

**Assess Your Understanding**

# States of Matter

## How Do You Describe a Solid?

- 1a. **IDENTIFY** The two types of solids are \_\_\_\_\_  
and \_\_\_\_\_.
- b. **EXPLAIN** Are the particles in a solid motionless? Explain your answer. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- c. **DRAW CONCLUSIONS** Candle wax gradually loses its shape as it is heated. What type of solid is candle wax? Explain. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**got it?** .....

- I **get it!** Now I know that a solid has a definite shape and volume because \_\_\_\_\_  
\_\_\_\_\_
- I **need extra help with** \_\_\_\_\_

## How Do You Describe a Liquid?

- 2a. **NAME** A substance that flows is called a \_\_\_\_\_.
- b. **DESCRIBE** Why is a liquid able to flow? \_\_\_\_\_  
\_\_\_\_\_
- c. **COMPARE AND CONTRAST** How do liquids with a high viscosity differ from liquids with a low viscosity? \_\_\_\_\_  
\_\_\_\_\_

**got it?** .....

- I **get it!** Now I know that a liquid has a definite volume but not a definite shape because \_\_\_\_\_  
\_\_\_\_\_
- I **need extra help with** \_\_\_\_\_

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

**Assess Your Understanding**

# States of Matter

## How Do You Describe a Gas?

3a. DESCRIBE Describe how the motions of gas particles are related to the pressure exerted by the gas. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

b. RELATE CAUSE AND EFFECT Why does pumping more air into a basketball increase the pressure inside the ball? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**got it?** .....

I **get it!** Now I know that a gas has neither a definite shape nor definite volume because \_\_\_\_\_  
\_\_\_\_\_

I need extra help with \_\_\_\_\_

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

**Key Concept Summaries**

# States of Matter

## How Do You Describe a Solid?

The particles in a **solid** are packed tightly together, vibrating slightly about their fixed positions. **This fixed, closely packed arrangement of particles in a solid causes it to have a definite shape and volume.** There are two types of solids: The particles in **crystalline** solids form a regular, repeating

pattern; the particles in **amorphous** solids are held tightly together, but not in a repeating pattern. When a crystalline solid is heated, it melts at a distinct temperature. Amorphous solids become softer and softer, not melting at a distinct temperature.

## How Do You Describe a Liquid?

The particles in a **liquid** are packed almost as closely as those in a solid, but they can move around each other freely. **Because its particles are free to move, a liquid has no definite shape. However, it does have a definite volume.** Liquids are also called **fluids**, meaning "substances that flow." **Viscosity**

is a fluid's resistance to flow. For example, honey has a higher viscosity than water. Liquids have **surface tension**, an inward force that brings the molecules on the surface closer together. Surface tension causes water to bead up on surfaces.

## How Do You Describe a Gas?

Like a liquid, a **gas** is also a fluid. Gas particles move in all directions. **As they move, gas particles spread apart, filling all the space available. Thus, a gas has neither definite shape nor definite volume.** The volume of a gas is the same as the volume of its container; the particles just move farther apart or closer together. The **pressure** of a gas is the force

of the outward push of its particles on the walls of its container divided by the area of the walls. The temperature of a gas (or other substance) is a measure of the average energy of motion of the particles. The faster the particles are moving, the greater their energy and the higher the temperature.

**On a separate sheet of paper, draw representations of the molecules in a solid, in a liquid, and in a gas.**

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

## Lesson Quiz

# States of Matter

Fill in the blank to complete each statement.

1. The amount of space that matter fills is its \_\_\_\_\_.
2. A state of matter with a definite volume, but no definite shape is a(n) \_\_\_\_\_.
3. A(n) \_\_\_\_\_ will always take the shape and volume of its container.
4. The \_\_\_\_\_ is a measure of the average speed of the particles in a substance.
5. A(n) \_\_\_\_\_ has a definite volume but no shape of its own.
6. The \_\_\_\_\_ of a gas is the force of its outward push divided by the area of the walls of its container.

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

7. \_\_\_\_\_ Viscosity is the inward force among the molecules of a liquid.
8. \_\_\_\_\_ A(n) amorphous solid has a definite melting point.
9. \_\_\_\_\_ Both gases and liquids are fluids.
10. \_\_\_\_\_ All solids have a closely packed, fixed arrangement of particles.

**Assess Your Understanding**

# Changes of State

## What Happens to the Particles of a Solid as It Melts?

1a. IDENTIFY The change in state from a solid to a liquid is called \_\_\_\_\_.

b. COMPARE AND CONTRAST How does what happens to the particles in a substance during melting differ from what happens during freezing? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**got it?**.....

I get it! Now I know that melting occurs when the particles in a solid \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

I need extra help with \_\_\_\_\_

\_\_\_\_\_

## What Happens to the Particles of a Liquid as It Vaporizes?

2a. IDENTIFY The change in state from a liquid to a gas is called \_\_\_\_\_.

b. APPLY CONCEPTS How does the thermal energy of water vapor change as the vapor condenses? \_\_\_\_\_

\_\_\_\_\_

c. RELATE CAUSE AND EFFECT Why do clouds form before it rains? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**got it?**.....

I get it! Now I know vaporization occurs when the particles in a liquid \_\_\_\_\_

\_\_\_\_\_

I need extra help with \_\_\_\_\_

\_\_\_\_\_

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**Assess Your Understanding**

# Changes of State

**What Happens to the Particles of a Solid as it Sublimes?**

3a. IDENTIFY What is dry ice? \_\_\_\_\_

b. PREDICT If you allowed dry ice to stand in a bowl at room temperature for several hours, what would be left? \_\_\_\_\_  
\_\_\_\_\_

c. ANSWER  Why does a substance change states? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**got it?**.....

I get it! Now I know that sublimation occurs when the particles in a solid \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

I need extra help with \_\_\_\_\_  
\_\_\_\_\_

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**Key Concept Summaries**

# Changes of State

## What Happens to the Particles of a Solid as It Melts?

The change in state from a solid to a liquid is called **melting**. Most pure substances have a specific temperature at which this happens, called the **melting point**. **At its melting point, the particles of a solid vibrate so fast that they break free from their fixed positions.** The reverse of melting

is the change of state from a liquid to a solid. This is called **freezing**. **At its freezing point, the particles of a liquid are moving so slowly that they begin to take on fixed positions.** The freezing point of water, 0°C, is the same as its melting point.

## What Happens to the Particles of a Liquid as It Vaporizes?

The change from a liquid to a gas is called **vaporization**. **Vaporization occurs when the particles in a liquid gain enough energy to move independently.** Vaporization that takes place only on the surface of a liquid is called **evaporation**. Vaporization that takes place both below and at the

surface of a liquid is called **boiling**. The temperature at which a liquid boils is called its **boiling point**. The reverse of vaporization is called **condensation**; it is the change in state from a gas to a liquid. **Condensation occurs when particles in a gas lose enough thermal energy to form a liquid.**

## What Happens to the Particles of a Solid as It Sublimes?

**Sublimation** occurs when the surface particles of a solid gain enough energy that they form a gas.

**During sublimation, particles of a solid do not pass through the liquid state as they form a gas.**

One winter morning, you wake up to see the outside thermometer below 0°F. You find ice frozen along the sill of the *inside* of your window. The windowsill was dry when you went to bed. Describe how you think the ice formed overnight.

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

Lesson Quiz

# Lesson Quiz

Write the letter of the correct answer on the line at the left.

- |   |  |
|---|--|
| <p>1. ____ Which of the following describes the process of freezing?</p> <p>A Freezing occurs when the temperature of a substance drops to 0°C.</p> <p>B Freezing occurs when the particles of a solid vibrate so fast that they break free.</p> <p>C Freezing occurs when the temperature drops enough a gas turns into a solid.</p> <p>D Freezing occurs when the particles in a liquid slow down and take fixed positions.</p> | <p>2. ____ The process that makes ice cubes shrink as they sit in a freezer is called</p> <p>A sublimation</p> <p>B condensation</p> <p>C freezing</p> <p>D boiling</p>        |
| <p>3. ____ The temperature at which a liquid turns to a gas is</p> <p>A called the freezing point</p> <p>B called the boiling point</p> <p>C 100°C</p> <p>D the same for an amorphous or a crystalline solid</p>  | <p>4. ____ Particles of which of the following have the greatest thermal energy?</p> <p>A a liquid</p> <p>B a crystalline solid</p> <p>C a gas</p> <p>D an amorphous solid</p> |

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

5. \_\_\_\_\_ Sublimation and boiling both happen at the surface of the substance.
6. \_\_\_\_\_ Vaporization is the reverse of condensation.
7. \_\_\_\_\_ The temperature at which a liquid turns to a gas is called the boiling point.
8. \_\_\_\_\_ Boiling is the reverse of freezing.
9. \_\_\_\_\_ Water particles in gas coming off of a pan of boiling water are moving slower than the particles of the water in the pan.
10. \_\_\_\_\_ Evaporation and condensation are both types of vaporization.



**Assess Your Understanding**

# Gas Behavior

## How Are Pressure and Temperature of a Gas Related?

**got it?** .....

- I get it! Now I know that when the temperature of a gas at a constant volume increases, \_\_\_\_\_  
\_\_\_\_\_
- I need extra help with \_\_\_\_\_  
\_\_\_\_\_

## How Are Volume and Temperature of a Gas Related?

- 1a. IDENTIFY The graph of Charles's law shows that the volume of a gas is \_\_\_\_\_  
\_\_\_\_\_ to its Kelvin temperature at constant pressure.
- b. PREDICT Suppose the gas in **Figure 4** could be cooled to 100 K (-173°C). Predict the volume of the gas at this temperature. \_\_\_\_\_

**got it?** .....

- I get it! Now I know that when the temperature of a gas is decreased at constant pressure, \_\_\_\_\_  
\_\_\_\_\_
- I need extra help with \_\_\_\_\_  
\_\_\_\_\_

Place the outside corner, the corner away from the bottom left, in the corner of your copy machine to copy onto letter-size paper.

Assess Your Understanding

# Gas Behavior

## How Are Pressure and Volume of a Gas Related?

2a. IDENTIFY The graph of Boyle's law shows that the gas pressure is \_\_\_\_\_  
\_\_\_\_\_ to volume at constant temperature.

b. READ GRAPHS Use the graph that you made in the Analyzing Data  
feature to find the pressure of the gas when its volume is 125 mL. \_\_\_\_\_

**got it?** .....

I get it! Now I know that when the pressure of a gas at a constant temperature is  
increased, \_\_\_\_\_  
\_\_\_\_\_

I need extra help with \_\_\_\_\_  
\_\_\_\_\_

Place the outside corner, the corner away from the dotted line, in the corner of your copy machine to copy onto letter-size paper.

## Key Concept Summaries

# Gas Behavior

### How Are Pressure and Temperature of a Gas Related?

Recall that the higher the temperature of a substance, the faster its particles are moving on average. The faster gas particles move, the more frequently they collide with the walls of their container and the greater the force of the collisions. **When the temperature of a gas at constant volume is**

**increased, the pressure of the gas increases.**

**When the temperature is decreased, the pressure of the gas decreases.** This explains why truck (and sometimes car) tires burst on a long drive on a very hot day.

### How Are Volume and Temperature of a Gas Related?

**When the temperature of a gas is increased at constant pressure, the volume increases.**

**When the temperature of a gas is decreased at constant pressure, its volume decreases.** This principle is called **Charles's law**. When the volume of a gas at constant pressure is graphed as compared to

its temperature, the graph is a straight line that passes through the origin. This shows that the variables volume and pressure have a **directly proportional** relationship—one variable is equal to the product of a constant and the other variable.

### How Are Pressure and Volume of a Gas Related?

**When the pressure of a gas at constant temperature is increased, the volume of the gas decreases. When the pressure is decreased, the volume increases.** This is called **Boyle's law**. If the relationship between the pressure and the volume of a gas, at constant temperature, is graphed, the result is

a curve. A high pressure corresponds to a low volume and a low pressure corresponds to a high volume. The product of the variables pressure and volume is a constant. The pressure and volume are **inversely proportional** to each other.

Suppose you take a sealed, air-filled balloon, squeeze it and then release it. Next you take the balloon and place it in a refrigerator for half an hour, then remove it. In each case, explain the changes in volume, pressure, and temperature.

## Lesson Quiz

# Gas Behavior

Write the letter of the correct answer on the line at the left.

- \_\_\_ At constant temperature, when the volume of a gas is decreased, what happens to its pressure?  
A It decreases.  
B It will vary.  
C It increases.  
D It remains constant.
- \_\_\_ At constant pressure, when the temperature of a gas is decreased, what happens to its volume?  
A It decreases.  
B It will vary.  
C It increases.  
D It remains constant.
- \_\_\_ At constant pressure, how are the temperature and volume of a gas related?  
A They are inversely proportional.  
B They are directly proportional.  
C They are constant.  
D They are indirectly proportional.
- \_\_\_ If the sun shining through windows heats the air in a sealed room, what happens to the air pressure in that room?  
A It decreases.  
B It will vary.  
C It increases.  
D It remains constant.

Fill in the blank to complete each statement.

- When Martin pushes down on the handle of his bicycle pump, the air pressure within the pump \_\_\_\_\_.
- \_\_\_\_\_ law describes the relationship between a gas's volume and pressure when its temperature is constant.
- \_\_\_\_\_ law describes the relationship between a gas's temperature and volume when its pressure is constant.
- At constant temperature, the pressure and volume of a gas are \_\_\_\_\_ proportional.
- At constant volume, when the temperature of a gas decreases, the pressure \_\_\_\_\_.
- When the graph relating two variables is a straight line passing through the origin, the variables are \_\_\_\_\_ proportional to each other.