Chapter 3
States of Matter

Preview

Section 1  Three States of Matter
Section 2  Behavior of Gases
Section 3  Changes of State

Concept Mapping
Bellringer

In the kitchen, you might find three different forms of water. What are these three forms of water, and where exactly in the kitchen would you find them?

Record your answers in your science journal.
Objectives

• **Describe** the properties shared by particles of all matter.

• **Describe** three states of matter.

• **Explain** the differences between the states of matter.
Particles of Matter

• The **states of matter** are the physical forms in which a substance can exist. The three most familiar states of matter are solid, liquid, and gas.

• Matter is made up of tiny particles called *atoms* and *molecules*. These particles are always in motion and are always bumping into one another.
Particles of Matter, *continued*

- The particles in matter interact with each other.

- The way the particles interact with each other helps determine the state of the matter.

- The interactions between particles in three states of matter is shown on the next slide.
**Models of a Solid, a Liquid, and a Gas**

- **Particles of a solid** do not move fast enough to overcome the strong attraction between them. So, they are close together and vibrate in place.

- **Particles of a liquid** move fast enough to overcome some of the attraction between them. The particles are close together but can slide past one another.

- **Particles of a gas** move fast enough to overcome almost all of the attraction between them. The particles are far apart and move independently of one another.
Solids

• A **solid** is the state of matter that has a definite shape and volume.

• The particles in a solid do not move fast enough to overcome the attraction between them.

• Each particle vibrates in place and is locked in place by the particles around it.
Solids, continued

• There Are Two Kinds of Solids  Crystalline solids have a very orderly, three-dimensional arrangement of particles. Iron, diamond, and ice are crystalline solids.

• Amorphous solids are made of particles that do not have a special arrangement. Glass, rubber, and wax are amorphous solids.
Liquids

- **Liquid** is the state of matter that has a definite volume and but takes the shape of its container.

- The particles of a liquid move fast enough to overcome some of the attraction between them.

- The particles in a liquid slide past each other.
Liquids, *continued*

- **Liquids Have Unique Characteristics** Two special properties of liquids are surface tension and viscosity.

- **Surface tension** is a force that acts on the particles at the surface of a liquid.

- **Viscosity** is a liquid’s resistance to flow.
Gases

- **Gas** is the state of matter that has no definite shape or volume.

- The particles of a gas move quickly and can break away completely from one another.

- The amount of empty space between gas particles can change.
Bellringer

What gas is used in a balloon to make it float in the air? Have you ever seen a hot-air balloon floating in the sky?

In your science journal, write an explanation of why you think the balloon can fly with only air in it and not helium.
Objectives

• **Describe** three factors that affect how gases behave.

• **Predict** how a change in pressure or temperature will affect the volume of a gas.
Describing Gas Behavior

• **Temperature**  Temperature is a measure of how fast the particles in an object are moving. The faster the particles are moving, the more energy they have.

• **Volume**  Volume is the amount of space that an object takes up. Because gas particles spread out, the volume of any gas depends on the container that the gas is in.
Describing Gas Behavior, continued

• **Pressure**  The amount of force exerted on a given area of surface is called pressure. You can think of pressure as the number of times the particles of a gas hit the inside of their container.
Gas Behavior Laws

- **Boyle’s Law**  Boyle’s law states that for a fixed amount of gas at a constant temperature, the volume of the gas is inversely related to pressure.

- **Charles’s Law**  Charles’s law states that for a fixed amount of gas at a constant pressure, the volume of the gas changes in the same way that the temperature of the gas changes.
Section 2  Behavior of Gases

**Boyle’s Law**
- Lifting the piston lets the particles of gas spread far apart. The volume of the gas increases as the pressure decreases.
- Releasing the piston allows the particles of gas to return to their original volume and pressure.
- Pushing the piston forces the gas particles close together. The volume of the gas decreases as the pressure increases.

**Charles’s Law**
- Decreasing the temperature of the gas causes the particles to move more slowly. The gas particles hit the piston less often and with less force. So, the volume of the gas decreases.
- Increasing the temperature of the gas causes the particles to move more quickly. The gas particles hit the piston more often and with greater force. So, the volume of the gas increases.
Bellringer

Write a description of what must be done to liquid water to change it to ice or to change it to steam. Based on your explanation, predict what must happen to cause matter to change state.

Write your answer in your science journal.
Objectives

• **Describe** how energy is involved in changes of state.

• **Describe** what happens during melting and freezing.

• **Compare** evaporation and condensation.

• **Explain** what happens during sublimation.

• **Identify** the two changes that can happen when a substance loses or gains energy.
Energy and Changes of State

• A **change of state** is the change of a substance from one physical form to another.

• The particles of a substance move differently depending on the state of the substance.

• The particles also have different amounts of energy when the substance is in different states.
Changes of State

The terms in the arrows are changes of state. Water commonly goes through the changes of state shown here.

- Freezing
- Melting
- Evaporation
- Condensation
Melting: Solid to Liquid

• **Melting** is the change of state from a solid to a liquid. The temperature at which a solid changes to a liquid is its melting point.

• **Adding Energy** For a solid to melt, particles must overcome their attractions to each other. When a solid is at its melting point, any energy added is used to overcome attractions between particles.
Freezing: Liquid to Solid

• Freezing is the change of state from a liquid to a solid. The temperature at which a liquid changes to a solid is its freezing point.

• **Removing Energy** When a liquid is at its freezing point, removing energy will cause the particles to begin locking into place.
Evaporation: Liquid to Gas

- **Evaporation** is the change of state from a liquid to a gas. Evaporation can occur at the surface of a liquid that is below its boiling point.

- **Boiling** is the change of a liquid to a gas throughout the liquid. The temperature at which a liquid boils is its *boiling point*.
**Chapter 3**

**Section 3  Changes of State**

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**Boiling and Evaporation**

**Boiling** occurs in a liquid at its boiling point. As energy is added to the liquid, particles throughout the liquid move faster. When they move fast enough to break away from other particles, they evaporate and become a gas.

**Evaporation** can also occur in a liquid below its boiling point. Some particles at the surface of the liquid move fast enough to break away from the particles around them and become a gas.
Evaporation: Liquid to Gas, continued

• **Effects of Pressure on Boiling Point**  The boiling point of a liquid decreases as atmospheric pressure decreases. Atmospheric pressure is caused by the weight of the gases in the atmosphere.

• Atmospheric pressure is lower at higher elevations. So, the boiling point is lower on top of mountains than it is at sea level.
Condensation: Gas to Liquid

- **Condensation** is the change of state from a gas to a liquid. The condensation point of a substance is the temperature at which the gas becomes a liquid.

- Energy must be removed for condensation to occur. Removing energy slows the movement of gas particles which allows them to clump together.
Vaporization and Condensation

Click below to watch the Visual Concept.
Sublimation: Solid to Gas

- **Sublimation** is the change of state in which a solid changes directly into a gas.

- For sublimation to occur, the attractions between the particles must be completely overcome. So, the substance must gain energy during sublimation.
Change of Temperature Vs. Change of State

• When most substances lose or gain energy, one of two things happens to the substance: its temperature changes or its state changes.

• But the temperature of a substance does not change until a change of state is complete.

• The graph on the next slide shows how temperature changes as energy is added to ice.
The energy that is added during a change of state is used to break the attractions between particles. So, the temperature does not change until the change of state is complete.
Concept Mapping

Use the terms below to complete the Concept Mapping on the next slide.

changes of state  condensing
melting  states of matter
 evaporating  solid
 liquid
States of Matter

Use the following terms to complete the concept map below:
changes of state, melting, evaporating, liquid, condensing, states of matter, solid

- such as
- gas
- are converted in
- from liquid to solid by freezing
- from liquid to gas by
- from gas to liquid by
- from solid to liquid by
States of Matter

Use the following terms to complete the concept map below:
changes of state, melting, evaporating, liquid, condensing, states of matter, solid

States of matter

such as

solid □ liquid □ gas

are converted in

changes of state

from liquid to solid by
from liquid to gas by
from gas to liquid by
from solid to liquid by

freezing □ evaporating □ condensing □ melting