SECTION 1

Matter

As You Read

What You'll Learn

- **Recognize** that matter is made of particles in constant motion.
- **Relate** the three states of matter to the arrangement of particles within them.

Vocabulary

matter
solid
liquid
gas

Why It's Important

Everything you can see, taste, and touch is matter. Without matter—well, nothing would matter!

What is matter?

Take a look at the beautiful scene in **Figure 1.** What do you see? Perhaps you notice the water and ice. Maybe you are struck by the Sun in the background. All of these images show examples of matter. **Matter** is anything that takes up space and has mass. Matter doesn't have to be visible—even air is matter.

States of Matter All matter is made up of tiny particles, such as atoms, molecules, or ions. Each particle attracts other particles. In other words, each particle pulls other particles toward itself. These particles also are constantly moving. The motion of the particles and the strength of attraction between the particles determine a material's state of matter.

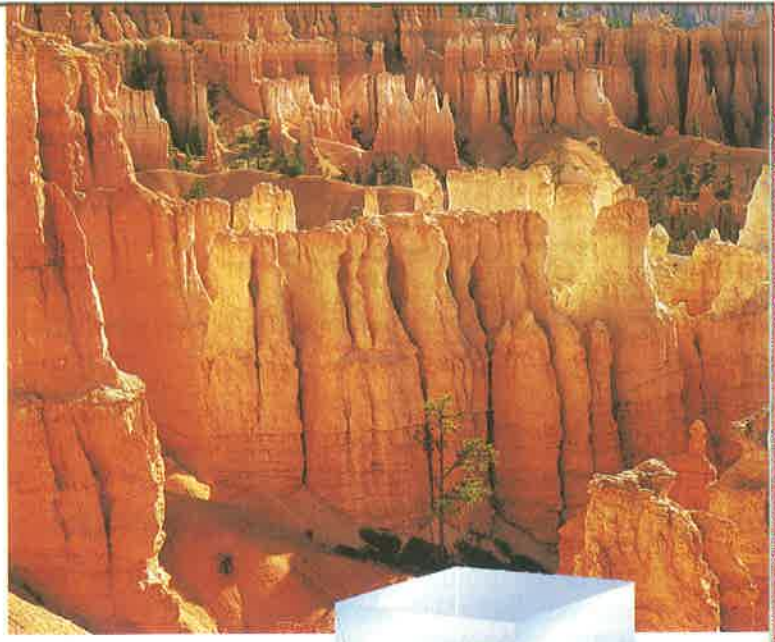
Reading Check *What determines a material's state of matter?*

There are three familiar states of matter—solid, liquid, and gas. A fourth state of matter known as plasma occurs only at extremely high temperatures. Plasma is found in stars, lightning, and neon lights. Although plasma is common in the universe, it is not common on Earth. For that reason, this chapter will focus only on the three states of matter that are common on Earth.

Figure 1
Matter exists in all four states in this scene. *Identify the solid, liquid, gas, and plasma in this photograph.*

Solids

What makes a solid a solid? Think about some solids that you are familiar with. Chairs, floors, rocks, and ice cubes are a few examples of matter in the solid state. What properties do all solids share? A **solid** is matter with a definite shape and volume. For example, when you pick up a rock from the ground and place it in a bucket, it doesn't change shape or size. A solid does not take the shape of a container in which it is placed. This is because the particles of a solid are packed closely together, as shown in **Figure 2.**



Solid

Figure 2
The particles in a solid vibrate in place, maintaining a constant shape and volume.

Particles in Motion The particles that make up all types of matter are in constant motion. Does this mean that the particles in a solid are moving too? Although you can't see them, a solid's particles are vibrating in place. The particles do not have enough energy to move out of their fixed positions.

Reading Check ***What motion do solid particles have?***

Crystalline Solids In some solids, the particles are arranged in a repeating, three-dimensional pattern called a crystal. These solids are called crystalline solids. In **Figure 3** you can see the arrangement of particles in a crystal of sodium chloride, which is table salt. The particles in the crystal are arranged in the shape of a cube. Diamond, another crystalline solid, is made entirely of carbon atoms that form crystals that look more like pyramids. Sugar, sand, and snow are other crystalline solids.

A

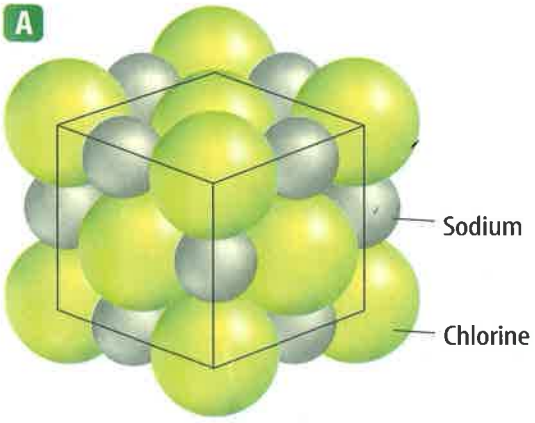
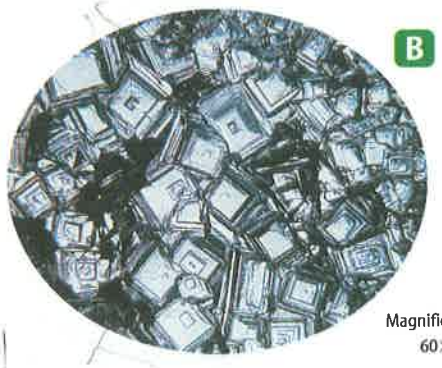


Figure 3
A The particles in a crystal of sodium chloride (NaCl) are arranged in an orderly pattern. B This magnified image shows the cubic shape of sodium chloride crystals.

B



Magnification: 60×

Amorphous Solids Some solids come together without forming crystal structures. These solids often consist of large particles that are not arranged in a repeating pattern. Instead, the particles are found in a random arrangement. These solids are called amorphous (uh MOR fuhs) solids. Rubber, plastic, and glass are examples of amorphous solids.

Reading Check *How is a crystalline solid different from an amorphous solid?*

Liquids

From the orange juice you drink with breakfast to the water you use to brush your teeth at night, matter in the liquid state is familiar to you. How would you describe the characteristics of a liquid? Is it hard like a solid? Does it keep its shape? A **liquid** is matter that has a definite volume but no definite shape. When you pour a liquid from one container to another, the liquid takes the shape of the container. The volume of a liquid, however, is the same no matter what the shape of the container. If you pour 50 mL of juice from a carton into a pitcher, the pitcher will contain 50 mL of juice. If you then pour that same juice into a glass, its shape will change again but its volume will not.

Free to Move The reason that a liquid can have different shapes is because the particles in a liquid move more freely, as shown in **Figure 4,** than the particles in a solid. The particles in a liquid have enough energy to move out of their fixed positions but not enough to move far apart.

Earth Science
INTEGRATION

About 74.93 percent of Earth's freshwater is in the form of solid ice. Most of the remaining freshwater, about 25.04 percent, exists as a liquid in lakes, rivers, and in the ground. A small fraction, about 0.03 percent, of Earth's freshwater can be found in the air as water vapor, which is the gas state of water. Create a circle graph showing the states of Earth's freshwater.

Liquid

Figure 4
The particles in a liquid stay close together, although they are free to move past one another.

Viscosity Do all liquids flow the way water flows? You know that honey flows more slowly than water and you've probably heard the phrase "slow as molasses." Some liquids flow more easily than others. A liquid's resistance to flow is known as the liquid's viscosity. Honey has a high viscosity. Water has a lower viscosity. The slower a liquid flows, the higher its viscosity is. The viscosity results from the strength of the attraction between the particles of the liquid. For many liquids, viscosity increases as the liquid becomes colder.

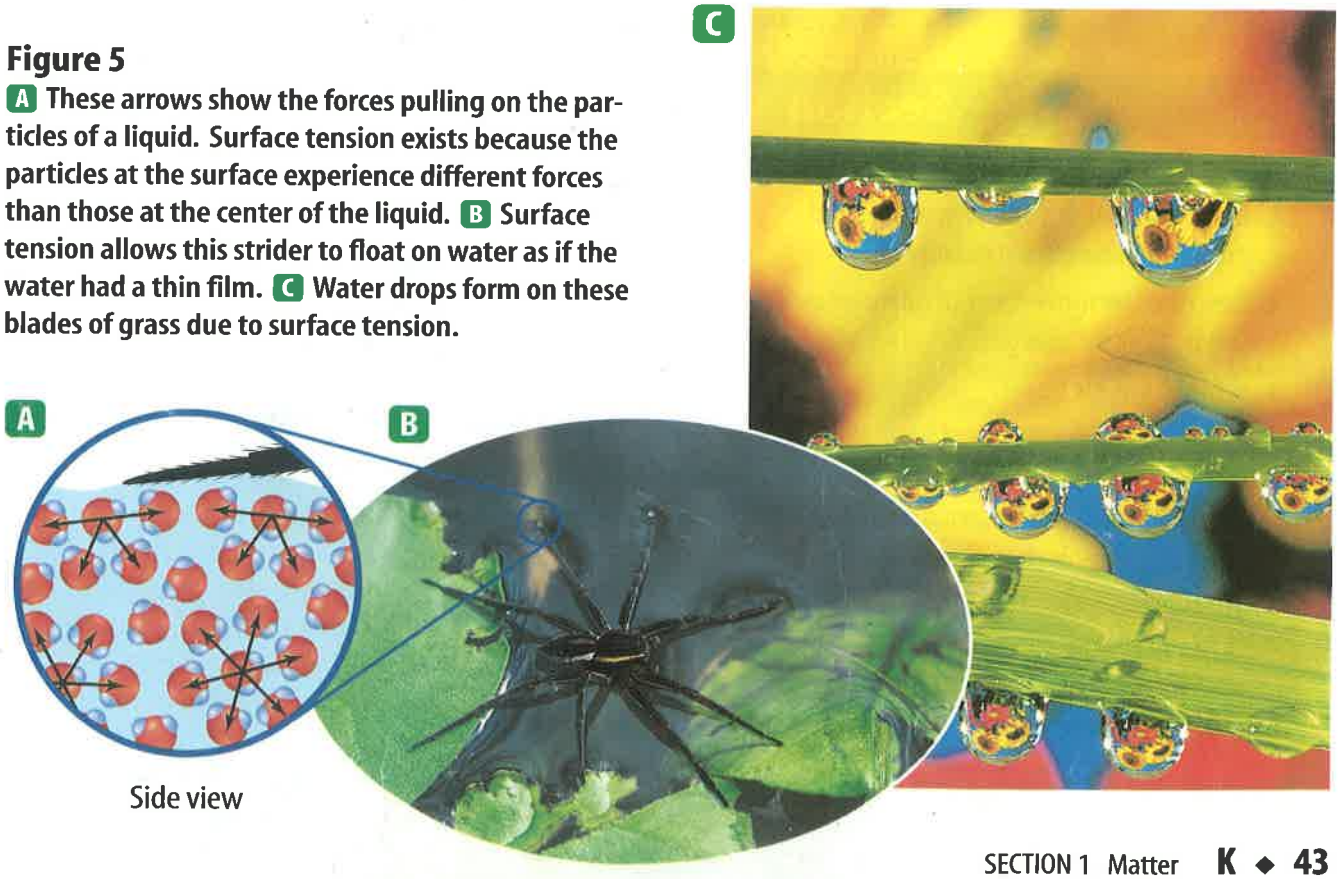
Surface Tension If you're careful, you can float a needle on the surface of water. This is because attractive forces cause the particles on the surface of a liquid to pull themselves together and resist being pushed apart. You can see in **Figure 5A** that particles beneath the surface of a liquid are pulled in all directions. Particles at the surface of a liquid are pulled toward the center of the liquid and sideways along the surface. No liquid particles are located above to pull on them. The uneven forces acting on the particles on the surface of a liquid are called surface tension. Surface tension causes the liquid to act as if a thin film were stretched across its surface. As a result you can float a needle on the surface of water. For the same reason, the water strider in **Figure 5B** can move around on the surface of a pond or lake. When a liquid is present in small amounts, surface tension causes the liquid to form small droplets, as shown in **Figure 5C.**

SCIENCE Online

Research Visit the Glencoe Science Web site at **science.glencoe.com** for more information about the states of matter. How does the fourth state of matter, plasma, differ from the others? Make a poster that describes and gives examples of the four states of matter.

Figure 5

A These arrows show the forces pulling on the particles of a liquid. Surface tension exists because the particles at the surface experience different forces than those at the center of the liquid. B Surface tension allows this strider to float on water as if the water had a thin film. C Water drops form on these blades of grass due to surface tension.



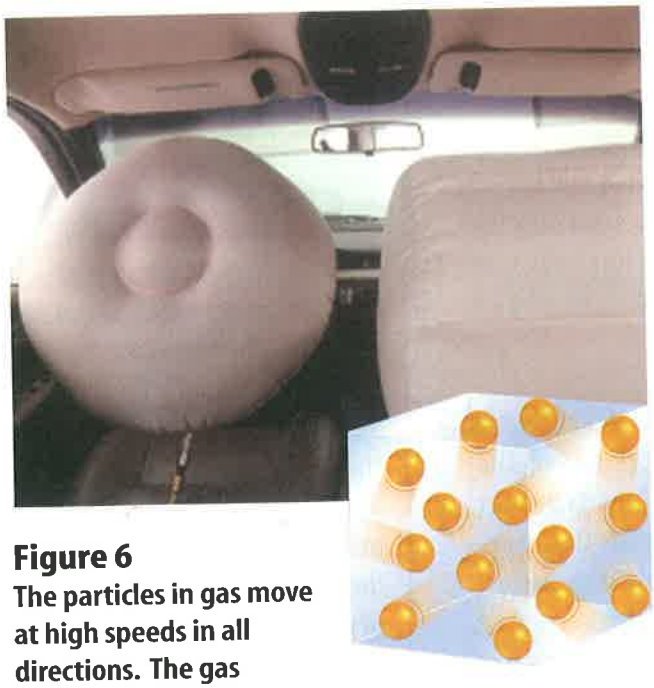


Figure 6
The particles in gas move at high speeds in all directions. The gas inside these air bags spreads out to fill the entire volume of the bag.

Gases

Unlike solids and liquids, most gases are invisible. The air in the air bags in **Figure 6** and the helium in some balloons are examples of gases. **Gas** is matter that does not have a definite shape or volume. The particles in gas are much farther apart than those in a liquid or solid. Gas particles move at high speeds in all directions. They will spread out evenly, as far apart as possible. If you poured a small volume of a liquid into a container, the liquid would stay in the bottom of the container. However, if you poured the same volume of a gas into a container, the gas would fill the container completely. A gas can expand or be compressed. Decreasing the volume of the container squeezes the gas particles closer together.

Reading Check ***How will the shape and volume of helium gas change when it escapes from a balloon?***

You sometimes will hear the term *vapor* applied to gases. A vapor is matter that exists in the gas state but is generally a liquid or solid at room temperature. Water, for example, is a liquid at room temperature. Steam, the gas state of water, is called water vapor.

Section 1 Assessment

1. Define matter in your own words and provide at least three examples.
2. Describe the movement of particles within solids, liquids, and gases.
3. Why do liquids flow?
4. A scientist places 25 mL of a yellow substance into a 50-mL container. The substance quickly fills the entire container. In which state of matter is the substance? Why?
5. **Think Critically** Two of the three common states of matter can be grouped together. Which two states share a similar property? Explain your reasoning.

Skill Builder Activities

6. **Concept Mapping** Using what you have read, draw a Venn diagram in your Science Journal and fill in the characteristics of the states of matter. Add information that you've gained from experience. **For more help, refer to the Science Skill Handbook.**
7. **Communicating** You are surrounded by solids, liquids, and gases all the time. In your Science Journal, make a table with three columns. List several examples of each state of matter. **For more help, refer to the Science Skill Handbook.**