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Warm-Up | Gases

Lesson Objectives

By the end of this lesson, you should be able to:

- Describe the postulates of kinetic-molecular theory.
- Interpret the behavior of ideal gases in terms of kinetic-molecular [ ], including diffusion and effusion.
- Describe how kinetic-molecular theory explains the properties of [ ], including temperature, pressure, compressibility, and volume.

Science Practice: Identify the limitations of kinetic-molecular theory.

Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you.

____ effusion	A. a theoretical gas composed of random, noninteracting point particles
____ diffusion	B. a theory that describes gases as a large number of constantly and randomly moving particles (atoms/ molecules) that collide with one another and with the walls of the container
____ kinetic-molecular theory	C. the energy associated with movement
____ kinetic energy	D. the movement of a gas through a small opening into a larger volume
____ ideal gas	E. the spread of particles through random motion from regions of high to low concentration

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Lesson Question

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Kinetic-Molecular Theory

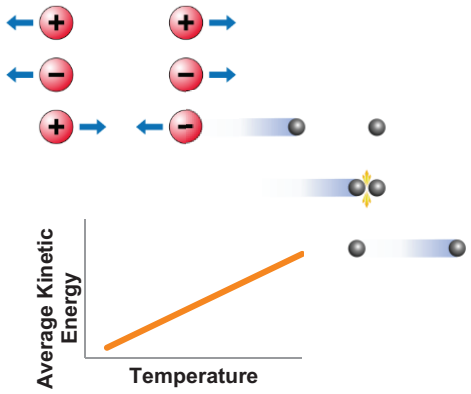
Kinetic-molecular theory: describes gases as a large number of constantly and randomly moving [ ] (atoms/molecules) that [ ] with each other and with the walls of the container

Postulates of kinetic-molecular theory:

- Gases are made up of a large number of hard [ ] that are in continuous, random motion.
- Most of the [ ] of a gas is empty space.

Postulates continued:

- There is no force of [ ] or repulsion between gas particles.
- All collisions between particles are perfectly [ ].



- **Kinetic energy**: [ ] resulting from the motion of particles
- The average kinetic energy of the particles depends only on temperature.

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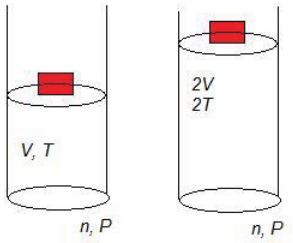
Ideal Gases

- **Ideal gas**: a theoretical gas composed of random, point particles [ ]
  - Properties of an ideal gas can be explained by [ ] theory.
- Describes gas behavior under common conditions



An ideal gas is an approximation. [ ] gases deviate from ideality, especially under extreme conditions.

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Properties of Gases

- [ ]
  - Significant volume change with increased pressure
- No fixed [ ] or [ ]
  - Expand to fill a container

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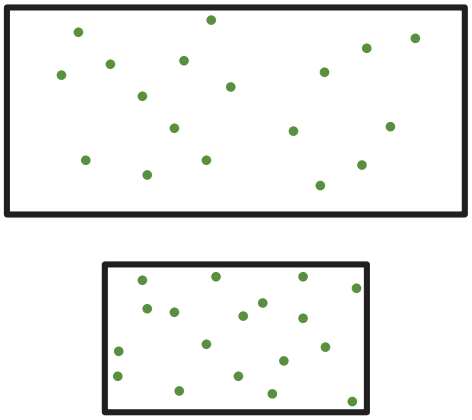
Compression and Expansion

- Kinetic-molecular theory:
  - Large spaces between [ ] particles
  - No [ ] between particles
- Compression forces particles closer together
- Lack of interaction allows [ ] to spread apart



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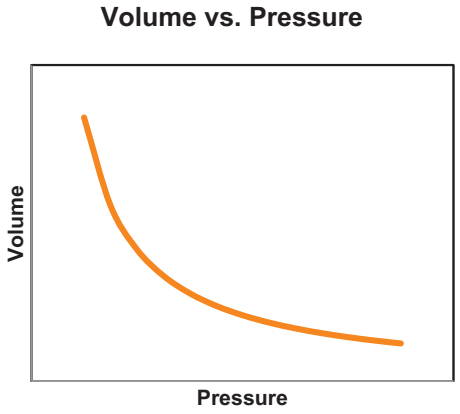
Behavior of Ideal Gases

- [ ] relationship:
  - [ ] and volume



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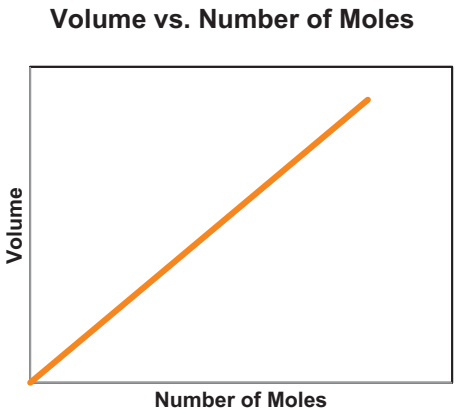
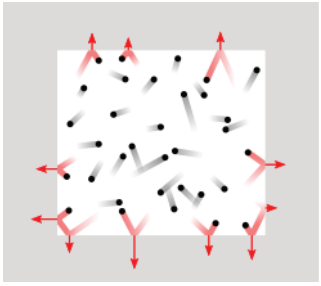
Behavior of Ideal Gases

- Inverse relationship:
  - Pressure and volume
- [ ] relationships:
  - Volume and number of [ ]
  - Pressure and temperature
  - Volume and temperature
  - Pressure and [ ] of moles



Pressure and Temperature

- Collisions with container walls → pressure
  - $P = \frac{F}{[\ ]}$
  - More or harder collisions → greater pressure



- Average [ ] energy of particles → temperature
  - Faster [ ] → higher temperature

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Kinetic-Molecular Theory and Gas Behavior

- Pressure and _____
  - Smaller volume → crowded particles → more collisions → higher _____
- Pressure and amount of gas
  - More gas particles → more _____ → higher pressure
- Pressure and temperature
  - Higher temperature → more kinetic _____ → more collisions → higher pressure

- Temperature and volume
  - Higher _____ → more kinetic energy → more space between _____ → higher volume
- Volume and _____ of gas
  - More gas particles → more volume

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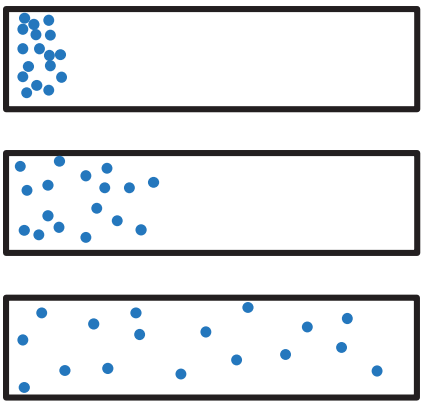
Diffusion and Effusion

- [ ]: the spread of particles through random motion from regions of high concentration to regions of low concentration
- **Effusion**: the movement of a gas through a small opening into a [ ] volume

Diffusion and Kinetic-Molecular Theory

- Kinetic-molecular theory:
  - Particles are in [ ] random motion,
  - Particle motions obey [ ] laws
- [ ] motions move particles from areas of high concentration to areas of low concentration
  - Net diffusion ends when concentrations are equal



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Effusion and Kinetic-Molecular Theory

- [ ] law: rate of effusion is inversely proportional to the [ ] root of molecular [ ] mass
- Kinetic-molecular theory: [ ] is related only to [ ] kinetic energy
  - $KE = \frac{1}{2}mv^2$

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Lesson Question

How do scientists describe the behavior of particles in gases?

Answer

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Kinetic-Molecular Theory and Ideal Gases

- The postulates of kinetic-molecular theory are as follows:
  - Gases are made up of a large number of hard [ ] (atoms, molecules, particles) that are in continuous, random motion. They obey Newton's laws, so they travel in a straight-line motion.
  - Gas particles have very small [ ] relative to the spaces between them. Most of the volume of a gas is empty space.
  - There is no [ ] of attraction or repulsion between gas particles.
  - All collisions between particles are perfectly elastic.
  - The average kinetic energy of the particles depends only on temperature.
- An ideal gas is a gas that obeys exactly all postulates of kinetic-molecular theory.
- Kinetic-molecular theory is an approximation and is less accurate for gases under extreme conditions.

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Behavior and Properties of Gases

Kinetic-molecular theory can explain many of the observable properties of gases:

- Gases are compressible because they contain mostly empty space.
- Gases expand to fill a container because there are no _____ forces holding their particles together.
- Pressure is the result of _____ of gas particles with a surface.
- The behavior of gas particles under changing conditions explains the relationships between _____, volume, temperature, and the amount of gas.

Diffusion and Effusion

- Kinetic-molecular theory explains diffusion.
- Diffusion is the movement of a gas from an area of high _____ to an area of low concentration.
- Effusion is the movement of a gas through a small opening.
- _____ law of effusion can be derived from kinetic-molecular theory.
- Graham's law states that the effusion rate of a gas is inversely proportional to the square root of its molar mass.

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Use this space to write any questions or thoughts about this lesson.

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