LOUISIANA

INTEGRATED iSCIENCE

GLENCOE

McGraw Hill Education

SAMPLER

GRADE 7

Louisiana Student Standards for Science

Correlated to Grade 7

Student Performance Expectations [PE]	Chapter and Lesson References
Matter and Its Interactions	
7-MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, or mixing zinc with hydrogen chloride. Examples of chemical and physical properties to analyze include density, melting point, boiling point, solubility, flammability, or odor.]	**Chapter 1** Project-Based Learning Activity *A Tale of Two Changes* (online at ConnectED)
7-MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and the state of a pure substance when thermal energy is added or removed.* [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings or diagrams. Examples of particles could include molecules or inert atoms such as the noble gases. Examples of pure substances could include water, carbon dioxide, or helium.]	**Chapter 3, 4** Project-Based Learning Activity *Particles in Motion* (online at ConnectED)
7-MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.* [Clarification Statement: Emphasis is on the law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms. The use of atomic masses, balancing symbolic equations, or intermolecular forces is not the focus of this performance expectation.]	**Chapter 1** Project-Based Learning Activity *All Things Being Equal* (online at ConnectED)
Energy	
7-MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Emphasis is on observing change in temperature as opposed to calculating total thermal energy transferred. Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.]	**Chapter 3** Project-Based Learning Activity *Cookin' with the Sun, SCI: Science Camp Investigation* (online at ConnectED)
Earth's Systems	
7-MS-ESS2-4 Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. [Clarification Statement: Emphasis is on the ways water changes its state and location as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.]	**Chapters 5** Project-Based Learning Activity *Campers in the Mist* (online at ConnectED)
7-MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as condensation).]	**Chapters 7** Project-Based Learning Activity *Weather Wardrobe* (online at ConnectED)
7-MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth causes patterns of atmospheric and oceanic circulation that determine regional climates. [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation (e.g. el niño/ la niña) is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.]	**Chapters 6, 8** Project-Based Learning Activity *As the Water Churns* (online at ConnectED)

Student Performance Expectations [PE]	Chapter and Lesson References
Earth And Human Activity	
7-MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.)]	**Chapters 5, 8** Project-Based Learning Activity *Question the Experts* (online at ConnectED)
From Molecules To Organisms: Structures And Processes	
7-MS-LS1-3 Use an argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems. Systems could include circulatory, excretory, digestive, respiratory, muscular, endocrine, or nervous systems.]	**Chapters 10, 11, 12** Project-Based Learning Activity *The Knee Bone's Connected to the…* (online at ConnectED)
7-MS-LS1-6 Construct a scientific explanation based on evidence for the role of photosynthesis and cellular respiration in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.]	**Chapter 16** Project-Based Learning Activity *Sun Block* (online at ConnectED)
7-MS-LS1-7 Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.]	**Chapter 16** Project-Based Learning Activity *You Are What You Eat* (online at ConnectED)
Ecosystems: Interactions, Energy, And Dynamics	
7-MS-LS2-5 Undertake a design project that assists in maintaining diversity and ecosystem services. [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, habitat conservation or soil erosion mitigation. Examples of design solution constraints could include scientific, economic, or social considerations.]	**Chapter 17**
7-MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. [Clarification Statement: Emphasis is on recognizing patterns in data, making inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]	**Chapter 16, 17** Project-Based Learning Activity *Snake Invaders* (online at ConnectED)

Student Performance Expectations [PE]	Chapter and Lesson References
Heredity: Inheritance And Variation Of Traits	
7-MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]	**Chapters 13, 15** Project-Based Learning Activity *It's in the Cards* (online at ConnectED)
Biological Evolution: Unity And Diversity	
7-MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.* [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations about why some traits are suppressed and other traits become more prevalent for those individuals better at finding food, shelter, or avoiding predators.]	**Chapter 14** Project-Based Learning Activity *Spot On* (online at ConnectED)
7-MS-LS4-5 Gather, read, and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy) and on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]	**Chapter 14** Project-Based Learning Activity *Foods of the Future* (online at ConnectED)

Table of Contents

TABLE OF CONTENTS

Student Resources

Chapter 1

LOUISIANA 7-MS-PS1-2, 7-MS-PS1-5

Foundations of Chemistry

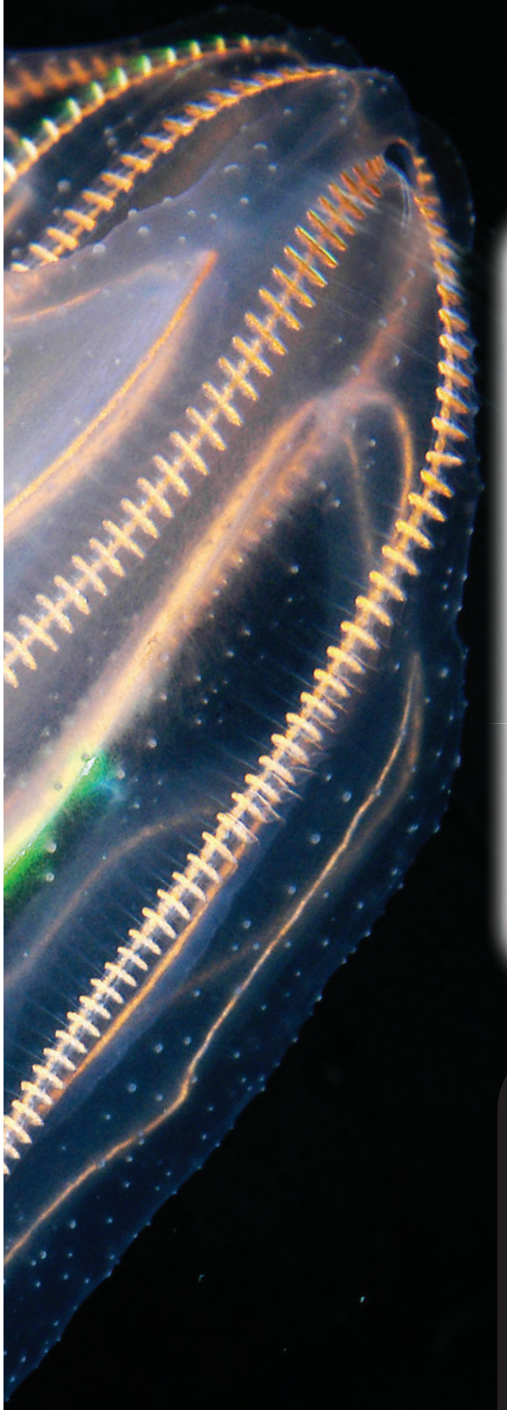
THE BIG IDEA **What is matter, and how does it change?**

Gregory G.Dimijian/Photo Reasearchers, Inc.

Inquiry Why does it glow?

This siphonophore (si FAW nuh fawr) lives in the Arctic Ocean. Its tentacles have a very powerful sting. However, the most obvious characteristic of this organism is the way it glows.

- What might cause the siphonophore to glow?
- How do you think its glow helps the siphonophore survive?
- What changes happen in the matter that makes up the organism?



Get Ready to Read

What do you think?

Before you read, decide if you agree or disagree with each of these statements. As you read this chapter, see if you change your mind about any of the statements.

1. The atoms in all objects are the same.
2. You cannot always tell by an object's appearance whether it is made of more than one type of atom.
3. The weight of a material never changes, regardless of where it is.
4. Boiling is one method used to separate parts of a mixture.
5. Heating a material decreases the energy of its particles.
6. When you stir sugar into water, the sugar and water evenly mix.
7. When wood burns, new materials form.
8. Temperature can affect the rate at which chemical changes occur.

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- LearnSmart®
- Chapter Resources Files, Reading Essentials, Get Ready to Read, Quick Vocabulary
- Animations, Videos, Interactive Tables
- Self-checks, Quizzes, Tests
- Project-Based Learning Activities
- Lab Manuals, Safety Videos, Virtual Labs & Other Tools
- Vocabulary, Multilingual eGlossary, Vocab eGames, Vocab eFlashcards
- Personal Tutors

Lesson 1

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- What is a substance?
- How do atoms of different elements differ?
- How do mixtures differ from substances?
- How can you classify matter?

Vocabulary

matter p. 9
atom p. 9
substance p. 11
element p. 11
compound p. 12
mixture p. 13
heterogeneous mixture p. 13
homogeneous mixture p. 13
dissolve p. 13

Multilingual eGlossary

BrainPOP®
Science Video
What's Science Got to do With It?

Classifying Matter

Inquiry Making Green?

You probably have mixed paints together. Maybe you wanted green paint and had only yellow paint and blue paint. Perhaps you watched an artist mixing several tints get the color he or she needed. In all these instances, the final color came from mixing colors together and not from changing the color of a paint.

Magdevski/Getty Images

Launch Lab

15 minutes

How do you classify matter?

An object made of paper bound together might be classified as a book. Pointed metal objects might be classified as nails or needles. How can you classify an item based on its description?

1. Read and complete a lab safety form.
2. Place the **objects** on a table. Discuss how you might separate the objects into groups with these characteristics:
   a. Every object is the same and has only one part.
   b. Every object is the same but is made of more than one part.
   c. Individual objects are different. Some have one part, and others have more than one part.
3. Identify the objects that meet the requirements for group *a,* and record them in your Science Journal. Repeat with groups *b* and *c.* Any object can be in more than one group.

Think About This

1. Does any object from the bag belong in all three of the groups (*a, b,* and *c*)? Explain.
2. What objects in your classroom would fit into group *b?*
3. **Key Concept** What descriptions would you use to classify items around you?

Understanding Matter

Have you ever seen a rock like the one in **Figure 1?** Why are different parts of the rock different in color? Why might some parts of the rock feel harder than other parts? The parts of the rock look and feel different because they are made of different types of matter. **Matter** *is anything that has mass and takes up space.* If you look around, you will see many types of matter. If you are in a classroom, you might see things made of metal, wood, or plastic. If you go to a park, you might see trees, soil, or water in a pond. If you look up at the sky, you might see clouds and the Sun. All of these things are made of matter.

Everything you can see is matter. However, some things you cannot see also are matter. Air, for example, is matter because it has mass and takes up space. Sound and light are not matter. Forces and energy also are not matter. To decide whether something is matter, ask yourself if it has mass and takes up space.

An **atom** *is a small particle that is a building block of matter.* In this lesson, you will explore the parts of an atom and read how atoms can differ. You will also read how different arrangements of atoms make up the many types of matter.

Word Origin

matter
from Latin materia, meaning "material, stuff"

Figure 1 You can see different types of matter in this rock.

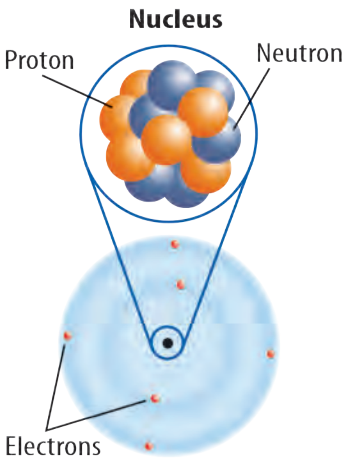


Figure 2 An atom has electrons moving in an area outside a nucleus. Protons and neutrons make up the nucleus.

Personal Tutor

Atoms

To understand why there are so many types of matter, it helps if you first learn about the parts of an atom. Look at the diagram of an atom in **Figure 2.** At the center of an atom is a nucleus. Protons, which have a positive charge, and neutrons, which have a neutral charge, make up the nucleus. Negatively charged particles, or electrons, move quickly throughout an area around the nucleus called the electron cloud.

Reading Check What are the parts of an atom?

Not all atoms have the same number of protons, neutrons, and electrons. Atoms that have different numbers of protons differ in their properties. You will read more about the differences in atoms on the next page.

An atom is almost too small to imagine. Think about how thin a human hair is. The diameter of a human hair is about a million times greater than the diameter of an atom. In addition, an atom is about 10,000 times wider than its nucleus! Even though atoms are so tiny, they determine the properties of the matter they compose.

MiniLab

20 minutes

How can you model an atom?

How can you model an atom out of its three basic parts?

1. Read and complete a lab safety form.
2. Twist the ends of a piece of **florist wire** together to form a ring. Attach two **wires** across the ring to form an *X*.
3. Use **double-sided tape** to join the **large pom-poms** (protons and neutrons), forming a nucleus. Hang the nucleus from the center of the *X* with **fishing line.**
4. Use fishing line to suspend each **small pom-pom** (electron) from the ring so they surround the nucleus.
5. Suspend your model as instructed by your teacher.

Hutchings Photography/Digital Light Source

Analyze and Conclude

1. **Infer** Based on your model, what can you infer about the relative sizes of protons, neutrons, and electrons?
2. **Model** Why is it difficult to model the location of electrons?
3. **Key Concept** Compare your atom with those of other groups. How do they differ?

Substances

You can see that atoms make up most of the matter on Earth. Atoms can combine and arrange in millions of different ways. In fact, these different combinations and arrangements of atoms are what makes up the various types of matter. There are two main classifications of matter–substances and mixtures.

A **substance** *is matter with a composition that is always the same.* This means that a given substance is always made up of the same combination(s) of atoms. Aluminum, oxygen, water, and sugar are examples of substances. Any sample of aluminum is always made up of the same type of atoms, just as samples of oxygen, sugar, and water each are always made of the same combinations of atoms. To gain a better understanding of what makes up substances, let's take a look at the two types of substances–elements and compounds.

Key Concept Check What is a substance?

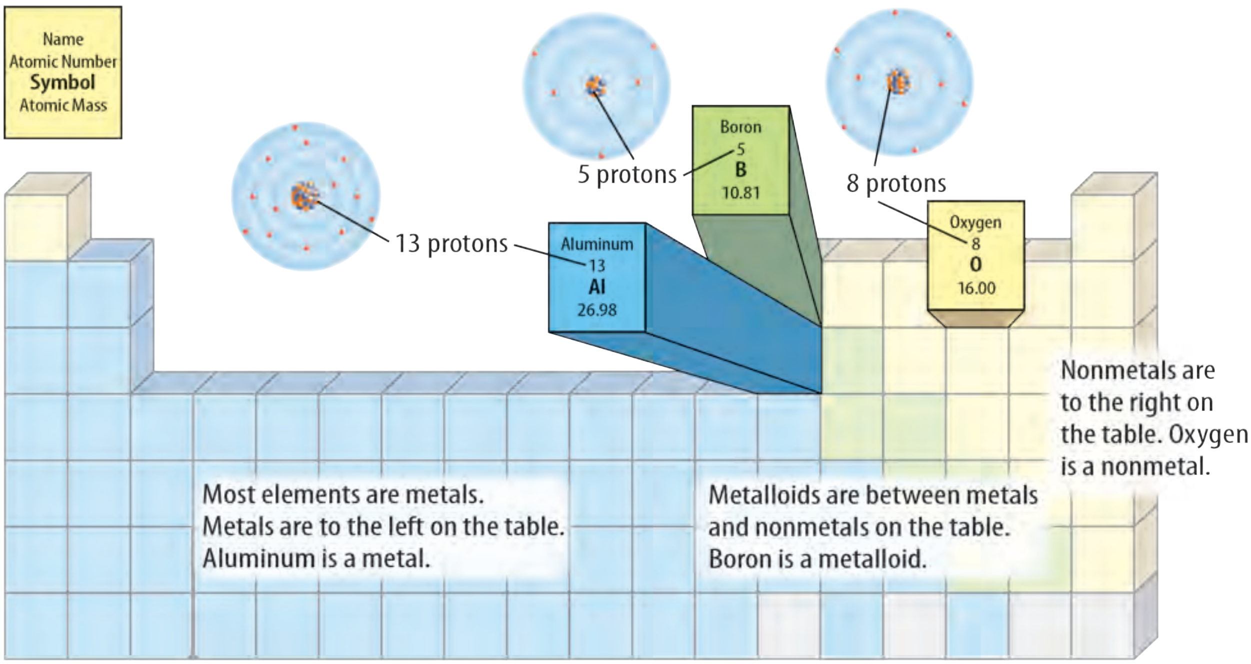
Elements

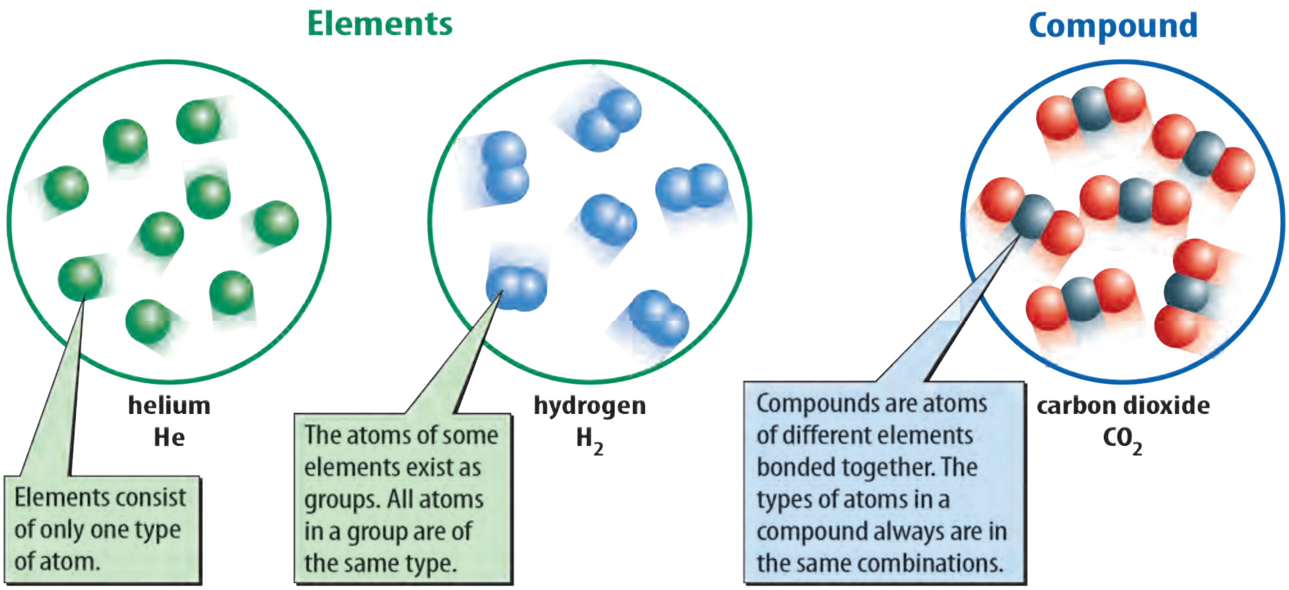
Look at the periodic table of elements on the inside back cover of this book. The substances oxygen and aluminum are on the table. They are both elements. *An* **element** *is a substance that consists of just one type of atom.* Because there are 118 known elements, there are 118 different types of atoms. Each type of atom contains a different number of protons in its nucleus. For example, each aluminum atom has 13 protons in its nucleus. The number of protons in an atom is the atomic number of the element. Therefore, the atomic number of aluminum is 13, as shown in **Figure 3.**

The atoms of most elements exist as individual atoms. For example, a roll of pure aluminum foil consists of trillions of individual aluminum atoms. However, the atoms of some elements usually exist in groups. For example, the oxygen atoms in air exist in pairs. Whether the atoms of an element exist individually or in groups, each element contains only one type of atom. Therefore, its composition is always the same.

Key Concept Check How do atoms of different elements differ?

Figure 3 Each element on the periodic table consists of just one type of atom.

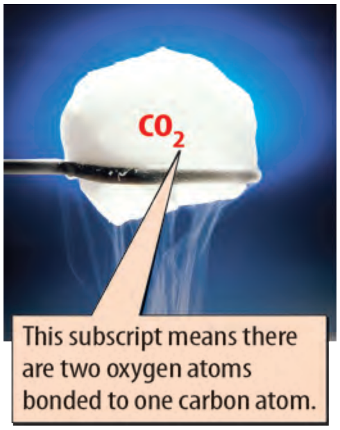




▲ **Figure 4** If a substance contains only one type of atom, it is an element. If it contains more than one type of atom, it is a compound.

Personal Tutor

Figure 5 Carbon dioxide is a compound composed of carbon and oxygen atoms. ▼



Compounds

Water is a substance, but it is not an element. It is a compound. *A* **compound** *is a type of substance containing atoms of two or more different elements chemically bonded together.* As shown in **Figure 4,** carbon dioxide (CO_2) is also a compound. It consists of atoms of two different elements, carbon (C) and oxygen (O), bonded together. Carbon dioxide is a substance because the C and the O atoms are always combined in the same way.

Chemical Formulas The combination of symbols and numbers that represents a compound is called a chemical formula. Chemical formulas show the different atoms that make up a compound, using their element symbols. Chemical formulas also help explain how the atoms combine. As illustrated in **Figure 5,** CO_2 is the chemical formula for carbon dioxide. The formula shows that carbon dioxide is made of C and O atoms. The small *2* is called a subscript. It means that two oxygen atoms and one carbon atom form carbon dioxide. If no subscript is written after a symbol, one atom of that element is present in the chemical formula.

Properties of Compounds Think again about the elements carbon and oxygen. Carbon is a black solid, and oxygen is a gas that enables fuels to burn. However, when they chemically combine, they form the compound carbon dioxide, which is a gas used to extinguish fires. A compound often has different properties from the individual elements that compose it. Compounds, like elements, are substances, and all substances have their own **unique** properties.

ACADEMIC VOCABULARY

unique
(adjective) having nothing else like it

Charles D. Winters/Science Source

Mixtures

Another classification of matter is mixtures. *A* **mixture** *is matter that can vary in composition.* Mixtures are combinations of two or more substances that are physically blended together. The amounts of the substances can vary in different parts of a mixture and from mixture to mixture. Think about sand mixed with water at the beach. The sand and the water do not bond together. Instead, they form a mixture. The substances in a mixture do not combine chemically. Therefore, they can be separated by physical methods, such as filtering.

Heterogeneous Mixtures

Mixtures can differ depending on how well the substances that make them up are mixed. Sand and water at the beach form a mixture, but the sand is not evenly mixed throughout the water. Therefore, sand and water form a heterogeneous mixture. *A* **heterogeneous mixture** *is a type of mixture in which the individual substances are not evenly mixed.* Because the substances in a heterogeneous mixture are not evenly mixed, two samples of the same mixture can have different amounts of the substances, as shown in **Figure 6.** For example, if you fill two buckets with sand and water at the beach, one bucket might have more sand in it than the other.

Homogeneous Mixtures

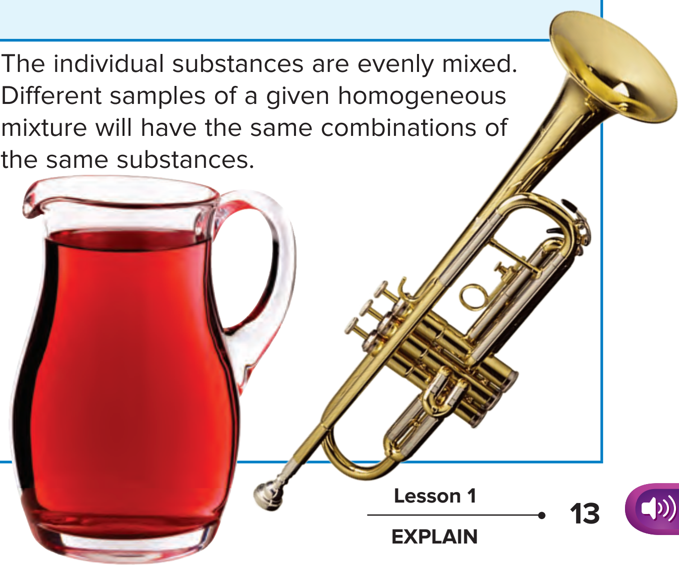
Unlike a mixture of water and sand, the substances in mixtures such as apple juice, air, or salt water are evenly mixed. *A* **homogeneous mixture** *is a type of mixture in which the individual substances are evenly mixed.* In a homogeneous mixture, the particles of individual substances are so small and well-mixed that they are not visible, even with most high-powered microscopes.

A homogeneous mixture also is known as a solution. In a solution, the substance present in the largest amount is called the solvent. All other substances in a solution are called solutes. The solutes dissolve in the solvent. *To* **dissolve** *means to form a solution by mixing evenly.* Because the substances in a solution, or homogeneous mixture, are evenly mixed, two samples from a solution will have the same amounts of each substance. For example, imagine pouring two glasses of apple juice from the same container. Each glass will contain the same substances (water, sugar, and other substances) in the same amounts. However, because apple juice is a mixture, the amounts of the substances from one container of apple juice to another might vary.

Key Concept Check How do mixtures differ from substances?

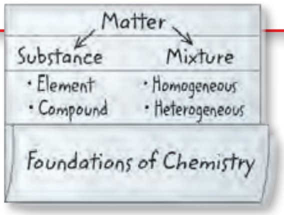
Figure 6 Types of mixtures differ in how evenly their substances are mixed.

Heterogeneous Mixture	Homogeneous Mixture
• The individual substances are not evenly mixed. • Different samples of a given heterogeneous mixture can have different combinations of the same substances.	• The individual substances are evenly mixed. • Different samples of a given homogeneous mixture will have the same combinations of the same substances.



FOLDABLES®

Use three sheets of copy paper to make a layered Foldable. Cut and label the tabs as illustrated. Use this Foldable to summarize the lesson.



Compounds v. Solutions

If you have a glass of pure water and a glass of salt water, can you tell which is which just by looking at them? You cannot. Both the compound (water) and the solution (salt water) appear identical. How do compounds and solutions differ?

Because water is a compound, its composition does not vary. Pure water is always made up of the same atoms in the same combinations. Therefore, a chemical formula can be used to describe the atoms that make up water (H_2O). Salt water is a homogeneous mixture, or solution. The solute (NaCl) and the solvent (H_2O) are evenly mixed but are not bonded together. Adding more salt or more water only changes the relative amounts of the substances. In other words, the composition varies. Because composition can vary in a mixture, a chemical formula cannot be used to describe mixtures.

Summarizing Matter

You have read in this lesson about classifying matter by the arrangement of its atoms. **Figure 7** is a summary of this classification system.

Key Concept Check How can you classify matter?

Figure 7 Scientists classify matter according to the arrangement of the atoms that make up the matter.

Classifying Matter

Matter
- Anything that has mass and takes up space
- Matter on Earth is made up of atoms.
- Two classifications of matter: substances and mixtures

Substances
- Matter with a composition that is always the same
- Two types of substances: elements and compounds

Element
- Consists of just one type of atom
- Organized on the periodic table
- Each element has a chemical symbol.

Compound
- Two or more types of atoms bonded together
- Properties are different from the properties of the elements that make it up
- Each compound has a chemical formula.

Substances physically combine to form mixtures.

Mixtures can be separated into substances by physical methods.

Mixtures
- Matter that can vary in composition
- Substances are not bonded together.
- Two types of mixtures: heterogeneous and homogeneous

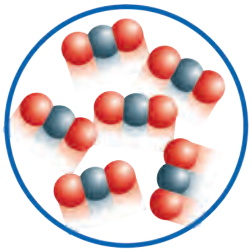
Heterogeneous Mixture
- Two or more substances unevenly mixed
- Different substances are visible by an unaided eye or a microscope.

Homogeneous Mixture—Solution
- Two or more substances evenly mixed
- Different substances cannot be seen even by a microscope.

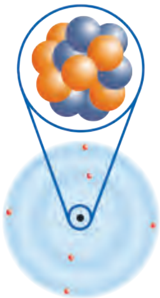
Lesson 1 Review

Online Quiz

Visual Summary



A substance has the same composition throughout. A substance is either an element or a compound.



An atom is the smallest part of an element that has its properties. Atoms contain protons, neutrons, and electrons.

The substances in a mixture are not chemically combined. Mixtures can be either heterogeneous or homogeneous.

FOLDABLES®

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

What do you think NOW?

You first read the statements below at the beginning of the chapter.

1. The atoms in all objects are the same.

2. You cannot always tell by an object's appearance whether it is made of more than one type of atom.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1. Substances and mixtures are two types of __________.
2. **Use the term** *atom* in a complete sentence.
3. **Define** *dissolve* in your own words.

Understand Key Concepts

4. **Explain** why aluminum is a substance.
5. The number of __________ always differs in atoms of different elements.
   - **A.** electrons
   - **B.** protons
   - **C.** neutrons
   - **D.** nuclei
6. **Distinguish** between a heterogeneous mixture and a homogeneous mixture.
7. **Classify** Which term describes matter that is a substance made of different kinds of atoms bonded together?

Interpret Graphics

8. **Describe** what each letter and number means in the chemical formula below.

$$C_6H_{12}O_6$$

9. **Organize Information** Copy and fill in the graphic organizer below to classify matter by the arrangement of its atoms.

Type of Matter	Description

Critical Thinking

10. **Reorder** the elements aluminum, oxygen, fluorine, calcium, and hydrogen from the least to the greatest number of protons. Use the periodic table if needed.
11. **Evaluate** this statement: Substances are made of two or more types of elements.

sonsam/Getty Images

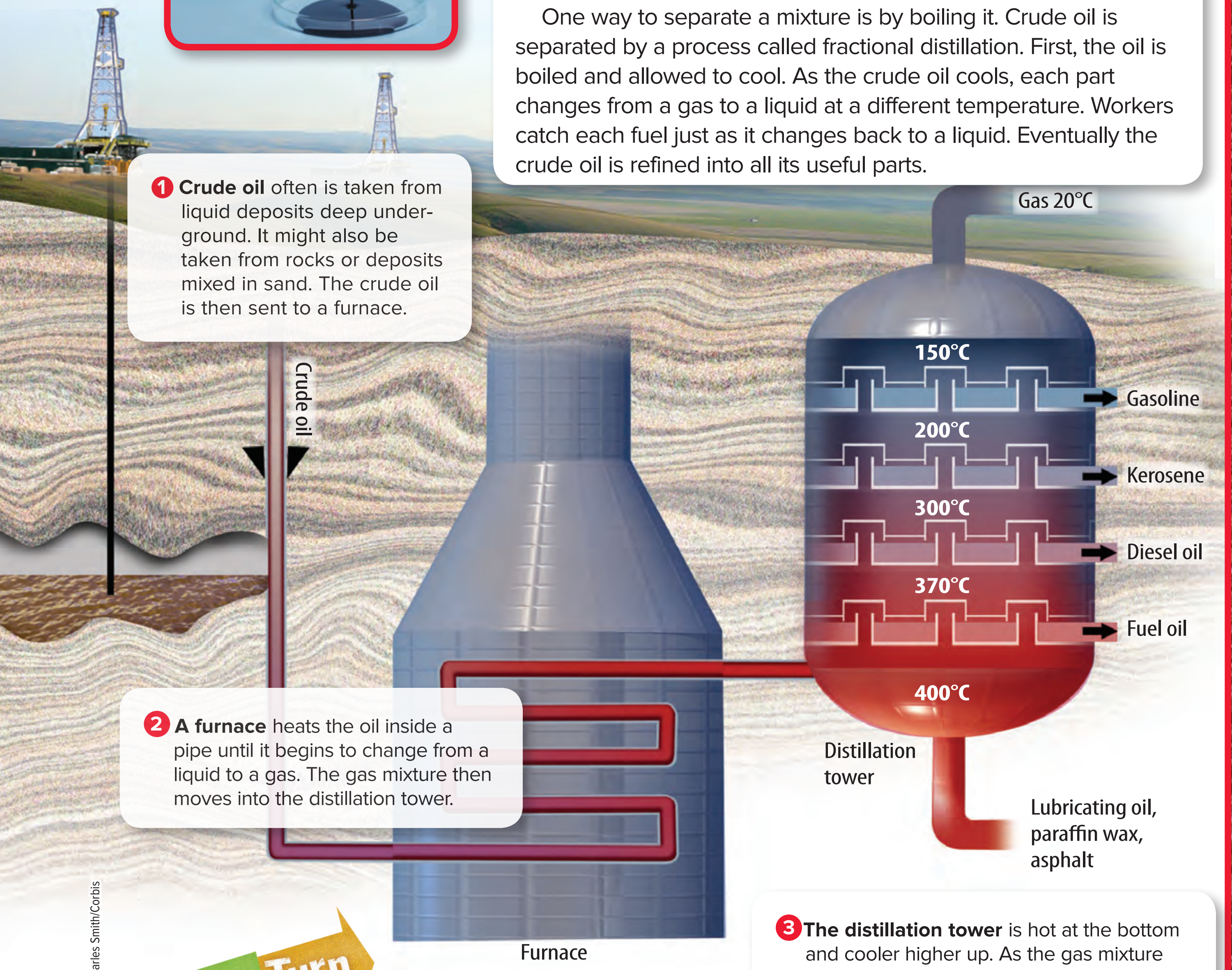
Crude Oil

HOW IT WORKS

Separating Out Gasoline

Have you ever wondered where the gasoline used in automobiles comes from? Gasoline is part of a mixture of fuels called crude oil. How can workers separate gasoline from this mixture?

One way to separate a mixture is by boiling it. Crude oil is separated by a process called fractional distillation. First, the oil is boiled and allowed to cool. As the crude oil cools, each part changes from a gas to a liquid at a different temperature. Workers catch each fuel just as it changes back to a liquid. Eventually the crude oil is refined into all its useful parts.



1 **Crude oil** often is taken from liquid deposits deep underground. It might also be taken from rocks or deposits mixed in sand. The crude oil is then sent to a furnace.

2 **A furnace** heats the oil inside a pipe until it begins to change from a liquid to a gas. The gas mixture then moves into the distillation tower.

3 **The distillation tower** is hot at the bottom and cooler higher up. As the gas mixture rises to fill the tower, it cools. It also passes over trays at different levels. Each fuel in the mixture changes to a liquid when it cools to a temperature that matches its boiling point. Gasoline changes to a liquid at the level in the tower at 150°C. A tray then catches the gasoline and moves it away.

It's Your Turn

DEVELOP AND USE A MODEL Blood is a mixture, too. Donated blood is often refined in laboratories to separate it into parts. Research how blood is separated. Using blood as an example, develop a model to compare and contrast pure substances and mixtures. Identify examples of elements, compounds, homogeneous mixtures, and heterogeneous mixtures in blood.

Lesson 2

Reading Guide

Key Concepts
ESSENTIAL QUESTIONS

- What are some physical properties of matter?
- How are physical properties used to separate mixtures?

Vocabulary
physical property p. 18
mass p. 20
density p. 21
solubility p. 22

Multilingual eGlossary

Science Video

Physical Properties

Fuse/Getty Images, (inset)Mike Perry/Alamy

Inquiry Panning by Properties?

The man lowers his pan into the waters of a river and scoops up a mixture of water, sediment, and hopefully gold. As he moves the pan in a circle, water sloshes out of it. If he is careful, gold will remain in the pan after the water and sediment are gone. What properties of water, sediment, and gold enable this man to separate this mixture?

Launch Lab

15 minutes

Can you follow the clues?

Clues are bits of information that help you solve a mystery. In this activity, you will use clues to help identify an object in the classroom.

1. Read and complete a lab safety form.
2. Select one **object** in the room. Write a different clue about the object on each of five **index cards.** Clues might include one or two words that describe the object's color, size, texture, shape, or any property you can observe with your senses.
3. Stack your cards face down. Have your partner turn over one card and try to identify the object. Respond either "yes" or "no."
4. Continue turning over cards until your partner identifies your object or runs out of cards. Repeat for your partner's object.

Think About This

1. What kind of clues are the most helpful in identifying an object?
2. How would your clues change if you were describing a substance, such as iron or water, rather than an object?
3. **Key Concept** How do you think you use similar clues in your daily life?

Physical Properties

REVIEW VOCABULARY

property
a characteristic used to describe something

As you read in Lesson 1, the arrangement of atoms determines whether matter is a substance or a mixture. The arrangement of atoms also determines the **properties** of different types of matter. Each element and compound has a unique set of properties. When substances mix together and form mixtures, the properties of the substances that make up the mixture are still present.

You can observe some properties of matter, and other properties can be measured. For example, you can see that gold is shiny, and you can find the mass of a sample of iron. Think about how you might describe the different substances and mixtures in the photo on the previous page. Could you describe some of the matter in the photo as a solid or a liquid? Why do the water and the rocks leave the pan before the gold does? Could you describe the mass of the various items in the photo? Each of these questions asks about the physical properties of matter. *A* **physical property** *is a characteristic of matter that you can observe or measure without changing the identity of the matter.* There are many types of physical properties, and you will read about some of them in this lesson.

States of Matter

How do aluminum, water, and air differ? Recall that aluminum is an element, water is a compound, and air is a mixture. How else do these three types of matter differ? At room temperature, aluminum is a solid, water is a liquid, and air is a gas. Solids, liquids, and gases are called states of matter. The state of matter is a physical property of matter. Substances and mixtures can be solids, liquids, or gases. For example, water in the ocean is a liquid, but water in an iceberg is a solid. In addition, water vapor in the air above the ocean is a gas.

Did you know that the particles, or atoms and groups of atoms, that make up all matter are constantly moving and are attracted to each other? Look at your pencil. It is made up of trillions of moving particles. Every solid, liquid, and gas around you is made up of moving particles that attract one another. What makes some matter a solid and other matter a liquid or a gas? It depends on how close the particles in the matter are to one another and how fast they move, as shown in **Figure 8.**

Reading Check How do solids, liquids, and gases differ?

FOLDABLES®

Make a vertical two-tab book. Record what you learn about different states of matter under the tabs.

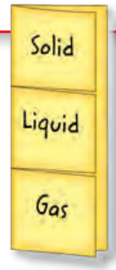
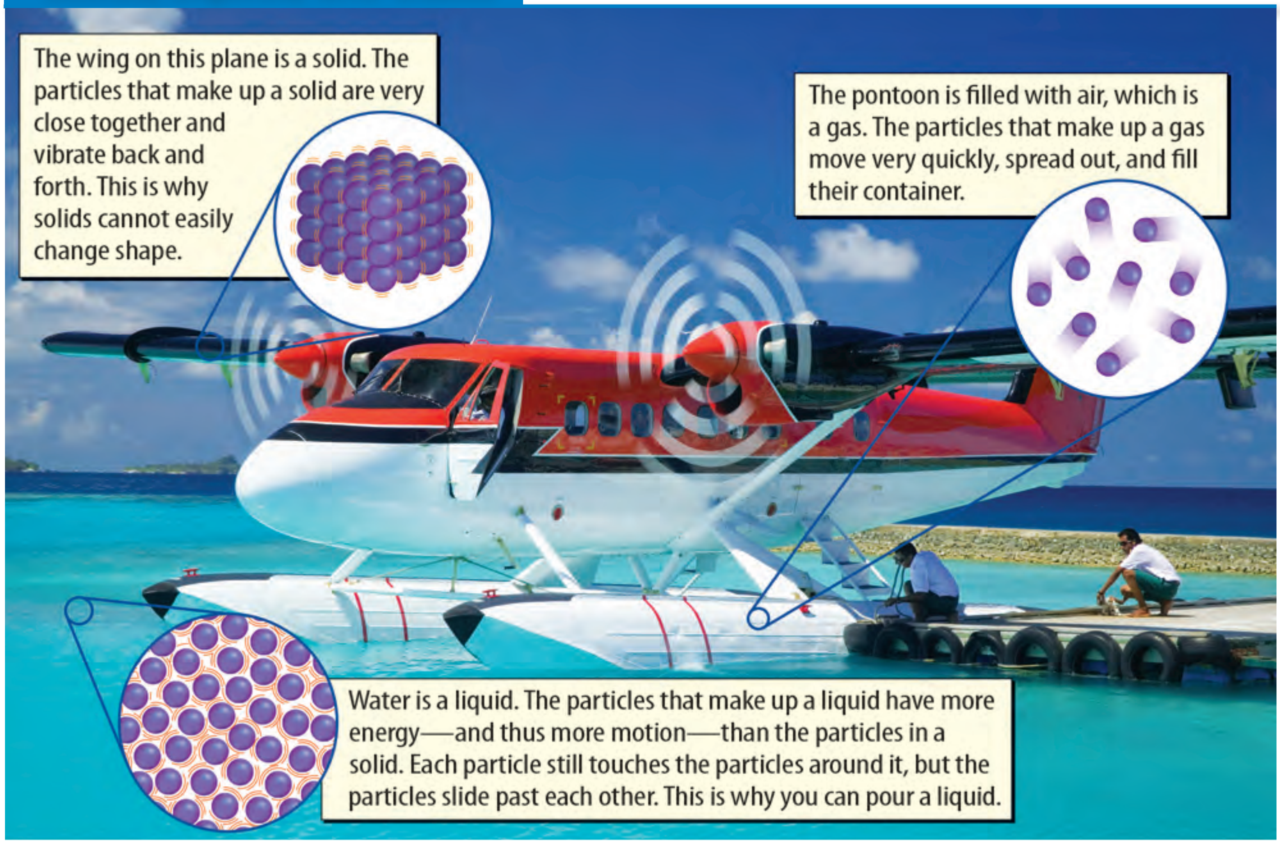


Figure 8 The three common states of matter on Earth are solid, liquid, and gas.

Solids, Liquids, and Gases

Animation



Rob Rae/age fotostock

Visual Check Which state of matter flows, keeps the same volume, and takes the shape of its container?

Figure 9 The larger dumbbells have greater mass than the smaller dumbbells because they contain more matter.

Size-Dependent Properties

State is only one of many physical properties that you can use to describe matter. Some physical properties, such as mass and volume, depend on the size or amount of matter. Measurements of these properties vary depending on how much matter is in a sample.

Mass Imagine holding a small dumbbell in one hand and a larger one in your other hand. What do you notice? The larger dumbbell is heavier. The larger dumbbell has more mass than the smaller one. **Mass** *is the amount of matter in an object.* Both small dumbbells shown in **Figure 9** have the same mass because they both contain the same amount of matter. Mass is a size-dependent property of a given substance because its value depends on the size of a sample.

Mass sometimes is confused with weight, but they are not the same. Mass is the amount of matter in something. Weight is the pull of gravity on that matter. Weight changes with location, but mass does not. Suppose one of the dumbbells in the figure was on the Moon. The dumbbell would have the same mass on the Moon that it has on Earth. However, the Moon's gravity is much less than Earth's gravity, so the weight of the dumbbell would be less on the Moon.

MiniLab

20 minutes

Can the weight of an object change?

When people go on a diet, both their mass and weight might change. Can the weight of an object change without changing its mass? Let's find out.

1. Read and complete a lab safety form.
2. Use a **balance** to find the mass of five **metal washers.** Record the mass in grams in your Science Journal.
3. Hang the washers from the hook on a **spring scale.** Record the weight in newtons.
4. Lower just the washers into a **500-mL beaker** containing approximately 300 mL water. Record the weight in newtons.

Analyze and Conclude

1. **Draw Conclusions** Did the weight of the washers change during the experiment? How do you know?
2. **Predict** In what other ways might you change the weight of the washers?
3. **Key Concept** What factors affect the weight of an object, but not its mass?

Volume Another physical property that depends on the size or the amount of a substance is volume. A unit often used to measure volume is the milliliter (mL). Volume is the amount of space something takes up. Suppose a full bottle of water contains 400 mL of water. If you pour exactly half of the water out, the bottle contains half of the original volume, or 200 mL, of water.

Reading Check What is a common unit for volume?

Size-Independent Properties

Unlike mass, weight, and volume, some physical properties of a substance do not depend on the amount of matter present. These properties are the same for both small samples and large samples. They are called size-independent properties. Examples of size-independent properties are melting point, boiling point, density, electrical conductivity, and solubility.

Melting Point and Boiling Point The temperature at which a substance changes from a solid to a liquid is its melting point. The temperature at which a substance changes from a liquid to a gas is its boiling point. Different substances have different boiling points and melting points. The boiling point for water is 100°C at sea level. Notice in **Figure 10** that this temperature does not depend on how much water is in the container.

Density Imagine holding a bowling ball in one hand and a foam ball of the same size in the other. The bowling ball is heavier because the density of the material that makes up the bowling ball is greater than the density of foam. **Density** *is the mass per unit volume of a substance.* Like melting point and boiling point, density is a size-independent property.

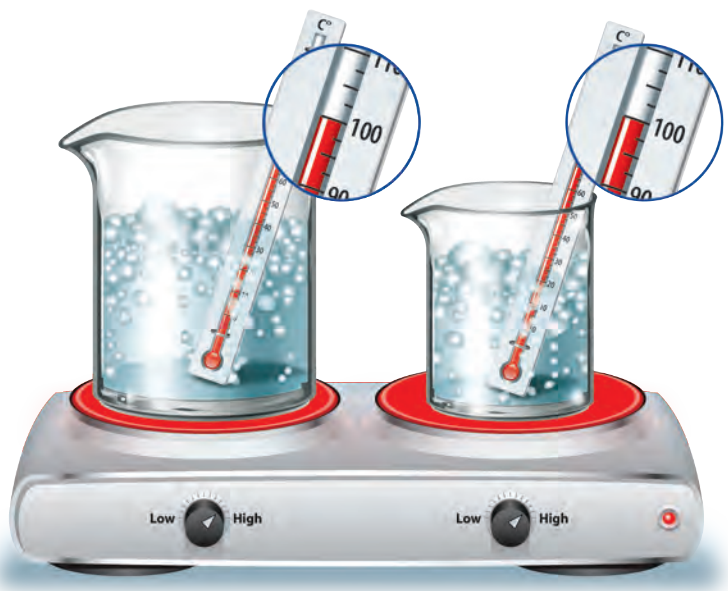


Figure 10 The boiling point of water is 100°C at sea level. The boiling point does not change for different volumes of water.

Math Skills

Use Ratios
When you compare two numbers by division, you are using a ratio. Density can be written as a ratio of mass and volume. What is the density of a substance if a 5-mL sample has a mass of 25 g?

1. Set up a ratio.
$$\frac{\text{mass}}{\text{volume}} = \frac{25\text{ g}}{5\text{ mL}}$$

2. Divide the numerator by the denominator to get the mass (in g) of 1 mL.
$$\frac{25\text{ g}}{5\text{ mL}} = \frac{5\text{ g}}{1\text{ mL}}$$

3. The density is 5 g/mL.

Practice
A sample of wood has a mass of 12 g and a volume of 16 mL. What is the density of the wood?

Math Practice

Personal Tutor

Word Origin
density
from Latin *densus,* means "compact"; and Greek *dasys,* means "thick"

Conductivity Another property that is independent of the sample size is conductivity. Electrical conductivity is the ability of matter to conduct, or carry along, an electric current. Copper often is used for electrical wiring because it has high electrical conductivity. Thermal conductivity is the ability of a material to conduct thermal energy. Metals tend to have high electrical and thermal conductivity. Stainless steel, for example, often is used to make cooking pots because of its high thermal conductivity. However, the handles on the pan probably are made out of wood, plastic, or some other substance that has low thermal conductivity.

Reading Check What are two types of conductivity?

Solubility Have you ever made lemonade by stirring a powdered drink mix into water? As you stir, the powder mixes evenly in the water. In other words, the powder dissolves in the water.

What do you think would happen if you tried to dissolve sand in water? No matter how much you stir, the sand does not dissolve. **Solubility** *is the ability of one substance to dissolve in another.* The powdered drink mix is soluble in water, but sand is not. **Table 1** explains how physical properties such as conductivity and solubility can be used to identify objects and separate mixtures.

Key Concept Check What are five different physical properties of matter?

Table 1 This table contains the descriptions of several physical properties. It also shows examples of how physical properties can be used to separate mixtures.

Visual Check How might you separate a mixture of iron filings and salt?

Table 1 Physical Properties of Matter

	Property		
	Mass	**Conductivity**	**Volume**
			
Description of property	The amount of matter in an object	The ability of matter to conduct, or carry along, electricity or heat	The amount of space something occupies
Size-dependent or size-independent	Size-dependent	Size-independent	Size-dependent
How the property is used to separate a mixture (example)	Mass typically is not used to separate a mixture.	Conductivity typically is not used to separate a mixture.	Volume could be used to separate mixtures whose parts can be separated by filtration.

Separating Mixtures

In Lesson 1, you read about different types of mixtures. Recall that the substances that make up mixtures are not held together by chemical **bonds.** When substances form a mixture, the properties of the individual substances do not change. One way that a mixture and a compound differ is that the parts of a mixture often can be separated by physical properties. For example, when salt and water form a solution, the salt and the water do not lose any of their individual properties. Therefore, you can separate the salt from the water by using differences in their physical properties. Water has a lower boiling point than salt. If you boil salt water, the water will boil away, and the salt will be left behind. Other physical properties that can be used to separate different mixtures are described in **Table 1.**

Physical properties cannot be used to separate a compound into the elements it contains. The atoms that make up a compound are bonded together and cannot be separated by physical means. For example, you cannot separate the hydrogen atoms from the oxygen atoms in water by boiling water.

SCIENCE USE V. COMMON USE

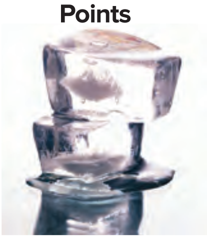
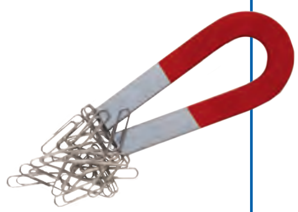
bond

Science Use a force between atoms or groups of atoms

Common Use a monetary certificate issued by a government or a business that earns interest

Key Concept Check How are physical properties used to separate mixtures?

Interactive Table

Property				
Boiling/Melting Points 	**State of matter** 	**Density** 	**Solubility** 	**Magnetism** 
The temperature at which a material changes state	Whether something is a solid, a liquid, or a gas	The amount of mass per unit of volume	The ability of one substance to dissolve in another	Attractive force for some metals, especially iron
Size-independent	Size-independent	Size-independent	Size-independent	Size-independent
Each part of a mixture will boil or melt at a different temperature.	A liquid can be poured off a solid.	Objects with greater density sink in objects with less density.	Dissolve a soluble material to separate it from a material with less solubility.	Attract iron from a mixture of materials.

Lesson 2 Review

Online Quiz

Visual Summary

A physical property is a characteristic of matter that can be observed or measured without changing the identity of the matter.

Examples of physical properties include mass, density, volume, melting point, boiling point, state of matter, and solubility.

Many physical properties can be used to separate the components of a mixture.

FOLDABLES®

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

What do you think NOW?

You first read the statements below at the beginning of the chapter.

3. The weight of a material never changes, regardless of where it is.

4. Boiling is one method used to separate parts of a mixture.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

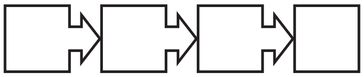
1. **Distinguish** between mass and weight.
2. **Use the term** *solubility* in a sentence.
3. An object's _________ is the amount of mass per a certain unit of volume.

Understand Key Concepts

4. **Explain** how to separate a mixture of sand and pebbles.
5. Which physical property is NOT commonly used to separate mixtures?
   - **A.** magnetism
   - **B.** conductivity
   - **C.** density
   - **D.** solubility
6. **Analyze** Name two size-dependent properties and two size-independent properties of an iron nail.

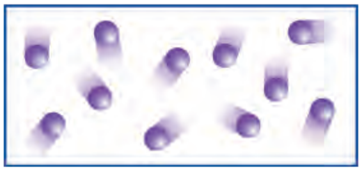
Interpret Graphics

7. **Sequence** Draw a graphic organizer like the one below to show the steps in separating a mixture of sand, iron filings, and salt.



Critical Thinking

8. **Examine** the diagram below.



How can you identify the state of matter represented by the diagram?

Math Skills

Math Practice

9. A piece of copper has a volume of 100.0 cm^3. If the mass of the copper is 890 g, what is the density of copper?

How can following a procedure help you solve a crime?

Materials

Plastic sealable bag

triple-beam balance

50-mL graduated cylinder

paper towels

Also needed:

Crime Scene Objects

Safety

Imagine that you are investigating a crime scene. You find several pieces of metal and broken pieces of plastic that look as if they came from a car's tail light. You also have similar objects collected from the suspect. How can you figure out if they are parts of the same objects?

Learn It

To be sure you do the same tests on each object, it is helpful to **follow a procedure.** A procedure tells you how to use the materials and what steps to take.

Try It

1. Read and complete a lab safety form.
2. Copy the table below into your Science Journal.
3. Use the balance to find the mass of an object from the crime scene. Record the mass in your table.
4. Place about 25 mL of water in a graduated cylinder. Read and record the exact volume. Call this volume V_1.
5. Carefully tilt the cylinder, and allow one of the objects to slide into the water. Read and record the volume. Call this volume V_2.
6. Repeat steps 3–5 for each of the other objects.

Apply It

7. Complete the table by calculating the volume and the density of each object.
8. What conclusions can you draw about the objects collected from the crime scene and those collected from the suspect?
9. **Key Concept** How could you use this procedure to help identify and compare various objects?

Object	Mass (M) (g)	V_1 (mL)	V_2 (mL)	Volume of Object (V) ($V_2 - V_1$) (mL)	Density of Object M/V (g/mL)
1					
2					
3					
4					
5					
6					

Lesson 3

Physical Changes

John Terence Turner/Taxi/Getty Images

Reading Guide

Key Concepts

ESSENTIAL QUESTIONS

- How can a change in energy affect the state of matter?
- What happens when something dissolves?
- What is meant by conservation of mass?

Vocabulary

physical change p. 27

Multilingual eGlossary

Inquiry Change by Chipping?

This artist is changing a piece of wood into an instrument that will make beautiful music. He planned and chipped, measured and shaped. Chips of wood flew, and rough edges became smooth. Although the wood changed shape, it remained wood. Its identity did not change, just its form.

Launch Lab

20 minutes

Where did it go?

When you dissolve sugar in water, where does the sugar go? One way to find out is to measure the mass of the water and the sugar before and after mixing.

1. Read and complete a lab safety form.
2. Add **sugar** to a **small paper cup** until the cup is approximately half full. Bend the cup's opening, and pour the sugar into a **balloon.**
3. With the balloon hanging over the side, stretch the neck of the balloon over a **flask** half full of **water.**
4. Use a **balance** to find the mass of the flask-and-balloon assembly. Record the mass in your Science Journal.
5. Lift the end of the balloon, and empty the sugar into the flask. Swirl until the sugar dissolves. Measure and record the mass of the flask-and-balloon assembly again.

Think About This

1. Is the sugar still present after it dissolves? How do you know?
2. **Key Concept** Based on your observations, what do you think happens to the mass of objects when they dissolve? Explain.

Physical Changes

How would you describe water? If you think about water in a stream, you might say that it is a cool liquid. If you think about water as ice, you might describe it as a cold solid. How would you describe the change from ice to water? As ice melts, some of its properties change, such as the state of matter, the shape, and the temperature, but it is still water. In Lesson 2, you read that substances and mixtures can be solids, liquids, or gases. In addition, substances and mixtures can change from one state to another. *A* **physical change** *is a change in size, shape, form, or state of matter in which the matter's identity stays the same.* During a physical change, the matter does not become something different even though physical properties change.

Change in Shape and Size

Think about changes in the shapes and the sizes of substances and mixtures you experience each day. When you chew food, you are breaking it into smaller pieces. This change in size helps make food easier to digest. When you pour juice from a bottle into a glass, you are changing the shape of the juice. If you fold clothes to fit them into a drawer, you are changing their shapes. Changes in shape and size are physical changes. The identity of the matter has not changed.

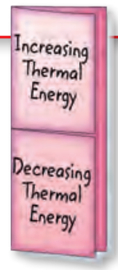
Word Origin

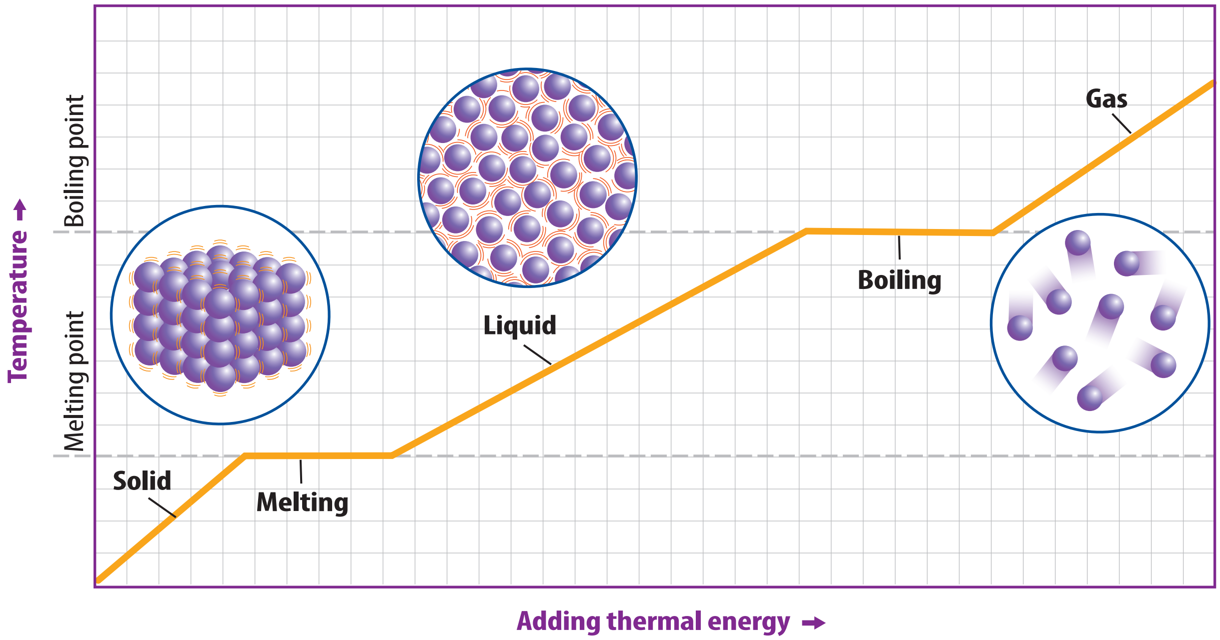
physical
from Greek *physika,* means "natural things"

change
from Latin *cambire,* means "to exchange"

FOLDABLES®

Make a vertical two-tab book. Label the tabs as illustrated. Record specific examples illustrating how adding or releasing thermal energy results in physical change.





▲ **Figure 11** As thermal energy is added to a material, temperature increases when the state of the material is not changing. Temperature stays the same during a change of state.

Animation

Figure 12 Solid iodine undergoes sublimation. It changes from a solid to a gas without becoming a liquid. ▼

Change in State of Matter

Why does ice melt in your hand? Or, why does water turn to ice in the freezer? Matter, such as water, can change state. Recall from Lesson 2 how the particles in a solid, a liquid, and a gas behave. To change the state of matter, the movement of the particles has to change. In order to change the movement of particles, thermal energy must be either added or removed.

Adding Thermal Energy When thermal energy is added to a solid, the particles in the solid move faster and faster, and the temperature increases. As the particles move faster, they are more likely to overcome the attractive forces that hold them tightly together. When the particles are moving too fast for attractive forces to hold them tightly together, the solid reaches its melting point. The melting point is the temperature at which a solid changes to a liquid.

After all the solid has melted, adding more thermal energy causes the particles to move even faster. The temperature of the liquid increases. When the particles are moving so fast that attractive forces cannot hold them close together, the liquid is at its boiling point. The boiling point is the temperature at which a liquid changes into a gas and the particles spread out. **Figure 11** shows how temperature and change of state relate to each other when thermal energy is added to a material.

Some solids change directly to a gas without first becoming a liquid. This process is called sublimation. An example of sublimation is shown in **Figure 12.** You saw another example of sublimation in **Figure 5** in Lesson 1.

Removing Thermal Energy When thermal energy is removed from a gas, such as water vapor, particles in the gas move more slowly and the temperature decreases. Condensation occurs when the particles are moving slowly enough for attractive forces to pull the particles close together. Recall that condensation is the process that occurs when a gas becomes a liquid.

After the gas has completely changed to a liquid, removing more thermal energy from the liquid causes particles to move even more slowly. As the motion between the particles slows, the temperature decreases. Freezing occurs when the particles are moving so slowly that attractive forces between the particles hold them tightly together. Now the particles only can vibrate in place. Recall that freezing is the process that occurs when a liquid becomes a solid.

Freezing and melting are reverse processes, and they occur at the same temperature. The same is true of boiling and condensation. Another change of state is deposition. Deposition is the change from a gas directly to a solid, as shown in **Figure 13.** It is the process that is the opposite of sublimation.

Key Concept Check How can removing thermal energy affect the state of matter?

MiniLab 30 minutes

Can you make ice without a freezer?

What happens when you keep removing energy from a substance?

1. Read and complete a lab safety form.
2. Draw the data table below in your Science Journal. Half fill a **large test tube** with **distilled water.** Use a **thermometer** to measure the temperature of the water, then record it.
3. Place the test tube into a **large foam cup** containing **ice** and **salt.** Use a **stirring rod** to slowly stir the water in the tube.
4. Record the temperature of the water every minute until the water freezes. Continue to record the temperature each minute until it drops to several degrees below 0°C.

Time (min)	0	1	2	3	4	5	6	7	8
Temperature (°C)									

Analyze and Conclude

1. **Organize Data** Graph the data in your table. Label time on the *x*-axis and temperature on the *y*-axis.
2. **Interpret Data** According to your data, what is the freezing point of water?
3. **Key Concept** What caused the water to freeze?

Figure 13 When enough thermal energy is removed, one of several processes occurs.

Freezing | Condensation | Deposition

▲ **Figure 14** Salt dissolves when it is added to the water in this aquarium.

Dissolving

Have you ever owned a saltwater aquarium, such as the one shown in **Figure 14**? If you have, you probably had to add certain salts to the water before you added the fish. Can you see the salt in the water? As you added the salt to the water, it gradually disappeared. It was still there, but it dissolved, or mixed evenly, in the water. Because the identities of the substances–water and salt–are not changed, dissolving is a physical change.

Like many physical changes, dissolving is usually easy to reverse. If you boil the salt water, the liquid water will change to water vapor, leaving the salt behind. You once again can see the salt because the particles that make up the substances do not change identity during a physical change.

Key Concept Check What happens when something dissolves?

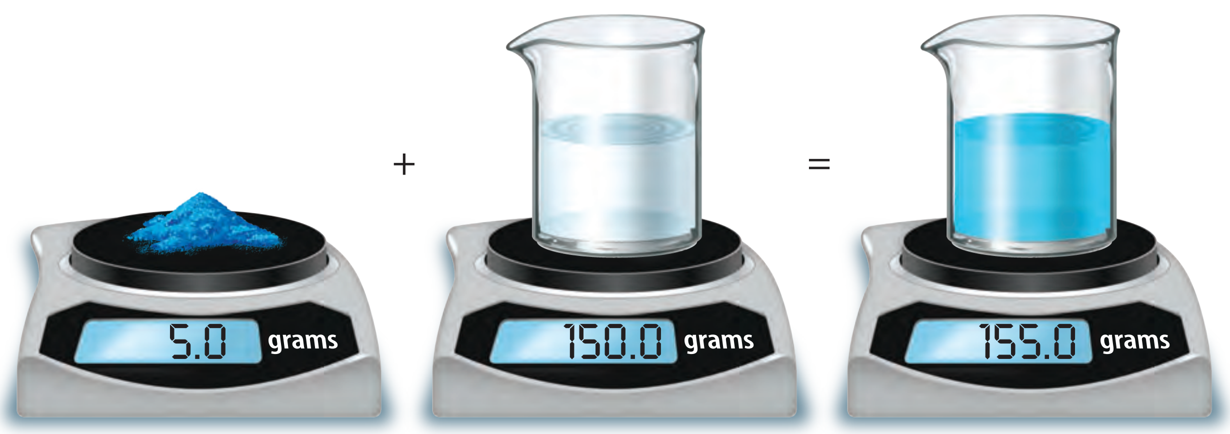
Conservation of Mass

During a physical change, the physical properties of matter change. The particles in matter that are present before a physical change are the same as those present after the physical change. Because the particles are the same both before and after a physical change, the total mass before and after the change is also the same, as shown in **Figure 15**. This is known as the law of conservation of mass. You will read in Lesson 4 that mass also is conserved during another type of change–a chemical change.

Key Concept Check What is meant by conservation of mass?

Figure 15 Mass is conserved during a physical change. ▼

Conservation of Mass



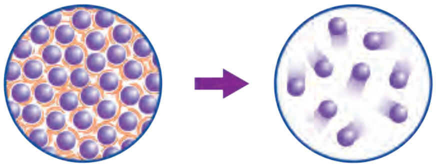
Visual Check If a sample of water has a mass of 200 g and the final solution has a mass of 230 g, how much solute dissolved in the water?

Lesson 3 Review

Online Quiz

Visual Summary

During a physical change, matter can change form, shape, size, or state, but the identity of the matter does not change.



Matter either changes temperature or changes state when enough thermal energy is added or removed.

Mass is conserved during physical changes, which means that mass is the same before and after the changes occur.

FOLDABLES®

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

What do you think NOW?

You first read the statements below at the beginning of the chapter.

5. Heating a material decreases the energy of its particles.

6. When you stir sugar into water, the sugar and water evenly mix.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

1 **Use the term** *physical change* in a sentence.

Understand Key Concepts

2 **Describe** how a change in energy can change ice into liquid water.

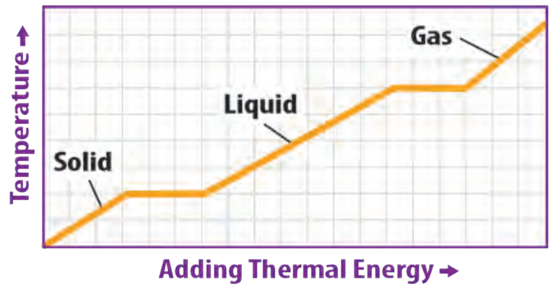
3 Which never changes during a physical change?

A. state of matter
B. temperature
C. total mass
D. volume

4 **Relate** What happens when something dissolves?

Interpret Graphics

5 **Examine** the graph below of temperature over time as a substance changes from solid to liquid to gas. Explain why the graph has horizontal lines.



6 **Take Notes** Copy the graphic organizer below. For each heading, summarize the main idea described in the lesson.

Heading	Main Idea
Physical Changes	
Change in State of Matter	
Conservation of Mass	

Critical Thinking

7 **Design** a demonstration that shows that temperature remains unchanged during a change of state.

IT Stock/age fotostock

How can known substances help you identify unknown substances?

While investigating a crime scene, you find several packets of white powder. Are they illegal drugs or just harmless packets of candy? Here's one way to find out.

Materials

plastic spoons

magnifying lens

stirring rod

Also needed: known substances (baking soda, ascorbic acid, sugar, cornstarch) test tubes, test tube rack, watch glass, dropper bottles containing water, iodine, vinegar, and red cabbage indicator

Safety

Learn It

A **control** is something that stays the same. If you determine how a known substance reacts with other substances, you can use it as a control. Unknown substances are **variables.** They might or might not react in the same way.

Try It

1. Read and complete a lab safety form.
2. Copy the data table below into your Science Journal.
3. Use a magnifying lens to observe the appearance of each known substance.
4. Test small samples of each known substance for their reaction with a drop or two of water, vinegar, and iodine solution.
5. Mix each substance with water, and add the red cabbage indicator.
6. After you complete your observations, ask your teacher for a mystery powder. Repeat steps 3–6 using the mystery powder. Use the data you collect to identify the powder.

Apply It

7. What test suggests that a substance might be cornstarch?
8. Why should you test the reactions of the substances with many different things?
9. **Key Concept** How did you use the properties of the controls to identify your variable?

Substance	Appearance	Texture	Reaction to Water	Reaction to Iodine	Reaction to Vinegar	Red Cabbage Indicator
Baking soda						
Sugar						
Ascorbic acid						
Cornstarch						
Mystery powder						

Lesson 4

Reading Guide

Key Concepts
ESSENTIAL QUESTIONS

- What is a chemical property?
- What are some signs of chemical change?
- Why are chemical equations useful?
- What are some factors that affect the rate of chemical reactions?

Vocabulary
chemical property p. 34
chemical change p. 35
concentration p. 38

Multilingual eGlossary

BrainPOP®
What's Science Got to do With It?

Chemical Properties and Changes

Luis Calabor/Getty Images

Inquiry A Burning Issue?

As this car burns, some materials change to ashes and gases. The metal might change form or state if the fire is hot enough, but it probably won't burn. Why do fabric, leather, and paint burn? Why do many metals not burn? The properties of matter determine how matter behaves when it undergoes a change.

Launch Lab

15 minutes

What can colors tell you?

You mix red and blue paint to get purple paint. Iron changes color when it rusts. Are color changes physical changes?

1. Read and complete a lab safety form.
2. Divide a **paper towel** into thirds. Label one section *RCJ,* the second section *A,* and the third section *B.*
3. Dip one end of three **cotton swabs** into **red cabbage juice** (RCJ). Observe the color, and set the swabs on the paper towel, one in each of the three sections.
4. Add one drop of **substance A** to the swab in the *A* section. Observe any changes, and record observations in your Science Journal.
5. Repeat step 4 with **substance B** and the swab in the *B* section.
6. Observe **substances C** and **D** in their **test tubes.** Then pour C into D. Rock the tube gently to mix. Record your observations.

Think About This

1. What happened to the color of the red cabbage juice when substances A and B were added?
2. **Key Concept** Which of the changes you observed do you think was a physical change? Construct an argument, using evidence from the lab, to support your claim.

Chemical Properties

Recall that a physical property is a characteristic of matter that you can observe or measure without changing the identity of the matter. However, matter has other properties that can be observed only when the matter changes from one substance to another. *A* **chemical property** *is a characteristic of matter that can be observed as it changes to a different type of matter.* For example, what are some chemical properties of a piece of paper? Can you tell by just looking at it that it will burn easily? The only way to know that paper burns is to test its combustibility by bringing a flame near the paper and watching if it burns. When paper burns, it changes into different types of matter. Reactivity, such as rusting, is another chemical property.

Comparing Properties

You now have read about physical properties and chemical properties. All matter can be described using both types of properties. For example, a wood log is solid, rounded, heavy, and rough. These are physical properties that you can observe with your senses. The log also has mass, volume, and density, which are physical properties that can be measured. The ability of wood to burn is a chemical property. This property is obvious only when you burn the wood. It also will rot, another chemical property you can observe when the log decomposes, becoming other substances. When you describe matter, you need to consider both its physical and its chemical properties.

Key Concept Check What are some chemical properties of matter?

Chemical Changes

Recall that during a physical change, the identity of matter does not change. However, *a* **chemical change** *is a change in matter in which the substances that make up the matter change into other substances with new physical and chemical properties.* For example, when iron undergoes a chemical change with oxygen, rust forms. The substances that undergo a change no longer have the same properties because they no longer have the same identity.

Reading Check What is the difference between a physical change and a chemical change?

Signs of Chemical Change

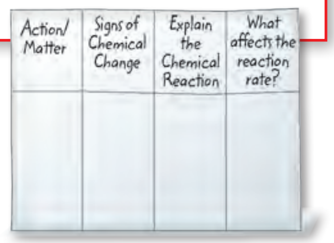
How do you know when a chemical change occurs? What signs show you that new types of matter form? As shown in **Figure 16,** signs of chemical changes include the formation of a new substance such as a gas or a precipitate. Other signs can include a change in energy, odor, or color.

It is important to remember that these signs do not always mean a chemical change occurred. Think about what happens when you heat water on a stove. Bubbles form as the water boils. In this case, bubbles show that the water is changing state, which is a physical change. The evidence of chemical change shown in **Figure 16** means that a chemical change might have occurred. However, the only proof of chemical change is the formation of a new substance.

Key Concept Check What are signs of a chemical change?

FOLDABLES®

Use a sheet of paper to make a chart with four columns. Use the chart throughout this lesson to explain how the identity of matter changes during a chemical change.



WORD ORIGIN

chemical
from Greek *chemeia,* means "cast together"

Some Signs of Chemical Change

Figure 16 Sometimes you can observe clues that a chemical change has occurred.

Bubbles | **Energy change** | **Odor change** | **Color change**

Visual Check What signs show that a chemical change takes place when fireworks explode?

MiniLab 20 minutes

Can you spot the clues for chemical change?

What are some clues that let you know a chemical change might have taken place?

1. Read and complete a lab safety form.
2. Add about 25 mL of room-temperature water to a **self-sealing plastic bag.** Add two **dropperfuls** of **red cabbage juice.**
3. Add one **measuring scoop** of **calcium chloride** to the bag. Seal the bag. Tilt the bag to mix the contents until the solid disappears. Feel the bottom of the bag. Record your observations in your Science Journal.
4. Open the bag, and add one measuring scoop of **baking soda.** Quickly press the air from the bag and reseal it. Tilt the bag to mix the contents. Observe for several minutes. Record your observations.

Analyze and Conclude

1. **Observe** What changes did you observe?
2. **Infer** Which of the changes suggested that a new substance formed? Explain.
3. **Key Concept** Are changes in energy always a sign of a chemical change? Explain.

Explaining Chemical Reactions

You might wonder why chemical changes produce new substances. Recall that particles in matter are in constant motion. As particles move, they collide with each other. If the particles collide with enough force, the bonded atoms that make up the particles can break apart. These atoms then rearrange and bond with other atoms. When atoms bond together in new combinations, new substances form. This process is called a reaction. Chemical changes often are called chemical reactions.

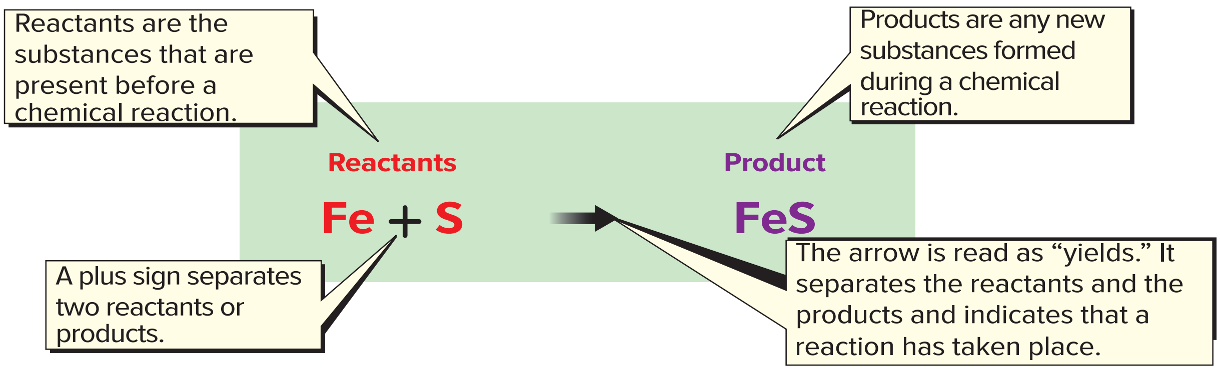
Reading Check What does it mean to say that atoms rearrange during a chemical change?

Using Chemical Formulas

A useful way to understand what happens during a chemical reaction is to write a chemical equation. A chemical equation shows the chemical formula of each substance in the reaction. The formulas to the left of the arrow represent the reactants. Reactants are the substances present before the reaction takes place. The formulas to the right of the arrow represent the products. Products are the new substances present after the reaction. The arrow indicates that a reaction has taken place.

Key Concept Check Why are chemical equations useful?

Figure 17 Chemical formulas and other symbols are parts of a chemical equation.



Hutchings Photography/Digital Light Source

Balancing Chemical Equations

Look at the equation in **Figure 17.** Notice that there is one iron (Fe) atom on the reactants side and one iron atom on the product side. This is also true for the sulfur (S) atoms. Recall that during both physical and chemical changes, mass is conserved. This means that the total mass before and after a change must be equal. Therefore, in a chemical equation, the number of atoms of each element before a reaction must equal the number of atoms of each element after the reaction. This is called a balanced chemical equation, and it illustrates the law of conservation of mass. Matter and energy are also conserved during chemical reactions. **Figure 18** explains how to write and balance a chemical equation.

When balancing an equation, you cannot change the chemical formula of any reactants or products. Changing a formula changes the identity of the substance. Instead, you can place coefficients, or multipliers, in front of formulas. Coefficients change the amount of the reactants and products present. For example, an H_2O molecule has two H atoms and one O atom. Placing the coefficient *2* before H_2O ($2H_2O$) means that you double the number of H atoms and O atoms present:

2×2 H atoms = 4 H atoms
2×1 O atom = 2 O atoms

Note that $2H_2O$ is still water. However, it describes two water particles instead of one.

Figure 18 Equations must be balanced because mass is conserved during a chemical reaction.

Balancing Chemical Equations

Personal Tutor

Balancing Chemical Equations Example

When methane (CH_4)—a gas burned in furnaces—reacts with oxygen (O_2) in the air, the reaction produces carbon dioxide (CO_2) and water (H_2O). Write and balance a chemical equation for this reaction.

1 Write the equation, and check to see if it is balanced.

a. Write the chemical formulas with the reactants on the left side of the arrow and the products on the right side.

b. Count the atoms of each element in the reactants and in the products.
- Note which elements have a balanced number of atoms on each side of the equation.
- If all elements are balanced, the overall equation is balanced. If not, go to step 2.

a. $CH_4 + O_2 \rightarrow CO_2 + H_2O$ **not balanced**

b. reactants → products

reactants	products	
C=1	C=1	**balanced**
H=4	H=2	**not balanced**
O=2	O=3	**not balanced**

2 Add coefficients to the chemical formulas to balance the equation.

a. Pick an element in the equation whose atoms are not balanced, such as hydrogen. Write a coefficient in front of a reactant or a product that will balance the atoms of the chosen element in the equation.

b. Recount the atoms of each element in the reactants and the products, and note which are balanced on each side of the equation.

c. Repeat steps 2a and 2b until all atoms of each element in the reactants equal those in the products.

a. $CH_4 + O_2 \rightarrow CO_2 + 2H_2O$ **not balanced**

b. reactants → products

reactants	products	
C=1	C=1	**balanced**
H=4	H=4	**balanced**
O=2	O=4	**not balanced**

c. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ **balanced**

reactants	products	
C=1	C=1	**balanced**
H=4	H=4	**balanced**
O=4	O=4	**balanced**

3 Write the balanced equation that includes the coefficients: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

Factors that Affect the Rate of Chemical Reactions

Figure 19 The rate of most chemical reactions increases with an increase in temperature, concentration, or surface area.

1 Temperature

Chemical reactions that occur during cooking happen at a faster rate when temperature increases.

2 Concentration

Acid rain contains a higher concentration of acid than normal rain does. As a result, a statue exposed to acid rain is damaged more quickly than a statue exposed to normal rain.

3 Surface Area

When an antacid tablet is broken into pieces, the pieces have more total surface area than the whole tablet does. The pieces react more rapidly with water because more of the broken tablet is in contact with the water.

The Rate of Chemical Reactions

Recall that the particles that make up matter are constantly moving and colliding with one another. Different factors can make these particles move faster and collide harder and more frequently. These factors increase the rate of a chemical reaction, as shown in **Figure 19.**

1 A higher temperature usually increases the rate of reaction. When the temperature is higher, the particles move faster. Therefore, the particles collide with greater force and more frequently.

2 **Concentration** is the *amount of substance in a certain volume.* A reaction occurs faster if the concentration of at least one reactant increases. When concentration increases, there are more particles available to bump into each other and react.

3 Surface area also affects reaction rate if at least one reactant is a solid. If you drop a whole effervescent antacid tablet into water, the tablet reacts with the water. However, if you break the tablet into several pieces and then add them to the water, the reaction occurs more quickly. Smaller pieces have more total surface area, so more space is available for reactants to collide.

Key Concept Check List three factors that affect the rate of a chemical reaction.

Chemistry

To understand chemistry, you need to understand matter. You need to know how the arrangement of atoms results in different types of matter. You also need to be able to distinguish physical properties from chemical properties and describe ways these properties can change. In later chemistry chapters and courses, you will examine each of these topics closely to gain a better understanding of matter.

Lesson 4 Review

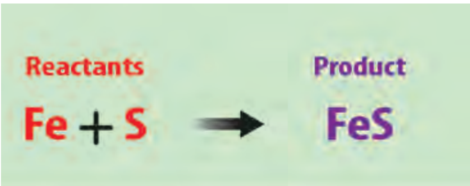
Online Quiz

Visual Summary

A chemical property is observed only as a material undergoes chemical change and changes identity.

Signs of possible chemical change include bubbles, energy change, and change in odor or color.

Chemical equations show the reactants and products of a chemical reaction and that mass is conserved.



FOLDABLES®

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

What do you think NOW?

You first read the statements below at the beginning of the chapter.

7. When wood burns, new materials form.

8. Temperature can affect the rate at which chemical changes occur.

Did you change your mind about whether you agree or disagree with the statements? Rewrite any false statements to make them true.

Use Vocabulary

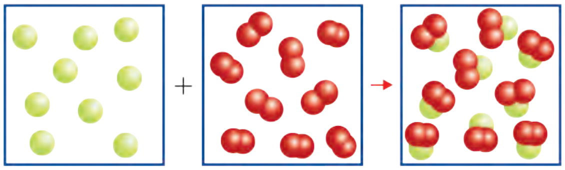
1. The amount of substance in a certain volume is its ________.
2. **Use the term** *chemical change* in a complete sentence.

Understand Key Concepts

3. **List** some signs of chemical change.
4. Which property of matter changes during a chemical change but does NOT change during a physical change?
   A. energy
   B. identity
   C. mass
   D. volume
5. **State** why chemical equations are useful.
6. **Analyze** What affects the rate at which acid rain reacts with a statue?

Interpret Graphics

7. **Examine** Explain how the diagram below shows conservation of mass.



8. **Compare and Contrast** Copy and fill in the graphic organizer to compare and contrast physical and chemical changes.

Physical and Chemical Changes	
Alike	
Different	

Critical Thinking

9. **Compile** a list of three physical changes and three chemical changes you have observed recently.
10. **Recommend** How could you increase the rate at which the chemical reaction between vinegar and baking soda occurs?

Lab

1–2 class periods

Design an Experiment to Solve a Crime

Recall how you can use properties to identify and compare substances. You now will apply those ideas to solving a crime. You will be given evidence collected from the crime scene and from the suspect's house. As the investigator, decide whether evidence from the crime scene matches evidence from the suspect. What tests will you use? What does the evidence tell you?

Materials

triple-beam balance

50-mL graduated cylinder

magnifying lens

bar magnet

Also needed: crime scene evidence, unknown substances, dropper bottles containing water, iodine, cornstarch, and red cabbage indicator, test tubes, test tube rack, stirring rod

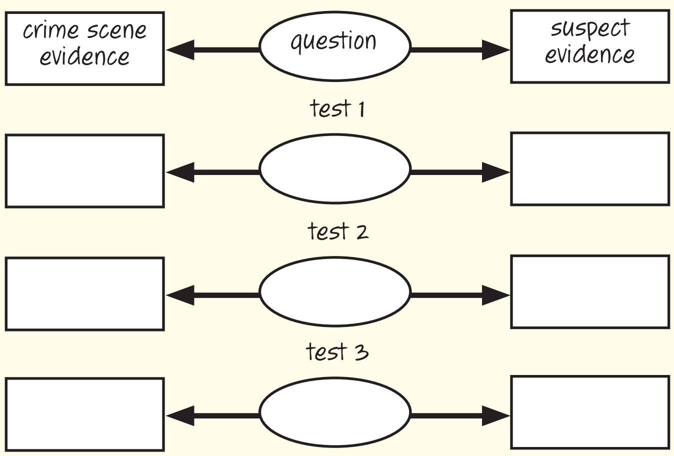
Safety

Question

Determine which factors about the evidence you would like to investigate further. Consider how you can describe and compare the properties of each piece of evidence. Evaluate the properties you will observe and measure, and decide whether it would be an advantage to classify them as physical properties or chemical properties. Will the changes that the evidence will undergo be helpful to you? Think about controls, variables, and the equipment you have available. Is there any way to match samples exactly?

Procedure

1. Read and complete a lab safety form.
2. In your Science Journal, write the procedures you will use to answer your question. Include the materials and steps you will use to test each piece of evidence. By the appropriate step in the procedure, list any safety procedures you should observe while performing the investigation. Organize your steps by putting them in a graphic organizer, such as the one below. Have your teacher approve your procedures.



3 Begin by observing and recording your observations on each piece of evidence. What can you learn by comparing physical properties? Are any of the samples made of several parts?

4 Use the available materials to test the evidence. Accurately record all observations and data for each piece of evidence.

5 Add any additional tests you think you need to answer your questions.

Analyze and Conclude

6 **Examine** the data you have collected. What does the evidence tell you about whether the crime scene and the suspect are related?

7 **Formulate** Write your conclusions in your Science Journal. Be thorough because these are the notes you would use if you had to testify in court about the case.

8 **Analyze** Which data suggest that evidence from the crime scene was or wasn't connected to the suspect?

9 **Draw Conclusions** If you were to testify in court, what conclusions would you be able to state confidently based on your findings?

10 **The Big Idea** How does understanding physical and chemical properties of matter help you to solve problems?

Communicate Your Results

Compare your results with those of other teams. Discuss the kinds of evidence that might be strong enough to convict a suspect.

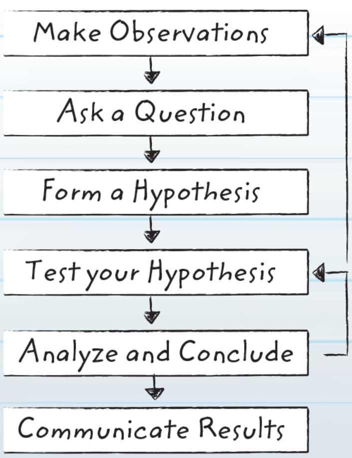
Inquiry Extension

Research the difference between individual and class evidence used in forensics. Decide which class of evidence your tests provided.

Lab Tips

- Don't overlook simple ideas such as matching the edges of pieces.
- Can you separate any of the samples into other parts?
- Always get your teacher's approval before trying any new test.

Remember to use scientific methods.



Hutchings Photography/Digital Light Source

Chapter 1 Study Guide

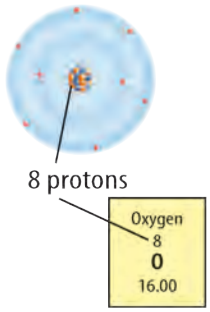
WebQuest

Matter is anything that has mass and takes up space. Its physical properties and its chemical properties can change.

Key Concepts Summary

Lesson 1: Classifying Matter

- A **substance** is a type of **matter** that always is made of atoms in the same combinations.
- **Atoms** of different elements have different numbers of protons.
- The composition of a substance cannot vary. The composition of a **mixture** can vary.
- Matter can be classified as either a substance or a mixture.

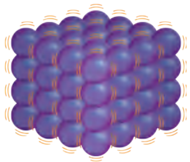


Vocabulary

matter p. 9
atom p. 9
substance p. 11
element p. 11
compound p. 12
mixture p. 13
heterogeneous mixture p. 13
homogeneous mixture p. 13
dissolve p. 13

Lesson 2: Physical Properties

- **Physical properties** of matter include size, shape, texture, and state.
- Physical properties such as **density,** melting point, boiling point, and size can be used to separate mixtures.



Vocabulary

physical property p. 18
mass p. 20
density p. 21
solubility p. 22

Lesson 3: Physical Changes

- A change in energy can change the state of matter.
- When something dissolves, it mixes evenly in a substance.
- The masses before and after a change in matter are equal.

Vocabulary

physical change p. 27

Lesson 4: Chemical Properties and Changes

- **Chemical properties** include ability to burn, acidity, and ability to rust.
- Some signs that might indicate **chemical changes** are the formation of bubbles and a change in odor, color, or energy.
- Chemical equations are useful because they show what happens during a chemical reaction.
- Some factors that affect the rate of chemical reactions are temperature, **concentration,** and surface area.

Vocabulary

chemical property p. 34
chemical change p. 35
concentration p. 38

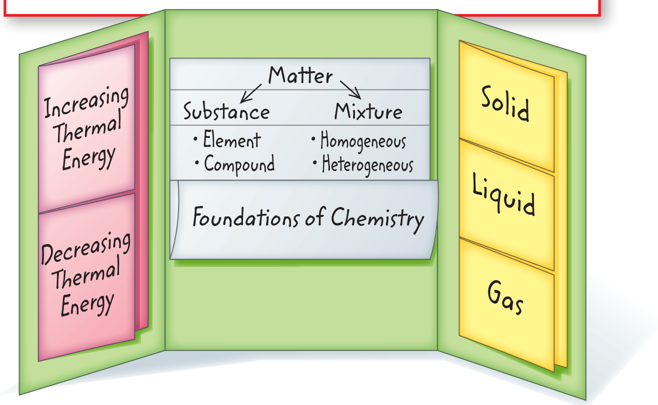
(t)Digital Vision/Getty Images, (b)Martin Hospach/Getty Images

Vocabulary eFlashcards
Vocabulary eGames
Personal Tutor

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. Fasten the Foldable from Lesson 4 on the back of the board.



Use Vocabulary

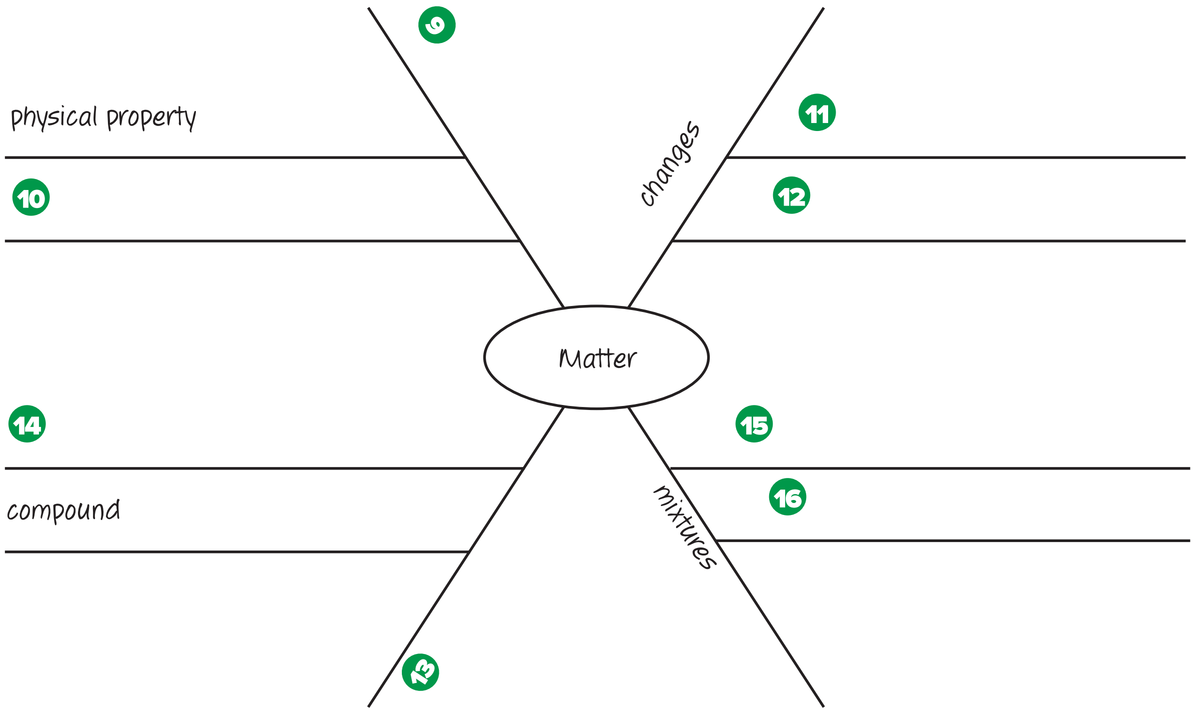
Give two examples of each of the following.

1. element
2. compound
3. homogeneous mixture
4. heterogeneous mixture
5. physical property
6. chemical property
7. physical change
8. chemical change

Link Vocabulary and Key Concepts

Interactive Concept Map

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



Chapter 1 Review

Understand Key Concepts

1. The formula $AgNO_3$ represents a compound made of which atoms?
   A. 1 Ag, 1 N, 1 O
   B. 1 Ag, 1 N, 3 O
   C. 1 Ag, 3 N, 3 O
   D. 3 Ag, 3 N, 3 O

2. Which is an example of an element?
   A. air
   B. water
   C. sodium
   D. sugar

3. Which property explains why copper often is used in electrical wiring?
   A. conductivity
   B. density
   C. magnetism
   D. solubility

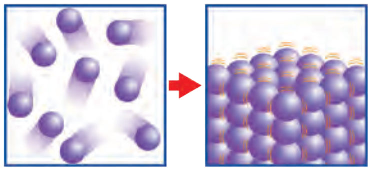
4. The table below shows densities for different substances.

Substance	Density (g/cm^3)
1	1.58
2	0.32
3	1.52
4	1.62

   For which substance would a 4.90-g sample have a volume of 3.10 cm^3?
   A. substance 1
   B. substance 2
   C. substance 3
   D. substance 4

5. Which would decrease the rate of a chemical reaction?
   A. increase in concentration
   B. increase in temperature
   C. decrease in surface area
   D. increase in both surface area and concentration

6. Which physical change is represented by the diagram below?



   A. condensation
   B. deposition
   C. evaporation
   D. sublimation

7. Which chemical equation is unbalanced?
   A. $2KClO_3 \rightarrow 2KCl + 3O_2$
   B. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$
   C. $Fe_2O_3 + CO \rightarrow 2Fe + 2CO_2$
   D. $H_2CO_3 \rightarrow H_2O + CO_2$

8. Which is a size-dependent property?
   A. boiling point
   B. conductivity
   C. density
   D. mass

9. Why is the following chemical equation said to be balanced?

$$O_2 + 2PCl_3 \rightarrow 2POCl_3$$

   A. There are more reactants than products.
   B. There are more products than reactants.
   C. The atoms are the same on both sides of the equation.
   D. The coefficients are the same on both sides of the equation.

10. The elements sodium (Na) and chlorine (Cl) react and form the compound sodium chloride (NaCl). Which is true about the properties of these substances?
   A. Na and Cl have the same properties.
   B. NaCl has the properties of Na and Cl.
   C. All the substances have the same properties.
   D. The properties of NaCl are different from the properties of Na and Cl.

Online Test Practice

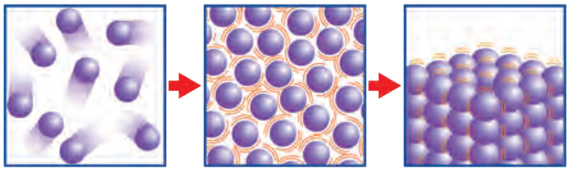
Critical Thinking

11 **Compile** a list of ten materials in your home. Classify each material as an element, a compound, or a mixture.

12 **Evaluate** Would a periodic table based on the number of electrons in an atom be as effective as the one shown in the back of this book? Why or why not?

13 **Develop** a demonstration to show how weight is not the same thing as mass.

14 **Construct** an explanation for how the temperature and energy of a material changes during the physical changes represented by the diagram below.



15 **Revise** the definition of physical change given in this chapter so it mentions the type and arrangement of atoms.

16 **Find an example** of a physical change in your home or school. Describe the changes in physical properties that occur during the change. Then explain how you know the change is not a chemical change.

17 **Develop** a list of five chemical reactions you observe each day. For each, describe one way that you could either increase or decrease the rate of the reaction.

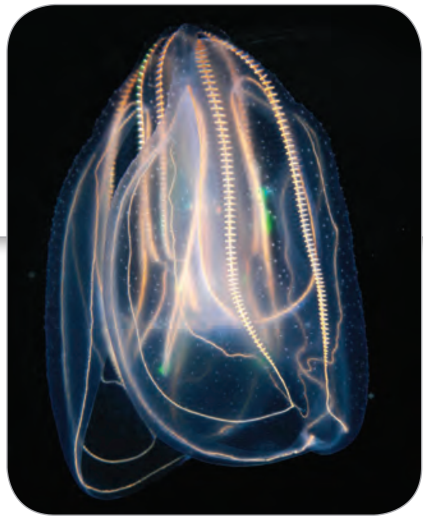
Writing in Science

18 **Write** a poem at least five lines long to describe the organization of matter by the arrangement of its atoms. Be sure to include both the names of the different types of matter as well as their meanings.

REVIEW THE BIG IDEA

19 Explain how you are made of matter that undergoes changes. Provide specific examples in your explanation.

20 How does the photo below show an example of a physical change, a chemical change, a physical property, and a chemical property?



Gregory G.Dimijian/Photo Reasearchers, Inc

Math Skills

Math Practice

Use Ratios

21 A sample of ice at 0°C has a mass of 23 g and a volume of 25 cm^3. Why does ice float on water? (The density of water is 1.00 g/cm^3.)

22 The table below shows the masses and the volumes for samples of two different elements.

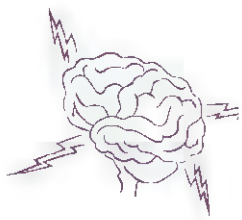
Element	Mass (g)	Volume (cm^3)
Gold	386	20
Lead	22.7	2.0

Which element sample in the table has greater density?

A Tale of Two Changes

Your science and language-arts teachers have teamed up on a creative-writing assignment. They want you to write a short story containing both physical and chemical changes. Then, you will trade your story with another student. You will analyze each other's stories and determine the types of changes that occurred.

Get Started!



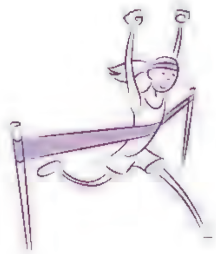
- Brainstorm what you will write about in your story.
- Determine the physical changes and chemical changes that will occur in your story. What evidence will you include to help your reader?
- Outline your story. Consider the following information as you make your outline.
  - ☐ Your story must include at least three examples of physical changes and three examples of chemical changes.

☐ Your story should have an introduction, a main body, and a conclusion.

☐ Be sure to include characters and settings.

- Write your story.

Finish Up!



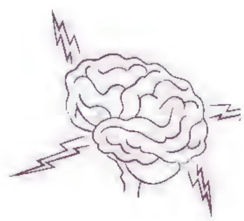
- Review and edit your story.
- Did you use the correct criteria to distinguish a chemical change from a physical change? Explain your answer.
- Did you consider your audience while writing your story? Explain how you did this.
- Identify the strengths and weaknesses of your story.
- As you analyze the story from your fellow student, how are you able to distinguish between physical and chemical changes?
  What evidence do you need to use to decide?

All Things Being Equal

Your school has started a "Take Science Home" campaign. To help pick topics for your project, your teacher put topic ideas into a hat. The slip of paper that you picked reads: "Develop and use a model to teach your family that the total number of atoms does not change in a chemical reaction, and thus, mass is conserved."

Excited about this topic, you begin to develop your model to explain the law of conservation of mass to your family.

Get Started!



- Choose a balanced chemical equation to model.
- Decide on a way that you will represent and distinguish among the atoms in the equation in your model.
- Develop your model, keeping your audience in mind. How will you represent and explain scientific terms and concepts so that your family members will understand them?

Finish Up!

- Present your model to your family, explaining what the model represents.
- Ask family members questions to determine whether your model effectively represented the law of conservation of mass.
- If your model failed to represent the law of conservation of mass or confused your family, identify its weaknesses. Then, revise the model.
- If you revised your model, present your new model to your family members. Is your revised model an improvement over your original model? Why or why not?

INTEGRATED

iSCIENCE

GLENCOE

GRADE 7

Unit 1 Energy and Matter
Unit 2 Earth: A Dynamic Planet
Unit 3 Life: Structure and Function
Unit 4 Heredity and Changes Over Time
Unit 5 Exploring Ecology

GRADE 6

Unit 1 Motion and Energy
Unit 2 Exploring Earth
Unit 3 Exploring the Universe
Unit 4 Understanding Matter
Unit 5 Exploring Life

GRADE 8

Unit 1 Interactions of Matter
Unit 2 Earth and Geological Changes
Unit 3 Water and Other Resources
Unit 4 Life: Changes and Interactions

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SAMPLE