BP302T

PHYSICAL PHARMACEUTICS-I

"Transforming Students into Pharma Professionals"

Hand written Notes unit-2

PHARMA NFT

States of Matter

Unit-2nd

Matter : Any substance or anything which have some mass and it take some place.

Three types of matter :—

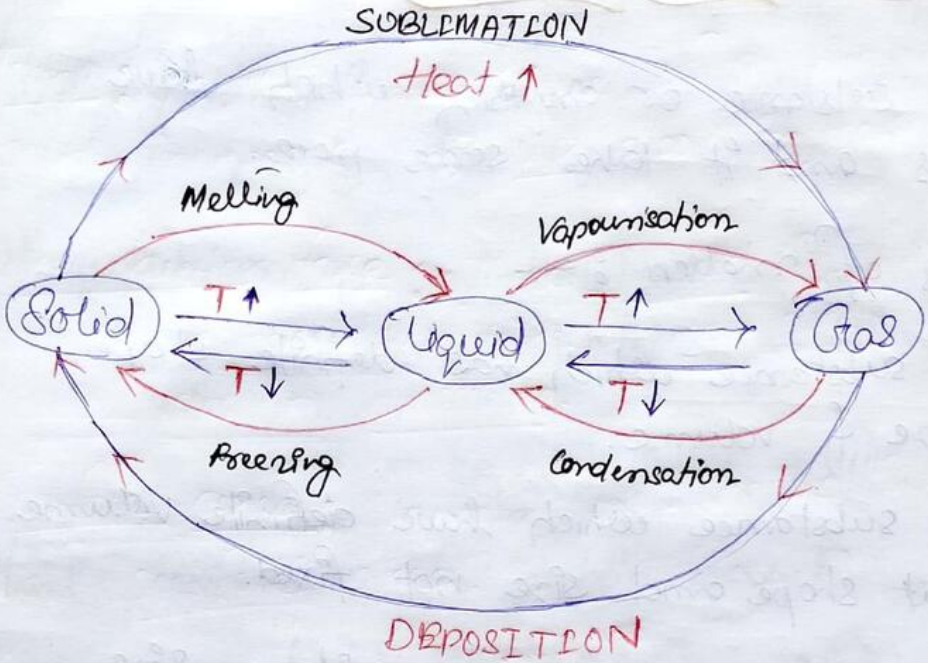
(i) **Solid** : A substance which has definite shape, size & volume.

(ii) **Liquid** : A substance which have definite volume. but shape and size not fixed.

(iii) **Gas** : A substance which have shape, size and volume not fixed.

Properties	Solid	Liquid	Gas
Intermolecular space/voids			
• Weight	More	S > L > G	Less
• Compressibility	Less	S < L < G	More
• Shape	fixed	Not fixed	Not fixed
• Size	fixed	Not fixed	Not fixed
• Volume	Fixed	Fixed	Not fixed
• Condensation	More	S > L > G	Less
• Flow properties	Less	S < L < G	More

Changes in the state of matter



Melting: When solid is converted into liquid by increasing heat. eg- Ice cube to water.

Vapourisation: When liquid is converted into gas by increasing temp.
eg- water convert into vapours.

Sublimation: When solid particles directly convert into gas by increasing temp. or in high temp.
eg- On very high temp, ice directly convert into vapours.

Condensation: When gas is converted into liquid by decreasing temp.
eg- water vapour in the air turn into liquid on colder surface

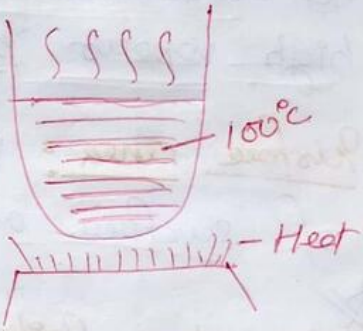
Freezing: When liquid is converted into solid state by decreasing temp.
eg- water convert into ice cube in refrigerator.

• Deposition: When gas state particles (or vapours) directly convert into solid state without first becoming a liquid.

eg- At very cold place, water vapour directly converted into ice.

Latent Heat

That heat which changes liquid into a vapour (phase change) without change of temp.



→ After 100°C temp. will not increase it remains same and the heat used to convert phase by liquid.

Vapour pressure

The pressure of a vapour in contact with its solid or on liquid form.

Rate of vapourisation

Rate of condensation
(gas convert to liquid)

When both is equal or gas is in equilibrium, that time, the pressure exerted by vapour on the any surface is called vapour pressure.

Factors effecting vapour pressure

Temp: As the temperature of a liquid or solid increases, its VP also increase

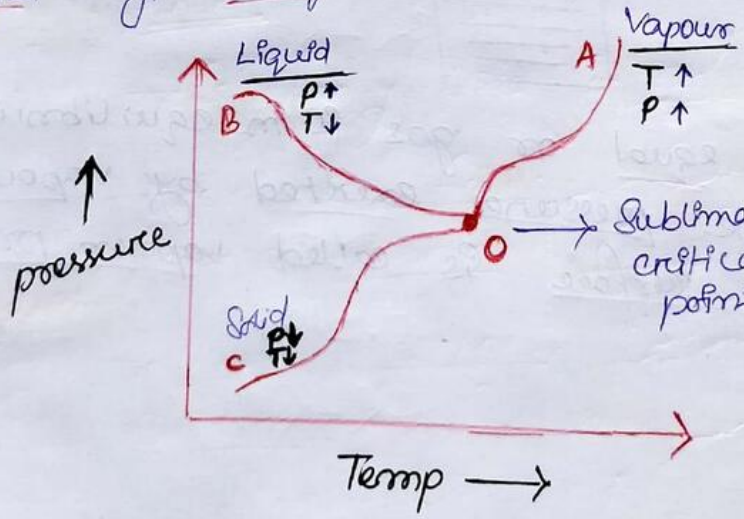
Intermolecular force: Those liquid in which the intermolecular forces are weak shows high vapour pressure

Surface area: Vapour pressure is independent of surface area.

Sublimation Critical Point

⇒ Sublimation is a process in which any solid is directly converted into gas without convert in liquid.

⇒ we know that the phase of any matter can be changed by change in temp & pressure.



⇒ O is the point where all phase of matter are in equilibrium state.

⇒ Line OA represents, when we ↑ Temp & ↑ pressure then any solid directly convert into gas.

⇒ Line OB represents, when we ↑ pressure and ↓ temp. then any substance exist in liquid form.

⇒ Line OC represents when we ↓ Temp & ↓ pressure then substance exist in solid phase.

⇒ The point at which this sublimation process takes place is called sublimation critical point.

Advantages

- The main advantages of sublimation is for purification process.
- Minimum amount of product is loss.
- Solvents are not used.

** Eutectic Mixture : It is a mixture in which two solid particles mix together and reduced their melting point and converted into liquid at normal (room) temperature.

eg – Ibuprofen, Thymol $\xrightarrow{Mix}$ Eutectic mixture

M.P ⇒ 62°C MP ⇒ 42°C M.P ⇒ 37°C

Factors eg Principle:

Temp: As solid incre

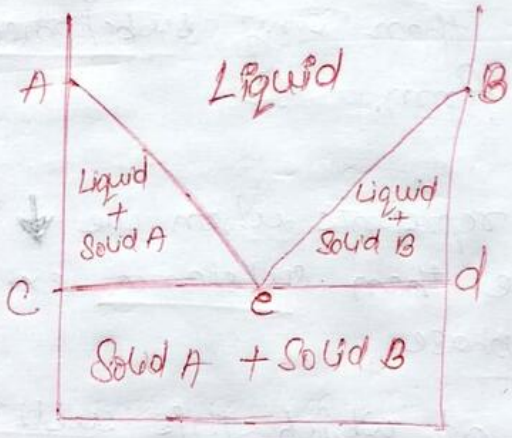
Intermolecula the interac high vapo

Surface ar of surfa

Sublimation

⇒ Sublimat is directly fm liquid

⇒ we know changed k



→ Below the eutectic temp., the mixture of the two substance will exist as a solid.

→ While above it the mixture will convert fnto a liquid.

→ Point 'e' is the lowest melting point.

Uses

→ Commonly used in drug designing.

→ For identification of the compounds having similar melting point.

→ Local anesthetics in case of children. (useful medication for providing pain relief)

↑ press

⇒ O is th are in

⇒ Line OA then any

Gases

→ Gases are compressible

→ Have no definite shape & volume

→ Density of gases are much smaller than liquids and solids.

→ Weak forces of attraction between the particles. (so, they are freely move)

Aerosol: An aerosol is a suspension of fine solid particles or liquid droplets in air or another gas.

eg - Natural aerosol are fog, mist.

Inhaler: An inhaler is a device that ~~gets~~ filled with medicine & directly goes into our lungs.

→ People inhale medicine in mouth through inhalers.

eg - Asthma pump.

Relative humidity: It is the ratio of water vapour present in the air drop to the saturated air × 100.

$$\frac{\text{water droplets in air}}{\text{Saturated air}} \times 100$$

Liquid complexes: These are binary mixtures that have coexistance b/w two phases.

- Solid- liquid (suspension)
- Liquid-gas (foams)
- Liquid- Liquid (emulsion)

eg- shaving cream.

2020

Liquid crystals: They are matter in a state that has properties between a solid and a liquid

eg- cholesteryl benzoate (145°-178°)

solid $\xrightarrow{145^\circ}$ Semi liquid $\xrightarrow{178^\circ}$ Liquid.

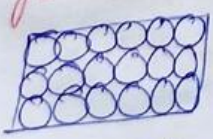
2020

Glassy state: Supere cooled liquid.

Liquid $\xrightarrow{cool}$ Solid $\xrightarrow{very\ slowly\ cool\ continuous}$ supere cooled liquid ↓ Glassy state

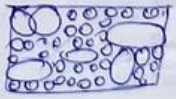
Solid: A substance that have definite shape, size and volume.

Crystalline Solid



- Which have shape & size fixed & pattern of intermolecules are fixed.
- eg- Metal, ice etc.

Amorphous solid



- The atoms & molecules are not arranged in a definite pattern.
- Glass, plastic etc.

⊙ Melting point & boiling point sharp.

⊙ Sharp cutting is possible.

⊙ Melting & boiling point wide range.

⊙ No sharp cutting is possible.

Polymorphism: These are those solid which has ability to change their form according to situation. eg- Carbon: diamond (tetrahedral lattice arrangement) in a cubic.

Physicochemical properties of drug molecules

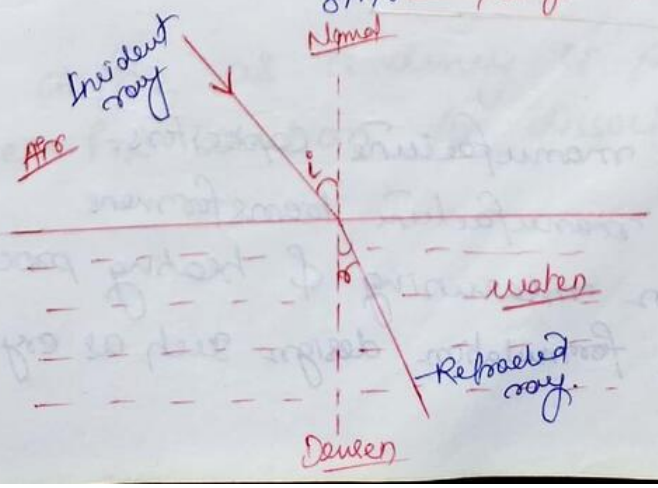
Refractive index: It is the ratio of velocity of light in empty space or vacuum divided by its velocity in the selected medium.

$$n = \frac{c}{v}$$

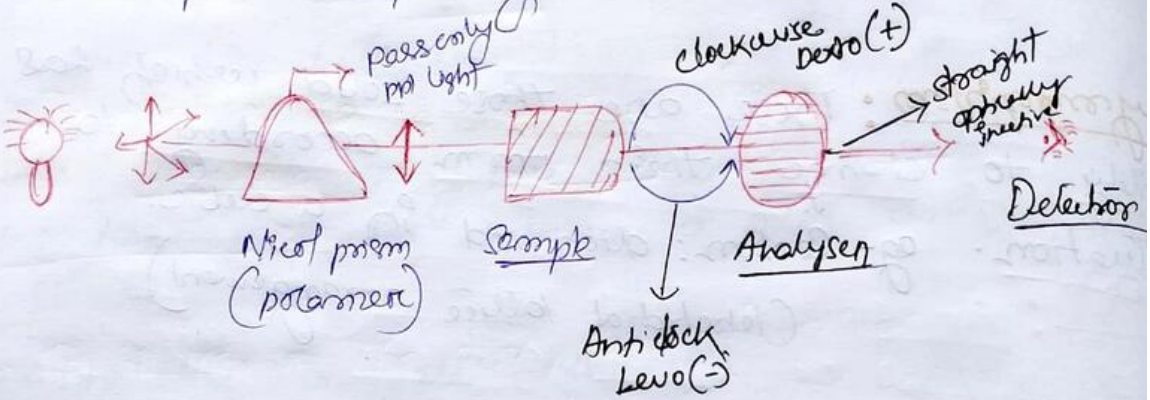
where,
c = velocity of light in vacuum
v = velocity of light in selected medium.

→ **Snell's law**: It gives the relation between the angle of incidence and angle of refraction.

$$n = \frac{\sin i}{\sin r}$$ → angle of incidence, → angle of refraction.



Optical Rotation: When we pass light through a medium, if light turn or rotate then it is optical active & if the light not rotate then our sample is optically inactive.



Light rotate → Optically active
Light not rotate → Optically inactive
Clockwise rotate → Dextro (+)
Anticlockwise rotate → Levo (-)

2) **Dielectric Constant:**

→ A quantity measuring the ability of a substance to store electrical energy in a electrical field.

→ It is the ratio b/w the permitivity of the medium to the permitivity of free space (ϵ_0)

$$\text{Dielectric constant} = \frac{\epsilon}{\epsilon_0}$$

3) **Applications**

→ Used to manufacture capacitors.
→ Used to manufacture transformers.
→ Used for measuring & heating processes.
→ Used for formulation design such as crystallization.

Dipole Moment

It is the product of the magnitude of the separated charge and the distance of the separator.

$$\mu = q.r$$

r → distance b/w them

q → Magnitude of seperated charge.

Applications

→ To predict the nature of the molecule.

→ To Predict the nature of the chemical bond.

→ The measurement of the dipole moment gives an idea of the degree of polarity for an diatomic molecule.

→ shape of molecules.

Specific DM → Non systemic molecule

Zero DM → Systemic molecule

Dissociation const.

$$H_2O \rightleftharpoons H^+ + OH^-$$

A/c to law of mass action.

$$\text{Rate of rxn} \propto \frac{[H^+][OH^-]}{[H_2O]}$$

$$\frac{dx}{dt} = K_a \frac{[H^+][OH^-]}{[H_2O]}$$

$$K_a = \frac{[H_2O]}{[H^+][OH^-]} \cdot \frac{dx}{dt}$$

K_a ← Dissociation const.

⇒ It is define as tendency of particular substance in solution to dissociate into ions.

Applications

⇒ It is important for the quantitative evaluation of systems involving acid-base equilibrium.

⇒ Dissociation const. is also important for working with buffers and pH indicator.

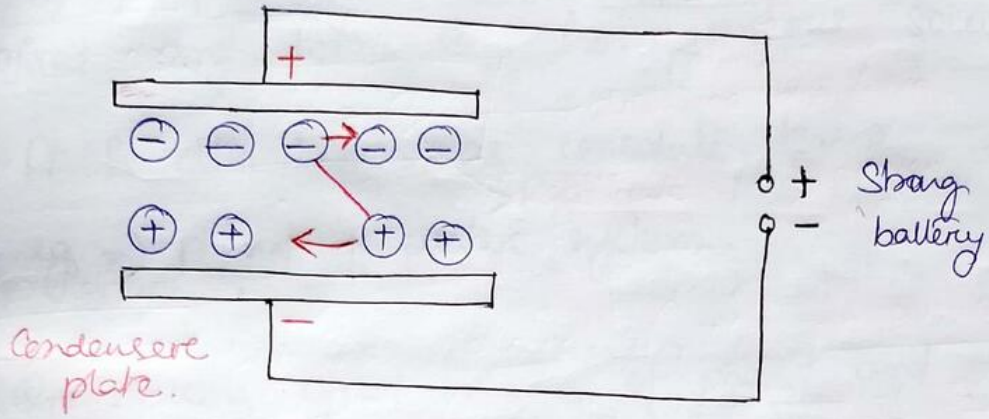
⇒ The absorption of drugs in GIT can be predicted using dissociation constant of the drug.

⇒ It is the key physicochemical parameter influencing many biopharmaceutical characters.

⇒ Dissociation const. is incorporated in H-H equation to calculate the extent of ionization or dissociation.

Determination of Dipole Moment

→ Electric Condenser



→ The parallel plates of condenser → charged by connecting with strong battery.

↓

Electric field is set up with field strength equal to applied voltage (V) divided by distance (d) b/w plates.

↓

Polar molecules are electric dipoles rotate and align with.

→ Negative end toward positive plate

→ Positive end toward negative ~~people~~ plate.

This orientation affects the electric field b/w two plates.

→ If plates is charged with voltage 'V'. (before induction of polar substance)

→ On introducing polar substance b/w plates

↓

the voltage change to lower value V'

The ratio $\varepsilon = \frac{V}{V'}$

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Critical Solution Tempr

Critical Solution tempr is the temperature beyond which partially miscible liquids get completely mixed and form a homogeneous solution.

→ It is also known as consolute tempr.

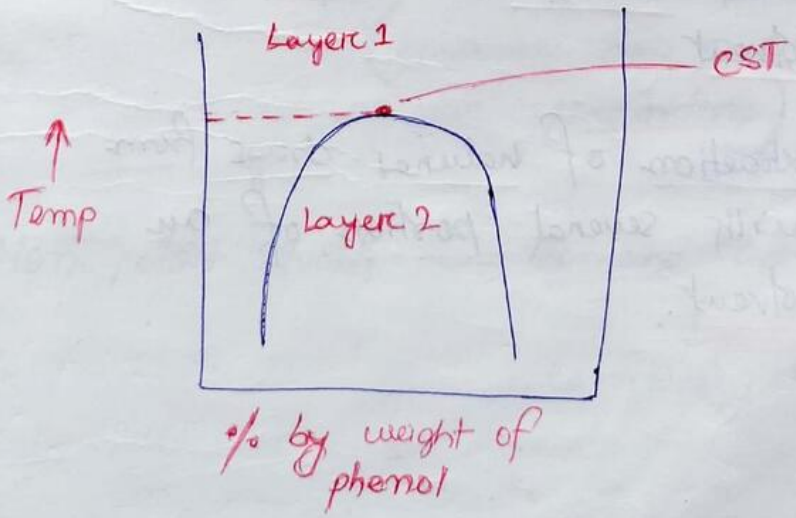
→ eg => phenol + water system.

=> On shaking equal volume of phenol and water, we get two layers.

→ The upper layer is a solution of water in phenol and the lower layer is a solution of phenol in water.

→ At a fix tempr, the composition of each solution is mixed and both the soln are in equilibrium.

→ The tempr at which such solutions are completely miscible in all proportion is known as critical solution tempr.



(i) Upper Critical Soln Temp. (UCST)

The UCST is the critical temp above which pair of partially liquid becomes completely miscible in all the proportion.

(ii) Lower Critical Soln Temp (LCST)

The LCST is the critical temp below which pair of partially liquid becomes completely miscible in all the proportion.

Applications

→ CST provides the temperature limits for some reactions if it occur in two miscible liquids.

→ CST is used to determine the water content in substances such as methyl & ethyl alcohol.

→ Used to determine the efficiency with which one solvent can extract a compound from a second solvent.

→ Used in extraction of natural drugs from a solvent with several portion of an immiscible solvent.

Solubility of Liquids in Liquids

Two or more liquids are frequently mixed together for preparation of pharmaceutical solutions.

For example

alcohol + water → To form hydroalcoholic solutions of various conc.

Volatile oils + water → To form dilute aq. waters.

Volatile oils + alcohol → Spirits and elixirs.

Liquid–liquid system can be divided into —

① Complete miscibility

Polar and semipolar solvents → water and alcohol
→ Glycerin and alcohol
→ Alcohol and acetone

↓

are said completely miscible (because they mix in all proportion)

* Non polar solvents → Benzene and ether

↓

completely miscible.

② Partial Miscibility

→ Certain amount of water & ether, water & phenol form two liquid layer.

→ Each layer contain some amount of other liquid.

→ The mutual solubility of partially miscible liquids influenced by tempr.

Components of Aerosols

Propellent

→ Main constituent of aerosol.

- Liquified gas = Available in liquid form & when they release convert into gas.
- Compressed gas = Available in gas & release as a gas.

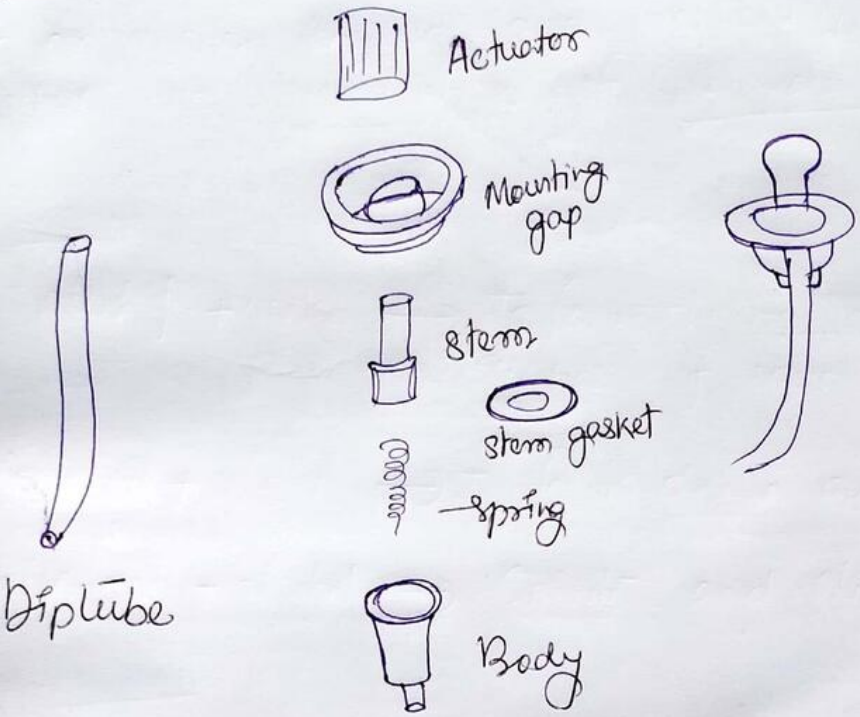
eg - CFC, hydrocarbon.

Container : Should have the property to bear the pressure of 140-180 PSIG
They are available in tin, Al, stainless steel.

Product concentrate

Active medicament which we mix with propellent & solvent.

Valve & Actuator



Aerosols: Pressurized dosage forms containing one or more active ingredients which upon actuation emit a fine dispension of liquid or solid materials in a gaseous medium.

Merits

→ Preferred for solutions, emulsions & suspensions.
→ Less contamination.
→ No refrigeration.

Demerits

→ Costly.
→ Very toxic (some propellents)
→ Allergic in some cases.

BP302T

PHYSICAL PHARMACEUTICS–I

"Transforming Students into Pharma Professionals"

Same unit Notes with different Contant

PHARMA NFT

PHYSICAL PHARMACEUICS-I

UNIT => 2

IMPORTANT Questions.

1) Discuss in detail properties of the various states of matter. How does transition take place from one state of matter to other?

2) Define the following —
i) Enthalpy ii) Entropy iii) triple point
iv) vapour pressure.

3) Explain the principle of sublimation with the help of neat diagram?

4) Explain Eutectic Mixtures with examples.

5) what is charle's law? explain it.

6) Give the statement & postulates of kinetic molecular theory of ideal gases.

7) write a short note on —
i) Relative humidity.
ii) Liquid complexes.
iii) Liquid crystals.
iv) Glassy state.

8) Differentiate b/w crystalline solid and amorphous solid.

9) Define crystalline solid. what are the types of crystals? Enlist and explain characteristics of crystals.

10) What do you mean by or understand by polymorphism? write its importance in pharmacy.

11) write down method of determination and applications of any three of the following –

i) dielectric constant
ii) Refractive index
iii) Dipole movement
iv) Dissociation constant

UNIT => 2

STATES OF MATTER AND PROPERTIES OF MATTER

-> Matter :

- Matter is a substance which occupies space and possesses rest mass, specially as distinct ~~for~~ from energy.
- Matters can be classified as :

* Physical classification :

i) solid : A substance which ~~has~~ have definite, shape, size & volume.

ii) liquid : A substance which have definite, volume but shape & size not fixed

iii) Gas : A substance which have shape, size and volume not fixed.

* chemical classification :

i) Pure substance : Eg => Elements & compounds.

ii) Mixture : Eg => Homogeneous & Heterogeneous.

↓ uniform composition in mixture

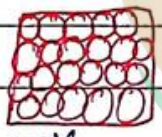
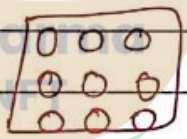
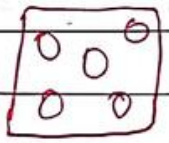
↓ composition vary in mixture.

* Comparision of solid, liquid & gases:

→ Solids: • Max. force of attraction.
• closely packed particles.

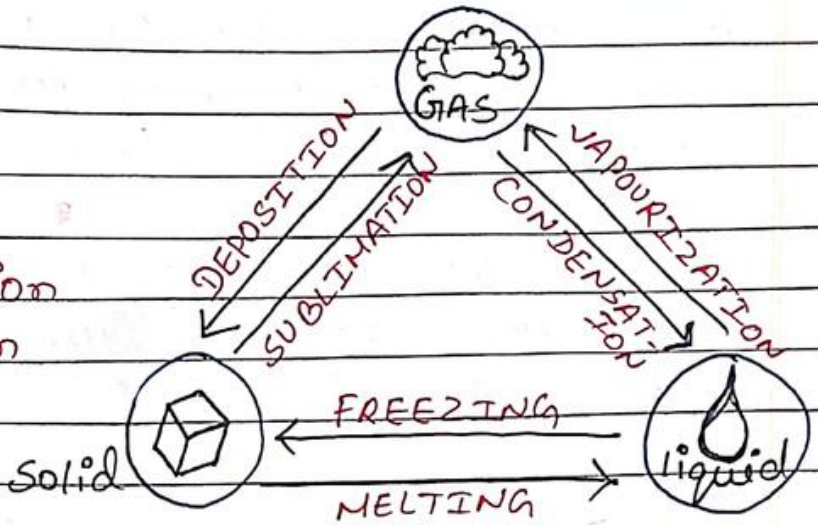
→ Liquids: lesser intermolecular force of attraction.
• Particle move/flow with each other.

→ Gases: • Minimum intermolecular force of attraction.
• Particles flow independently.

Properties	Solid	Liquid	Gas
• Intermolecular space			
• weight	very High	High	low
• shape	fixed	not fix	not fixed
• size	fixed	not fix	not fixed
• volume	fixed	fixed	Not fixed.
• flow Properties	No [very less]	More than solid	very high.

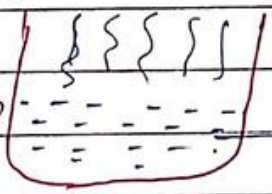
Changes in the state of matter:

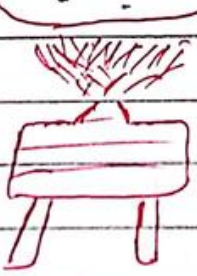
1. Freezing
2. Melting
3. Deposition
4. Sublimation
5. Vapourization
6. Condensation

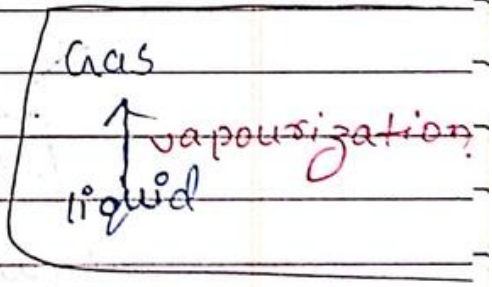


Latent heats

- When energy is absorbed as heat by solid or liquid, the temperature of the object doesnot necessarily rise [no change in temperature if we provide heat] i.e., hidden heat which change the phase, or state of an object to another. called latent heat or the heat of transformation



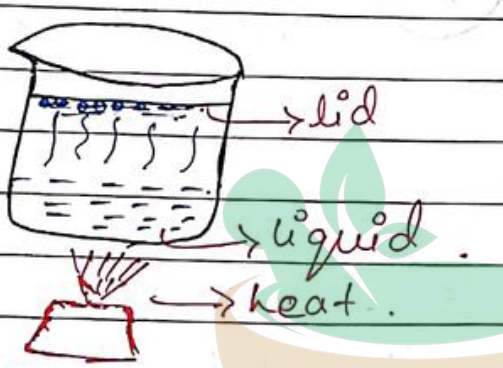




- It is denoted by L.

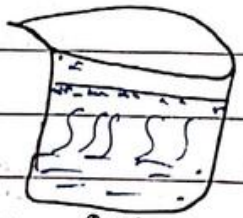
Vapour Pressure :

- The vapour pressure of a liquid is the equilibrium pressure of a vapour above its liquid i.e., the pressure of the vapour resulting from evaporation of a liquid above the sample of the liquid in the closed container.



Initial.
Rate of evaporation is High
Rate of condensation is low

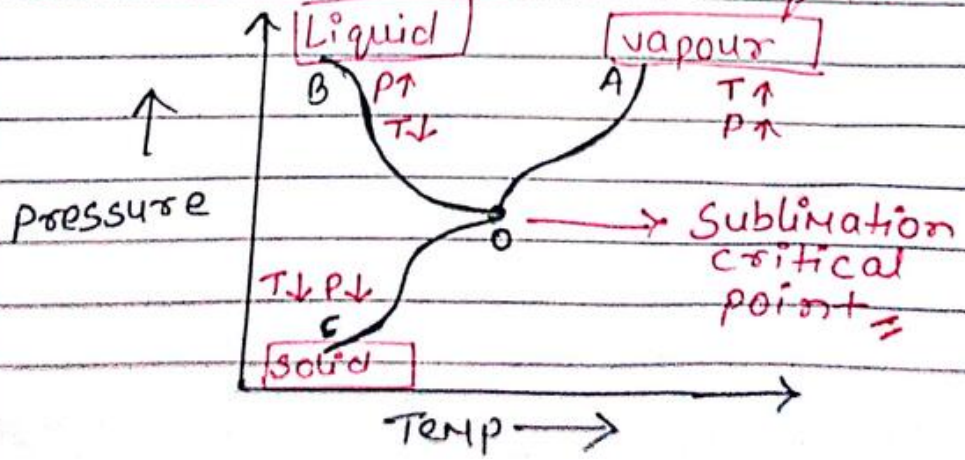
Intermediate
Rate of Evaporation is low
Rate of condensation is High.



Equilibrium
Rate of Evaporation
= (equal to)
Rate of condensation.

Sublimation Critical Point :

- Sublimation is a ~~point~~ process in which any solid is directly converted into gas without convert in liquid.
- We know that the phase of any matter can be change by change in temperature and pressure.
- O is the point where all phase of matter are in equilibrium state.
- Line OA represents, when we ↑ Temp. & ↑ Pressure then any solid directly convert into gas.
- Line OB represents, when we ↑ Pressure and ↓ temperature then any substance exist in liquid form.



- Line OC represents when we ↓ Temp. & ↓ Pressure then substance exist in solid phase.

- The point at which this sublimation process takes place is called sublimation critical point.

→ Advantages :-

- The main advantages of sublimation is for purification process.

- The minimum amount of product is loss.

- Solvents are not used.

- When the substance weights less than 100mg the best method for purification is sublimation.

Date

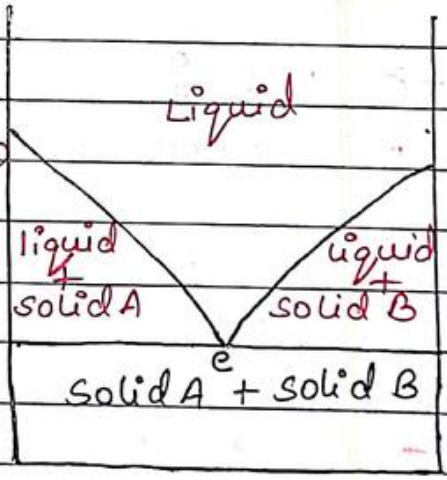
Eutectic Mixture :

- A Eutectic mixture is defined as a mixture of two or more components which usually do not interact to form a new chemical compound, but at certain ratios inhibit the crystallization state or process of one another resulting in a system having a lower melting point of individual component.

Eg => Ibuprofen, Thymol. Mix. → Eutectic Mixture
M.P => 62°C M.P => 42°C M.P => 37°C

→ Principle :

- Below the eutectic temp. the Mixture of the two substance will exist as a solid.
- while above it the Mixture will convert into a liquid.



e = Eutectic point

- Point 'e' is the lowest melting point.

→ factors governing eutectic mixture formation :-

- The component must be miscible in a liquid state & mostly immiscible in solid state.
- The molecules which are in accordance to modified Van Hoff's equation can form eutectic mixtures.
- The component should have chemical groups that can interact to form physical bonds such as intermolecular hydrogen bonding etc.

→ uses :

- commonly used in drug designing.
- For identification of the compounds having similar melting point.
- local anesthetics in case of childred (useful medication for providing pain relief).

Gases :

→ Properties of gases :-

- Gases are compressible.
- They have no definite shape and volume.
- The density of gases are much smaller then liquids and solids.
- weak force of attraction between the particles. (So, they are freely move).

→ Gas laws :

1) Boyle's law :

- It states that the pressure of a gas is inversely proportional to the volume of gas at constant temp.

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

2) charle's law :

- It states that the volume of a gas is directly proportional to the temp. of gas at fixed pressure.

$$V \propto T$$

3) Gay-Lussac's law

- The pressure of a gas is directly proportional to the temp. at constant volume.

$$P \propto T \qquad P = kT$$

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

4) Avagadro's law

- The volume is directly proportional to the no° of moles of gas.

- At constant T & P.

$$V \propto n$$

$$V = kn$$

$$\frac{V}{n} = k \text{ (const.)}$$

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

Aerosols : [Biphasic preparation]

- Aerosols is a suspension of fine solid particles or liquid droplets in air or another gas.

Eg => Perfumes -> fog.

-> Inhalers :

- An inhaler is a device that filled with medicine & directly goes into our lungs.
- People inhaled medicine in mouth through inhalers.
- Eg => Asthma pump, COPD [chronic obstructive pulmonary disease]

-> Relative humidity

- It is the ratio of water vapor present in the air drop to the saturated air x 100.

$$\frac{\text{water droplets in air}}{\text{saturated air}} \times 100$$

-> Liquid complexes: These are binary mixtures that have coexistence b/w two phases.

- solid - liquid (suspension)
- liquid - ~~foams~~ gas (foams)
- liquid - liquid (emulsion)

eg => shaving cream.

→ Liquid crystals :

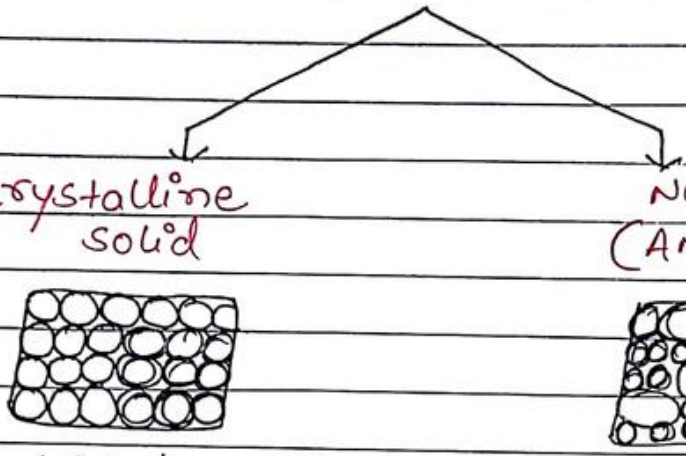
- They are matter in a state that has properties between a solid and a liquid.
- eg :→ cholestryl benzoate (145°-178°)

solid $\xrightarrow{145^\circ}$ semi liquid $\xrightarrow{178^\circ}$ liquid

→ Glassy state : → super cooled liquid

- ~~sol~~
- liquid $\xrightarrow{\text{cool}}$ solid $\xrightarrow[\text{continuous}]{\text{very cool}}$ super cooled liquid → Glassy state.

→ Solid : A substance that have definite = shape, size and volume.



Crystalline solid	Non-crystalline solid (Amporphous solid)
• which have shape & size fixed & pattern of intermolecular are fixed.	• the atoms and molecules are not arranged in a difinite pattern.
• eg ⇒ Metal, ice etc.	• eg ⇒ Glass, plastic, etc.
• Melting point & Boiling point sharp.	• Melting & Boiling point wide range.
• Sharp cutting is possible	• No sharp cutting is possible.

→ Polymorphism : These are compounds has ability to change their form according to situation.

eg ⇒ carbon → Diamond in a cubic.

Physicochemical Properties of Drug Molecules :

1) Refractive Index :

- It is the ratio of velocity of light in empty space or vaccum divided by its velocity in the selected Medium.
- It is expressed as :

$$n = \frac{c}{v}$$

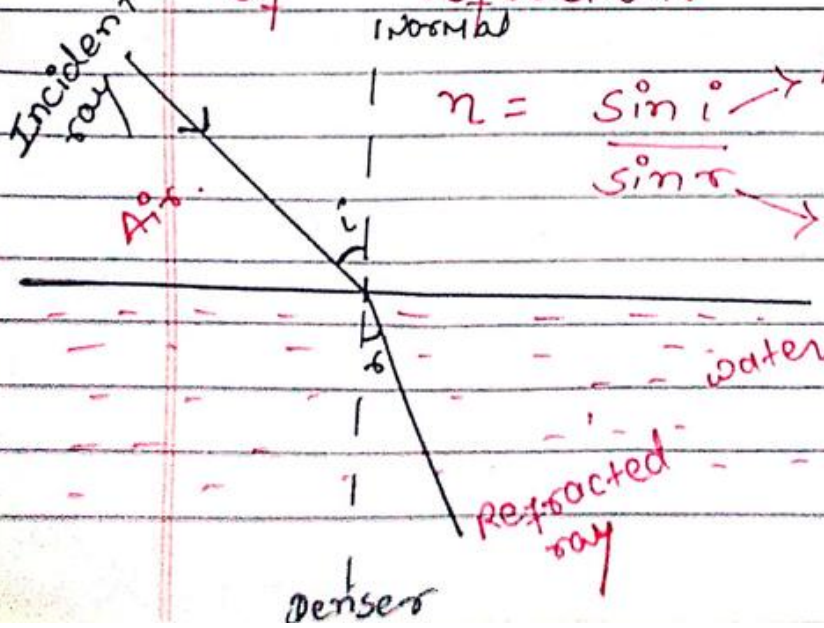
where,

c = velocity of light in vaccum

v = velocity of light in selected Medium.

→ Snell's law :

- It gives the relation between the angle of incidence and angle of refraction.



$$n = \frac{\sin i}{\sin r}$$

→ Angle of incidence

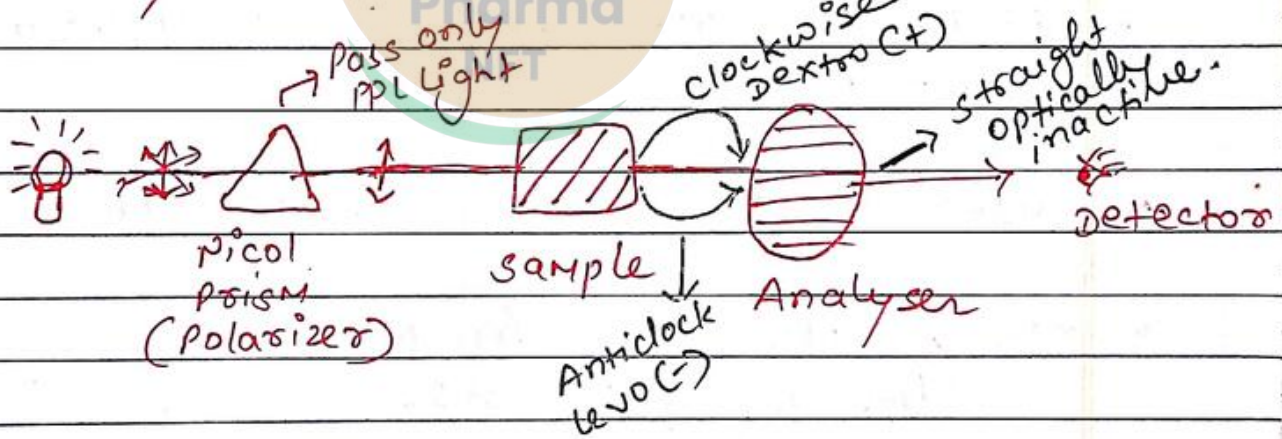
→ Angle of refraction

2) Optical Rotation :

- When we pass light through a medium, if light turn or rotate then it is optical active & if the light not rotate then our ~~med~~ sample is optically inactive.

- Polarimeters use to measure the degree of rotation of polarised light.

- A polarimeter consists of :
  - Polarized light source
  - Polarizer
  - Analyzer
  - Sample tube
  - Detector.



- Light rotate → optically active
- Light not rotate → optically inactive
- clockwise rotate → Dextro (+)
- Anticlock wise rotate → Levo (-).

3) Dielectric Constant :

- A quantity measuring the ability of a substance to store electrical energy in a electric field.
- It is the ratio b/w the permitivity of the medium to the permitivity of free space (ε_0).

$$\text{Dielectric constant} = \frac{\varepsilon}{\varepsilon_0}$$

→ Applications

- Dielectrics are used to manufacture capacitors.
- used to manufacture transformers.
- They are used in measuring & heating processes.

4) Dipole Moment :

- It is the product of the magnitude of the separated charge and the distance of the separator.

$$\mu = q \cdot r$$

r → distance b/w them

q → Magnitude of separated charge

→ Application :

- To predict the nature of the molecule.
- To predict the nature of the chemical bond.
- The measurement of the dipole moment given an idea of the degree of polarity in an diatomic molecule.

5) Dissociation constant :

- $H_2O \rightleftharpoons H^+ + OH^-$

A/c to law of mass action

$$\text{Rate of rkn} \propto \frac{[H^+][OH^-]}{[H_2O]}$$

$$\frac{dx}{dt} = k_a \frac{[H^+][OH^-]}{[H_2O]}$$

$$k_a = \frac{[H_2O]}{[H^+][OH^-]} \cdot \frac{dx}{dt}$$

↓

Dissociation const.

- It is define as tendency of particular substance in solution to dissociate into ions.

→ Application

- It is important for the quantative evaluation of systems involving acid - base equilibrium.
- Dissociation constant is also important for working with buffers and pH indicator.

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