

Chapter 3 Solids, Liquids, and Gases ▪ Section 3 Summary

The Behavior of Gases

Key Concepts

- What types of measurements are useful when working with gases?
- How are the volume, temperature, and pressure of a gas related?

When working with a gas, it is helpful to know its volume, temperature, and pressure. Volume, the amount of space that matter fills, is measured in units of cubic centimeters or milliliters. Because gas particles move and fill the space available, the volume of a gas is the same as the volume of its container.

Temperature is a measure of the average energy of random motion of the particles of a substance. The faster the particles are moving, the greater their energy and the higher the temperature. Even at ordinary temperatures, the average speed of particles in a gas is very fast.

Because gas particles are moving, they are constantly colliding with one another. They also collide with the walls of their container. As a result, the gases push on the walls of the container. The **pressure** of the gas is the force of its outward push divided by the area of the walls of the container. Pressure is measured in units of pascals (Pa) or kilopascals (kPa).

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

The firmness of an object inflated with a gas comes from the pressure of the gas. When an inflated object develops a leak, the gas flows from the area of high pressure in the object to an area of low pressure outside. The pressure inside the object drops until it equals the pressure outside the object.

In the 1700s, the French scientist Jacques Charles examined the relationship between the temperature and volume of a gas. He measured the volume of a gas at various temperatures in a container whose volume could change. **When the temperature of a gas is increased at constant pressure, its volume increases. When the temperature of a gas is decreased at constant pressure, its volume decreases.** This principle is called **Charles's law**.

Pressure is related to the volume of a container. The relationship between the pressure and volume of a gas is called **Boyle's law**, after the English scientist Robert Boyle, from the 1600s. **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.**

Pressure is also related to the temperature of a gas. The higher the temperature, the faster the gas particles move. The faster the gas particles move, the more frequently they collide with the walls of their container, and the greater the pressure will be. **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.**

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The Behavior of Gases (pp. 103–111)

This section explains how the volume, temperature, and pressure of a gas are related.

Use Target Reading Skills

As you read, complete the outline about the behavior of gases. Use the red headings for the main ideas and the blue headings for subtopics. Add supporting ideas to the subtopics.

| The Behavior of Gases | |
|----------------------------|--|
| I. Measuring Gases | |
| A. Volume | |
| | |
| B. Temperature | |
| | |
| C. Pressure | |
| | |
| II. Temperature and Volume | |
| A. | |
| | |
| B. | |
| | |
| III. | |

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Measuring Gases (pp. 104–105)

1. List the three measurements that are helpful to know when working with a gas.

2. The volume of a gas is the same as the volume of its _____.

3. What is temperature? _____

4. Is the following sentence true or false? The faster gas particles are moving, the greater their energy and the lower the temperature.

5. The force pushing on a surface divided by the area of that surface is called _____.

6. What is the formula used to calculate pressure?

7. Why does a ball leak air even when it has a tiny hole?

Charles's Law (pp. 106–107)

8. What is the principle known as Charles's law?

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The Behavior of Gases *(continued)*

9. If the temperature of a gas is decreased at constant pressure, what happens to its volume?

10. Why does a hot air balloon rise when the air inside it is heated?

Pressure and Volume (pp. 108–109)

11. What does Boyle’s law say about the relationship between the pressure and volume of a gas?

12. Complete the table about the relationship between the pressure and volume of a gas, assuming temperature is held constant.

| Pressure and Volume of a Gas | |
|-------------------------------------|--------------------------------|
| Change | Increases or Decreases? |
| Pressure decreases | a. Volume |
| Pressure increases | b. Volume |
| Volume increases | c. Pressure |
| Volume decreases | d. Pressure |

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Pressure and Temperature (p. 110)

13. Suppose a gas is kept in a closed, rigid container. If the temperature of the gas is increased, what happens to its pressure on the container?

14. If the temperature of that gas in the container is decreased, what happens to its pressure?

15. What can cause tires to burst on long trips in warm weather?
