Intermolecular Forces

Intermolecular forces are the forces of attraction and repulsion between interatcting particles

- **London dispersion forces** are the weakest intermolecular forces present among non-polar atoms and molecules.
- **Dipole – dipole** forces act between the molecules possessing permanent dipole.
- **Dipole – induced dipole forces** are the attractive forces operate between polar molecules having permanent dipole.
- Hydrogen bond is found in the molecules in which highly polar N-H, H-O and H-F bonds are present.

Gaseous State

Physical Properties:

- Gases are highly compressible.
- Gases exert pressure equally in all directions.
- Gases have much lower density than solids and liquids.
- Volume and shape of gases are not fixed.
- They mix evenly and completely in all proportions.

Gas Law

- **Boyle's Law (Pressure – Volume relationship):** At constant temperature, the pressure of a fixed amount of gas varies inversely with its volume

$P_1V_1 = P_2V_2 = \text{constant} \longrightarrow \frac{P_1}{V_1} = \frac{P_2}{V_2}$

- **Charle's Law (Temperature – Volume relationship)** : At constant pressure, the volume of a fixed mass of a gas is directly proportional to the absolute temperature

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \longrightarrow \frac{V}{T} = \text{Constant}$$

- **Gay Lussac's Law (Pressure – Temperature relationship):** At constant volume, pressure of a fixed amount of a gas varies directly with temperature P/T= constant
- **Avogadro Law :(Volume – Amount Relationship):** Equal volume of all gases under the same conditions of temperature and pressure contains equal no. of molecules

Ideal Gas Equation

$R = \frac{pV}{nT}$ **R is gas constant/ universal gas constant**

Density and Molar Mass of a Gaseous Substance

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

Dalton's Law of Partial Pressure

Total pressure exerted by the mixture of non- reactive gases is equal to sum of the partial pressures of individual gases. $P_{total} = p_1+p_2+p_3$..... (At Constant T,V)

Deviation from ideal gas behaviour

- Real gases show deviations from ideal gas law because molecules interact with each other.
- Pressure exerted by the gas is lower than the pressure exerted by the ideal gas

$$P_{ideal} = P_{real} + \frac{an^2}{V^2}$$

$$\text{Compressibility factor } (Z) = \frac{PV}{nRT}$$

Intermolecular forces vs Thermal Interaction

Gas →Liquid→ Solid Predominance of intermolecular interactions	Gas→Liquid→Solid Predominance of thermal energy

Thermal Energy

Thermal energy is the energy of body arising from motion of its atoms or molecules.

Liquid State

Intermolecular forces are stronger than gaseous state.

- Boiling is the condition of free vapourisation throughout the liquid.
- Normal b.p. is boiling point at 1 atm.
- Standard b.p.is boiling point at 1 bar.

Viscosity

$F = \eta A \frac{d_v}{d_z}$

- **Viscosity coefficient** (η) is the force when velocity gradient is unity and the area of contact is unit area.
- SI unit of viscosity coefficient is Newton second per square metre ($N\ s\ m^{-2}$) = Pa s (Pascal second)

Kinetic -Molecular Theory of Gases

Postulates

- A gas contains a large number of small particles called molecules. Size and mass of all molecules of each gas are identical.
- There is no force of attraction between the particles of a gas at ordinary temperature and pressure.
- Particles of a gas are always in constant and random motion.
- Particles of a gas move in all possible directions in straight lines.
- Collisions of gas molecules are perfectly elastic.
- At any particular time, different particles in the gas have different speeds and hence different kinetic energies.
- If a molecule has variable speed, then it must have a variable kinetic energy.

Liquifaction of Gases

Volume of one mole of gas at critical temperature is called critical volume (Vc) and pressure at this temperature is called critical pressure (Pc)

Surafce Tension

Is the force acting per unit length perpendicular to the line drawn on the surface of liquid.

Denoted by Gamma (γ)

Unit: Nm-1