Section 1

Reading Preview

Essential Questions

- What is the kinetic theory of matter?
- How do particles move in the different states of matter?
- How do particles behave at the boiling and melting points?

Review Vocabulary

kinetic energy: energy of motion

New Vocabulary

kinetic theory
melting point
heat of fusion
boiling point
heat of vaporization
sublimation
plasma
thermal expansion

g Multilingual eGlossary

FOLDABLES Incorporate information from this section into your Foldable.

Matter and Thermal Energy

MAIN Idea **Matter can exist as a solid, a liquid, a gas, or a plasma**

Real-World Reading Link Water can be a cool, refreshing drink, a hard surface for sliding on, or a dangerously hot gas. How water behaves depends on its state of matter.

Kinetic Theory

You encounter solids, liquids, and gases every day. Look at **Figure 1.** Can you identify the states of matter present? The tea is in the liquid state. The ice cubes dropped into the tea to cool it are in the solid state. Surrounding the glass, as part of the air, is water in the gas state. How do these states compare?

Gas state To understand the states of matter, we must think about the particles that make up matter. Consider the air around you: it is composed of nitrogen, oxygen, and water, along with other gases. These atoms and molecules—the particles that make up the air—are constantly moving. The **kinetic theory** is an explanation of how the particles in gases behave. To explain the behavior of particles, it is necessary to make some basic assumptions. The assumptions of the kinetic theory are as follows:

1. All matter is composed of tiny particles (atoms, molecules and ions).
2. These particles are in constant, random motion.
3. The particles collide with each other and with the walls of any container in which they are held.
4. The amount of energy that the particles lose from these collisions is negligible.

Figure 1 Water is a substance that can exist in all three common states of matter at the same time.

Identify *the solid and liquid states of water in this photo.*

particles are in constant motion, colliding with each other and with the walls of their container, gases do not have a fixed volume or shape. Instead, the particles that make up a gas spread out so that they fill whatever container they are in.

Liquid state Although the kinetic theory explains the behaviors of gas particles, some of the assumptions of the theory apply to liquids and solids as well. The particles of a substance in the liquid state, shown in **Figure 2,** are also constantly moving, although they are not moving as quickly as they would be if the substance were in the gas state. Therefore, the particles that make up a substance have less kinetic energy when in its liquid state than when in its gas state.

Because they have less energy, the particles are less able to overcome their attractions to each other. They can slide past each other, allowing a liquid to flow and take the shape of its container. However, because the particles that make up a liquid have not completely overcome the attractive forces between them, the particles cling together, giving the liquid a definite volume.

Solid state Unlike a gas or a liquid, a solid has a definite shape and volume. The particles that make up a solid are closely packed together, as shown in **Figure 2.** They are still in motion, but they have so little kinetic energy that the particles are unable to overcome their attractions to each other.

Many solids are crystalline, which means their particles have specific geometric arrangements. **Figure 3** shows the geometric arrangement of ice. Notice that the hydrogen and oxygen atoms alternate in the arrangement.

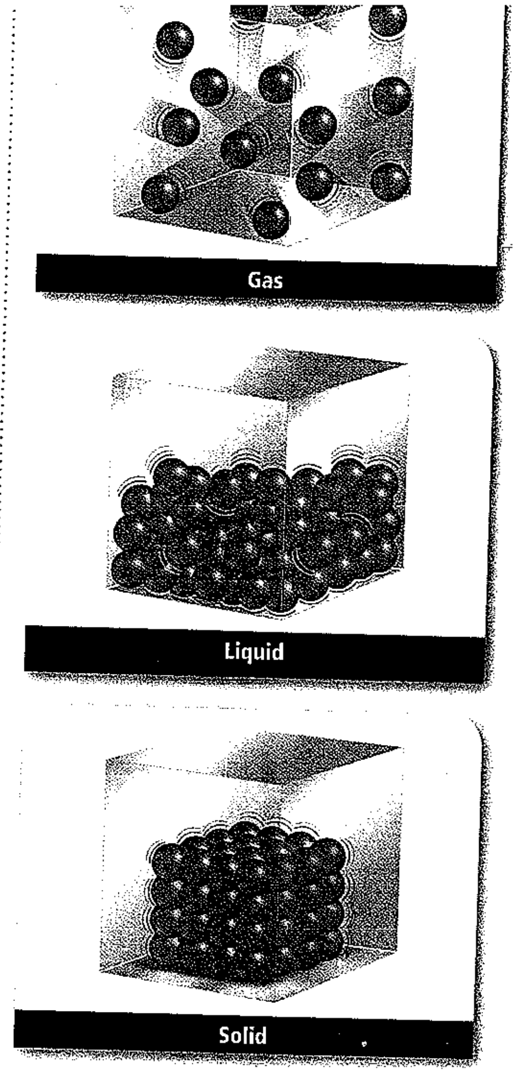

Figure 2 Solids, liquids, and gases differ in how their particles move. These differences account for their physical properties.

Compare and contrast ***the shape and volume of each state of matter.***

Concepts in Motion
Animation

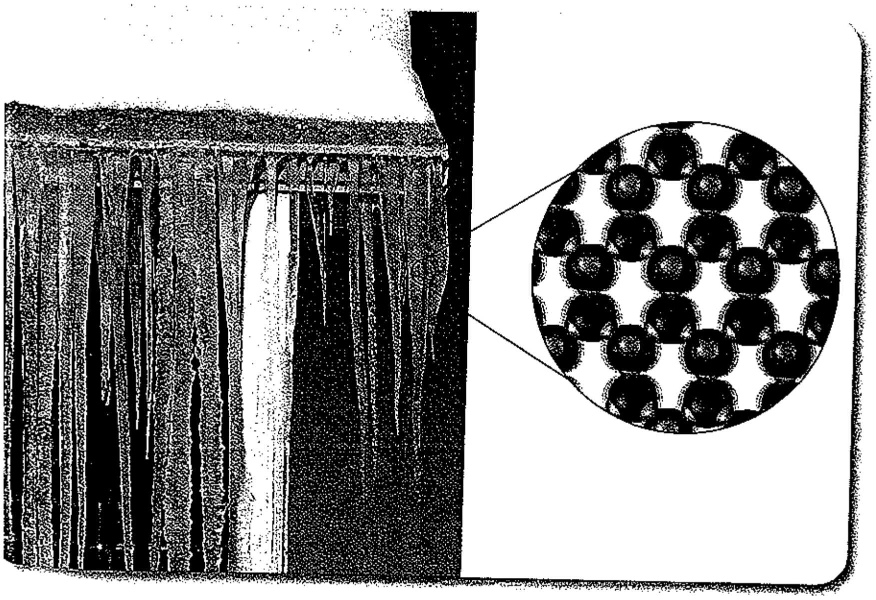

Figure 3 Ice is a crystalline solid—its particles have a specific geometric arrangement. Although ice does not look like it is moving, its molecules are vibrating in place.