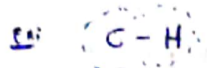


States of Matter

→ Binding forces between molecules:

✓ Inter-molecular forces: The attraction betⁿ un-like molecules i.e.

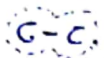
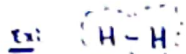
Adhesion. (i) The attraction betⁿ different molecules.



✓ Intra-molecular forces: The attraction of like-molecules i.e.

Cohesion. (ii)

The attraction betⁿ within the molecule.



Imp: 1. To EXIST molecule as gases, liquids, solids.

2. In Interfacial phenomena, flocculation in Surfⁿ,
Stabilization of Emulsions.

↓ Repulsive - Attractive forces.

1. Vander-woal forces →
- a) Dipole-dipole or Keesom forces
 - b) Dipole-Induced dipole (or) Debye Interactions
 - c) Induce dipole-Induced dipole (or) London Attraction.
 - d) Ionⁿ dipole - Ion-Induced dipole

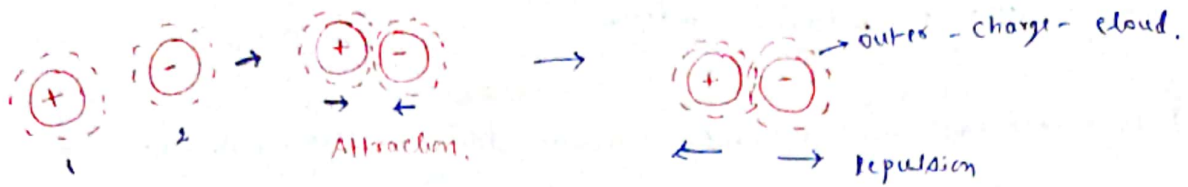
2. Hydrogen bond

1. Repulsive - and Attractive forces:

upon molecules interact, both Repulsive & Attⁿ. forces operate.

→ 2 molecules are brought close together, opposite charges

in 2 molecules closer together than like charges cause Attraction.



→ when the 2 molecules brought so close that the outer-charge-clouds touch, the molecules repel each-other like RIGID elastic bodies,

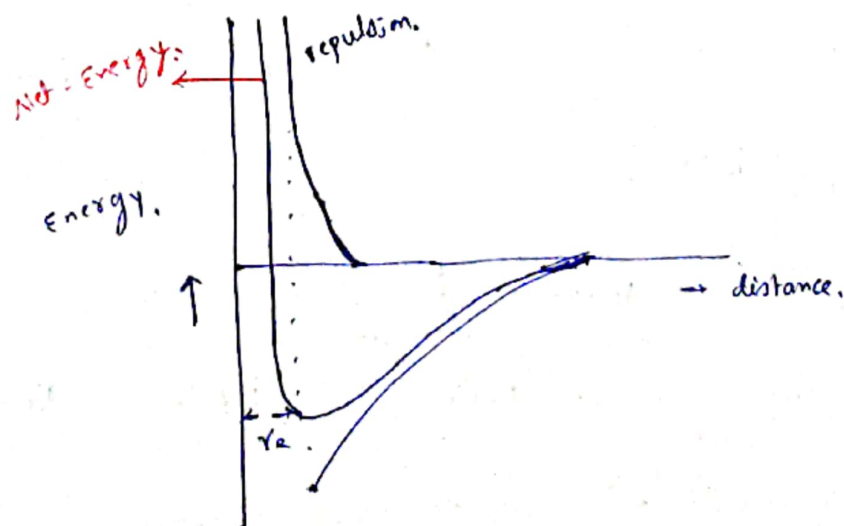
→ Attⁿ. forces → Necessary to molecules COHERE

→ Rep^t. forces → • molecules do-not Interpenetrate and annihilate one other.

↓
Repulsion is due to the Interpenetration of the

electric clouds of molecules and increases exponentially with decrease in distance betⁿ the molecules, ($3 \text{ or } 4 \times 10^{-8} \text{ cm}$; 3-4 angstroms)

→ At 3-4 Ang., the rep^t & Attⁿ. forces are Equal & the potential energy of the 2 molecules is minimum & the system is Most-stable.



→ Types of Attractive Intermolecular force

Vander-waals forces:

- a) Dipole-dipole (or) Keesom forces → In dipolar molecules, the -ve pole of one molecule points toward the +ve pole of the next. & weak attraction.
- b) Dipole-Induced dipole (or) Debye interactions → The permanent dipoles are capable of inducing an electric dipole in non-polar molecules (which are easily polarizable) in order to produce Debye interactions.
- c) Induced-dipole & Induced dipole: The non-polar molecules can induce polarity in one another by London-attractants.

Ex: Hydrogen gas, Cl_2 , benzene → Attract one another by weak electrostatic forces i.e. London forces.

Attraction $P.E \propto \frac{1}{r^6}$

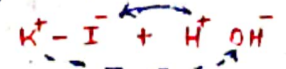
Repulsion:
P.E more rapidly \propto distance.

Imp: condensation of non-polar gases to liquids, solubility of drugs, formation of metal-complexes.

d) Ion-dipole and Ion-Induced dipole:

The attraction betⁿ polar (or) nonpolar molecules and Ion.

Ex 1: Solubility of crystalline substance in H_2O ; $KI + H_2O$.

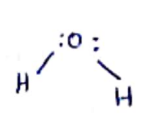


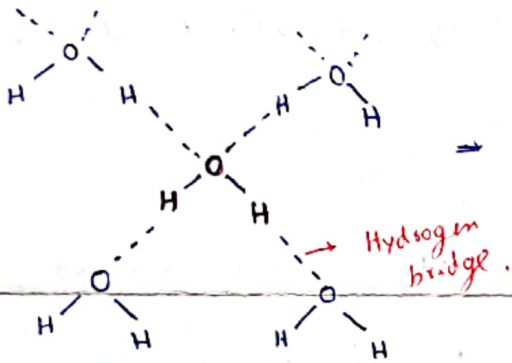
Ex 2: Formation of Iodide complex, $I_2 + K^+ I^- \rightarrow K^+ I_3$ (poly-Iodide)
 → Solubility of Iodine in soln. of pot. Iodide.

Hydrogen bonds:

The Interaction betⁿ a molecule containing of hydrogen atom and a strongly electronegative atom such as fluorine, O₂ and nitrogen.

→ Because of the small size of hydrogen atom and its large electrostatic atom and form an electrostatic type of union known as hydrogen bond (or) hydrogen bridge.

Ex: water → H₂O ⇒  Exist in Ice, liq. water, vapour.
high D-E, low v.p., high B.P.



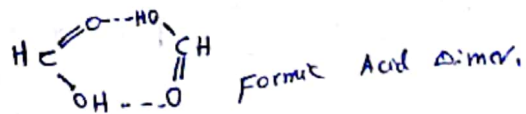
→ if hydrogen bonds break

Ice → ^{liq} water → vapour.

3-D Anoj of water.

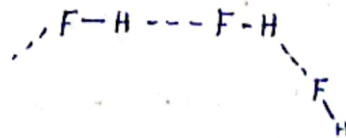
→ Formic acid & Acetic acid have strong hydrogen bonds to yield dimers. (even at vapour state).

Ex: Formic acid H-COOH



→ Hydrogen fluoride

as polymer.
(F-H)_n (n > 6)



→ Bond Energy → is a measure of strength of bond.

Hydrogen bonds	→ weak	→ 2-8 Kcal/mole.	→ Interaction bet ⁿ molecules
covalent bond	→ st	→ 5-100 Kcal/mole	by orientation, H ₂ O
Ionic bond	→ more st	→ not 100 Kcal/mole.	Induction, HCl
			dispersion, HI
			and
			Table → 2-2.

STATES OF MATTER

①

Ideal Gas Law:

→ Gas Laws → Boyle, Charles & Gay-Lussac.

✓ Boyle's Law ⇒ Relates the volume & pressure of a given mass of Gas at const. temp.

$$P \propto \frac{1}{V} \Rightarrow PV = K.$$

✓ Charles & Gay-Lussac ⇒ Volume & abs. temp. of a given mass of gas at const. pressure are directly proportional.

$$V \propto T \Rightarrow V = K \cdot T.$$

⇒ upon combining Equations → $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
(Set-1) (Set-2) conditions.

⇒ The ratio $PV/T = \text{const.}$

$$\frac{PV}{T} = R \Rightarrow PV = R \cdot T.$$

⇒ 'n' moles of gas $\boxed{PV = nRT}$ General Ideal Gas Law.
↳ [conditions].

⇒ Real-gases not follow the Laws, but Ideal-gases follows.

'R' Value Estimation: 1 mole of gas, (n=1).

conditions T = 0°C, P = 760 mm of Hg, V = 22.414 lit
(273.16 K) (1 atm).

$$1 \times 22.414 \text{ lit} = 1 \text{ mole} \times R \times 273.16 \text{ K}$$

$$R = 0.08205 \text{ lit/mole.deg}$$

⇒ R value → Energy units, → $P = \text{dyne/cm}^2$

$$1 \text{ atm} = 1.0133 \times 10^6 \text{ dyne/cm}^2.$$

$$R = \frac{PV}{T} = \frac{(1.0133 \times 10^6) \times 22,414 \text{ cm}^3}{273.16}$$

$$R = 8.314 \times 10^7 \text{ Erg/mde.deg.}$$

⇒ ∴ 1 Joule = 10^7 Ergs.

$$R = \underline{8.314} \text{ Joules/mde.deg.} \checkmark$$

⇒ calories units, 1 cal = 4.184 Joules.

$$R = \frac{8.314 \text{ J/mde.deg}}{4.184 \text{ Joules/cal}} = \underline{1.987} \text{ cal/mde.deg.}$$

Md. wt: Approx. md. wt. of gas can be determined by use of the ideal-gas law.

⇒ The no. of moles of gas 'n' is replaced by its Equivalent g/M ($g \rightarrow$ grams of gas, $M \rightarrow$ md. wt.).

$$PV = \frac{g}{M} \cdot R \cdot T$$

$$M = \frac{g \cdot R \cdot T}{P \cdot V}$$

Methods for Est. of md. wt:

i) Regnault method

ii) Victor-Meyer method.

(Alcohol. CHCl₃ used)

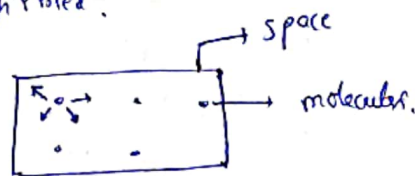
Kinetic molecular Theory:

(2)

→ The theory that was developed to explain the behaviour of the gases ~~parts~~ + to lend additional support to the validity of the gas laws.

Statement:

- 1) Gases are composed of particles called molecules, the total volume of which is so small as to be negligible in relation to the volume of the space in which the molecules are confined.



conditions:

low P, high Temp

- 2) The gas particles do not attract one another but rather move in complete independence.
- 3) The particles exhibit continuous random motion owing to their kinetic energy.

Avg. K.E \propto Abs. Temp. of gas.

$$E = \frac{3}{2} RT$$

- 4) The molecules exhibit perfect elasticity.

There is no net loss of speed after they collide with one another or with the walls of the containing vessel.

fundamental kinetic equation $PV = \frac{1}{3} n \cdot m \bar{c}^2$ [\bar{c} = velocity]

here \Rightarrow Root-mean square velocity $(\bar{c}^2)^{1/2} = \mu$

$$\mu = \sqrt{\frac{3PV}{nm}}$$

$\Rightarrow PV = RT$; n becomes avogadro number = N .

\rightarrow $\therefore N$ multiplied by m ($N \times \text{mass}$) = M (mol. wt).

$$\mu = \sqrt{\frac{3RT}{M}}$$

\Rightarrow In density units,

$$\mu = \sqrt{\frac{3PV}{nm}} \quad (n = 1 \text{ mole}).$$

$$\mu = \sqrt{\frac{3PV}{m}}$$

$$f = m/v.$$

$$\mu = \sqrt{\frac{3 \cdot P}{f}}$$

\Rightarrow The rate of diffusion of gas is inversely proportional to the square root of its density.

\Rightarrow low f gases \rightarrow more diffusion,

high f \rightarrow less "