

States of Matter

★ Boyle's law

(Pressure - Volume Relationship)

$$P \propto \frac{1}{V}$$

(At constant T and n) $\Rightarrow$

$$P = K_1 \frac{1}{V}$$

$$P_1 V_1 = P_2 V_2$$

OR

$$\frac{P_1}{P_2} = \frac{V_2}{V_1}$$

K_1 = Proportionality constant

V = Volume

P = Pressure

T = Temperature

m = Mass

★ Density

$$d = \frac{m}{V}$$

From Boyle's law,

$$d = \left[\frac{m}{K_1} \right] P$$

★ Charles's law

(Temperature - Volume Relationship)

$$V \propto T$$

(At constant P and n) $\Rightarrow$

$$V = K_2 T$$

OR

$$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$

K_2 = constant

n = no. of moles

★ Avogadro's law

(Volume - amount Relationship)

$$V \propto n$$

$\Rightarrow$

$$V = K_4 n$$

★ Ideal gas equation

$$PV = nRT$$

R = gas constant ($8.20578 \times 10^{-2} \text{ L} \cdot \text{atm} \cdot \text{mol}^{-1} \text{ K}^{-1}$)

★ Combined gas law

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

★ Gay Lussac's law

(Pressure - Temperature Relationship)

$$P \propto T$$

$$\frac{P}{T} = \text{constant} = K_3$$

★ Molar mass of gaseous substance

$$M = \frac{dRT}{P}$$

M = Molecular mass

d = density

★ Dalton's law of partial pressure

$$P_{\text{total}} = P_1 + P_2 + P_3 + \dots$$

(At constant T and V)

★ Pressure of dry gas

$$P_{\text{dry gas}} = P_{\text{total}} - \text{aqueous density}$$

★ Partial Pressure in terms of mole fraction

$$P_i = x_i P_{\text{total}}$$

P_i = Partial Pressure

x_i = Mole fraction

★ Average speed of molecules

$$u_{\text{av}} = \frac{u_1 + u_2 + \dots + u_n}{n}$$

OR

$$u_{\text{av}} = \sqrt{\frac{8RT}{\pi M}}$$

★ Root mean square velocity

$$u_{\text{rms}} = \sqrt{u^2} = \sqrt{\frac{u_1^2 + u_2^2 + \dots + u_n^2}{n}}$$

OR

$$u_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

$$u_{\text{rms}} > u_{\text{av}} > u_{\text{mp}}$$

$$u_{\text{mp}} : u_{\text{av}} : u_{\text{rms}} :: 1 : 1.128 : 1.224$$

n = no. of molecules

$u_1, u_2, u_3 \dots u_n$ = individual speeds

u_{rms} = root mean square speed

u_{av} = average speed

u_{mp} = most probable speed

★ Viscosity

$$F = \eta A \frac{du}{dz}$$

η = coefficient of viscosity

A = Area of contact

$\frac{du}{dz}$ = velocity gradient

★ Most Probable Speed

$$u_{\text{mp}} = \sqrt{\frac{2RT}{M}}$$

★ Compressibility factor

$$Z = \frac{PV}{nRT}$$

For ideal gas $Z = 1$ and

$$Z = \frac{V_{\text{real}}}{V_{\text{ideal}}}$$

🌟 Graham's diffusion law

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} = \sqrt{\frac{M_2}{M_1}}$$

🌟 Kinetic gas Equation

$$PV = \frac{1}{3} mnu^2$$

🌟 Kinetic Energy of one molecule of gas

$$E_k = \frac{3}{2} kT$$

🌟 Vandenwaals Equation

$$\left[P + \frac{a}{V^2}\right](V - b) = RT$$

for $n=1$

🌟 Maxwell velocity distribution

$$\frac{dn_c}{n} = 4\pi \left[\frac{M}{2\pi RT}\right]^{1/2} c^2 e^{-Mc^2/2RT} dc$$

dn_c = The number of molecules whose speed is between c and $c+dc$
 T = Absolute temperature

🌟

$$\text{fluidity} = \frac{1}{\eta}$$

r = Speed of diffusion

d = density of gas

M = Molecular mass of gas

P = Pressure of gas

V = Volume of gas

m = weight of single molecule of gas

n = number of molecules present in the volume

V = Volume

u = Root mean square velocity of molecules

$k = \frac{R}{N}$ (Boltzmann's constant)