Name _____ Class _____ Date _____

CHAPTER 3 States of Matter

SECTION 1

Matter and Energy

KEY IDEAS

As you read this section, keep these questions in mind:

- What makes up matter?
- What is the difference between a solid, a liquid, and a gas?
- What kind of energy do all particles of matter have?

What Makes Up Matter?

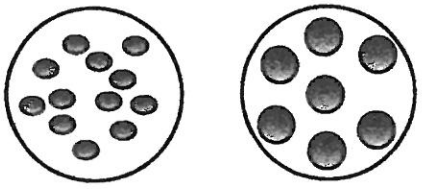
Recall that matter is anything that has mass and takes up space. This textbook is made of matter. Trees, cars, food, air, and you are all made of matter. What is matter made of?

All matter is made of atoms. The atoms in many forms of matter are joined in molecules. All of these particles move constantly. They may move in all directions or vibrate in place. These motions explain many of our observations of how matter behaves. ☑

If you leave a bottle of perfume open, eventually you will be able to smell the perfume from across the room. Why? Like the particles of all matter, the particles in the perfume move constantly. When the bottle is open, some perfume particles can leave the bottle and enter the air. They can move through the air and reach your nose.

Scientists have made many observations about the movement of particles. These observations helped scientists develop the *kinetic theory of matter*. This theory has three main parts:

1. All matter is made of particles that are in constant motion.
2. The faster particles move, the higher the temperature of the substance.
3. At the same temperature, more massive particles move more slowly than less massive ones.



READING TOOLBOX

Summarize As you read, make a table that compares the three common states of matter.

READING CHECK

1. Identify What makes up all matter?

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LOOKING CLOSER

2. Explain Both of these samples of matter are at the same temperature. Which particles are moving more slowly? Explain your answer.

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What Are the Common States of Matter?

The kinetic theory can help you understand the differences between the three common states of matter: solid, liquid, and gas. The figure below shows models for each of these three states.

LOOKING CLOSER

3. Compare How does the movement of particles in a liquid differ from the movement of particles in a solid?

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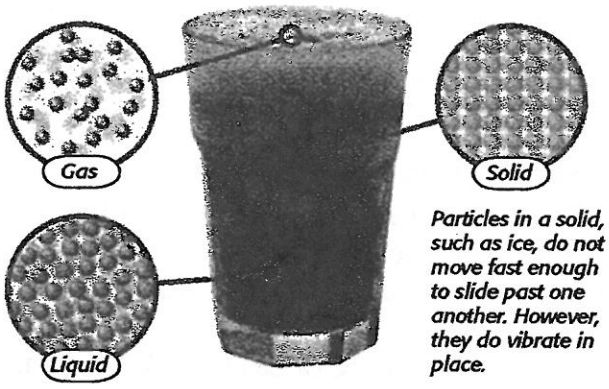
Particles in a gas, such as carbon dioxide, move very fast. The particles are usually far apart.

Particles in a liquid move quickly, but they are fairly close together. The particles in a liquid can move past each other. This allows a liquid to flow.



Particles in a solid, such as ice, do not move fast enough to slide past one another. However, they do vibrate in place.

You can classify matter as a solid, liquid, or gas by determining whether the shape and volume are definite or variable. *Definite* means something does not change. *Variable* means something can change.

SOLIDS

The particles in a solid cannot change position easily. Strong attractions hold them close together. The particles can only vibrate in place. These strong attractions give a solid a rigid structure. As a result of its rigid structure, a solid has a definite volume and a definite shape. ☑

READING CHECK

4. Identify What causes a solid to have a definite volume and shape?

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Solids

- ☑ Definite volume
- ☑ Definite shape

LIQUIDS

The particles that make up a liquid move more quickly than those in a solid. Because the particles move more quickly, they can overcome some of the forces of attraction between them. Thus, liquids can flow freely. ☑

Liquids take the shape of the container they are in. In other words, a liquid has a variable shape. For example, if you pour water into a glass, the water will take the shape of the glass. However, the volume of that water does not change even if you use a different glass.

Liquids
- ☑ Definite volume
- ☑ Variable shape

READING CHECK

5. Explain Why can the particles in a liquid overcome some forces of attraction?

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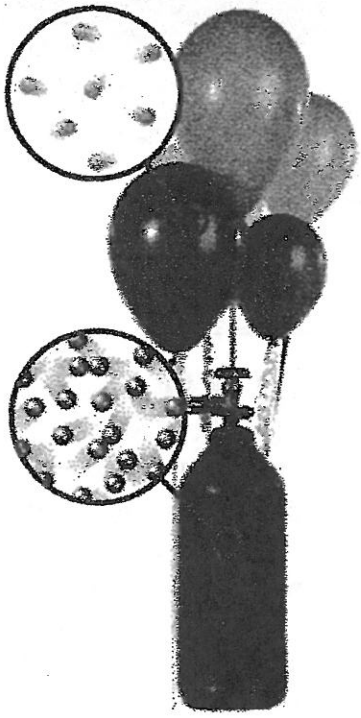
GASES

The particles in a gas move more quickly than the particles in solids and liquids do. Like liquids, gases can change shape. However, gases can also change volume. The particles in a gas are generally far apart from one another. They can move to fill up the entire space inside a closed container. However, if you apply pressure to the gas, the particles can move closer together.



The shape and volume of a gas are variable. The helium atoms in the cylinder have been *compressed*, or forced close together. The atoms in the balloon have more space, so they spread out.

Gases
- ☑ Variable volume
- ☑ Variable shape

LOOKING CLOSER

6. Compare How does the amount of space between particles differ in the balloon and helium cylinder?

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What Is a Fluid?

Recall that both liquids and gases have variable shapes. The particles in these states of matter are not held rigidly in place. Instead, the particles can move past each other. A state of matter in which the particles are free to move past each other is called a **fluid**. ☑

READING CHECK

7. Describe Describe the movement of particles in a fluid.

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What Is a Plasma?

Most matter on Earth is either a solid, liquid, or gas. However, most of the other matter in the universe, including the stars, is made of plasma. A **plasma** is made up of electrically charged, or *ionized*, particles. Like gases, plasmas have variable shape and volume. However, unlike gases, plasmas conduct electricity. Lightning is an example of plasma.

At certain places on Earth, streams or bands of light sometimes appear in the night sky. These lights are called auroras. Auroras form when plasma collides with gas particles in the upper atmosphere.

Critical Thinking

8. Infer Is a plasma a fluid? Explain your answer.

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Plasmas

☑ Variable volume

☑ Variable shape

What Kind of Energy Do All Particles Have?

In order to move, you need energy. **Energy** is the ability to change or move matter. Energy can take many different forms. The energy of motion is called *kinetic energy*.

READING CHECK

9. Explain Why do all particles of matter have kinetic energy?

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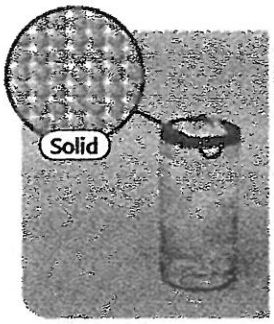
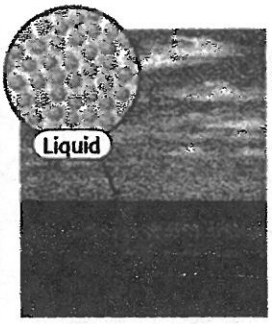
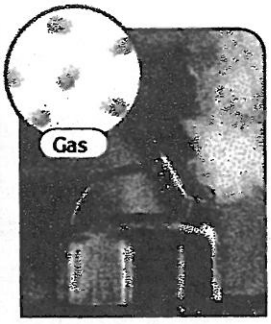
Recall that the particles that make up all matter move constantly. Because they are moving, all particles of matter have kinetic energy. However, not all particles have the same amount of kinetic energy. ☑



Compared to the particles in liquids and gases, the particles in a solid move very slowly. Particles in a solid have the least kinetic energy.



Particles in a liquid have more kinetic energy than particles in a solid, but less than particles in a gas.



Compared to the particles in solids and liquids, particles in a gas have the most kinetic energy.

LOOKING CLOSER

10. Identify Which of the three common states of matter has particles with the most kinetic energy?

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TEMPERATURE

Particles of matter are always moving, but all particles in a material do not move at exactly the same speed. Thus, some particles have more kinetic energy than others. Because particles in a substance have different amounts of kinetic energy, scientists usually measure only the *average* kinetic energy of particles.

Many people think of temperature as a measure of how hot or cold something feels. In fact, **temperature** is a measure of the average kinetic energy of the particles in an object. When you measure an object's temperature, you are measuring the average kinetic energy of its particles. The higher the average kinetic energy of the particles in a substance, the higher its temperature. ☑

READING CHECK

11. Identify What does temperature measure?

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THERMAL ENERGY

The temperature of a substance is not affected by how much of the substance you have. For example, imagine that you have just poured a cup of hot tea. The average kinetic energy of tea particles is the same in the teacup and the teapot.

Although the average kinetic energy of the particles in the cup and pot are the same, the *total* kinetic energy in each container is different. Why? The teapot holds more particles than the cup does. The total kinetic energy of all the particles in a substance is called **thermal energy**. Thus, when two samples of the same substance have the same temperature, the larger sample will have more thermal energy.

Name _____ Class _____ Date _____

Section 1 Review

SECTION VOCABULARY

energy the capacity to do work

fluid a nonsolid state of matter in which the atoms or molecules are free to move past each other, as in a gas or liquid

plasma in physical science, the state of matter that consists of free-moving ions and electrons; a plasma's properties differ from the properties of a solid, liquid, or gas

temperature a measure of how hot (or cold) something is, specifically a measure of the average kinetic energy of the particles in an object

thermal energy the total kinetic energy of a substance's atoms

1. **List** List three states of matter that are fluids.

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2. **Describe** Complete the table below to describe four states of matter.

State of matter	Is shape definite or variable?	Is volume definite or variable?	Is it a fluid?	How do the particles move?	Are the particles electrically charged?
Solid		definite			
Liquid				move past each other	
Gas					no
Plasma	variable				

3. **Infer** Which is easier to compress, a gas or a solid? Explain your answer.

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4. **Identify Relationships** Which particles have more kinetic energy—those in a substance with a high temperature or those in a substance with a low temperature?

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5. **Compare** A scientist has two samples of a substance. Both samples have the same temperature. One sample has a mass of 10 g. The other sample has a mass of 20 g. Compare the average kinetic energy and total kinetic energy of the particles in each sample.

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