Gas Laws and KMT

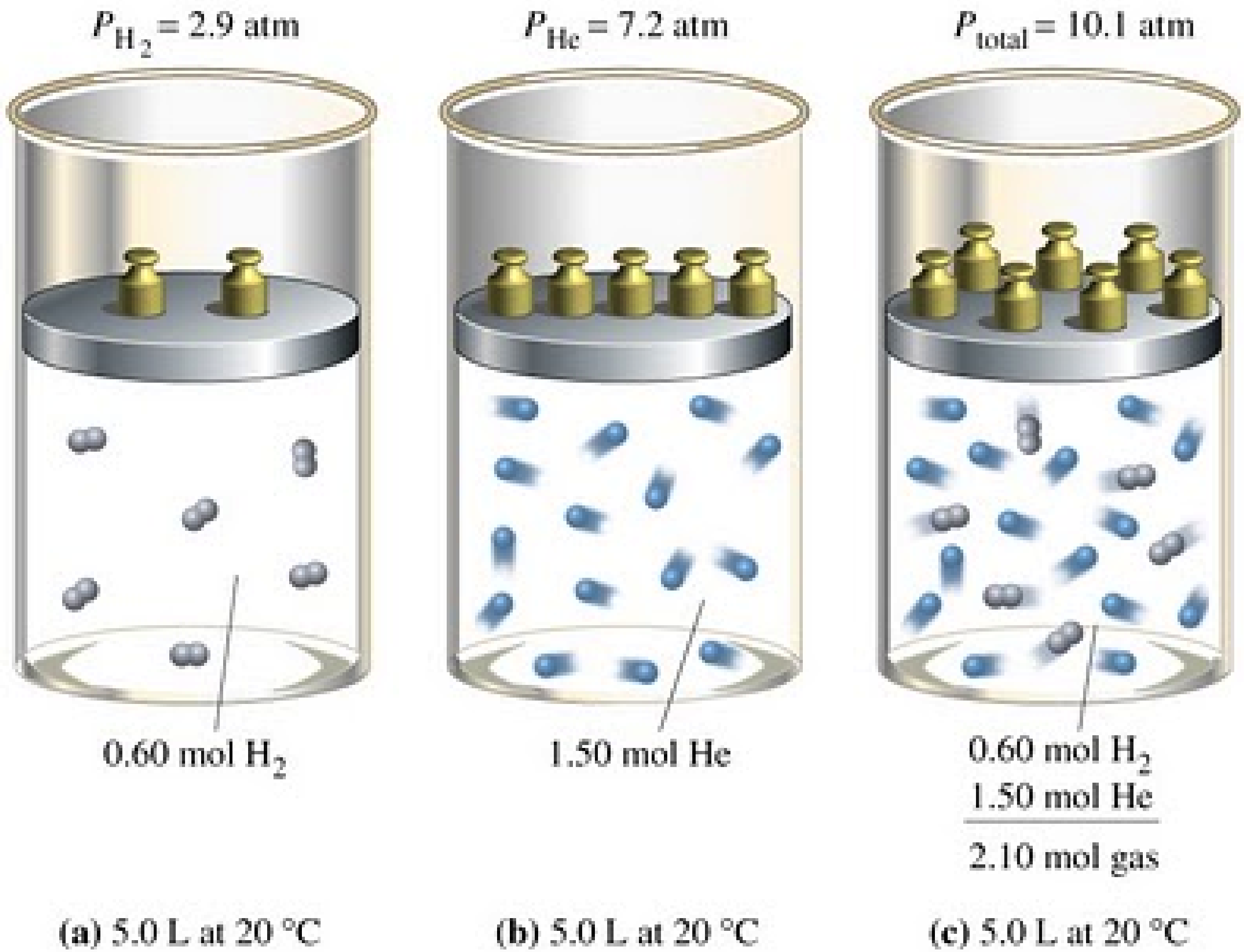
Unit 7 Module 4

Pressure of Gas Mixtures

- Dalton's Law of Partial Pressures

  The total pressure of a mixture of gases is equal to the sum of the partial pressures of the components in that mixture. P_1, P_2, P_3, etc. are the partial pressures of the component gases. Each gas in a mixture exerts the same pressure in the mixture as it would by itself because the number of collisions of each gas with the walls of the container is unaffected by the presence of the other gaseous components. Remember, pressure is caused by collisions of gas particles with the walls of the container.

$$\mathbf{P_{total} = P_1 + P_2 + P_3 + \ldots + P_n}$$


P_{H_2} = 2.9 atm
P_{He} = 7.2 atm
P_{total} = 10.1 atm
0.60 mol H_2
1.50 mol He
0.60 mol H_2
1.50 mol He
2.10 mol gas
(a) 5.0 L at 20 °C
(b) 5.0 L at 20 °C
(c) 5.0 L at 20 °C

Dalton's Law Example #1

- A mixture of oxygen gas (O_2), carbon dioxide (CO_2), and nitrogen (N_2) has a total pressure of 0.97 atm. What is the partial pressure of O_2, if the partial pressure of CO_2 is 0.70 atm and the partial pressure of N_2 is 0.12 atm?

Dalton's Law Example #2

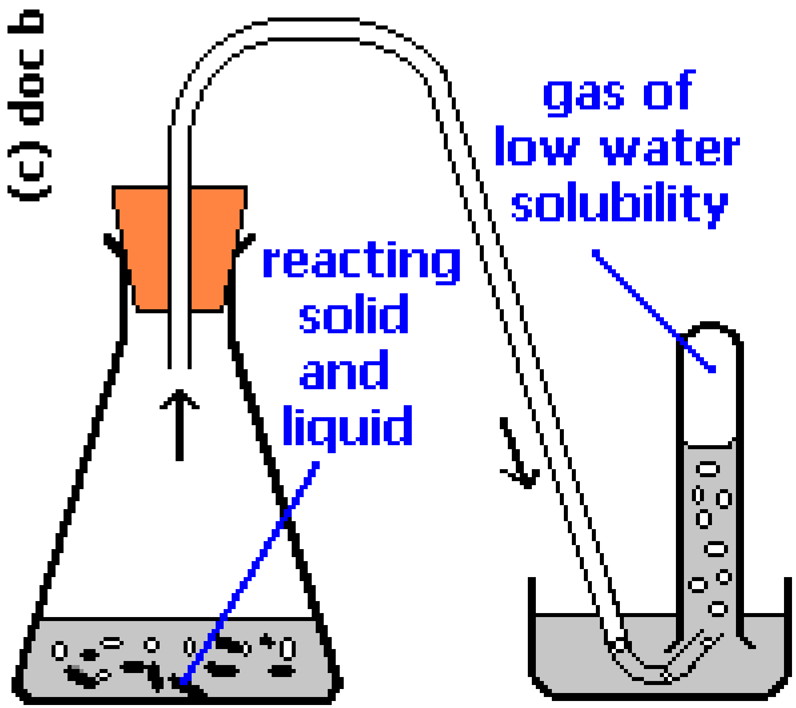
- Find the total pressure for a mixture that contains four gases with partial pressure of 5.00 kPa, 4.56 kPa, 3.02 kPa, and 1.20 kPa.

Dalton's Law Example #3

- Air is a gaseous mixture comprised of 77% nitrogen, 21% oxygen, 1% water vapor, and 1% other gases. If atmospheric pressure is 760 mmHg, what is the partial pressure of the nitrogen gas?

Pressure of Gas Mixtures

- Dalton's law is most often used in problems where a gas is collected "over water" or by "water displacement". The gas collected then represents a mixture of the sample gas and a small amount of water vapor.



Dalton's Law (cont'd)

- The pressure exerted by the water vapor depends on temperature. The water vapor pressure at a specific temperature will be given within the problem or provided in a water vapor pressure table. If the total pressure (also equal to the atmospheric/barometric pressure) of the mixture is known, then the pressure of the gas sample can be calculated using Dalton's Law.

$$\mathbf{P}_{\textit{total}} = \mathbf{P}_{\textit{gas being collected}} + \mathbf{P}_{\textit{water vapor}}$$

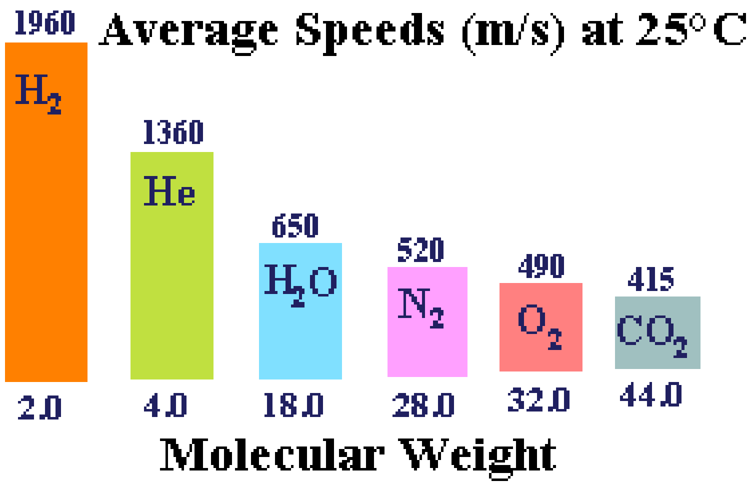
Dalton's Law Example #4

- A sample of N_2 gas is collected over water at a temperature of 23ºC, where the vapor pressure is 21.1 mmHg. What is the pressure of N_2 gas if the atmospheric pressure is 785 mmHg?

Other Gas Laws

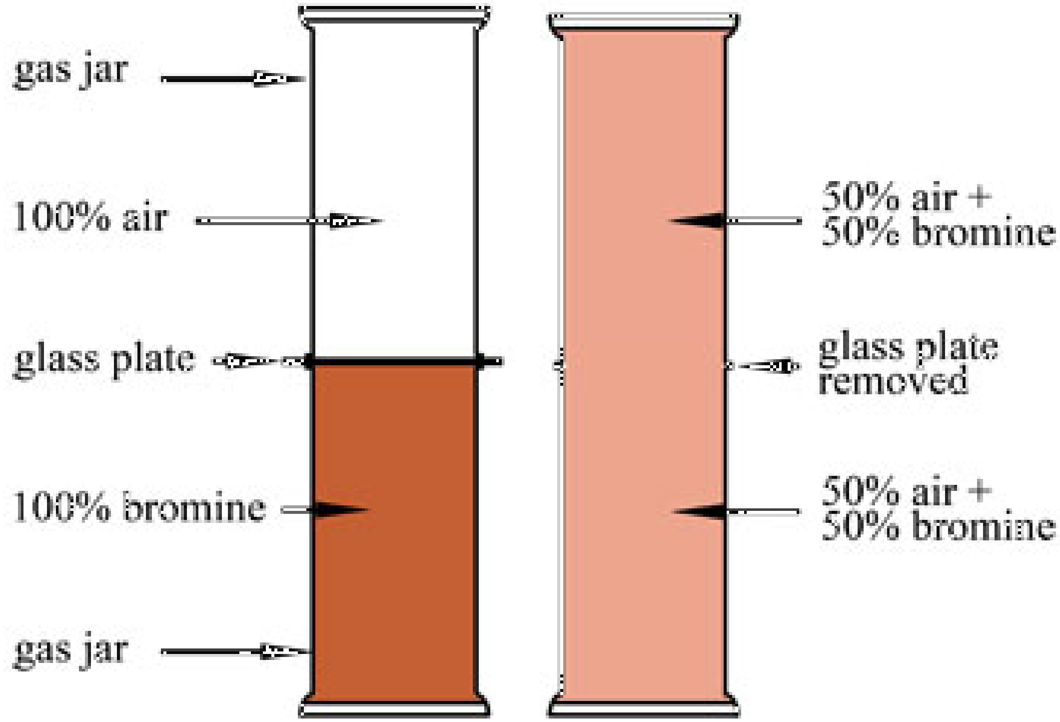
- Graham's Law of Diffusion/Effusion

  Under ideal conditions, the rates at which different gases diffuse (spread out) are ***inversely*** proportional to their molar masses. In other words, larger gas molecules will move slower than smaller gas molecules.

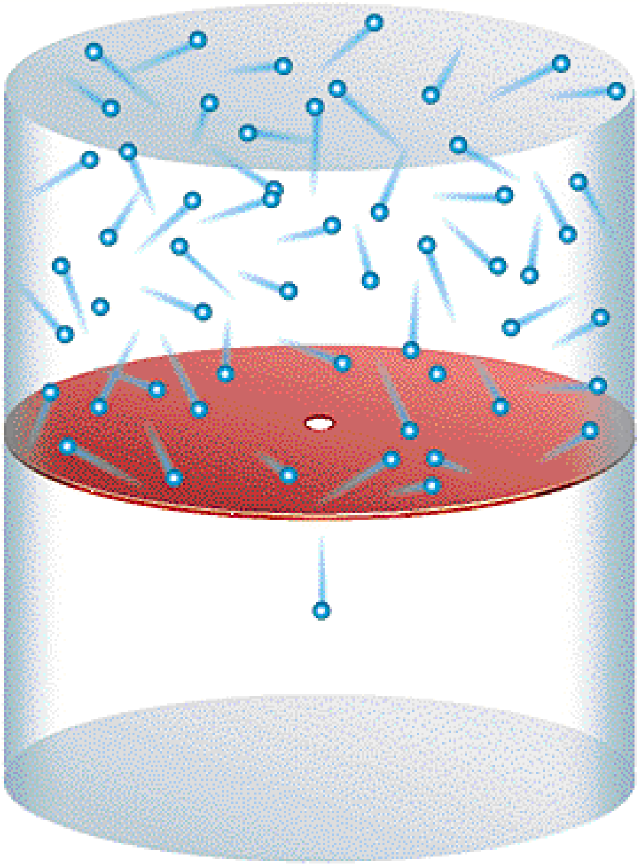


Diffusion vs. Effusion

- *Diffusion* - the movement of gaseous particles from a region of high concentration to a region of low concentration.



- *Effusion* - essentially "diffusion in a box" where gas *travels through a small opening* into an evacuated chamber until a state of "equilibrium" is achieved between the two chambers. Equilibrium is achieved when the rates of particle movement from one chamber to another are equal.



Graham's Law Examples

Rank the following gases from slowest to fastest rate of diffusion: H_2, CO_2, Ne, H_2S.