Matter

LESSON 9.1
PAGES 304–311

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Recognize the four different states of matter
- Distinguish between chemical and physical properties and changes
- Explain the relationship between energy and states of matter

✓ *Determine Student Readiness*

Determine students' readiness for learning about matter by discussing water. Invite students to tell you what they know about water. Encourage discussion of the different forms that water can take. Give examples, if necessary, such as water in a glass, an ice cube, and steam from a kettle of boiling water. Once students are able to recognize that water is matter and that it exists in different forms, explain that these forms are called *states of matter*.

Key Concept

Matter is anything that has mass and takes up space. Matter exists on Earth in one of four states—solid, liquid, gas, or plasma.

Concept Background: Matter is anything that has mass and volume. Matter can take different forms: solid, liquid, gas, or plasma. Matter cannot be created or destroyed, but its form can change. All matter has energy. Remind students of the discussion of water that occurred while you determined student readiness for learning. Ask a volunteer to identify the three states of water on Earth. Explain that water, regardless of its state, has mass, meaning it is made of a measurable amount of matter. It also has volume, meaning it is possible to measure the space the liquid, frozen, or gaseous water occupies.

Develop Core Skills

Core Skill: Compare and Contrast Information

Explain to students that when they compare two objects or events, they describe how the two things are alike. When they contrast the objects or events, they tell how they are different. To demonstrate the process simply, select two items of interest to students, such as two sports, two kinds of vehicles, or two kinds of animals. Draw and label a Venn diagram on the board. Invite students to come forward to record characteristics in the diagram. Afterward, summarize the similarities and differences. Tell students that they can use this strategy of comparing and contrasting to help them understand important concepts presented in texts and supporting diagrams.

Core Skill: Draw Conclusions

Tell students that to draw conclusions from text, readers apply their own background knowledge to details in the text to make reasonable guesses about events and the author's stated main idea. Provide students with information from which they can draw a conclusion. For example, offer a prepared text from an event that occurred at the school or in the community. Ask students what conclusions they can draw from the information. Ask them what facts led them to their conclusions. You may want to track how much students relied on facts and how much they relied on their own personal knowledge to draw their conclusions.

Pre-Teach Vocabulary

Connect to Life Experiences

Write the word *simulation* on the board. Ask students if they've ever heard of or participated in an online simulation game, such as a game that allows them to build cities, ant colonies, and rain forests; or games that let them pretend to fly or drive a car. Invite volunteers to use these examples to define the word *simulation* as a model of an action, object, or event in real life.

Tier 2 Words:	Tier 3 Words:	Test Words:
simulation (p. 305)	chemical property (p. 307)	conclusion (p. 307)
	element (p. 307)	
	matter (p. 304)	
	physical property (p. 307)	
	state of matter (p. 305)	

DURING THE LESSON

PAGE 304

The States of Matter

Read the first paragraph aloud. Then begin drawing a concept map on the board. Begin by writing the words *States of Matter* inside a circle. Next, draw four satellite circles labeled *Solid*, *Liquid*, *Gas*, and *Plasma*. Read the text on pages 304–306 as a class, pausing frequently to invite volunteers to add information to the concept map. When the map is complete, ask students to explain each state of matter in terms of how particles are arranged and how the addition or subtraction of heat can cause a state of change.

PAGE 305

Compare and Contrast Information

Write the words *Text* and *Simulation* on the board. Ask students to compare and contrast the terms, helping them recognize that a text explains a real-world process, while a simulation represents or models that process. Then read the introductory text as a class. Give students time to read the example independently. Afterward, invite students to discuss the advantages of using simulations and experiments to support science texts.

PAGE 306

Core Skill: Compare and Contrast Information
Read the text with students, and then ask them to compare and contrast the information they gather from both the diagram and the text. Afterward, invite students to discuss what they are able to observe in the illustrated simulation that they would not be able to observe in an experiment. Prompt students to recognize that in an experiment, they would be unable to see how a substance's particle structure changes as the environment changes.

THINK ABOUT SCIENCE ANSWER KEY

1. B
2. C
3. A

PAGE 307

Properties of Matter
Write the terms *physical properties* and *chemical properties* on the board. Read the words aloud, and explain to students that when a physical change of state happens, the particles within a substance stay the same, but the amount of space they take up changes. Conversely, in a chemical change, the identities of the particles within the new substance permanently change. Ask volunteers to explain why stirring salt into water represents a physical change, whereas burning wood represents a chemical change.

Core Skill: Draw Conclusions
Read the text with students. Then organize students into small groups. Have each group review the list of changes and categorize them as chemical or physical changes. When students have completed the task, have someone from each group write the results on the board. Examine the results as a class, discussing and resolving any discrepancies that may exist. Encourage students to justify their decisions.

THINK ABOUT SCIENCE ANSWER KEY

1. A physical property can be observed without changing the identity of matter and includes observations such as color, size, and shape. Chemical properties describe how a substance reacts with another.
2. An element is a type of matter that cannot be broken down into a simpler substance.

PAGE 308

Early Ideas About the Elements
Write the following questions on the board: *How is your understanding of elements different from the understandings of scientists in ancient Greece? Why do you think early chemists focused their studies on transforming common metals into gold?* Organize students into small groups. Read the questions aloud, and ask students to use them to guide their reading. When students have read the text, ask representatives from each group to respond to the questions.

Properties of Elements
Write the words *metals*, *nonmetals*, and *metalloids* on the board. Read the words aloud, and ask students to read the text in search of definitions. After students have finished reading, ask volunteers to define each term.

Next, review the chart of the properties of the ten most common elements on Earth presented on page 309. Then display or project an image of the Periodic Table of the Elements that clearly identifies the metals, nonmetals, and metalloids. Help students use the table to classify the elements that appear in the chart "Properties of Ten Most Common Elements on Earth." Explain to students that although many elements share some properties, every element has its own distinct set of properties. Have students review the properties of the elements in the chart.

21st Century Skill: Social and Cross-Cultural Skills
Read the text with students. Invite them to suggest how cultural differences among scientists can increase scientific productivity and accomplishments. Give them time to conduct their research and share their results.

WRITE TO LEARN ANSWER KEY

Suggest that each student share his or her conclusion with a partner. Each partner should ask questions about the event or incident described to see if there are more details available. Students should then augment their conclusions based on the additional details elicited by their partners.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student page 486.

Engage and Extend

ELL Instruction: Explain Connections Revisit the concept map that students began building at the beginning of the lesson. Ask students to explain the connections they see in the map. Encourage students to add further information or clarify existing information.

Extension Activity: Summarize a Multistep Procedure Have students use print or online materials to find examples of science experiments that demonstrate changes of state. Ask students to select an experiment, such as producing sugar crystals on a string or clouds in a bottle. Have students gather the necessary materials, follow the procedure, collect data, and summarize their findings in a presentation.

The Atom

LESSON 9.2
PAGES 312–319

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Describe the structure of an atom
- Identify the properties of the elements using the periodic table of the elements

✓ *Determine Student Readiness*

Determine students' readiness for learning by discussing prior knowledge about atoms, elements, and electric charge. Examine the Periodic Table of the Elements on pages 316 and 317 and have students identify elements they are already familiar with.

Key Concept

Elements are made of tiny particles called atoms.

Concept Background: Explain to students that atoms are the basic building blocks of matter. Discuss what this statement means and lead students to understand that matter is considered solid, liquid, or gas (or plasma). Have students look at the Bohr Model on page 312 and discuss the structure of atoms.

Develop Core Skills

Core Skill: Apply Scientific Models

Explain to students that in this lesson, they will make a model to better understand the atom. Ask students whether they have made models before, either for recreation or for work. Examples may include model cars and airplanes. Ask students how these models improved their understanding of the object they modeled.

Core Skill: Cite Textual Evidence

When presenting information in a text, an author must convince the audience that the statement is true by offering evidence in the form of details. Have students form small groups. Assign one section of the lesson to each group and ask them to find the main idea of their section. As a class, discuss the main idea of each section and cite the textual evidence that supports that main idea.

Pre-Teach Vocabulary

Label the Model

Write the Tier 3 words and their definitions on the board. Then reproduce the Bohr model of the atom from page 312. Ask volunteers to use the definitions to label the parts of the model. Challenge other students to evaluate the accuracy of the labels.

Tier 2 Words:	Tier 3 Words:
model (p. 312)	atom (p. 312)
neutral (p. 312)	electron (p. 312)
table (p. 315)	neutron (p. 312)
	proton (p. 312)

DURING THE LESSON

PAGE 312

Structure of the Atom

Explain to students that all matter is made of elements, and all elements are made of tiny particles called atoms. Guide students through the section on page 312. Examine the diagram of the Bohr Model, and define each object labeled on the model. Display or project an image of the Cloud Model of the Atom, and ask students to compare and contrast the models. Explain that because scientists cannot know where an electron is located at any given time, the cloud-like region surrounding the atom's nucleus represents the area in which electrons are likely to be found.

Discuss the concept of an ion. Explain that electrons have a negative charge and protons have a positive charge. When an atom has an equal number of electrons and protons, it is balanced, meaning it has no overall charge. It is neither positive nor negative. However, if the number of electrons changes, so does the atom's charge. For example, if an atom loses an electron, it is left with one more proton than it has electrons, resulting in an overall positive charge. If the atom gains an electron, it has one more electron than proton, resulting in an overall negative charge. These charged atoms are called ions.

Allow students time to study the diagram on page 314. Lead students to understand that electrons are constantly moving, so the cloud path shows where they could be.

Evidence-based Reading Support: Alphabetics

Roots

Write the word *nucleus* on the board. Next to the word, write: from the Latin word *nucleus*, meaning "kernel," which derives from the Latin word *nucula*, meaning "little nut." Invite a volunteer to suggest reasons why scientists called the central part of an atom a "nucleus." Then ask students if they can recall other uses of the word *nucleus*. (*A cell's DNA is found in its nucleus. The grandparents form the nucleus of a large extended family.*)

PAGE 313

Cite Textual Evidence

Remind students that two or more related sentences can form a paragraph, and that each paragraph has a main idea. That main idea is normally stated, often in the first or last sentence. The remaining sentences contain factual details, or information that support the main idea. Explain that factual details represent textual evidence, and readers can cite textual evidence to answer questions and justify their answers. Have volunteers read and summarize the first two paragraphs. Then read aloud the directions presented in the third paragraph and give students time to complete the task. Afterward, ask students to identify the sentence that states the paragraph's main idea. (*the first sentence*) Then ask them to explain the purpose of the remaining sentences. (*facts that support the main idea*)

Core Skill: Apply Scientific Models
Provide students with small, round objects or candies to model the parts of an atom. If possible, provide different colors for protons, neutrons, and electrons. Have students read the text and complete the activity. Encourage students to be creative with their models while also maintaining accuracy. Allow students to compare their models.

PAGE 314

Atomic Number *and* Atomic Mass

Explain that the atomic number is a way to identify atoms. Since every atom of a particular element will always have the same number of protons, this number is a good way to classify them. Atomic mass is another useful way to classify atoms, because it differentiates between different isotopes of the same element.

THINK ABOUT SCIENCE ANSWER KEY

1. 8
2. ion
3. atomic number
4. electrons

Core Skill: Cite Textual Evidence
Have students read the text and then apply what they learned on page 313 to complete the activity.

PAGE 315

Organizing the Elements

As students read the text, have them refer often to the Periodic Table of the Elements on pages 316 and 317. Lead students to understand that the number of protons in an atom, or atomic number, is the same for all atoms of an element. So the atomic number is what causes the pattern of properties in the elements. Point out that the elements in the Periodic Table are arranged left to right and top to bottom in order of increasing atomic number.

Using the Periodic Table

Before reading the text, explain that there is no single or best way to arrange the elements visually, but scientists generally agree that the Periodic Table of the Elements is an effective means of organizing chemical information. Examine the Periodic Table of the Elements on pages 316 and 317 as a class. Use the example of the element carbon to discuss the explanation of the symbols within each cell in the table. Ask students to refer to this example as you ask questions about the table, such as: *What is the atomic number of titanium?* (22); *How many protons are in the nucleus of a cesium atom?* (55); *How many electron energy shells surround the nucleus of a lithium atom?* (3); *What is the atomic mass of tungsten?* (184)

Refer to the table as you read the text as a class. As you read, pause to give students time to locate and label specific groups in the table. Afterward, show or project a Periodic Table of the Elements that uses colors to identify metals and nonmetals, halogens, and noble gases. If possible, allow students to work with one of the many interactive periodic tables that are available online to learn more about the properties of chemicals within each group.

THINK ABOUT SCIENCE ANSWER KEY

1. Mendeleyev observed a relationship between the atomic mass of elements and their properties.
2. Elements are arranged in order of increasing atomic number and every element has a unique atomic number.
3. Elements in the same vertical column share many chemical properties.

21st Century Skill: Critical Thinking and Problem Solving
Have students research online for Mendeleyev's original periodic table. Point out for research purposes that his name is often spelled "Mendeleev." Have students discuss in groups how Mendeleyev knew those elements must exist. Then have them work in pairs to research how the elements were discovered.

WRITE TO LEARN ANSWER KEY

Before students begin to write, ask them to share examples of tables they have seen, made, or used. For example, students may have collected data and organized them into tables. Or they may have referred to train or bus schedules when planning to use public transportation. For students who are unfamiliar with transit schedules, display or project an image of a typical transit schedule or a schedule for your community. Allow students to refer to the schedule as they complete the writing task.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student page 487.

Engage and Extend

ELL Instruction: Interact with the Periodic Table Invite students to explore Earth's elements through the use of an interactive periodic table available online. Project the table and invite volunteers to come forward to select an element and click on it to learn the element's name and properties. Have students identify and share one important fact about each of the elements they choose.

Extension Activity: Design a Game Challenge students to use a print or digital version of the periodic table to create a game to help younger learners learn about the relationship between atomic number and chemical and physical properties of elements. Have students focus on elements in groups I, II, VII, and VIII. Have students write the rules for their games, observe as players play their games, and revise the games based on their observations.

Compounds and Molecules

LESSON 9.3
PAGES 320–325

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Explain how individual atoms interact to form compounds
- Compare and contrast different types of chemical bonds
- Communicate the structure of molecules using chemical formulas

✓ *Determine Student Readiness*

Determine students' readiness for learning by discussing prior knowledge about atoms and their electrons. Have students recall what happens when an atom loses or gains an electron. *(An ion results.)*

Key Concept

Individual atoms form compounds by making chemical bonds with one another. To do this, each atom gains, loses, or shares electrons.

Concept Background: Explain that compounds are made up of atoms that are bonded. There are various kinds of bonds, which may be strong or weak. Review the difference between mixtures and compounds. Mixtures are formed when molecules are physically combined. Compounds, on the other hand, are formed when molecules are chemically combined.

Develop Core Skills

Core Skill: Understand Text

Discuss cause and effect with students. Explain to students that when they ask the question "Why?," they are asking about a cause. When they ask "What happened?," they are asking about an effect. Offer an example, such as: *When I release a balloon, it floats upward.* Ask students to identify the cause *(releasing the balloon)* and the effect *(it floats upward)*. Then ask students to share their own examples of cause-and-effect relationships.

Core Skill: Determine Meaning

Write the letters ASAP on the board and ask a volunteer to interpret the acronym *(as soon as possible)*. Explain that an acronym is a set of letters that form a word to represent a larger word or expression. Then write the mathematical symbols for addition, subtraction, multiplication, and division on the board. Explain that these symbols represent a specific mathematical process. Next, write the temperature 98.6°F, the average human body temperature, on the board. Read the temperature aloud and explain that the superscript circle represents the word *degree*, and the letter *F* is an abbreviation for *Fahrenheit*. Invite students to offer their own examples of symbols they use or often see.

Pre-Teach Vocabulary

Identify a Formula

Write the word *formula* on the board. Ask volunteers to share examples of formulas they have used in math class. For example, students may have used the formula *length* × *width* to find the area of a rectangle, or the formula *distance* = *rate* × *time*. Engage students in a discussion of what makes a recipe an example of a formula.

Tier 2 Words:	Tier 3 Words:	Test Words:
bonding (p. 320)	molecule (p. 322)	cause (p. 321)
compound (p. 320)		effect (p. 321)
formula (p. 323)		
symbol (p. 321)		

DURING THE LESSON

PAGE 320

Compounds and Bonding

Explain to students that elements can combine to form compounds. The properties of these compounds are different from the original elements. This is why many more substances exist than just the ones on the Periodic Table.

Have students read the first section on page 320. Refer to the Periodic Table on pages 316 and 317 and have students recall which column has atoms with full outer electron shells (*the last column, which is the noble gases—also called inert gases*).

Have students divide a sheet of paper into two columns, labeling one *Ionic Bonds* and the other *Covalent Bonds*. As they read the section on pages 320 and 322, have them list the properties and characteristics of each type of bond. Explain to students that one way to think about ionic bonds is to imagine they are magnets. Since one ion has a positive charge and the other a negative charge, they are attracted to each other. This attraction bonds them together. Lead students to understand that compounds formed by covalent bonds are called molecules.

PAGE 321

Determine Meaning

Have students read the first two paragraphs and then identify symbols used in the lesson. Then have students read the passage and complete the activity.

Core Skill: Understand Text

Write the words *cause* and *effect* on the board. Leave a space between the words. Then draw an arrow from *cause* to *effect*. Ask students to interpret the symbol, or the meaning of the arrow. (*A cause leads to an effect.*) Next, write the words *since, because, so, consequently, thus,* and *therefore* on the board. Explain that the words you wrote are signal words, or words that indicate cause-effect relationships. Before students read the text and complete the task, invite volunteers to use signal words to create sentences that describe cause-effect relationships.

PAGE 322

21st Century Skill: Productivity and Accountability
Write the word *accountable* on the board. Explain that people hold one another accountable for their work, their decisions, and the products they make. Offer an example, such as how auto manufacturers are held accountable for making vehicles that meet specific safety regulations. Invite students to offer other or more personal examples of accountability, such as the responsibility they take for children left in their care. Invite students to discuss what kind of accountability is expected of scientists (*accurate reporting of investigative results, for example*) and why this accountability is necessary. Then read the text with the class, and invite volunteers to explain scientists' obligations to the larger community.

Evidence-based Reading Support: Comprehension
Make Connections
After students read the text on this page, ask them to examine the diagram once more. Reread paragraphs three through six. Pause after each paragraph to discuss how the diagram explains or models important ideas in the text. Discuss the value of looking for connections between visuals and text to support comprehension.

PAGE 323

Chemical Formulas
Ask students to examine the diagram before they read. Invite volunteers to interpret what they see. Then read the text with students. After reading each paragraph, pause to give students time to make connections between the diagram and the text. Finally, ask volunteers to explain the molecular structure of a propane molecule.

THINK ABOUT SCIENCE ANSWER KEY

1. covalent bond
2. compounds
3. formula

Core Skill: Determine Meaning
Ask students to recall the earlier discussion of symbols. Have students scan the text on the page to find examples of symbols. For example, students will find letters that stand for elements, numbers that stand for quantities, and plus and minus symbols that represent electrical charges. Then read the text with students and invite volunteers to identify the symbols in H_2O and C_3H_8.

Engage and Extend

ELL Instruction: Interpret Symbols Have students revisit the diagrams on pages 320, 322, and 323. Ask students to explain the diagrams, noting the meanings of letters, symbols, and signs.

WRITE TO LEARN ANSWER KEY

Before they begin writing, have students discuss in groups or pairs how they would describe how chemical bonding occurs. Encourage students to use words or phrases that signal cause-and-effect relationships, such as *because*, *as a result*, *therefore*, and *due to*.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student pages 487–488.

Extension Activity: Create a Model Write the following terms on the board: *ionic bonds*, *covalent bonds*, *polar covalent bonds*, and *hydrogen bonds*. Have students use print or digital resources to model each kind of bond. For example, students can model a molecule of salt to represent an ionic bond, a molecule of carbon dioxide to represent a covalent bond, a molecule of water to represent a polar covalent bond, and liquid water to represent a hydrogen bond. Have students write explanations of each bonding process. Encourage students to share their finished work.

Chemical Reactions and Solutions

LESSON 9.4
PAGES 326–331

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Recognize a balanced chemical equation
- Understand and apply the law of conservation of matter
- Identify different types of solutions

✓ *Determine Student Readiness*

Discuss with students what they know about chemical bonds and chemical formulas. Write $2H_2O$ and $2NH_3$ on the board and have students identify which digits represent the number of molecules and which digits represent the number of atoms. Then have a volunteer sketch the molecular structure.

Key Concept

Matter can neither be created nor destroyed. When elements or compounds enter chemical reactions, the number of their atoms always remains the same.

Concept Background: A chemical reaction can be represented by a chemical equation. The equation shows the chemicals that react on the left side, and the result on the right side. Have students recall the format of a mathematical equation, such as $4 + 2 = 6$. Explain that in a chemical equation, an arrow replaces the equal sign.

Develop Core Skills

Core Skill: Analyze Structure

Model how to identify the words that form a compound word. Write *nighttime* on the board. Using a piece of paper, cover *time* and have students name and define the visible word. Repeat this activity covering the word *night*. Together, determine the meaning of *nighttime*. Challenge students to look for and list other compound words as they read.

Core Skill: Compare and Contrast Information

Have students examine the diagrams presented in previous lessons in this chapter. As a class, discuss the value of visual representations such as diagrams. Encourage students to consider, for example, how diagrams can explain complex text. Also discuss how students find numerous online images to support texts on any subject. Invite students to discuss image searches they have conducted and how the images they found contributed to their comprehension of a text.

Pre-Teach Vocabulary

Flash Cards

Read the lesson vocabulary terms aloud with students. Ask if there are any terms students have seen before and if they know their definitions. Have students make a flash card for each word, including the definitions they already know. Have students add the new definitions to their flash cards as they read the lesson.

Tier 2 Words:
acid (p. 329)
balanced (p. 326)
base (p. 329)
solution (p. 328)

Tier 3 Words:
equation (p. 326)
law of conservation of matter (p. 326)

DURING THE LESSON

PAGE 326

Chemical Reactions

As students read the first section, write the following equations on the board:

(1) $2Fe + 2O_2 \rightarrow Fe_2O_3$
(2) $Fe + 3O_2 \rightarrow 2Fe_2O_3$
(3) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Explain that ferrous oxide is the chemical name for rust, and its chemical formula is Fe_2O_3. Ask student to identify which equation is balanced and why. (*3; It has the same number of atoms of each element on each side.*) Make sure students understand that the number of atoms, not the number of molecules, must be the same. Point out the equation describing photosynthesis. It takes six carbon dioxide molecules and six water molecules to form one glucose molecule and six oxygen molecules.

Explain that the equations are balanced because of the Law of Conservation of Matter. Assist a volunteer in sketching the molecular structure of each molecule of the equation on the top of page 328 to help students understand where each atom comes from.

PAGE 327

Compare and Contrast Information

Explain to students that there is so much information available in today's society that they may often find contradictions. They will need to be able to choose which source to trust.

Have students read the section and discuss the activity in small groups. Lead students to recognize that the information in the blog is not only inaccurate, but it includes opinions instead of facts.

Core Skill: Analyze Structure

Explain to students that compound words are made up of two shorter words. Students can use the meanings of the shorter words to understand the compound word. Write the word *photosynthesis* on the board. Beneath the word part *photo*, write: *from the Greek word* photo–, *meaning "light."* Beneath the word part *synthesis*, write: *from the Greek word* syntithenai, *meaning "put together, combine."* Ask a volunteer to define the terms. Lead students to understand that photosynthesis is the process of using light to combine carbon dioxide and water to make glucose (energy).

PAGE 328

Solutions

As students read the text, review the concepts of ionic bonds, ions, and charge from the previous lesson. Discuss what makes solutions different from other mixtures. As a class, identify and discuss other examples of solutions, including nonliquid solutions such as sugar water, 14-carat gold, and anesthetic gas.

Evidence-based Reading Support: Alphabetics
Word Forms

Direct students' attention to the boldfaced words on the page. Then write the words *solution*, *solute*, and *solvent* on the board. Next to the words, write: *from the Latin word* solutus, *the past participle of the Latin verb* solvere, *meaning "to loosen, untie, solve, dissolve."* Read the Latin root's meaning aloud. Then ask students to tie the root's meaning to the meanings of the boldfaced words.

THINK ABOUT SCIENCE **ANSWER KEY**

1. The same number of atoms of each element is present before and after a reaction.
2. In keeping with the law of conservation of matter, the same number of atoms of each element is shown on both sides of the equation.

21st Century Skill: Communication and Collaboration

Discuss the importance of models in science. Models are useful if the object being studied is too big, too small, or otherwise too difficult to interact with. Ask students to think of situations where models would be helpful. Examples include atomic models and models of the solar system.

PAGE 329

THINK ABOUT SCIENCE **ANSWER KEY**

1. B
2. D
3. E
4. A
5. C

Core Skill: Compare and Contrast Information

Before reading the text, ask students to explain the value of visual representations. Then read the text as a class, and guide students as they search for good particle models of solutions. Encourage students to collaborate as they compare and contrast the visual representations and text descriptions.

WRITE TO LEARN **ANSWER KEY**

Read the text with students before they write. Discuss how it's possible, particularly with access to online media, to find numerous articles related to the same topic. Help students identify topics of interest before they begin searching for related articles.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student page 488.

Engage and Extend

ELL Instruction: Clarify Language Ask students to look at the boldface words in the lesson and look for context clues that help define them. Check students' pronunciation of each word.

Extension Activity: Formulate a Procedure Have students formulate a procedure for making an electrolyte solution, an acid solution, an alkaline solution, or a salt. Instruct students to research online to find examples that are not in the text.

The Chemistry of Life

LESSON 9.5
PAGES 332–337

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Understand the importance of organic chemistry
- Identify the advantages and disadvantages of using hydrocarbons
- Describe the four groups of organic compounds found in living things

✓ *Determine Student Readiness*

Display or project an image of a food label. An online search for "food labels" results in numerous images of labels that provide nutrition facts. Select a label that identifies fats, carbohydrates, and proteins. Discuss the label as a class, inviting students to share what they know about these categories of ingredients. Explain that in this lesson, students will learn more about these food groups and the molecules that make them.

Key Concept

Carbon forms strong bonds and is the basis for the chemistry of living things.

Concept Background: Ask a volunteer to define the term *organically grown*. Explain that the term was first used in the 1940s to describe plants that were grown without the use of pesticides and fertilizers. Then write the term *organic chemistry* on the board. Explain that this field of chemistry began in the 1800s, and it focuses on the study of carbon-containing compounds. Explain that while not all organic compounds come from living or once living things, carbon is the basic element of all living things.

Develop Core Skills

Reading Skill: Understand Text

Discuss with students the enormous variety of media available online. Invite students to share which online sites they depend on most for information, including research, homework support, news, entertainment, and new learning opportunities. Invite students to discuss how finding online resources can increase understanding of written texts. Then read the text in the sidebar as a class. Give students time to work independently or in small groups to complete the task. Afterward, ask students to share their explanations and the sources they used for information.

Core Skill: Analyze Author's Purpose

Explain to students that all writers write with a purpose, or reason in mind. Engage students in a discussion of those reasons. Guide students to understand that writers write to inform, entertain, explain, argue, and persuade others to act or think in particular ways. Invite students to share some of their own reasons for writing and some of the techniques they use to accomplish their goals for writing. Also ask students to explain why it's important to figure out an author's purpose for writing before accepting what they read as factual or reliable.

Pre-Teach Vocabulary

Word Map

Show students how to construct a word map for each word in the vocabulary. Have students write the vocabulary word in a circle in the middle of a page. Alternatively, have student volunteers construct word maps that are drawn on the board. Read the definition of each word and have students write the definition in a satellite circle extending from the main word circle. Have students add to the word maps as they read the lesson, adding classifying information, use of the word in a sentence, and examples.

Tier 2 Words:	Tier 3 Words:	Test Words:
protein (p. 334)	biomolecules (p. 332)	replicate (p. 333)
	carbohydrates (p. 334)	
	distillation (p. 332)	
	hydrocarbons (p. 332)	
	lipids (p. 334)	
	organic chemistry (p. 332)	
	polymer (p. 334)	

DURING THE LESSON

PAGE 332

The Chemistry of Life

Write the word *biomolecule* on the board. Circle the prefix *bio-* and remind students that it refers to "life." Then invite students to predict the meaning of the term. Next, write the chemical name *carbon* on the board. Invite students to recall their introduction to carbon when they studied the Periodic Table of the Elements. Explain that carbon is found in large quantities in the Sun, other stars, comets, and many planetary atmospheres. It is also found throughout nature.

Read the text above the diagram of hydrocarbons as a class. Afterward, ask: *How are carbon's electrons related to the atom's ability to bond with other elements?* (They have four electrons that are available for bonding with other elements.) Next, write the word *hydrocarbon* on the board. Circle the word parts *hydro* and *carbon*, and explain that a hydrocarbon is a combination of the elements hydrogen and carbon. Examine the diagram as a class before reading the text that follows. After reading, ask students why petroleum must be distilled. (*It is a mixture of different kinds of hydrocarbons.*)

PAGE 333

Analyze Author's Purpose
Have a volunteer read the section about the scientific method aloud. Then have students work in pairs or small groups to complete the activity. Direct them to discuss the paragraph with a partner and come to agreement as to the author's purpose. Be sure to add the vocabulary word *replicate* to the word map.

Reading Skill: Understand Text
Read the text with students. Then project an image from an online search for "fractional distillation of hydrocarbons" to show students a visual explanation of the distillation process and the products that result. Invite students to use what they learn through examination of the visual and discussion to predict how water is distilled. Then give students time to find images and texts related to the "water distillation process" to confirm or revise their predictions. Or, write students' predictions on the board and conduct an online search for information as a class.

PAGE 334

Organic Polymers
Write the word *polymer* on the board. Show or project an image of the structure of a polymer, pointing out the pattern of repeating units. Then read the first paragraph as a class.

Use the subheads in this section to explain that they will be reading about three classes of organic polymers, or biomolecules, that are found in living things. Read the words *carbohydrates*, *proteins*, and *lipids* aloud. Help students make connections between these words and the examination of a food label at the beginning of the lesson. Explain that fats, which are recorded on food labels, are a kind of lipid.

Organize students into three groups. Assign one class of biomolecules to each group. Tell students in each group to read their assigned section to answer these questions: *What elements are found in your biomolecule? What are the purposes of your biomolecule? Why do living things need your biomolecule?* Give students time to read and answer the questions. Afterward, ask representatives from each group to share their answers.

Engage and Extend

ELL Instruction: Understand Word Parts Write the prefixes *bio–*, *poly–*, *carbo–*, and *hydro–* on the board. Remind students of the meaning of each prefix (*life, many, carbon, hydrogen*). Then have them look for words containing these word parts (*biomolecule*; *polymer*; *carbohydrate*; *hydrocarbon*). Ask students to use their understanding of the word parts to define the words they find.

Evidence-based Reading Support: Comprehension
Use Context Clues
After reading about the classes of biomolecules, have students locate the term *complex carbohydrate*. Then help them find clues in the text that explain the meaning of the term. For example, students will find that the text offers a clear definition of the term. It also gives examples of complex carbohydrates. Emphasize that definitions, examples, and explanations are clues that help readers define unfamiliar terms.

THINK ABOUT SCIENCE ANSWER KEY

1. polymer
2. nitrogen, sulfur
3. lipids

21st Century Skill: Leadership and Responsibility
Discuss with students the influence science has on public policy. Have students read the text and complete the research activity. Allow students to discuss whether they use the recommendations and have them provide explanations. Lead students to focus on a central question that they can research and report on.

WRITE TO LEARN ANSWER KEY

Before students begin to write, discuss the meaning of *bias*. A bias is a tendency to choose a particular option or favor one thing, person, idea, or group over another. Ask students why it is important to identify bias in informational text.

PAGE 335

Core Skill: Analyze Author's Purpose
Ask students if they were surprised by the last sentence of the section. Students may expect textbooks to inform rather than tell them what to do. How would you rewrite the final sentence of the paragraph so that the author's purpose is no longer persuasive but informational?

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student pages 488–489.

Extension Activity: Collect and Display Information Have students interview a dietician or nutritionist and find one or more reliable sources on the internet to gather information about the benefits and problems of including fats in the diet. Have students develop specific topic questions before conducting the interview that focus on the information they want to include in their report. Have students present their findings to the class. Student authors/presenters should make available the list of topic questions as well as the report. Have student audience members look for clues of bias in the presentation.

Chemical Equations

LESSON 9.6
PAGES 338–347

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Balance a chemical equation
- Identify types of chemical reactions

✓ *Determine Student Readiness*

To determine student readiness, ask students to define the terms *molecule* and *compound* and explain their connections to physical and chemical properties.

Key Concept

Chemical reactions can be expressed symbolically in the form of chemical equations. Familiarity with chemical equations makes it easier to understand and predict some reactions.

Concept Background: Chemical reactions are processes of change. Atoms combine, rearrange themselves, and form bonds to produce new substances with properties unlike the properties of the original elements that made them. Chemical reactions may be accompanied by observable effects, such as the emission of heat or light, the production of gas, or the formation of a precipitate or a solid that falls out of a solution. Ask students to recall the chemical equation representing the process of photosynthesis in previous lessons. Ask students to identify the substances that react, or combine, to make new products and to identify the new substances that form.

Develop Core Skills

Core Skill: Interpret Information in Text and Graphical Form

Explain to students that visual tools, which are also called graphics, include graphs, diagrams, tables, photographs, videos, animations, and illustrations. Ask students to discuss when and why they use visuals. To prompt responses, ask questions, such as: *How do visuals help you make sense of complicated text? How do visuals help you order, or sequence, events in a text? How do visuals help explain processes?* Encourage students that paying close attention to visuals or graphics while reading makes interpreting text much easier.

Core Skill: Determine Central Ideas

Write the term *thesis statement* on the board. Explain that a thesis statement is normally a single sentence found in the first paragraph of a text. The statement summarizes the text's main idea, or it might make a claim that readers may accept or reject. Everything that follows a thesis statement is designed to support the text's main idea or claim. Challenge students to help you locate a thesis statement on the first page of the lesson. Point out that the lesson's title is identical to the first subhead in the lesson. Then ask students to skim the first paragraph to find the thesis statement. (*Chemical equations summarize chemical reactions.*)

Pre-Teach Vocabulary

Predict Meanings

Write the word *reaction* on the board. Explain that the word describes the act or moment of reacting, or changing in response to a stimulus. Then write the vocabulary terms that contain the word *reaction* on the board. Define the word that precedes *reaction* in each term and ask students to help you define the word. Write students' responses on the board. Pause during reading to revisit students' definitions for the purpose of expanding or revising them.

Tier 2 Words:

combust (p. 339)

Tier 3 Words:

chemical equilibrium (p. 345)
decomposition reaction (p. 342)
double replacement reaction (p. 344)
net forward reaction (p. 344)
reversible reaction (p. 344)
single replacement reaction (p. 343)
stoichiometric coefficient (p. 340)
synthesis reaction (p. 342)

DURING THE LESSON

PAGE 338

Chemical Equations

Read the opening paragraph with students, emphasizing the thesis statement that concludes the paragraph. Invite students to discuss the similarities between mathematical and chemical equations. Then read the second paragraph with students and ask a volunteer to identify the reactants in the equations presented in the text. Finally, read the last paragraph with students and ask them to summarize the value of using equations to describe chemical reactions.

PAGE 339

Understanding the Symbols

Read the text with students, pausing to ask questions and to clarify understanding. Invite volunteers to make connections between the graphic at the top of page 339 and the text. As students read with you, ask them to identify any chemical symbols they find. Write the symbols on the board so that students can refer to them as they continue reading.

PAGE 340

What Is a Stoichiometric Coefficient?

Invite a volunteer to read the first paragraph aloud. Then invite additional volunteers to read each remaining paragraph aloud. After reading, ask each reader to refer to the chemical equation to summarize the paragraph.

PAGE 341

The Law of Conservation of Mass

Have students read the first paragraph independently. Then ask volunteers to summarize the Law of Conservation of Mass. Next, read the text with students, guiding them through the steps of balancing an equation. Provide additional examples and allow students to practice balancing an equation.

THINK ABOUT SCIENCE ANSWER KEY

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Core Skill: Interpret Information in Text and Graphical Form

Read the second paragraph as a class. Afterward, ask volunteers to respond to the question. Students will find another diagram supporting the text "Decomposition Reaction" on page 342. Give students time to examine the diagram and attempt to interpret its meaning now. Record students' ideas on the board. Revisit these ideas after students have read the text.

PAGE 342

Different Types of Chemical Reactions

Write the four categories of chemical reactions on the board. Organize students into two groups. Assign each group the task of reading, analyzing, and interpreting the text in the "Synthesis Reaction" and "Decomposition Reaction" sections. Give both groups paper, and have them model and explain each reaction. Ask questions to guide understanding. Revisit students' early attempts at interpreting the diagram on this page. Invite volunteers to explain how taking time to examine and interpret the diagram before reading supported their comprehension of the text.

PAGE 343

Single Replacement Reaction

Write the term *single replacement reaction* on the board. Then challenge students to use their understanding of the term to interpret the equation A + CB → C + AB. Help students recognize that only one (single) substance, A, takes the place of (replacement) an atom, in this case, C, in the product (complete process, or reaction). Read the text with students, pausing to ask questions to guide comprehension, such as: *Why is a more reactive element more likely to displace a less reactive element? What replacement occurs in the chemical reaction that produces iron dichloride and hydrogen gas?*

Engage and Extend

ELL Instruction: Describe a Diagram Ask students to examine the diagram on page 342. Have students use their own words to interpret the diagram. Ask students to explain the sequence of steps in the process illustrated in the diagram. Write the steps on the board. Afterward, read the words with students and ask students to help you determine whether more information is necessary to fully understand the process.

THINK ABOUT SCIENCE ANSWER KEY

Review with students the answers on page 489 of the student lessons.

21st Century Skill: Information and Communication Literacy

Engage students in a discussion of the value of communication literacy. In other words, ask students to explain why it is important for all people to have the skills that allow them to access, interpret, and communicate information and ideas. Also ask students how critical thinking and creativity are related to communication literacy. Next, explain the concept of peer review. Have students read the text and then explain how peer review contributes to information and communication literacy.

PAGE 344

Double Replacement Reaction

Before students read, ask students to use what they learned about single replacement reactions to predict the meaning of a double replacement reaction. Write AY + XB → AB + XY on the board. Then read the first paragraph for students and use the equation to explain what happens in a double replacement reaction. Read the remaining text with students, pausing after each paragraph to ask questions and clarify answers.

Core Skill: Determine Central Ideas

Explain that the second paragraph is the first paragraph of a paper on the topic of global warming. Ask students to read the paragraph in search of the thesis statement. Afterward, work as a class to find which sentence best summarizes the paper's claim. (*the last sentence*)

PAGE 345

WRITE TO LEARN ANSWER KEY

Encourage students to be descriptive in their observations and methodical in their approach. A final paragraph should explain the net forward reaction.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student page 489.

Extension Activity: Evaluate Two Sources of Information Have students use the internet or print resources to identify two sources of information that explain the environmental consequences of the production of nitric oxide. Ask students to examine each source and compile relevant data from each to write a summary. Tell students to conduct further research to resolve any discrepancies that appear in the two sources of information.

Cycles of Matter

LESSON 10.1
PAGES 358–367

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Define a biogeochemical cycle
- Identify five kinds of biogeochemical cycles

✓ Determine Student Readiness

Ask students to identify the source of the oxygen they breathe and the water they drink. Then ask them to describe what they think happens to the carbon dioxide that they exhale. Based on their answers, assess how much students recall about the ways in which living things are connected to their environments and the manner in which nutrients are recycled. Ask students to list the three states of matter (*gas*, *liquid*, *solid*).

Key Concept

All living things depend on specific nutrients, such as carbon, oxygen, hydrogen, nitrogen, and phosphorus. Although matter is neither created nor destroyed, it may change form. Nutrients are matter. They move in cycles through living organisms, rocks, soils, and water, and chemical compounds. These cycles are called biogeochemical cycles.

Concept Background: The nutrient and water cycles are critical to supporting life on Earth. Evaporation, condensation, and precipitation are the main components of the water cycle. Carbon and nitrogen are the main nutrients that plants and animals depend on. Oxygen is produced by photosynthetic organisms as a product of photosynthesis. Phosphorus is an element found in the energy molecule ATP and also in DNA, which carries the cell's genetic information.

Develop Core Skills

Core Skill: Follow a Multistep Procedure

Remind students that scientists spend much of their time investigating and experimenting. They follow procedures that can be replicated, or copied by other scientists. To get consistent and reliable results, scientists follow each step of a procedure precisely. Invite students to briefly list the steps of a procedure that they follow regularly, such as a warm-up routine before exercising. Ask them why it is important to follow the steps precisely.

Core Skill: Draw Conclusions

Remind students that when they draw conclusions, they combine evidence from a text or investigation with prior knowledge and experience to form a judgment. Ask students to listen as you read the italicized text on page 358 aloud. After reading, ask students what they can conclude about pizza boxes and other familiar packaging materials. Ask students to identify the text evidence and prior knowledge they used to form their conclusions.

Pre-Teach Vocabulary

Relate Word Parts

Write and discuss the following word parts and definitions on the board: bio–, *from the Greek word* bios, *meaning "the course of human life;"* geo–, *from the Greek word* gē, *meaning "earth;" and* chem–, *from the Greek word khemeioa, meaning "alchemy."* Explain that during the Middle Ages and into the 1600s, alchemists attempted to change a variety of metals into gold and to find a universal cure for disease. Their work was the precursor to modern chemistry. Ask students to identify a vocabulary word that they can define by combining their understanding of the word parts you wrote on the board and their prior knowledge. Guide students toward identifying the term *biogeochemical cycles*.

Tier 2 Words:	Tier 3 Words:
producers (p. 360)	algae (p. 361)
weathering (p. 364)	biogeochemical cycle (p. 358)
	detritivore (p. 359)
	nitrogen fixers (p. 363)
	nutrient (p. 358)

DURING THE LESSON

PAGE 358

What Are Nutrients?

After reading the text, draw a table with two columns on the board. Label the first column *Needed in Large Amounts*. Label the second column *Needed in Small Amounts*. Ask students to refer to the text to help you record information in the table.

Biogeochemical Cycles

Have students read the text independently. Afterward, ask: *What drives all biogeochemical cycles? Why are biogeochemical cycles necessary?*

PAGE 359

Evidence-based Reading Support: Alphabetics

Suffix *–vore*; Prefixes *carn–*, *herb–*, *omni–*, and *detri–*

Students may be familiar with the term *carnivore*. Point out that the suffix *–vore* is from the Latin word *vorare*, which means "to swallow up or to devour." The prefix *carn–* is from the Latin word *caro*, meaning "meat." Ask students to use dictionaries or etymology websites to look up the terms *herbivore*, *omnivore*, and *detritivore*; challenge them to describe the meaning of the prefix in each term.

Decomposers and Biogeochemical Cycles

Draw a Venn diagram on the board. Label the first circle *Detritivores* and the second circle *Decomposers*. Read the text with students, examine the diagram together, and then ask students to help you compare and contrast detritivores and decomposers.

THINK ABOUT SCIENCE ANSWER KEY

Review with students the answers on page 491 of the student lessons.

Core Skill: Follow a Multistep Procedure

Review the steps in the procedure for examining the rate of decomposition of rubber latex balloons. If possible, have students use activators and materials to complete the procedure. In either case, discuss the value of writing and following numbered steps. Explain the value of following such explicit instructions for a scientific investigation makes the investigation reproducible.

PAGE 360

The Carbon Cycle

Before reading, ask students to examine and interpret the illustration of the carbon cycle. Write their observations on the board. Then ask students to work in pairs to read the text, adding notes to the diagram as they read. Then, invite students to revisit their analysis of the diagram, making corrections and adding important details.

PAGE 361

The Oxygen Cycle

Write the following question on the board: *Why do algae play a more important role than land plants in the oxygen cycle?* Read the question aloud, and ask students to read the text to find the answer. When students have finished reading, discuss the answer as a class, helping students understand that because oceans cover three-fourths of the Earth's surface, algae are more plentiful and thus play a larger role in the oxygen cycle. Give students time to work in pairs or small groups to draw and label diagrams of the oxygen cycle. Have groups share their work.

PAGE 362

The Hydrologic Cycle

Have students examine the graphs "All Water on Earth." Ask: *If there is so much water on Earth's surface, why is there so little water available for drinking?* Have students work in pairs to read the text at the top of the page and answer the question. Then, ask volunteers to refer to the text below the diagram to explain each label on the diagram.

WRITE TO LEARN ANSWER KEY

Have students review the text on the hydrologic cycle before beginning to write. Encourage students to make an outline before writing and use the outline to guide the development of their ideas.

Engage and Extend

ELL Instruction: Explain a Cycle Ask students to select one of the cycles discussed in the lesson and explain it in their own words. If possible, project the cycle they choose on the board or a wall and give students the option of pointing to elements in the diagram as they explain the process.

PAGE 363

The Nitrogen Cycle

Ask students to read the first paragraph independently. Afterward, ask students why, like other living things, they need nitrogen to live. Next, write the following questions on the board: *Why is it difficult for living things to get the nitrogen they need, given how plentiful it is on Earth? What solution to this problem exists in nature?* Ask students to seek the answers as you read. After reading, invite volunteers to share their answers. Ask them to refer to the diagram of the nitrogen cycle in their answers.

THINK ABOUT SCIENCE ANSWER KEY

Review with students the answers on page 491 of the student lessons.

21st Century Skill: Media Literacy

Have students read the text and answer the question at the end of the sidebar activity. Invite students to give specific examples of personal experiences with the reliability of information they have found in an advertisement or on a website. Ask students to offer opinions on how being media literate can help them.

PAGE 364

The Phosphorus Cycle

Invite volunteers to recall their understandings of the terms *ATP* and *DNA*. Explain that each molecule contains phosphorus, making the element critical for life. Organize students into small groups. Have them read the text and make notes that will help them interpret the diagram of the phosphorus cycle. Then have students describe a potential path of a phosphorus atom through the cycle.

Core Skill: Draw Conclusions

Ask students to read the text and write a conclusion about oxygen levels in water where large amounts of phosphorus contribute to increased plant growth. Invite students to share their conclusions, citing text details and their own knowledge to support their ideas.

PAGE 365

THINK ABOUT SCIENCE ANSWER KEY

Review with students the answers on page 491 of the student lessons.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student pages 491–492.

Extension Activity: Interpret Information from a Graph Have students conduct an online investigation to locate graphs summarizing water-use data in their town or state. Ask students to describe patterns or trends in the data and use the data to predict trends in the next decade. Invite students to share the graphs they found and explain their interpretations and predictions.

Fossil Fuels

LESSON 10.2
PAGES 368–375

BEFORE THE LESSON

Objectives

After completing this lesson, students will be able to

- Identify fossil fuels
- Explain the processes by which fossil fuels formed
- Describe environmental consequences of using fossil fuels

✓ *Determine Student Readiness*

To determine students' readiness for this lesson on fossil fuels, ask students to think about the different kinds of energy they used before coming to school today. Help students build an awareness of their dependence on energy.

Key Concept

People depend on fossil fuels to meet their energy needs. Those fuels include oil, natural gas, and coal. Each fuel formed through a process of decay over millions of years.

Concept Background: Explain to students that energy resources are materials in the environment that people use as sources of energy. Energy resources are vital to a growing society. Some resources, like solar, water, wind, geothermal, biomass, and biofuel are renewable. Others, like fossil fuels and nuclear energy, are nonrenewable and have other drawbacks, such as pollution and toxic byproducts.

Develop Core Skills

Core Skill: Make Predictions

Remind students that scientists predict what they expect to happen during an experiment, based on what they already know. Tell students they can make predictions while they read, also using their prior knowledge and experience, as well as information from the text, including titles, subtitles, and visuals. Have students read the key concept and the italicized text at the beginning of the lesson. Then have them predict what the lesson will be about. Write their predictions on the board to revisit after reading.

Core Skill: Compare and Contrast Information

Remind students that when they compare, they identify ways that two or more things are similar. When they contrast, they identify examples of differences. Identifying similarities and differences can help scientists and others more clearly understand what they are observing or studying. Select two sports teams, websites, movies, or books familiar to students. Draw a Venn diagram on the board, and label the diagram. Ask students to compare and contrast the two selections.

Pre-Teach Vocabulary

Relate Terms

Write the vocabulary terms and brief definitions on the board. Next to the terms, write the words *Energy* and *Global Warming and Pollution*. Ask students to help you organize as many of the vocabulary terms as possible into the two categories. Draw a line from each vocabulary term to the appropriate category.

Tier 2 Words:	Tier 3 Words:
acid rain (p. 372)	biofuel (p. 373)
ozone (p. 372)	hydrocarbons (p. 368)
petroleum (p. 368)	particulates (p. 372)
smog (p. 372)	
toxins (p. 372)	

DURING THE LESSON

PAGE 368

What Are Fossil Fuels?

Explain that energy is required to do work. In cars, trucks, and tractors, that energy comes mainly from fossil fuels. Write the following question on the board: *How are the remains of once-living organisms related to the fuels we use to drive vehicles, to cook, and to heat homes and other buildings?* Invite students to suggest answers to the question before reading. After reading, ask students to identify the specific fossil fuels people depend on as sources of energy.

Evidence-based Reading Support: Alphabetics

Base Words

Write the following base words and their definitions on the board: Latin *petra*, meaning "rock" and Latin *oleum*, meaning "oil." Read the base words and definitions aloud. Then, write the word *petroleum* on the board, and ask students to define the term.

Crude Oil

Read the title aloud, and explain that *crude oil* is another name for petroleum. Have students read the text in pairs and illustrate the steps from drilling for petroleum to the manufacturing of petroleum products. Ask groups to share and explain their illustrations.

PAGE 369

THINK ABOUT SCIENCE — ANSWER KEY

Review with students the answers on page 492 of the student lessons.

21st Century Skill: Information, Communication, and Technology Literacy

Have students read the text and summarize how scientists use technology to find supplies of crude oil. Have students use the Internet to find resources to answer the questions at the conclusion of the text. Afterward, ask students to share and justify their answers.

PAGE 370

Natural Gas

Write the following questions on the board: *Why did people in most countries stop burning natural gas? Why is a smelly chemical added to the natural gas piped into homes and businesses?* Read the questions aloud, and direct students to use these questions to guide their reading.

Coal

Read the text with the class. Afterward, ask volunteers to list the steps in coal production on the board. Next, draw a Venn diagram on the board. Label the circles *Crude Oil* and *Coal*. Ask volunteers to compare and contrast the production processes used to access these resources. Help students summarize the four kinds of coal by drawing a four-column chart on the board. Label the columns with the headings *Lignite*, *Subbituminous*, *Bituminous*, and *Anthracite*. Invite volunteers to contribute details about each type of coal to list in the chart.

THINK ABOUT SCIENCE **ANSWER KEY**

Review with students the answers on page 492 of the student lessons.

PAGE 371

The Consequences of Burning Fossil Fuels

Write the terms *global warming*, *air pollution*, *acid rain*, and *land and water pollution* on the board. Next to the terms, write the following question: *What is the relationship between these words and the burning of fossil fuels?* Ask students to use this question as their guiding question as they read.

Direct students' attention to the photograph on page 372. Invite students to describe what they see. Then ask volunteers to read the text on air pollution. After reading, ask: *What makes ozone both helpful and harmful? What effects do toxins in the air have upon plant and animal life?* Ask students to cite evidence from the text.

Next, have students read the paragraph about acid rain independently. Afterward, ask: *What two things might acid rain do to weaken plants without killing them directly?* Have students suggest answers based on evidence in the text.

Have students examine the photograph on page 373 and read the caption. Then write on the board: *What are some of the consequences of mining and transporting fossil fuels?* Have students work in pairs to read the text. After, draw a three-column chart on the board. Title the chart *Consequences*. Label the columns *Mining*, *Pumping Oil*, and *Transporting Oil*. Ask students to add examples of consequences from each activity to add to the chart.

Return to the guiding question you wrote on the board prior to reading. Engage students in a discussion of possible answers. Guide them to understand the connection between the burning of fossil fuels and the consequences of global warming, air pollution, acid rain, and land and water pollution.

Core Skill: Make Predictions

Have students read the text and make predictions about why CDCL isn't more widely used. Help students understand that there are costs associated with altering existing power plants to use new technologies as they become available.

PAGE 372

THINK ABOUT SCIENCE **ANSWER KEY**

Review with students the answers on page 492 of the student lessons.

Core Skill: Compare and Contrast Information

Encourage students to discuss experiences in which they have found conflicting information, such as different summaries of news events. Invite students to talk about what they do when they find conflicting information. Then discuss how comparing and contrasting sources on the same topic makes it more likely that they will find accurate information. Then read the second paragraph aloud, explaining the task.

PAGE 373

Alternative Fuels

Ask volunteers to explain how biofuel may be a positive alternative to fossil fuels.

PAGE 374

WRITE TO LEARN **ANSWER KEY**

Encourage students to brainstorm ideas about the advantages and disadvantages of switching from fossil fuels to biofuel before creating their outlines.

AFTER THE LESSON

Read through with the students the answers to the vocabulary and skill reviews and the skill practice items located on student pages 492–493.

Engage and Extend

ELL Instruction: Retell Information Invite students to identify information from this lesson that they found most interesting. Encourage students to retell this information using their own words and to explain what made that information so interesting.

Extension Activity: Investigate Biofuels Have students review the information about alternative fuels on page 373. Have them use online resources to investigate how biofuels have been applied both successfully and unsuccessfully as alternative fuels. Ask students to write a summary of their findings and use evidence to predict the impact of biofuels on future energy consumption.