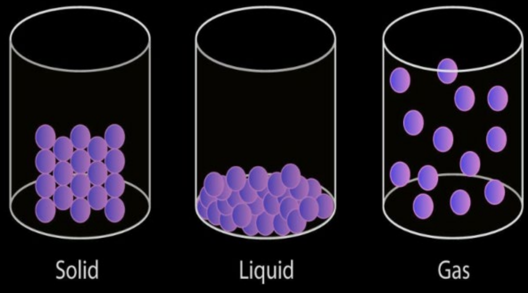
Kinetic molecular theory

It is a theory that explains the behavior of gases, it consist of statements that drive the ideal gas laws

- A gas is just made up of particles that are separated by relatively large distances
    - For water, the particles are about 1000 times further apart in the gas phase than in the liquid phase
- gas molecules are in constant, random motion and travel in a straight line and collide with themselves and their container
- Because of the collisions, the kinetic energy of the particles would sometime travel to the walls of the container, causing some pressure
    - If there a lot of particles moving very fast (high temperature), then there is a lot of pressure in the system
    - If there a few particles moving very slow (low temperature), then there is low pressure in the system
- At any temperature, the average kinetic energy of a gas molecule is directly proportional to that temperature
- At the same temperature, all gasses have the same average kinetic energy, As the temperature increases, so do the average velocities and kinetic energies of the molecules



Dalton's law of partial pressures

it states that pressure in a gas mixture, is the sum of the individual pressure of each gas in the mixture
As long as the gasses don't react with one another chemically
so for the atmospheric air

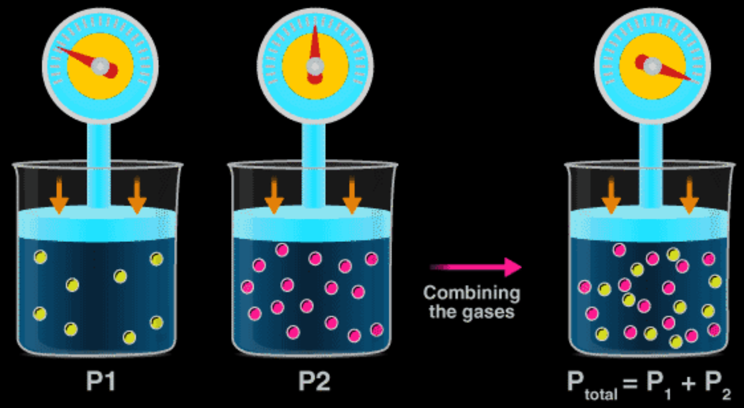
$$P_{air} = P_{nitrogen} + P_{oxygen} + P_{argon} + P_{carbon} + ... = 760 \text{ mmHg}$$

Let's say you have component A in the gas mixture with pressure of P_A
To get that pressure you need to have something called the **mole fraction (X)** of component A
It is the percentage of a gas in the gas mixture

$$X_A = \frac{number\ of\ moles\ (A)}{total\ number\ of\ moles}$$

Now to get the pressure of component A using X_A and total pressure (P_T)

$$P_a = X_a * P_t$$



DIFFUSION

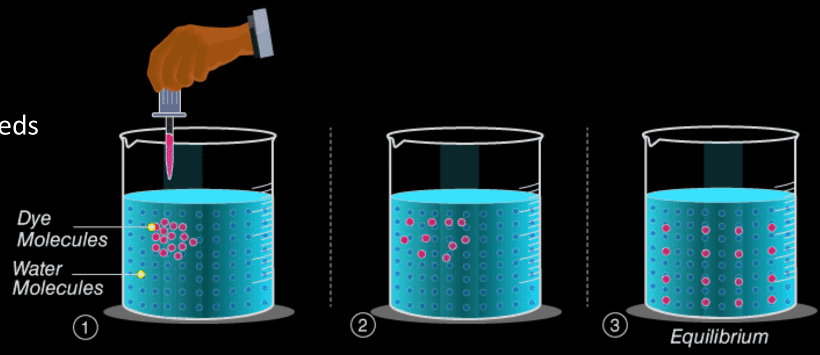
It is the process where gaseous atoms and molecules are transferred from regions to relatively high Concentrations to regions of relatively low concentrations
The rate of diffusion has to do with the speed of the gas molecules, all gases at the same temperature Have the same kinetic energy but the speed depends on their molar mass, higher mass gives lower speeds and vise versa, because of the kinetic energy law KE = ½MV^2, where M is the mass of the molecule

Since two gasses (let's say A and B) in the same temperature have the same kinetic energy we can use this equation

$$\tfrac{1}{2}M_AV_A^2 = \tfrac{1}{2}M_BV_B^2$$

Which is simplified into

$$\frac{V_A}{V_B} = \sqrt{\frac{M_B}{M_A}}$$



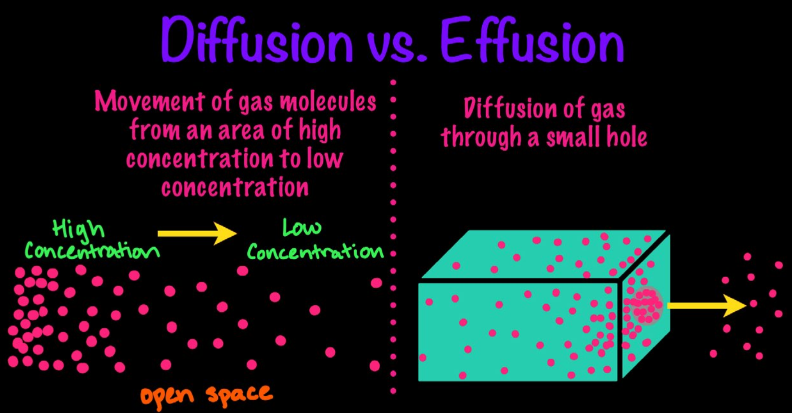
The velocity of large-mass gases is smaller than the velocity of small-mass gasses, so its diffusion is slower
So if the ratio of masses between gas A and B is 1:9, then the ratio of speeds will be 1:3
So if the ratio of masses between gas A and B is 1:16, then the ratio of speeds will be 1:4

So the ratio between the change in speed and change in mass is

$$\text{Ratio of change in speed} = \sqrt{ratio\ in\ change\ of\ mass}$$

EFFUSION

It is diffusion but through a small hole "like how it happens in a ballooln"



Graham’s law of effusion

Thomas graham studied the rate at which various gases effused, he found that the greater the mass (higher density), the slower the effusion and vice versa
He was able to develop a mathematical expression which is now called graham’s law of effusion

It states that the rate of effusion is inversely proportional to the square root of the density of the gas, and the rate of effusion is also inversely proportional to the square root of the molar mass of the gas

(As the molar mass of a gas increases, the rate of effusion decrease)

Graham’s law of effusion is:

$$\frac{R2}{R1} = \sqrt{\frac{M1}{M2}}$$

R = rate of effusion= velocity(V) M= molar mass

EXERCISE

The rate of effusion of Argon was measured to be 0.218 mol/s at a certain temperature. Calculate the rate of effusion of Helium gas.

molar mass (Ar) = 40 g

molar mass (He) = 4 g

$R_{argon} = .218$ mol/sec

$$\frac{.218}{R_{He}} = \sqrt{\frac{4}{40}}$$

$$\downarrow$$

$R_{He} = 0.684$ mol/sec