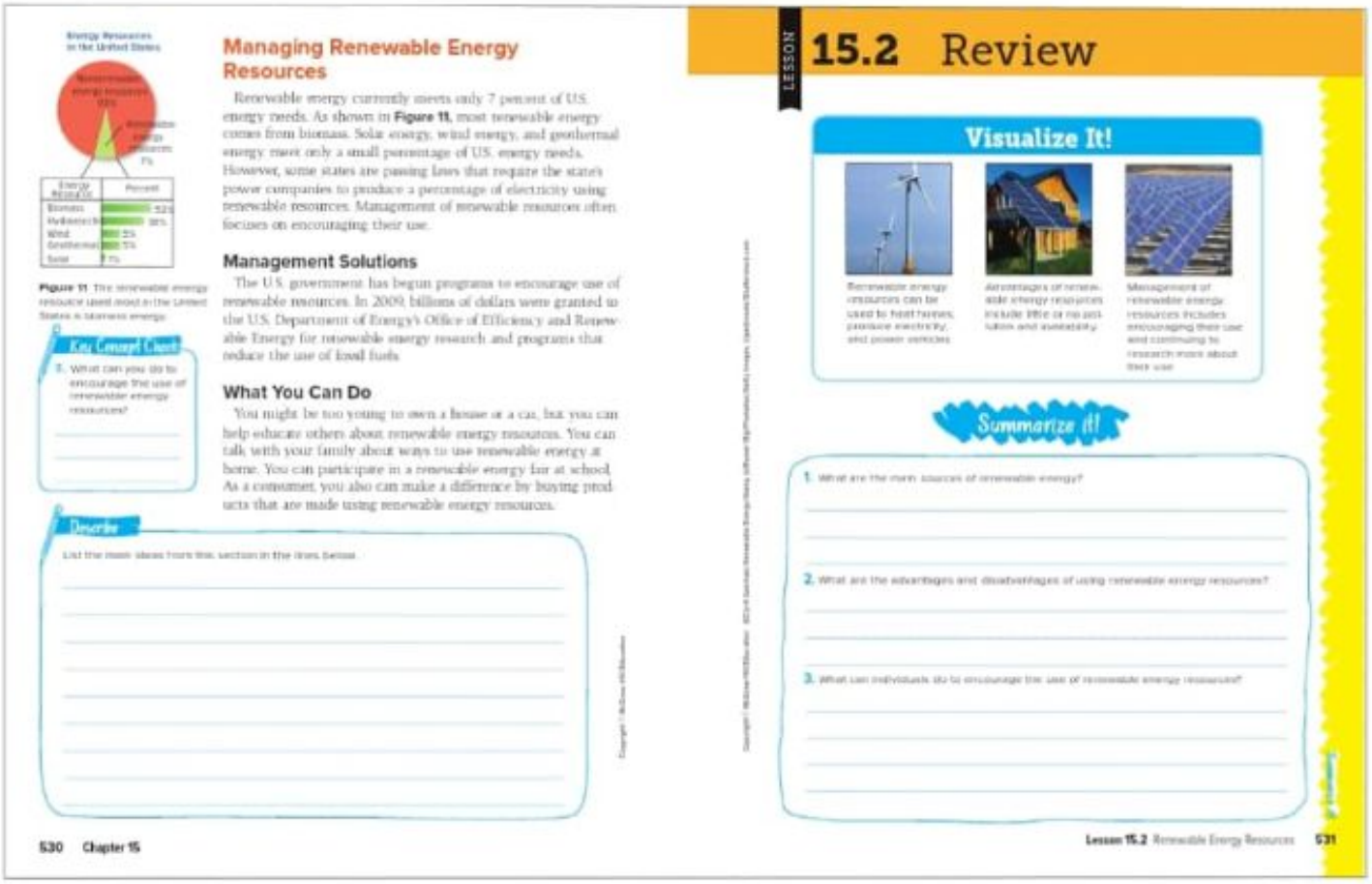
- Time on bike = 200 W-h × 1 h/200 W × 1 h = 1 h
- Time from solar panel = 200 W-h × 1 h/150 W × 1 h= 1 h 20 min
- Time from wind turbine = 200 W-h × 1 h/100 W × 1 h = 2 h

Appliance	Energy Used Per Hour	Time on Bike	Time for Solar Pane	Time for Wind Turbine
Desktop computer	75 W-h	**0.38 h = 22.5 min**	**0.5 h = 30 min**	**0.75 h = 45 min**
Hair dryer	1000 W-h	**5 h**	**6.67 h = 6 h 40 min**	**10 h**
Television	200 W-h	**1 h**	**1.33 h = 1 hr 20 min**	**2 h**

Think About This

1. The hairdryer took the longest energy-generating time from the renewable resources, because it needs the highest wattage per hour.
2. **Key Concept** You would have to determine whether the amount of sunlight or wind available in your geographic area would generate enough energy for a partial or a full-house system.

Teacher Notes



Managing Renewable Energy Resources

Renewable energy currently meets only 7 percent of U.S. energy needs. As shown in **Figure 11**, most renewable energy comes from biomass. Solar energy, wind energy, and geothermal energy meet only a small percentage of U.S. energy needs. However, some states are passing laws that require the state's power companies to produce a percentage of electricity using renewable resources. Management of renewable resources often focuses on encouraging their use.

Management Solutions

The U.S. government has begun programs to encourage use of renewable resources. In 2009, billions of dollars were granted to the U.S. Department of Energy's Office of Efficiency and Renewable Energy for renewable energy research and programs that reduce the use of fossil fuels.

What You Can Do

You might be too young to own a house or a car, but you can help educate others about renewable energy resources. You can talk with your family about ways to use renewable energy at home. You can participate in a renewable energy fair at school. As a consumer, you also can make a difference by buying products that are made using renewable energy resources.

Key Concept Check

1. What can you do to encourage the use of renewable energy resources?

Describe

List the main ideas from this section in the lines below.

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LESSON 15.2 Review

Visualize It!

Summarize it!

1. What are the main sources of renewable energy?

2. What are the advantages and disadvantages of using renewable energy resources?

3. What can individuals do to encourage the use of renewable energy resources?

Lesson 15.2 Renewable Energy Resources 531

Managing Renewable Energy Resources

Managing both renewable and nonrenewable resources is the responsibility of both the government and its citizens. Use the scaffolded questions below to informally assess students' comprehension of this concept.

Guiding Questions

AL **Use Figure 11 to identify which renewable resource provides most of the energy in the United States.**	*Biomass provides more than half—53 percent— of the energy generated with renewable resources in the United States.*
OL **Name several solutions to managing renewable resources.**	*Government programs and personal choices can help manage these important earth materials.*
Key Concept Check: What can you do to encourage the use of renewable energy resources?	*Sample answer: I can educate others and choose to buy products that were made using renewable energy resources.*

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: To which Key Concept does each image relate?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Renewable Energy Resources
- Advantages and Disadvantages of Renewable Resources
- Managing Renewable Energy Resources

Renewable Energy Resources

LAB Manager

Use Vocabulary

1. **Define** hydroelectric power in your own words.

2. Burning wood is an example of _____ energy.

Understand Key Concepts

3. Which can reduce the amount of organic material discarded in landfills?
   A. biomass energy C. water energy
   B. solar energy D. wind energy

4. **Compare and contrast** solar energy and wind energy.

5. **Determine** Your family wants to use renewable energy to heat your home. Which renewable energy resource is best suited to your area? Explain your answer.

Interpret Graphics

6. **Organize** Copy and fill in the graphic organizer below. In each oval, list a type of renewable energy resource.

7. **Compare** the use of renewable resources and nonrenewable resources in the production of electricity in the United States, based on the table below.

Sources of Electricity Generation, 2007

Energy Source	Percent
Fossil fuels	72.3
Nuclear power	19.4
Hydroelectric	6.8
Solar, wind, geothermal, biomass	2.5

Critical Thinking

8. **Design** and explain a model that shows how a renewable resource produces energy.

My Notes

Use Vocabulary

1. Sample answer: Hydroelectric power generates electricity from flowing water.
2. Biomass

Understand Key Concepts

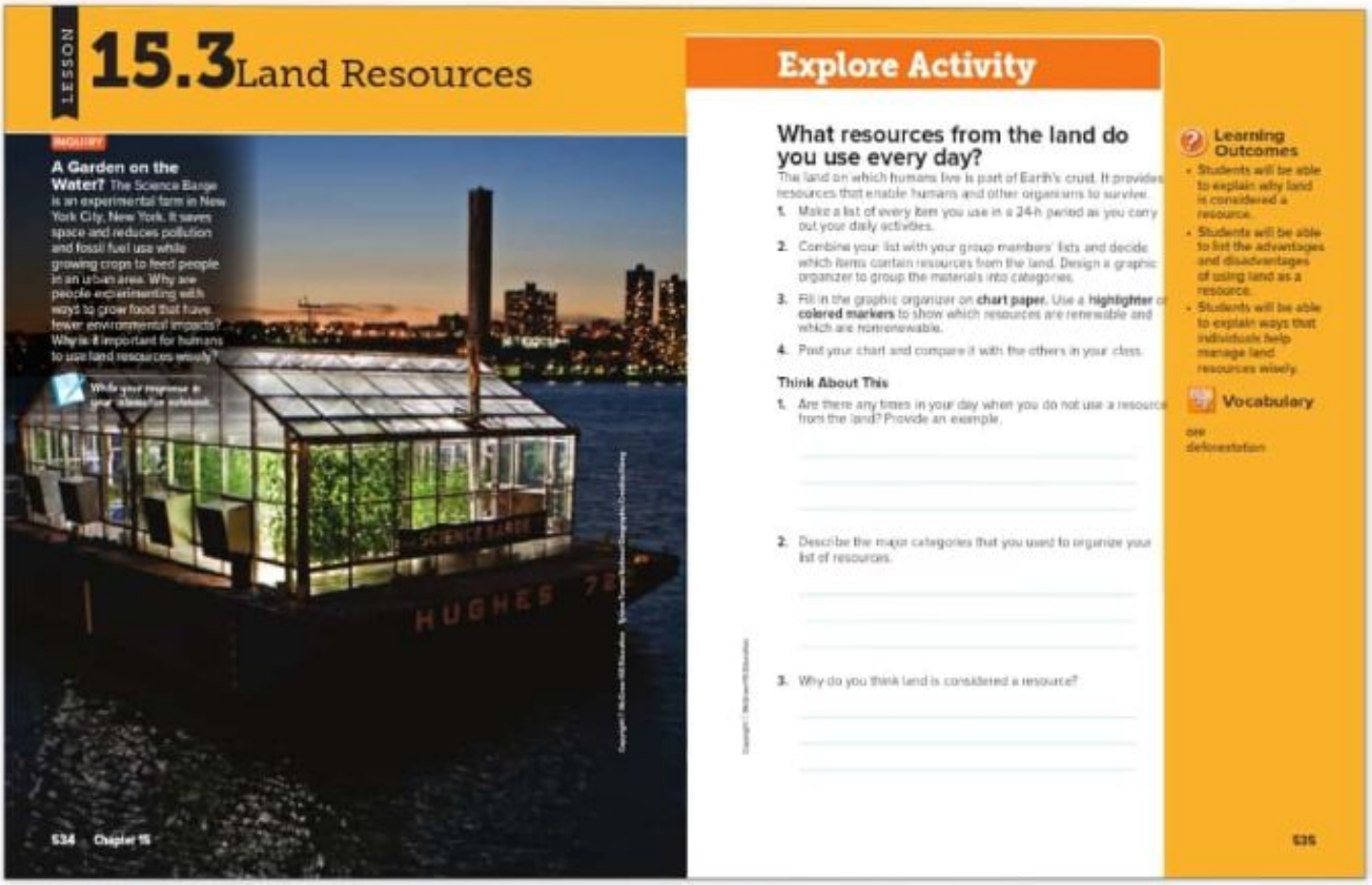
3. **A.** biomass energy
4. Both are renewable energy resources. Solar energy comes from the Sun and is nonpolluting. Wind energy comes from wind and is nonpolluting but could have a negative impact on bird populations.
5. Sample answer: We live in a place that gets strong, steady winds, so wind energy would be best suited to provide our energy needs.

Interpret Graphics

6. Each oval should include one of the following: solar energy, wind energy, water energy (or hydroelectric power), geothermal energy, or biomass energy.
7. Sample answer: About 8.3 percent of electricity generated in the United States in 2007 came from renewable energy resources (hydroelectric, solar, wind, geothermal, and biomass). About 91.7 percent came from nonrenewable energy resources (fossil fuels and nuclear power).

Critical Thinking

8. Designs will vary. Students might suggest a model dam with gates to show how the energy of flowing water can move objects in its path. Accept all reasonable designs and explanations.



LESSON

15.3 Land Resources

INQUIRY

A Garden on the Water? The Science Barge is an experimental farm in New York City, New York. It saves space and reduces pollution and fossil fuel use while growing crops to feed people in an urban area. Why are people experimenting with ways to grow food that have fewer environmental impacts? Why is it important for humans to use land resources wisely?

While you response in your Science notebook.

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Explore Activity

What resources from the land do you use every day?

The land on which humans live is part of Earth's crust. It provides resources that enable humans and other organisms to survive.

1. Make a list of every item you use in a 24-h period as you carry out your daily activities.
2. Combine your list with your group members' lists and decide which items contain resources from the land. Design a graphic organizer to group the materials into categories.
3. Fill in the graphic organizer on **chart paper.** Use a **highlighter** or **colored markers** to show which resources are renewable and which are nonrenewable.
4. Post your chart and compare it with the others in your class.

Think About This

1. Are there any times in your day when you do not use a resource from the land? Provide an example.

2. Describe the major categories that you used to organize your list of resources.

3. Why do you think land is considered a resource?

Learning Outcomes

- Students will be able to explain why land is considered a resource.
- Students will be able to list the advantages and disadvantages of using land as a resource.
- Students will be able to explain ways that individuals help manage land resources wisely.

Vocabulary

ore
deforestation

535

INQUIRY

About the Photo **A Garden on the Water?** The Science Barge is a sustainable hydroponic farm overseen by engineers and scientists. Solar energy, wind, and biomass supply the energy needed to run the farm, and the plants are irrigated with precipitation or recycled river water. Hydroponically grown plants do not require soil. After students have read the caption, ask the questions below. Then use the questions on the student page to begin your discussion of land resources and how they are used.

Guiding Questions

AL	How is this urban farm different from most other farms?	*This urban farm is much smaller, portable, and does not use land—it is located on a barge.*
OL	Inform students that the Science Barge grows plants without soil. Where do you think the plants get the nutrients they need?	*The plants get the nutrients they need from minerals that are dissolved in the water used to irrigate the plants.*
BL	What do you think are some advantages of growing crops in this type of environment?	*This type of environment uses renewable resources to sustain itself; it uses fewer resources to grow plants than traditional farms do; and because it is enclosed, such a farm doesn't need pesticides. Some students might also be able to infer that this farm generates few, if any, carbon dioxide emissions.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Working with Suffixes and Prefixes

Review the definition of a suffix and a prefix. Have students study the term *deforestation* and identify its prefix *(de–)* and its suffix *(–tion)*. Tell students that the prefix *de–* means "opposite" and the suffix *–tion* means "the process of." Have students use this information to define *deforestation*. *Deforestation is the process of removing large numbers of trees, or forests.* Tell students to look for other words containing suffixes and prefixes in this lesson.

ExploreActivity

What resources from the land do you use every day?

Prep: *5 min* **Class:** *20 min*

Purpose
To collect and organize evidence that illustrates how land is a source of supply and support for humans.

Materials
Student: chart paper, colored markers

Before You Begin
Review the definitions of renewable and nonrenewable resources. See **Lesson 1, Sources of Energy.**

Guide the Investigation
Display skeletons of various types of graphic organizers for students to use as references to help them design their own.

Think About This

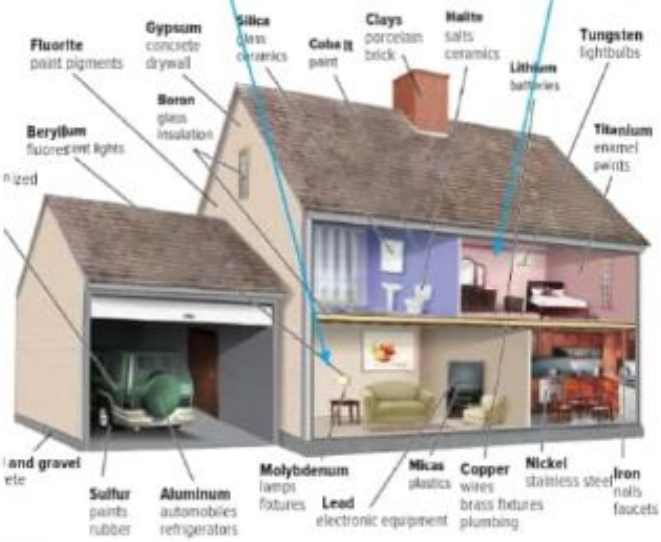
1. The answer likely will be "No." Students may recognize food, paper, or other materials as land resources, but they may not yet recognize that land itself is a resource. Even walking to school uses land as a resource—sidewalks, roads, and buildings take up space on the land.
2. Answers will vary. Sample answer: We organized our resources into the following categories: Wood, Metal, Plastic, Fossil Fuel, and Food.
3. **Key Concept** Answers will vary but should include the idea that land is a supports and supplies materials for all living things, including humans.

Teacher Notes

Visual Literacy: Mineral Resources

Have students use **Figure 14** to answer the question below.

Ask: **What mineral resources are used in lighting?** *tungsten and beryllium*



Ask: **Identify two products made from nonmetallic mineral resources.**
Visual Check Answers: *Accept answers that list any products made from nonmetallic mineral resources, including fluorite, gypsum, silica, clays, halite, sand and gravel, sulfur, and mica.*

Advantages and Disadvantages of Using Land Resources

Deforestation

Like all of Earth's resources, land use has its advantages and disadvantages. Deforestation is one negative effect of improper land use. After students have finished this page, have them make the Foldable suggested to summarize what they have learned.

Guiding Questions

AL What is deforestation?	*Deforestation is the cutting down of large areas of forests.*
OL What are some of the effects of deforestation?	*Deforestation increases soil erosion and destroys habitats. Deforestation also can affect global climates by allowing the amount of carbon dioxide in the air to accumulate. Increasing carbon dioxide in the air can cause Earth's surface temperature to rise.*
BL What are some other effects of deforestation that are not listed here?	*Deforestation disrupts Earth's water cycle and causes both flooding and drought in the affected areas. Removing large numbers of trees can cause the expansion of deserts and increase the likelihood of landslides on hill slopes.*
BL What are some other ways in which using land as a resource pollutes our planet?	*Answers will vary. Sample answers: Some deforestation is accomplished by burning. Burning large amounts of vegetation pollutes the air. Chemicals in runoff can harm the organisms living on nearby land or in nearby bodies of water.*

Differentiated Instruction

AL **Deforestation** Have small groups of students write and perform skits that demonstrate some of the effects of deforestation— soil is easily eroded, habitats are lost, and the climate warms. Suggest that one student describe what is happening as others in the group pantomime the effects.

AL **Take Action** Have a small group of students write and perform a short skit to try to convince another small group of students—a local business group—to preserve a tract of forested land that is earmarked to become a large mall or shopping center. Encourage both groups to present and defend their arguments constructively. Have the two groups come to an acceptable compromise in which both groups benefit.

Teacher Toolbox

Activity

Conserving Our Land Resources Have students brainstorm to come up with a small land conservation project that your class could complete after school or over a weekend. The project can be as simple as cleaning up a grassy area near the school or planting flowers or evergreen vegetation in pots to place around the school grounds. Have students obtain permission to participate and arrange to carry out the activity. Ask a local nursery to donate any needed materials and equipment. **Note:** If it is not feasible to carry out this activity, have students identify possible areas and draw before and after pictures of the sites.

Land Resources

Use Vocabulary

1. Cutting down forests for human activities is called _____.
2. **Use the word** ore in a sentence.

Understand Key Concepts

3. One disadvantage of using metallic mineral resources is that these resources are
   - **A.** easy to mine.
   - **B.** inexpensive.
   - **C.** nonrenewable.
   - **D.** renewable.
4. **Give an example** of how people use land as a resource.
5. **Compare** the methods used by governments and individuals to manage land resources wisely.

Interpret Graphics

6. **Take Notes** Copy the graphic organizer below, and list at least two land resources mentioned in this lesson. Describe how using each affects the environment.

Land Resource	How Use Affects Environment

7. **Identify** whether the mineral resources shown here are metallic or nonmetallic.

Critical Thinking

8. **Design** a way to manage land resources wisely. Use a method that is not discussed in this lesson.
9. **Decide** Land is a limited resource. There often is pressure to develop preserved land. Do you think this should happen? Why or why not?

My Notes

Use Vocabulary

1. Deforestation
2. Sample answer: Aluminum comes from a mineral ore called bauxite.

Understand Key Concepts

3. **C.** nonrenewable
4. Sample answer: Land is used for living space.
5. Governments can set aside land for preservation and enact laws to manage land resources. Individuals can recycle, compost, and create green spaces to manage land resources.

Interpret Graphics

6. Sample answer:

Land Resource	How Use Affects Environment
Forests	Cutting down forests can cause soil erosion and habitat loss. Deforestation can also lead to climate change.
Agriculture	Chemical runoff from fertilizers can pollute soil and water.

7. Zinc and aluminum are metallic mineral resources. Sand, gravel, and sulfur are nonmetallic mineral resources.

Critical Thinking

8. Answers will vary. One possible way to conserve land might be by living in a tree house. Encourage students to be creative.
9. Sample answer: Preserved lands protect habitats and provide nature-related recreational opportunities for people. However, when development must occur, care should be taken to not threaten endangered species, to protect air, soil, and water resources, and to preserve greenbelts as much as possible. This can be done through the proper enforcement of environmental and zoning laws.

LESSON

15.4 Air and Water Resources

INQUIRY

Are These Crop Circles? No, this dotted landscape in Colorado is the result of circle irrigation. The fields are round because the irrigation equipment pivots from the center of the field and moves in a circle to water the crops. Crop irrigation accounts for about 34 percent of water used in the United States.

Write your response in your interactive notebook.

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Explore Activity

How often do you use water each day?

In most places in the United States, people are fortunate to have an adequate supply of clean water. When you turn on the faucet, do you think about the value of water as a resource?

1. Prepare a two-column table to collect data on the number of times you use water in one day. Title the first column *Purpose* and the second column *Times Used*.
2. In the *Purpose* column, describe how you used the water, such as *Faucet, Toilet, Shower/Bath, Dishwasher, Laundry, Leaks,* and *Other*.
3. In the *Times Used* column, record and tally the total number of times you used water.
4. Calculate the percent that you use water for each category. Construct a circle graph showing the percentages of use in a day.

Think About This

1. For which purpose did you use water the most? The least?

2. In which category, or categories, could you conserve water? How?

Learning Outcomes

- Students will be able to explain why it is important to manage air and water resources wisely.
- Students will be able to explain how individuals can help manage air and water resources wisely.

Vocabulary

photochemical smog
acid precipitation

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INQUIRY

About the Photo **Are these crop circles?** Inform students that crop circles are patterns that have been observed in some agricultural fields. The patterns are formed by flattening crops such as rye, corn, wheat, and barley. Crop circles are thought by some to be the result of paranormal activity or bizarre acts of nature. Most such circles, however, are made by people, primarily as a hoax. After students read the caption, ask the Guiding Questions below.

Guiding Questions

AL **Describe how you think the sprinklers that irrigate these fields move.** *By looking at the circles, students should realize that the sprinklers move around a central point in the center of each field, much like the hands of a clock.*

OL **What do you think are some advantages of using circle irrigation methods to water crops?** *This question should make students think about traditional methods of irrigation and infer that the sprinklers in circle irrigation can be used to water large areas; are efficient for crops that require large amounts of water; and can be used on uneven land.*

BL **Not all fields that use circle irrigation are round. What might be one disadvantage of using circle irrigation on rectangular or square fields?** *Students should infer that crops around the outer edges of the fields get more water than those closer to the center. Also, if fields are rectangular or square, crops at the outer edges of these fields often are not irrigated by the pivot system, and some water would be wasted.*

LAB Manager

All the labs for this lesson can be found in the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Build on Prior Knowledge

In their studies of atmosphere and weather, students likely have learned about smog and precipitation. Have volunteers provide definitions of each term. *Sample answers: Smog is a haze that*

forms when air is polluted by certain substances. Precipitation is any form of water that falls from clouds. Have students keep these definitions in mind when they read about two types of air pollutants: photochemical smog and acid precipitation.

ExploreActivity

How often do you use water each day?

Prep: *5 min* **Class:** *20 min*

Purpose
To collect and graph data about daily water use.

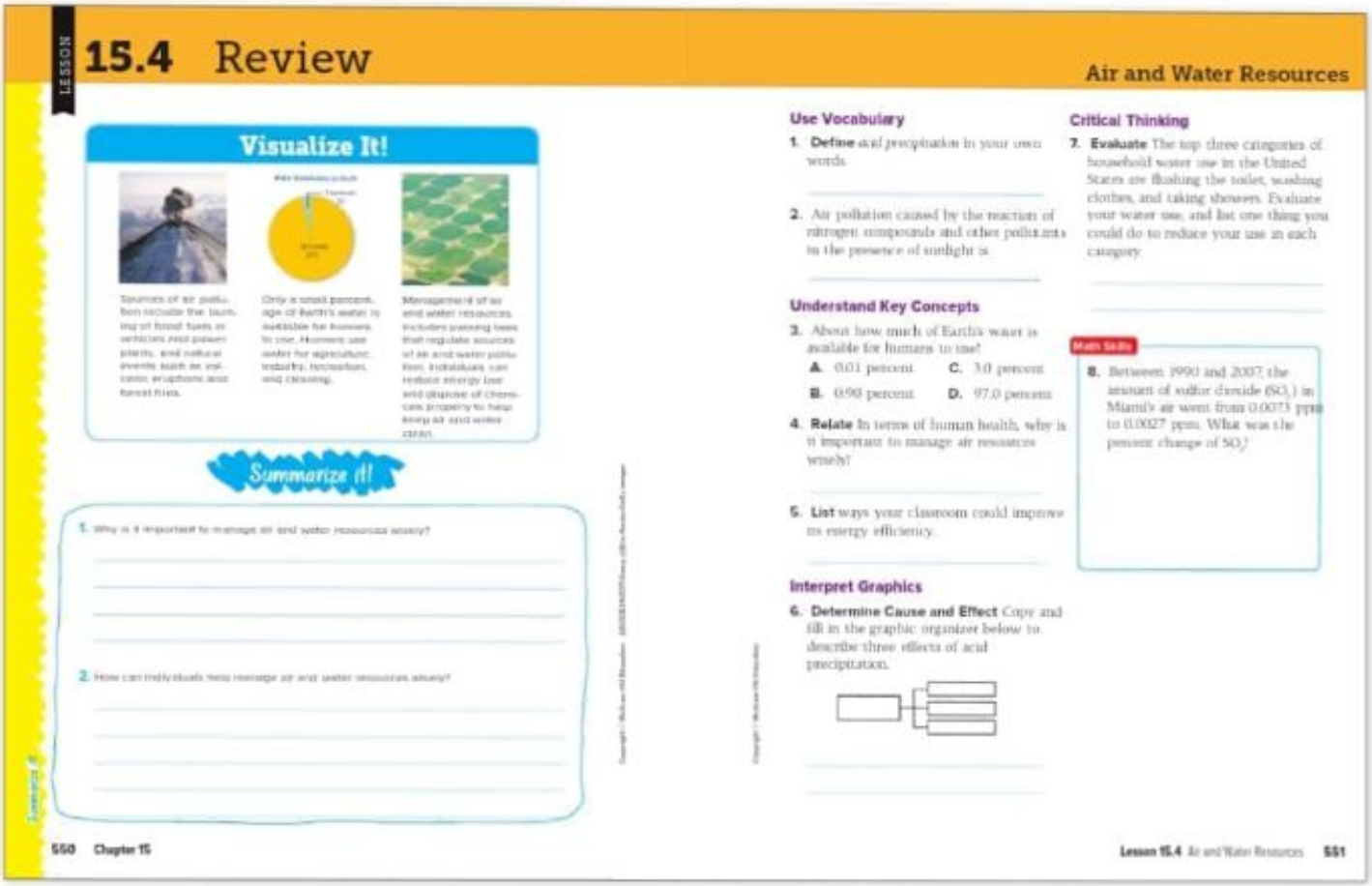
Before You Begin
- Display pictures that show the many uses of water on our planet.
- If necessary, review calculating percentages and/or constructing circle graphs.

Guide the Investigation
Discuss a sample data chart format as well as methods of tallying data.

Think About This
1. Answers will vary. Sample answer: Most of my water use fell into the *Faucet* category. I used the least amount of water in the *Laundry* category.
2. Answers will vary. Sample answer: I could probably conserve water by using less water when I shower or bathe.

Extension
To extend this lab, have groups discuss how their household water use might change from day to day or from season to season. Examples: The washing machine might not be used daily; in warm seasons, outdoor water use might increase because of watering lawns and gardens and filling swimming pools.

Teacher Notes



LESSON

15.4 Review

Air and Water Resources

Visualize It!

Sources of air pollution include the burning of fossil fuels in vehicles and power plants, and natural events such as volcanic eruptions and forest fires.

Only a small percentage of Earth's water is available for humans to use. Humans use water for agriculture, industry, recreation, and cleaning.

Management of air and water resources includes passing laws that regulate sources of air and water pollution. Individuals can reduce energy use and dispose of chemicals properly to help keep air and water clean.

Summarize it!

1. Why is it important to manage air and water resources wisely?

2. How can individuals help manage air and water resources wisely?

Use Vocabulary

1. **Define** *acid precipitation* in your own words.

2. Air pollution caused by the reaction of nitrogen compounds and other pollutants in the presence of sunlight is

Understand Key Concepts

3. About how much of Earth's water is available for humans to use?
   - **A.** 0.01 percent
   - **B.** 0.90 percent
   - **C.** 3.0 percent
   - **D.** 97.0 percent

4. **Relate** In terms of human health, why is it important to manage air resources wisely?

5. **List** ways your classroom could improve its energy efficiency.

Interpret Graphics

6. **Determine Cause and Effect** Copy and fill in the graphic organizer below to describe three effects of acid precipitation.

Critical Thinking

7. **Evaluate** The top three categories of household water use in the United States are flushing the toilet, washing clothes, and taking showers. Evaluate your water use, and list one thing you could do to reduce your use in each category.

Math Skills

8. Between 1990 and 2007, the amount of sulfur dioxide (SO_2) in Miami's air went from 0.0075 ppm to 0.0027 ppm. What was the percent change of SO_2?

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask: To which Key Concept does each image relate?**

Summarize it!

The information needed to complete this graphic organizer can be found in the following sections:

- Importance of Air and Water
- Managing Air and Water Resources

Use Vocabulary

1. Acid precipitation is rain, snow, sleet, or hail with a pH of 5.6 or less.
2. Photochemical smog

Understand Key Concepts

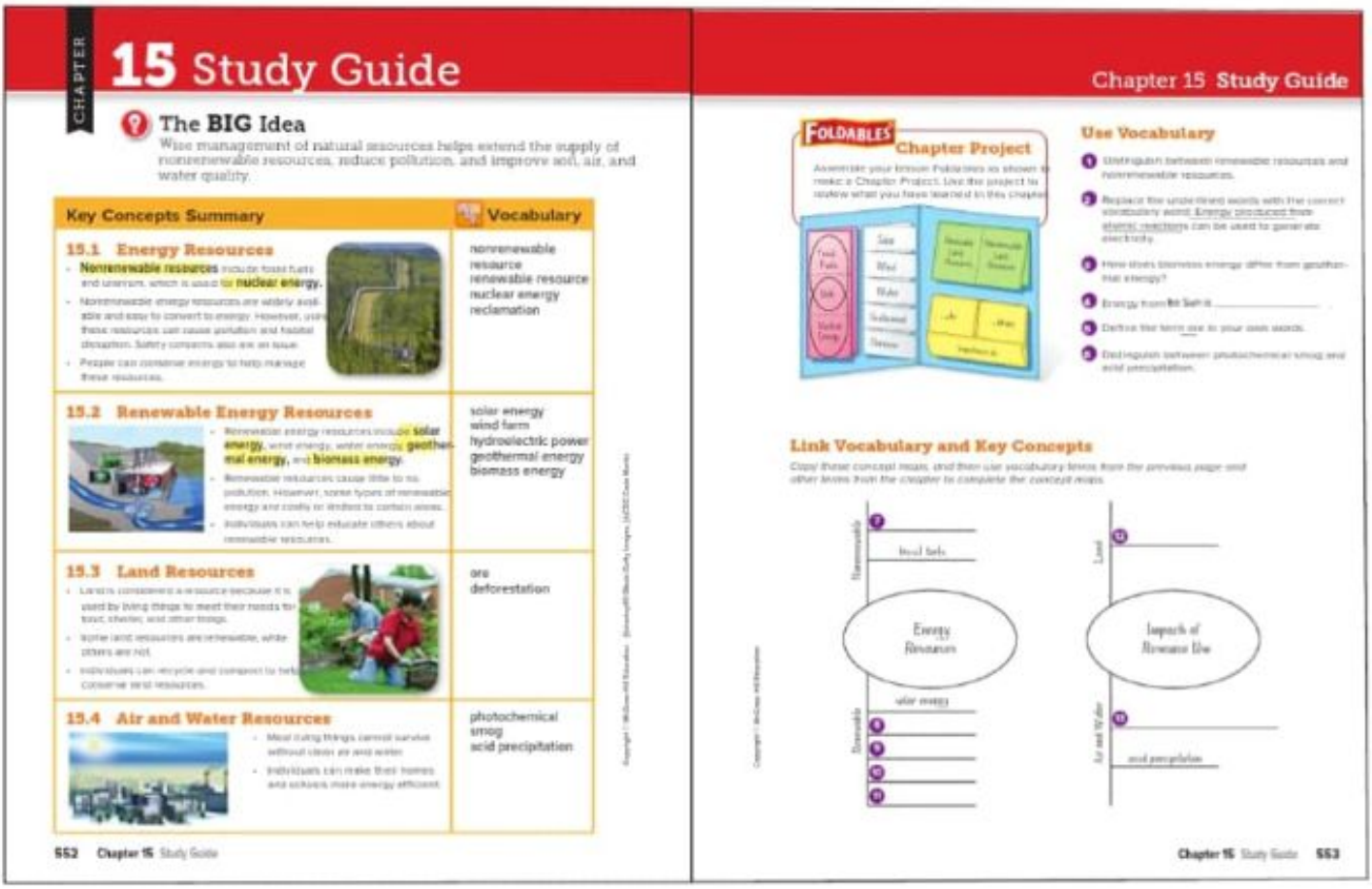
3. B. 0.90 percent
4. Air pollution can affect human health, causing respiratory illnesses. If air pollution is reduced through wise management, some people will have fewer respiratory problems.
5. Sample answer: If heat is escaping through the windows, the windows should be sealed.

Interpret Graphics

6. Acid rain can (1) harm aquatic life, (2) kill trees, and (3) damage structures.
7. Answers will vary but might include flushing the toilet less often; washing larger loads of laundry, using water-saving shower heads, and taking shorter showers.

Math Skills

8. It decreased by 1,440%.



CHAPTER 15 Study Guide

The BIG Idea

Wise management of natural resources helps extend the supply of nonrenewable resources, reduce pollution, and improve soil, air, and water quality.

Key Concepts Summary	Vocabulary
15.1 Energy Resources • **Nonrenewable resources** include fossil fuels and uranium, which is used for **nuclear energy**. • Nonrenewable energy resources are widely available and easy to convert to energy. However, using these resources can cause pollution and habitat disruption. Safety concerns also are an issue. • People can conserve energy to help manage these resources.	nonrenewable resource renewable resource nuclear energy reclamation
15.2 Renewable Energy Resources • Renewable energy resources include **solar energy**, wind energy, water energy, **geothermal energy**, and **biomass energy**. • Renewable resources cause little to no pollution. However, some types of renewable energy are costly or limited to certain areas. • Individuals can help educate others about renewable resources.	solar energy wind farm hydroelectric power geothermal energy biomass energy
15.3 Land Resources • Land is considered a resource because it is used by living things to meet their needs for food, shelter, and other things. • Some land resources are renewable, while others are not. • Individuals can recycle and compost to help conserve land resources.	ore deforestation
15.4 Air and Water Resources • Most living things cannot survive without clean air and water. • Individuals can make their homes and schools more energy efficient.	photochemical smog acid precipitation

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Chapter 15 Study Guide

FOLDABLES Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

Use Vocabulary

1. Distinguish between renewable resources and nonrenewable resources.
2. Replace the underlined words with the correct vocabulary word. Energy produced from atomic reactions can be used to generate electricity.
3. How does biomass energy differ from geothermal energy?
4. Energy from the Sun is _____.
5. Define the term ore in your own words.
6. Distinguish between photochemical smog and acid precipitation.

Link Vocabulary and Key Concepts

Copy these concept maps, and then use vocabulary terms from the previous page and other terms from the chapter to complete the concept maps.

Chapter 15 Study Guide 553

Key Concepts Summary

Study Strategy: Sentence Match-Up

Students often read over sentences blindly without taking in the information they have read. This exercise prompts students to pay attention to the information presented in the **Key Concept Summary** statements.

1. Have students work in pairs. Each pair should write the **Key Concept Summary** statements on scraps of paper.
2. Have students draw four large squares on another sheet of paper. At the top of each square, students should write the titles of each lesson: *Nonrenewable Energy Resources, Renewable Energy Resources, Land Resources, and Air and Water Resources.*
3. Have students shuffle the scraps of paper containing the Key Concept statements. Students should then work with their partners to place each statement in the correct square.
4. Once students are sure about their placements, have them tape the scraps of paper in place.

Example:

Land is considered a resource because it is used by living beings to meet their needs for food, shelter, and other things.

Vocabulary

Study Strategy: Find Out More

Learning vocabulary terms should not be limited to memorizing their definitions. In this activity, students explore the meanings of the chapter's vocabulary more fully.

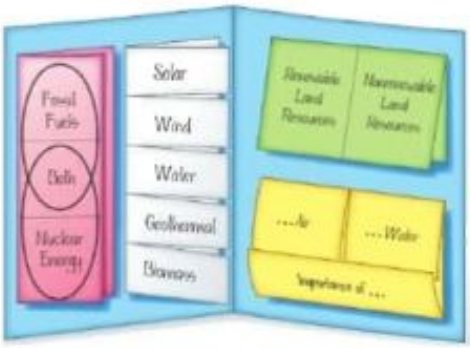
1. Assign each student one of the vocabulary terms from the chapter.
2. Tell students that their assigned term will be the subject and title of a short essay they will write.
3. In their Science Journals, students should then write a one- or twoparagraph essay about their assigned term.
4. If time allows, have students share their essays with the rest of the class.

Example:

Nonrenewable Resources

Many of the resources people use every day are nonrenewable resources. Nonrenewable resources take an extremely long time to form and are exhausted relatively quickly. Because of this, nonrenewable resources will be completely gone after they are all used up. Examples of nonrenewable resources include minerals and fossil fuels.

FOLDABLES Chapter Project



Use the Foldables® Chapter Project as a way to connect Key Concepts.

1. Ask students to organize their Foldables® in a way that reflects how the concepts in each Foldable relate to each other.
2. Use glue or staples to hold the sheets together as needed.
3. When complete, ask students to place their Foldables® Chapter Project at the front of the room. Have the class discuss the way in which students have organized their Foldables®.

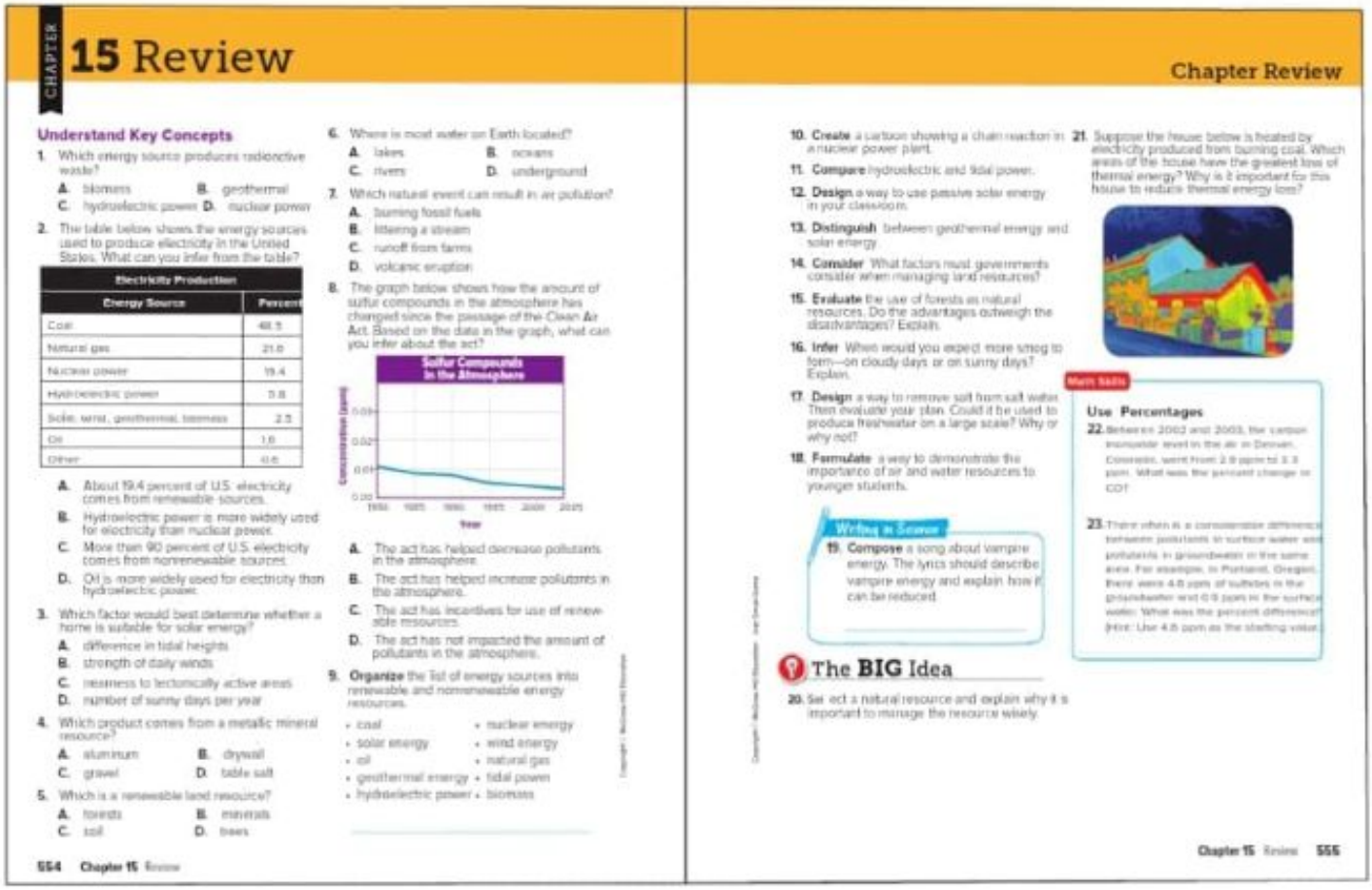
Teacher Notes

Use Vocabulary

1. Renewable resources are plentiful. Nonrenewable resources are those that can be used up faster than they are replaced.
2. Nuclear energy
3. Biomass energy is energy generated by burning organic matter. Geothermal energy is energy that originates in Earth's interior.
4. Solar energy
5. A mineral is an ore if it can be profitably mined or extracted.
6. Photochemical smog is a brownish haze that forms when nitrogen compounds react with sunlight. Acid precipitation is precipitation that forms when nitrogen and sulfur compounds react with water in the atmosphere.

Link Vocabulary and Key Concepts

7. Nuclear energy
8. 9. 10. 11. Wind energy /hydroelectric power/geothermal energy/ biomass energy
12. Deforestation
13. Photochemical smog



CHAPTER

15 Review

Understand Key Concepts

1. Which energy source produces radioactive waste?
   A. biomass B. geothermal
   C. hydroelectric power D. nuclear power

2. The table below shows the energy sources used to produce electricity in the United States. What can you infer from the table?

Electricity Production	
Energy Source	Percent
Coal	48.5
Natural gas	21.0
Nuclear power	19.4
Hydroelectric power	7.0
Solar, wind, geothermal, biomass	2.5
Oil	1.0
Other	0.6

   A. About 19.4 percent of U.S. electricity comes from renewable sources.
   B. Hydroelectric power is more widely used for electricity than nuclear power.
   C. More than 90 percent of U.S. electricity comes from nonrenewable sources.
   D. Oil is more widely used for electricity than hydroelectric power.

3. Which factor would best determine whether a home is suitable for solar energy?
   A. difference in tidal heights
   B. strength of daily winds
   C. nearness to tectonically active areas
   D. number of sunny days per year

4. Which product comes from a metallic mineral resource?
   A. aluminum B. drywall
   C. gravel D. table salt

5. Which is a renewable land resource?
   A. forests B. minerals
   C. soil D. trees

6. Where is most water on Earth located?
   A. lakes B. oceans
   C. rivers D. underground

7. Which natural event can result in air pollution?
   A. burning fossil fuels
   B. littering a stream
   C. runoff from farms
   D. volcanic eruption

8. The graph below shows how the amount of sulfur compounds in the atmosphere has changed since the passage of the Clean Air Act. Based on the data in the graph, what can you infer about the act?

   A. The act has helped decrease pollutants in the atmosphere.
   B. The act has helped increase pollutants in the atmosphere.
   C. The act has incentives for use of renewable resources.
   D. The act has not impacted the amount of pollutants in the atmosphere.

9. **Organize** the list of energy sources into renewable and nonrenewable energy resources.
   - coal
   - solar energy
   - oil
   - geothermal energy
   - hydroelectric power
   - nuclear energy
   - wind energy
   - natural gas
   - tidal power
   - biomass

10. **Create** a cartoon showing a chain reaction in a nuclear power plant.
11. **Compare** hydroelectric and tidal power.
12. **Design** a way to use passive solar energy in your classroom.
13. **Distinguish** between geothermal energy and solar energy.
14. **Consider** What factors must governments consider when managing land resources?
15. **Evaluate** the use of forests as natural resources. Do the advantages outweigh the disadvantages? Explain.
16. **Infer** When would you expect more smog to form—on cloudy days or on sunny days? Explain.
17. **Design** a way to remove salt from salt water. Then evaluate your plan. Could it be used to produce freshwater on a large scale? Why or why not?
18. **Formulate** a way to demonstrate the importance of air and water resources to younger students.

Writing in Science

19. **Compose** a song about vampire energy. The lyrics should describe vampire energy and explain how it can be reduced.

The BIG Idea

20. Select a natural resource and explain why it is important to manage the resource wisely.

21. Suppose the house below is heated by electricity produced from burning coal. Which areas of the house have the greatest loss of thermal energy? Why is it important for this house to reduce thermal energy loss?

Math Skills

Use Percentages

22. Between 2002 and 2003, the carbon monoxide level in the air in Denver, Colorado, went from 2.9 ppm to 3.3 ppm. What was the percent change in CO?

23. There often is a considerable difference between pollutants in surface water and pollutants in groundwater in the same area. For example, in Portland, Oregon, there were 4.6 ppm of sulfates in the groundwater and 0.9 ppm in the surface water. What was the percent difference? (Hint: Use 4.6 ppm as the starting value.)

Understand Key Concepts

1 D. nuclear power
2 C. More than 90 percent of U.S. electricity comes from nonrenewable sources.
3 D. number of sunny days per year
4 A. aluminum
5 D. trees
6 B. oceans
7 D. volcanic eruption
8 A. The act has helped decrease pollutants in the atmosphere.

Critical Thinking

9 Nonrenewable: coal, oil, nuclear energy, natural gas; Renewable: solar energy, geothermal energy, hydroelectric power, wind energy, tidal power, biomass

10 Cartoons should show the following steps: Uranium is placed into fuel rods. Neutrons are shot into the rods. The neutrons hit the uranium atoms. The atoms split and release two to three neutrons, along with energy. The neutrons hit other atoms, causing a chain reaction of splitting atoms.

11 Both use water to generate energy. Hydroelectric power produces electricity produced by releasing water from a dammed river. Tidal power generates electricity by storing and releasing tidal waters.

12 Sample answer: Students might say they could install blinds on windows. The blinds could be opened on cool days to let solar energy in to warm the room. The blinds could be closed on warm days to keep the classroom cool.

13 Geothermal energy is energy from Earth's interior. Solar energy is energy from the Sun.

14 Sample answer: Some land resources are renewable and others are nonrenewable, which might make a difference in how they are managed.

15 Sample answer: Many useful products come from forests. The advantages outweigh the disadvantages if forests are managed in a sustainable manner. However, rather than deforesting an entire area, selected trees should be cut down and the area should be replanted.

16 More smog would form on sunny days because smog forms when nitrogen compounds react with sunlight.

17 Designs will vary. Students might suggest using a heat source to distill the water. Currently, large-scale desalination is an expensive process.

18 Sample answer: Students might suggest putting on a play to show how most living things could not survive without adequate amounts of clean air and water. Accept all reasonable answers.

Writing in Science

19 Songs will vary but should explain that vampire energy is wasted energy from appliances that are always plugged in or that are in stand-by mode. Turning off appliances and/or unplugging them when they are not in use helps reduce vampire energy.

The BIG Idea

20 Sample answer: It is important to manage air wisely because most living things cannot survive without adequate amounts of clean air.

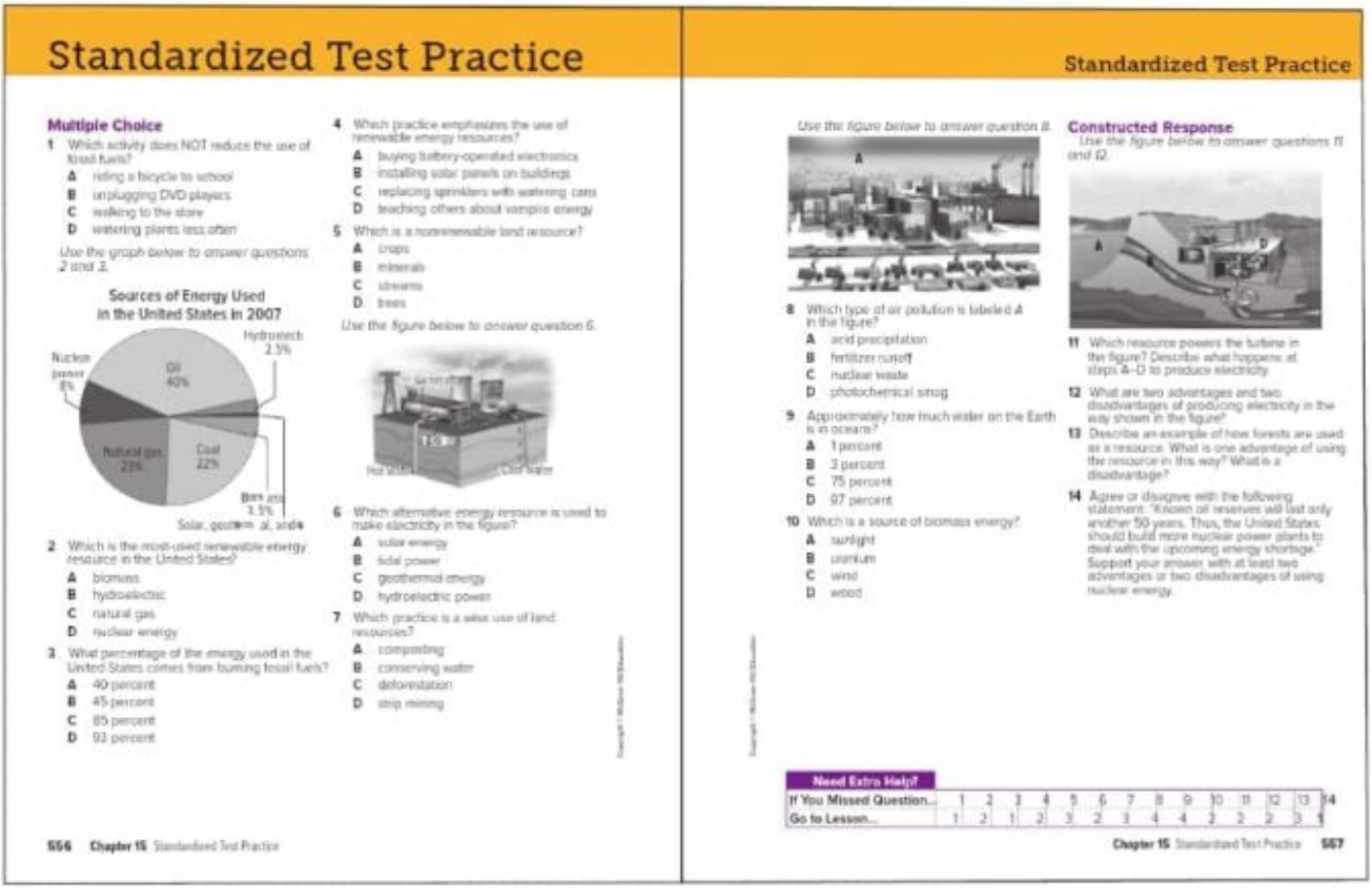
21 The main roof, the roof over the front door, and areas below the upstairs windows are the main places of loss. Coal, a fossil fuel, is a nonrenewable resource. Also, burning fossil fuels releases gases and soot into air, which can lead to the formation of photochemical smog and acid precipitation. Reducing the amount of coal needed to heat the house would conserve this resource and reduce air pollution by coal.

Math Skills

Use Percentages

22. 1 percent

23. 76 percent



Standardized Test Practice

Multiple Choice

1 Which activity does NOT reduce the use of fossil fuels?
A riding a bicycle to school
B unplugging DVD players
C walking to the store
D watering plants less often

Use the graph below to answer questions 2 and 3.

Sources of Energy Used in the United States in 2007

2 Which is the most-used renewable energy resource in the United States?
A biomass
B hydroelectric
C natural gas
D nuclear energy

3 What percentage of the energy used in the United States comes from burning fossil fuels?
A 40 percent
B 45 percent
C 85 percent
D 93 percent

4 Which practice emphasizes the use of renewable energy resources?
A buying battery-operated electronics
B installing solar panels on buildings
C replacing sprinklers with watering cans
D teaching others about vampire energy

5 Which is a nonrenewable land resource?
A crops
B minerals
C streams
D trees

Use the figure below to answer question 6.

6 Which alternative energy resource is used to make electricity in the figure?
A solar energy
B tidal power
C geothermal energy
D hydroelectric power

7 Which practice is a wise use of land resources?
A composting
B conserving water
C deforestation
D strip mining

Use the figure below to answer question 8.

8 Which type of air pollution is labeled *A* in the figure?
A acid precipitation
B fertilizer runoff
C nuclear waste
D photochemical smog

9 Approximately how much water on the Earth is in oceans?
A 1 percent
B 3 percent
C 75 percent
D 97 percent

10 Which is a source of biomass energy?
A sunlight
B uranium
C wind
D wood

Constructed Response

Use the figure below to answer questions 11 and 12.

11 Which resource powers the turbine in the figure? Describe what happens at steps A–D to produce electricity.

12 What are two advantages and two disadvantages of producing electricity in the way shown in the figure?

13 Describe an example of how forests are used as a resource. What is one advantage of using the resource in this way? What is a disadvantage?

14 Agree or disagree with the following statement: "Known oil reserves will last only another 50 years. Thus, the United States should build more nuclear power plants to deal with the upcoming energy shortage." Support your answer with at least two advantages or two disadvantages of using nuclear energy.

Need Extra Help?

If You Missed Question...	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Go to Lesson...	1	2	1	2	3	2	3	4	4	3	2	2	3	1

Multiple Choice

1 **D—Correct.** D reduces the use of water but not use of fossil fuels. A and C reduce the use of fossil fuels that operate individual cars. B reduces vampire energy, which is supported by the burning of fossil fuels.

2 **A—Correct.** B and C rely on renewable resources but are used less than A. D uses uranium, which is not a renewable resource.

3 **C—Correct.** Fossil fuels include petroleum, natural gas, and coal. A, B, and D include different combinations of resources in the graph.

4 **B—Correct.** A is using a nonrenewable resource. C may conserve water, but water is still being used. D emphasizes how to reduce using nonrenewable energy sources.

5 **B—Correct.** A, C, and D are all renewable resources we get from using land.

6 **C—Correct.** The figure shows a geothermal power plant. A, B, and D name other types of energy that are used to produce electricity in different types of plants.

7 **A—Correct.** B may be good for the environment, but they do not preserve land as a resource. C has a negative impact on land resources. D damages land.

8 **D—Correct.** A is a different type of air pollution. B results in land and water pollution. C is a by-product of nuclear energy production.

9 **D—Correct.** A is the amount of freshwater available for humans to use. B is the total amount of freshwater on Earth. C is the amount of water in the human body.

10 **D—Correct.** A and C are renewable energy sources but are not biomass. B is a nonrewable resource.

Constructed Response

11 The figure shows a hydroelectric plant, which uses moving water as the resource to produce electricity. (A) Water is stored behind the dam, forming a reservoir. (B) Downhill movement of water produces energy. (C) Energy from moving water turns a turbine that powers a generator. (D) The generator produces electricity.

12 Advantages: Hydroelectric power is (1) nonpolluting, and (2) available in the United States. Disadvantages: (1) It can only be produced in areas with fastflowing rivers; (2) it can have a negative effect on aquatic ecosystems; (3) decreased rainfall can cause less electricity to be produced.

13 Answers may include using timber for building, for fuel, or for paper products. Advantages may include that forests, and therefore trees, were plentiful in the United States, or that in addition to producing products from trees, the cleared land could be used for agriculture. Disadvantages include the slow rate of regrowth and loss of canopy and habitat.

14 Accept responses that agree with or disagree with the statement if supported appropriately. Advantages might include: (1) small amounts of uranium can produce large amounts of energy; (2) if properly run, nuclear power plants produce minimal air, water, or soil pollution. Disadvantages might include: (1) uranium is nonrenewable and will eventually be depleted; (2) nuclear reactors require careful monitoring to prevent releasing harmful radioactive substances into the environment; (3) nuclear waste materials are toxic and require special storage for thousands or millions of years.

Answer Key

Question	Answer
1	D
2	A
3	C
4	B
5	B
6	C
7	A
8	D
9	D
10	D
11	See extended answer.
12	See extended answer.
13	See extended answer.
14	See extended answer.