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CHAPTER # 05 :-

INTRO :- States & Phases of Matter

→ There are three states of matter

- Solid
- Liquid
- Gas

LIQUID :-

- The states of matter where Intermolecular forces are not strongly packed as solid and not loosly packed as gases.

- molecules which are in contact with Each & other.
- molecules are in constant random motion. but motion of molecule is limited by close packing.

Extra Information :-

- Solid → Vibrational motion only do.
- Liquid come in blw gas & solid , gas (molecule) does Vibrational motion & do Translation & Rotational motion.

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→ liquid molecules motion is restricted.

→ Solid → liquid → gas.
↓ ↓ ↓ → free to move.
Strong IMF inbw weak IM
solid & gas

→ IMF ∝ attractive force

→ IMF ∝ 1 / movement of molecule.

in Point we can Say that

• liquid attractive forces are greater than gas molecules but less than Solid molecule. Liquid molecule can flow/slide past eachother.

• Average Kinetic Energy of liquid molecules is directly proportional to Absolute Temp

Absolute Temperature:
The Temperature taken in Kelvin Scale

→ Average K.E ∝ Absolute Temp / K

The Temp increases as the K.E of molecules increases.

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- At constant temperature the Average K.E of molecule is equal to K.E of vapour of liquid.

Average K.E ∝ vapour of liquid. (at const Temp)

The more the vapour the more Average K.E will be at constant temperature.

→ if the Temp is high then it will equal to

Properties of liquid:-

Diffusion:

Movement of molecule from high concertration to lower concentration.

Example:

A drop of food colouring diffuses evenly in a glass of water.

→ Reason liquid molecule move randomly, allowing them to spread & mix.

→ molecules of liquid are in constant random motion.

Compression:

Reduction of ~~no~~ volume occupied by molecule called compression.

Example:

water in a syringe is compeessed when the plunger is pushed.

The molecules of water are

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→ as liquid have less Spaces So the compression will be negligible.

→ it we take 1atm & than move towards 2atm, So there Volume reduces to 0.0045.

Expasion:

Effect of Temp.

The more the Temp is the less ϑ_{MF} (Expasion) will be, vice versa

Temperature $\propto \frac{1}{\vartheta_{MF} \text{ (expansion)}}$

→ liquid expands when it is heated. (Temp = K.E), force of attraction decreases, hence collision increases liq will expands.

Motion of Molecule:

→ The molecule in liquid have random motion.

The motion of depends upon.

(1) Kinectic Energy

(2) Attractive force.

Hence,

K.E $\propto$ motion of molecule

$IMF \propto \frac{1}{\text{motion of molecules.}}$

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Spaces between Them:

The Space between the molecules of liquid is quite close to eachother but not strong Packing. Moderate IMF Ep Average K.E

INTERMOLECULAR SPACES:

→ force of attraction b/w molecules called Intermolecular forces

I.M.F ∝ Boiling Point.
I.M.F ∝ Vapour Pressure
I.M.F ∝ ~~Standard Temperature~~ Surface Tention

$$I.M.F \propto \frac{1}{\text{movement / collision.}}$$

Kinetic ENERGY BASED ON KMT (Kinetic Molecular Theory).

→ as due to IMF less movement of molecules occur So they will have strong IMF

'water' → molecules are closely Packed → less collision
→ less movement
→ strong I.M. Force of Attraction
→ low Kinetic Energy due to H-bonding

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Physical Properties of Liquid.

Additive Properties:

mean, it depends upon number & kind of atom

DEFINITION:

Properties which depends upon number & kind of atom. Quality of atom

Example:

Molar Mass,

i.e $O_2 \rightarrow 32$, $H_2 \rightarrow 2$, $C_6H_{12}O_6$.

Constitutive Property:

DEF

Properties which depend upon arrangement of atom in molecules

Example:-

- Optical Activity.

→ in Isomers.

Dextrorotatory bend it to right, levorotatory bend it to left.

Colligative property:-

Definition:-

Properties which depends upon no of atom/particle but not on nature.

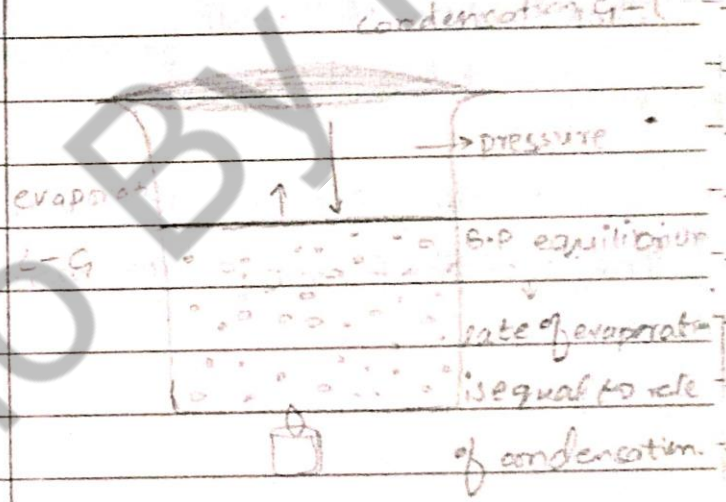
Example:-

- Molar Volume 1 mol = 22.414 dm^3
- Osp Osmotic pressure.
- Elevation in Boiling point.
- Lowering of Vapour pressure.

Vapour Pressure

DEFINITION:

"Pressure Exerted by vapour on the Surface of liquid when rate of evaporation is equal rate of condensation."



MCQs:

How we can measure vapour pressure - ?

Some Important Points:

→ always measured in closed container

→ Barometer → a device that measure atmospheric pressure.

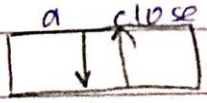
→ Malometer → a device that measure gas or liquid pressure.

↳ u-shape tube

$P = \frac{F}{A}$

Example:

Tea in a close container



→ observe V.P Exert.

Factor Effecting Vapour Pressure

DEFINITION:-

Temperature at which Vapour pressure of liquid becomes equal to external / atmospheric pressure is called Boiling point.

Boiling Point $\propto$ external Pressure

Factor Effecting Boiling Point

Intermolecular forces (IMF).

→ IMF $\propto$ Boiling point

Q. why boiling point of water is greater than Ethyl Alcohol?

Answer:- water's stronger hydrogen Bonding & polarity of increases intermolecular forces. requiring more energy to vaporize.

Q why boiling point of water is greater than Petrol?

water's H. bonding & Surface tension exceeds petrol's weaker London dispersion forces. weaker london Dispersion forces required less energy to evaporate making its boiling point lower than H_2O.

→ External pressure $\propto$ B.P

→ when E.P is 180atm than water boils at 100°C.

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Boiling Point of H_2O:

- 1 atm = (760 torr = 760 mm of Hg) — Water Boiling Point 100°C → Normal Condition.
- 760 torr = 98°C → Murree high Altitude
- 323 torr = 69°C → Mount Everest.
- 83.7 torr (↓ Through Vacum Pump) = 25°C → using vacume pump.
- 1489 torr/2atm = 120°C → Pressure cooker.

APPLICATION OF BOILING POINT

Pressure Cooker:

Increased pressure raises boiling point.

-) faster cooking
-) Energy efficiency
-) Retain nutrients.

Vaccume distillation:- Reduced Pressure lower boiling point,

- gentle seperation of heat sensitive compounds
- Purification of sensitive materials
- Energy Savings.

Glycerin B.P = 290° at 760 torr
↓
Decompose.

=

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Seperated = 210°C at 50 torr.

Viscosity:-

Definition:-

→ Internal resistance in the flow of liquid is called viscosity.

→ Thick liquid have more viscosity.

→ Honey is more viscous than water

∴ Resistance is occuring because of internal force of attraction

Example:-

→ honey, glycerine are Thick Liquid it mean they are more Viscous. Thick Liquid mean they have huge flow of Internal Resistance. & They (Both) are more viscous than water.

Water → Thin Liquid → Less Viscous. → less resistance

Proportionality:-

→ Viscosity ∝ Thick liquid.

→ Viscosity ∝ $\frac{1}{\text{Thin liquid.}}$

Unit:-

S.I unit is

•) $Kgm^{-1}s^{-1}$

•) $Nm^{-2}s$.

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Non S.I unit → 1 poise = $gm^{-1}s^{-1}$, $0.1 Kg m^{-1}s^{-1}$

Factor Effecting viscousity

Shape & Size of molecule:

→ Molecules having Small Size & regular Shape has low Viscousity.

Example:

H_2O, Acetone.

→ Molecule having large Size & irregular shape has high viscosity

Example:

honey & glycerine.

Temperature:

→ Temperature provide K.E to molecule .K.E provide distance hence the resistance will increase & they will flow more easily.

→ Temperature $\propto \frac{1}{\text{viscosity}}$

Temp inc → K.E inc → Distance blw molecule inc → less Resistance → Easily flow → less viscous

Example

Honey in the fridge will not be easy to get out so we put that in hot pot or microwave than it will has come out easily, as they have high & low viscosity respectively.

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IMF

→ it is Imf ∝ viscosity.

→ This mean: more Imf the more will be viscosity, less the Imf less will be viscosity

→ Imf Provides resistance to flow of liq.

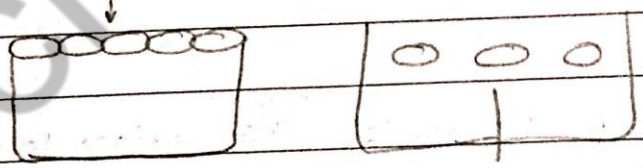
Q why Water is more viscous than alcohol?

Ans: water has 2 hydrogen bond while Alcohol. in the case of methanol it has 1 H bond. water has strong IMF, while Alcohol have weak IMF. Have strong/ more viscosity, & have less viscosity respectively. So water is more viscous than alcohol.

Surface Tension:

→ it is represented by 'γ'

→ Amount of energy required to expand the Surface Area of unit is called Surface Tension.



→ Tension: Strongly held with other molecule.

Surface Tension ∝ Energy

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→ The molecules will always get seperated or Expand but with different energy i.e, less energy, more energy.

→ Expansion molecules after gets evaporates

→ Surface Tension is the protective layer which held the molecules strongly.

Unit :-

S.I of Surface Tension is N/m or Jm^{-2}

Factor Effecting Surface tension:

- Surface Area.

$$\text{Surface Area} \propto \frac{1}{\text{Surface tension}}$$

→ The more the surface area the less will be surface tension.

Example:-

- Rain droplet.

↳ have less Surface area

↳ have more Surface tension

↳ inward pull → due to attractive forces (IMF) → more inward pull → attain spherical/ Bulgeoid shape.

- Temperature:

$$\text{Temperature} \propto \frac{1}{\text{Surface tension}}$$

↳ more the Surface Temperature is the ~~more~~ less the Surface Tension will be.

→ Temp inc → K.E inc → Gap b/w molecule ↑ ϑ_{IMF} Dec → less inward pulling → less Surface tension.

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- IMF / nature of liquid:

IMF ∝ surfacetension

The more the Imf the more will be surface tension

Example:

Water :-

→ polar molecule → have more IMF → Surfacetension more.

→ non-polar molecule → have less Imf → Less Surface Tension.

ENERGIETIC OF PHASE CHANGES

- Molar Heat of fusion

→ Amount of heat required to convert 1 mol of solid into liquid.

Example:-

$H_2O(s) \longrightarrow H_2O(l)$ $\quad \Delta H_f^\circ = +6.02\ KJ/mol$

ice water → as heat is absorbed during reaction. so This is endothermic reaction

→ it should be solid.

→ In the Example we have discussed "the Amount of energy required to convert ice into water." This process is called molar heat of fusion.

- Molar heat of vaporization ΔH_{vi}.

Amount of heat required to convert 1 mol of liquid into vapour.

→ This is also Endothermic reaction as heat is absorbed

Example:

$H_2O(l) \longrightarrow H_2O(g)$ $\quad \Delta H_V = 40.7\ KJ/mol$

water steam.

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- Molar heat of Sublimation:

Amount of heat required to convert 1 mol of solid into gas without going through liquid.

$S \longrightarrow G$

Substances that are subline: I_2, naficine, Benzoic acid

Example:

$I_{2(s)} \longrightarrow I_{2(g)}$ $\quad \Delta H_s^\circ = 6.24 KJ/mol$

→ all these values are endothermic.

Concept of Hydrogen Bonding & properties of water:

Surface Tension:

Surface tension $\propto$ H-bonding.

→ The more the surface tension more the Hydrogen Bonding will be.

Solvent	Surface Tension:
water	7.275
Methanol	2.26
Ethanol	2.28
Benzene	2.888
Hexane	1.84
CCl_4	2.70

Vapour pressure:-

Vapour Pressure $\propto \frac{1}{\text{Hydrogen-bonding}}$

→ more the h-bonding, less will be the vapour pressure.

Intermolecular forces:- Heat of vaporization

Hydrogen bonding (IMF) $\propto$ heat of vaporization

The the more H-bonding, more will heat of vapourization.

Boiling Point:-

Hydrogen Bonding $\propto$ Boiling point

The more the H-Bonding, the more will be Boiling point.

LIQUID CRYSTAL * important

→ Turbid liquid having properties of liquid as well as crystal (solid) is called liquid crystal.

E.g:- Cholesteryl Benzoate

crystal (solid) → Melt → Liq crystal → (Provide completely heat) → pure liquid state.

Intermediate state
↓
liquid crystal.

clevage temperature

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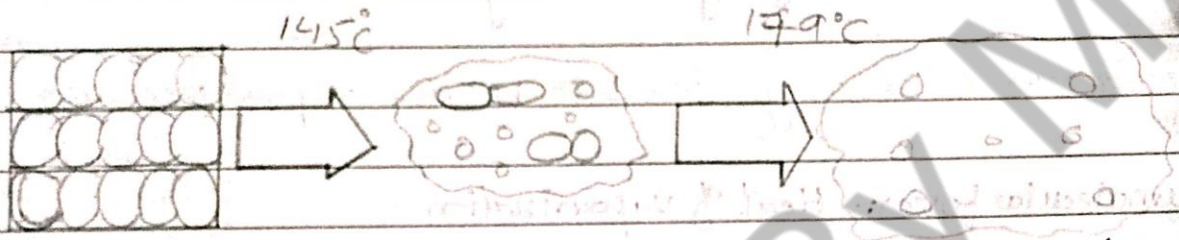
→ crystal are not metal.
→ crystal are

Diagram 8-



solid state | intermediate state | liquid state

→ when we press any screen of electronic device i.e T.V, mobile phone, or calculate will see multiply colour appearing as they have liquid crystal used in them.

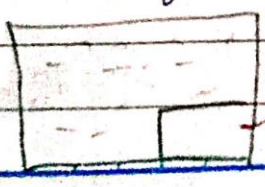
→ crystaline solid should be stable at room temperature.

Uses:-

→ Digital Screen (Calculater, LCD, phone etc).
→ Temperature Sensor (detect room temperature, high temp etc)

strip → Temp value → liq crystal.

→ Room Thermometer →
→ detects the point of failure in electric circuit



→ Place → where colour change when electricity Pass.

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→ Solvent chromatography (Test (medical test of cricketer, pilot) it help inter and give results in 10min).

→ used in optical fibre to maintain temperature, used in many industries etc.

KMT of Solid:-

→ all of the solid have attractive force blw them.
→ closely Packed Particles.
→ Intermolecular forces are strong.
→ all solids have rigidity → it mean they are hard to break.
→ they have high Density, as they have high mass.
→ There volume decreases as their atoms are closely packed so their volume gets decreased
→ There is no collision blw solid particle, as they are closely packed.
→ Solid particle have vibrational motion.
→ They have vibration K.E blw the particle
↳ They vibrate on their mean position.
→ Solids have specific geometrical shape i.e Nacl → cubic shape

Physical properties of Solid:-

Diffusion:
Solids have negligible Diffusion, as compared to liquid and gases.

Compression:
There is no effect of pressure or volume of Solid

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Expansion:

heat → volume inc → expansion occurs.

→ Expansion in solid are negligible

Motion of molecule:

Motion of molecule of solids is vibrational.

Intermolecular Forces:-

They have strong IMF

Kinetic Energy:

There k.E is Vibrational K.E

Types of Solids:

	Crystalline Solids	Amorphous Solids
Definition	Solids that have geomebrical shape.	Solids having no geometrical shape
Name	→ They are known as true solids	→ They are known as Psuedo solids
Arrangement	→ 3D - fixed Arrangement of particle	→ no proper arrangement.
water of crystallization	→ They have water of crystalization i.e:- $CuSO_4 \cdot 5H_2O$, $Na_2SO_4 \cdot 10H_2O$	→ They have no water of crystallization
color of solids.	They may be coloured if they have water of crystallization.	They are colourless solids.

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Sharp Melting Point.

Sharp Boiling point.

NaCl , $CuSO_4$, $KMnO_4$, Na_2SO_4

Melting Point

Melt over wide range of Temperature

Boiling Point

Boil over wide range of Temperature

Example

→ Rubber → plastic, glass