BRAIN MAP

KINETIC THEORY

Class XI

Relation between v_{rms}, v_{av} and v_{mp}

$v_{rms} : v_{av} : v_{mp}$

$= \sqrt{\frac{3RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{2RT}{M}}$

$= \sqrt{3} : \sqrt{\frac{8}{\pi}} : \sqrt{2}$; $(v_{rms} > v_{av} > v_{mp})$

Maxwell's Law of Distribution of Velocities

The distribution of molecules at different speed is given as,

$$dN = 4\pi N\left(\frac{m}{2\pi kT}\right)^{3/2} v^2 e^{-\frac{mv^2}{2kT}} dv$$

Mean Free Path

The average distance travelled between successive collisions of molecules of a gas is called mean free path (λ).

$\lambda = \frac{1}{\sqrt{2}n\pi d^2}$; where n is the number density and d is the diameter of the molecule.

Kinetic Interpretation of Temperature

$KE_{avg} = E = \frac{1}{2}mv_{rms}^2 = \frac{3}{2}kT$

$KE / \text{mole} = \left(\frac{3}{2}kT\right)N_A = \frac{3}{2}RT$

Kinetic Theory of Ideal Gases

Pressure Exerted by a Gas

$P = \frac{1}{3}\frac{mN}{V}v_{rms}^2 = \frac{1}{3}\rho v_{rms}^2 = \frac{2}{3}E'$

E' = Average KE per unit volume

KINETIC THEORY

Specific Heat Capacity

Law of Equipartition of Energy

For any system in thermal equilibrium, the total energy is equally distributed among its various degrees of freedom and each degree of freedom is associated with energy $\frac{1}{2}kT$.

Specific Heat of a Gas

At constant pressure (C_P) :

$C_P = \frac{(\Delta Q)_P}{n\Delta T}$ or $C_P = \left(1 + \frac{f}{2}\right)R$

At constant volume (C_V) :

$C_V = \frac{(\Delta Q)_V}{n\Delta T}$ or $C_V = \frac{1}{2}fR$

Mayer's relation : $C_P - C_V = R$

(f = degree of freedom)

Monoatomic Gas ($f = 3$)

$U = \frac{3}{2}RT, C_V = \frac{3}{2}R, C_P = \frac{5}{2}R, \gamma = \frac{5}{3}$

Diatomic Gas ($f = 5$)

$U = \frac{5}{2}RT, C_V = \frac{5}{2}R, C_P = \frac{7}{2}R, \gamma = \frac{7}{5}$

Polyatomic Gas

$U = (3 + f')\,RT$

$C_V = (3 + f')\,R$

$C_P = (4 + f')\,R$

$\gamma = (4 + f')/(3 + f')$

f' = a certain number of vibrational mode

Behaviour of Gases

Vander Waal's Equation

For n moles of a gas, $\begin{bmatrix}[a] = [ML^5T^{-2}] \\ [b] = [L^3]\end{bmatrix}$

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

- **Critical Temperature :** $T_c = \frac{8a}{27Rb}$
- **Critical Pressure :** $P_c = \frac{a}{27b^2}$
- **Critical Volume :** $V_c = 3b$

Graham's Law of Diffusion

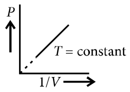
For given temperature and pressure, the rate of diffusion of gas is inversely proportional to the square root of the density of the gas. $r \propto \frac{1}{\sqrt{\rho}} \propto \frac{1}{\sqrt{M}}$

Gas Laws

Boyle's Laws

At constant temperature, volume of a fixed mass of a gas is inversely proportional to its pressure.

$P \propto \frac{1}{V}$ or PV = constant

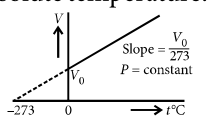


Charle's Laws

The volume of the gas is directly proportional to its absolute temperature.

$V \propto T$ (at constant P)

$V_t = V_0\left(1 + \frac{t}{273}\right)$



Gay-Lussac's Law

Pressure of the gas varies directly with the temperature at constant volume.

$P \propto T$ (at constant volume)

$P_t = P_0\left[1 + \frac{t}{273}\right]$