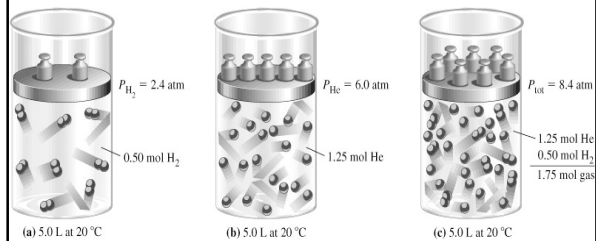


Partial Pressure, Effusion and Diffusion

Dalton's Law of Partial Pressure

It states that the total pressure of a mixture of gases is the sum of the partial pressures of the components of the mixture.



Partial Pressure

$$P_{tot} = P_a + P_b + \dots$$

$$V_a = n_a RT / P_{tot} \quad \text{and} \quad V_{tot} = V_a + V_b + \dots$$

$$\frac{V_a}{V_{tot}} = \frac{n_a RT / P_{tot}}{n_{tot} RT / P_{tot}} = \frac{n_a}{n_{tot}}$$

$$\frac{P_a}{P_{tot}} = \frac{n_a RT / V_{tot}}{n_{tot} RT / V_{tot}} = \frac{n_a}{n_{tot}}$$

$$P_a = \chi_a \cdot P_{tot} \quad P_b = \chi_b \cdot P_{tot}$$

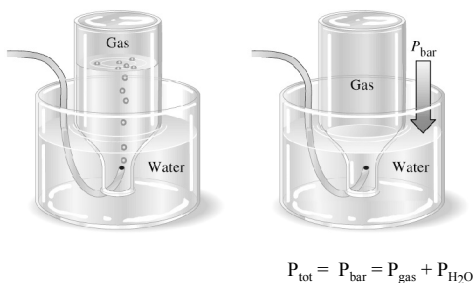
$$\frac{n_a}{n_{tot}} = \chi_a$$

↓
Mole fraction of
component A

Problem

The percent composition of air by volume is 78.08% N₂, 20.95% O₂, 0.93% Ar and 0.036% CO₂. What are the partial pressures of these four gases in a sample of air at a barometric pressure of 748 mm Hg?

Pneumatic Trough



Kinetic Molecular Theory

- Particles are point masses in constant, random, straight line motion.
- Particles are separated by great distances.
- Collisions are rapid and elastic.
- No force between particles.

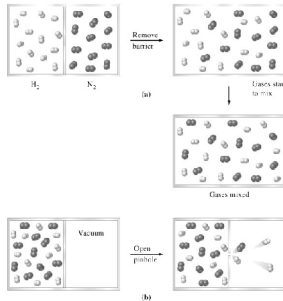


Average kinetic energy is directly proportional to temperature!!

- Total energy remains constant.

Gas Properties Relating to the Kinetic-Molecular Theory

- Diffusion
 - Migration of molecules that results in a homogenous mixture.
- Effusion
 - Escape of gas molecules through a tiny pinhole.



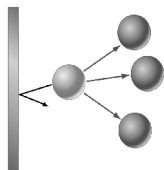
Graham's Law

$$\frac{\text{rate of effusion of } A}{\text{rate of effusion of } B} = \sqrt{\frac{M_B}{M_A}}$$

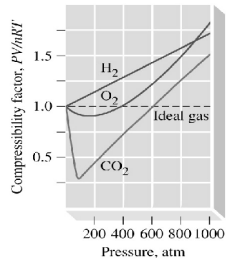
- Only for gases at low pressure (natural escape, not a jet).
- Tiny orifice (no collisions)
- Does not apply to diffusion.
- Ratio used can be:
 - Rate of effusion (as above)
 - Molecular speeds
 - Effusion times
 - Distances traveled by molecules
 - Amounts of gas effused.

Real Gases

- Compressibility factor $PV/nRT = 1$
- Deviations occur for real gases.
 - $PV/nRT > 1$ - molecular volume is significant.
 - $PV/nRT < 1$ - intermolecular forces of attraction.



Real Gases



van der Waals Equation

$$\left(P + \frac{n^2 a}{V^2} \right) (V - nb) = nRT$$
