

What is Graham's Law of Effusion?

Worksheet

Graham's law: $\text{rate} \propto 1/\sqrt{M}$ or $(\text{rate}/\text{rate}) = \sqrt{(M_2/M_1)}$. Lighter gases diffuse faster because their molecules move more quickly.

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

Questions

1. Which statement is correct for Graham's law?

- A) faster for heavier gas
- B) faster for lighter gas
- C) same for all gases
- D) depends only on pressure

2. H ($M=2$) vs Cl ($M=71$). Ratio r_{H_2} / r_{Cl_2} ?

- A) 1
- B) 5.96
- C) 35.5
- D) 0.17

3. Graham's law assumes

- A) different temperatures
- B) same kinetic energy
- C) same molar mass
- D) different pressures

4. If gas A effuses 3 faster than gas B, and B has $M=36$ g/mol, what is M_A ?

- A) 4 g/mol
- B) 9 g/mol
- C) 12 g/mol
- D) 108 g/mol

5. Hydrogen ($M=2$ g/mol) and oxygen ($M=32$ g/mol) effuse from the same container. What is the ratio of their effusion rates?

6. Gas A ($M=40$ g/mol) effuses through a pore at 5 mL/s. Gas B ($M=10$ g/mol) effuses at what rate?

7. If N ($M=28$) diffuses at rate 3 units, what is the diffusion rate of CO ($M=44$)?

8. Define: What is Graham's law of effusion?

9. Define: Which gas effuses faster - H or O?

10. Define: Formula for comparing two effusion rates?

Answer Key

1. B) faster for lighter gas - Lighter gases (smaller M) have faster average speed faster effusion.
2. B) $5.96 - (71/2) = 35.5$ 5.96.
3. B) same kinetic energy - $KE_{avg} = (3/2)kT$ is the same for both gases at same T, leading to mass-dependent speeds.
4. A) 4 g/mol - $3 = (36/M_A) \Rightarrow 9 = 36/M_A \Rightarrow M_A = 4$ g/mol.
5. $r_{H_2} / r_{O_2} = (M_{O_2} / M_{H_2}) = (32 / 2) = 16 = 4$ Hydrogen effuses 4 times faster than oxygen.
6. $r_A / r_B = (M_B / M_A) \Rightarrow 5 / r_B = (10 / 40) \Rightarrow 5 / r_B = 0.25 \Rightarrow r_B = 5 / 0.25 = 20$ mL/s
7. $r_{N_2} / r_{CO_2} = (M_{CO_2} / M_{N_2}) \Rightarrow 3 / r_{CO_2} = (44 / 28) \Rightarrow 3 / r_{CO_2} = 1.571 \Rightarrow r_{CO_2} = 3 / 1.571 = 1.91$ units
8. The rate of effusion is inversely proportional to the square root of molar mass: $r \propto 1/\sqrt{M}$.
9. H (molar mass 2) effuses faster than O (molar mass 32) because it is lighter.
10. $r/r = (M/M)$.

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