Classifying Matter and Its Changes

1.3

Matter is constantly changing. Plants grow by converting matter from the soil and air into matter they can use. Water falls from the sky, evaporates, and condenses again to form liquid water in a never-ending cycle. You can probably suggest many more examples of matter changing.

Matter changes in response to changes in energy. Adding energy to matter or removing energy from matter results in a change. Figure 1.9 shows a familiar example of a change involving matter and energy.

Section Preview/ Specific Expectations

In this section, you will

- **identify** chemical substances and chemical changes in everyday life
- **demonstrate** an understanding of the need to use chemicals safely in everyday life
- **communicate** your understanding of the following terms: *physical changes, chemical changes, mixture, pure substance, element, compound*

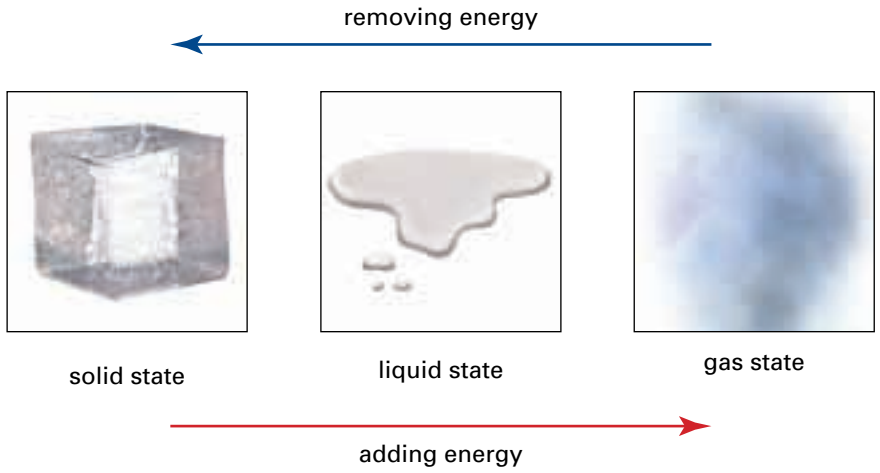

Figure 1.9 **Like all matter, water can change its state when energy is added or removed.**

Physical and Chemical Changes in Matter

A change of state alters the appearance of matter. The composition of matter remains the same, however, regardless of its state. For example, ice, liquid water, and water vapour are all the same kind of matter: water. Melting and boiling other kinds of matter have the same result. The appearance and some other physical properties change, but the matter retains its identity—its composition. Changes that affect the physical appearance of matter, but *not* its composition, are **physical changes**.

Figure 1.10 shows a different kind of change involving water. Electrical energy is passed through water, causing it to decompose. Two completely different kinds of matter result from this process: hydrogen gas and oxygen gas. These gases have physical and chemical properties that are different from the properties of water and from each other's properties. Therefore, decomposing water is a change that affects the composition of water. Changes that alter the composition of matter are called **chemical changes**. Iron rusting, wood burning, and bread baking are three examples of chemical changes.

You learned about physical and chemical properties earlier in this chapter. A physical change results in a change of physical properties only. A chemical change results in a change of both physical and chemical properties.

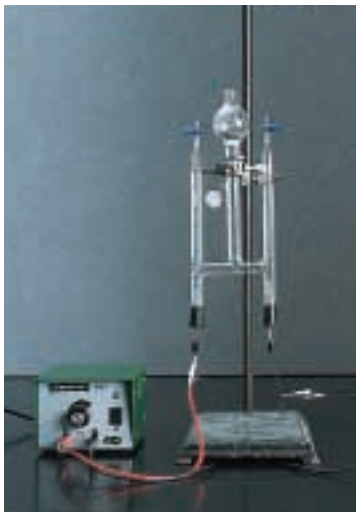

Figure 1.10 **An electrical current is used to decompose water. This process is known as electrolysis.**

mind STRETCH

Before adopting the metric system, Canadians measured temperature in units called Fahrenheit degrees (°F). Based on the Fahrenheit scale, water boils at 212°F and freezes at 32°F. A few countries, including the United States, still use the Fahrenheit scale. Without checking any reference materials, design a method for converting Fahrenheit temperatures to Celsius temperatures, and back again. Show your work, and explain your reasoning.

Practice Problems

4. Classify each situation as either a physical change or a chemical change. Explain your reasoning.
   - **(a)** A rose bush grows from a seed that you have planted and nourished.
   - **(b)** A green coating forms on a copper statue when the statue is exposed to air.
   - **(c)** Your sweat evaporates to help balance your body temperature.
   - **(d)** Frost forms on the inside of a freezer.
   - **(e)** Salt is added to clear chicken broth.
   - **(f)** Your body breaks down the food you eat to provide energy for your body's cells.
   - **(g)** Juice crystals dissolve in water.
   - **(h)** An ice-cream cone melts on a hot day.

Classifying Matter

Figure 1.11 **To see the components of soil, add some soil to a glass of water. What property is responsible for separating the components?**

All matter can be classified into two groups: mixtures and pure substances. A **mixture** is a physical combination of two or more kinds of matter. For example, soil is a mixture of sand, clay, silt, and decomposed leaves and animal bodies. If you look at soil under a magnifying glass, you can see these different components. Figure 1.11 shows another way to see the components of soil.

The components in a mixture can occur in different proportions (relative quantities). Each individual component retains its identity. Mixtures in which the different components are clearly visible are called *heterogeneous mixtures*. The prefix "hetero-" comes from the Greek word *heteros*, meaning "different."

Mixtures in which the components are blended together so well that the mixture looks like just one substance are called *homogeneous mixtures*. The prefix "homo- " comes from the Greek word *homos*, meaning "the same." Saltwater, clean air, and grape juice are common examples. Homogeneous mixtures are also called solutions. You will investigate solutions in Unit 3.

A **pure substance** has a definite composition, which stays the same in response to physical changes. A lump of copper is a pure substance. Water (with nothing dissolved in it) is also a pure substance. Diamond, carbon dioxide, gold, oxygen, and aluminum are pure substances, too.

Pure substances are further classified into elements and compounds. An **element** is a pure substance that cannot be separated chemically into any simpler substances. Copper, zinc, hydrogen, oxygen, and carbon are examples of elements.

A **compound** is a pure substance that results when two or more elements combine chemically to form a different substance. Compounds can be broken down into elements using chemical processes. For example, carbon dioxide is a compound. It can be separated into the elements carbon and oxygen. The Concept Organizer on the next page outlines the classification of matter at a glance. The ThoughtLab reinforces your understanding of properties, mixtures, and separation of substances.

Word LINK

The word "pure" can be used to mean different things. In ordinary conversation, you might say that orange juice is "pure" if no other materials have been added to it. How is this meaning of pure different from the scientific meaning in the term "pure substance?"

Concept Organizer — The Classification System for Matter.

Matter
- anything that has mass and volume
- found in three physical states: solid, liquid, gas

Mixtures
- physical combinations of matter in which each component retains its identity

Heterogenous Mixtures (Mechanical Mixtures)
- all components are visible

Homogeneous Mixtures (Solutions)
- components are blended so that it looks like a single substance.

Physical Changes

Pure Substances
- matter that has a definite composition

Elements
- matter that cannot be decomposed into simpler substances

Chemical Changes

Compounds
- matter in which two or more elements are chemically combined

ThoughtLab — Mixtures, Pure Substances, and Changes

You frequently use your knowledge of properties to make and separate mixtures and substances. You probably do this most often in the kitchen. Even the act of sorting clean laundry, however, depends on your ability to recognize and make use of physical properties. This activity is a "thought experiment." You will use your understanding of properties to mix and separate a variety of chemicals, all on paper. Afterward, your teacher may ask you to test your ideas, either in the laboratory or at home in the kitchen.

Procedure

1. Consider the following chemicals: table salt, water, baking soda, sugar, iron filings, sand, vegetable oil, milk, and vinegar. Identify each chemical as a mixture or a pure substance.
2. Which of these chemicals can you mix together *without* producing a chemical change? In your notebook, record as many of these physical combinations as you can.
3. Which of these chemicals can you mix together to produce a chemical change? Record as many of these chemical combinations as you can.
4. Record a mixture that is made with four of the chemicals. Then suggest one or more techniques that you can use to separate the four chemicals from one another. Write notes and sketch labelled diagrams to show your techniques. Identify the properties that your techniques depend on.

Analysis

1. In step 2, what properties of the chemicals did you use to determine your combinations?
2. In step 3, what properties did you use to determine your combinations?

Application

3. Exchange your four-chemical mixture with a partner. Do not include your notes and diagrams. Challenge your partner to suggest techniques to separate the four chemicals. Then assess each other's techniques. What modifications, if any, would you make to your original techniques?

Section Wrap-up

Notice that the classification system for matter, shown in the Concept Organizer, is based mainly on the changes that matter undergoes:

- physical changes to separate mixtures into elements or compounds
- chemical changes to convert compounds or elements into different compounds or elements

To explain how and why these chemical changes occur, you must look "deeper" into matter. You must look at its composition. This is what you will do in the next chapter. You will see how examining the composition of matter leads to a different classification system: the periodic table. You will also see how the periodic table allows chemists to make predictions about the properties and behaviour of matter.

Section Review

1. C Copy Figure 1.9 into your notebook. Add the following labels in the appropriate places: evaporation, condensation, melting, freezing, solidifying. **Note:** Some labels may apply to the same places on the diagram.

2. C You may recall that sublimation is a change of state in which a solid changes directly into a gas. The reverse is also true. Add the label "sublimation" to your diagram for question 1. Include arrows to show the addition or removal of energy.

3. K/U List three mixtures that you use frequently.
   - **(a)** Explain how you know that each is a mixture.
   - **(b)** Classify each mixture as either heterogeneous or homogenous.

4. K/U List three pure substances that you use frequently.
   - **(a)** Explain how you know that each is a pure substance.
   - **(b)** Try to classify each substance as an element or compound. Explain your reasoning.

5. I You are given a mixture of wood chips, sand, coffee grounds, and water. Design a process to clean the water.

6. MC The water going down your drain and toilet is cleaned and recycled. You will learn about water purification processes in Chapter 9.
   - **(a)** Propose a possible series of steps that you could use to clean the waste water from your home.
   - **(b)** Will this cleaned water be drinkable? Explain your answer.
   - **(c)** What further steps may be needed to clean this water?