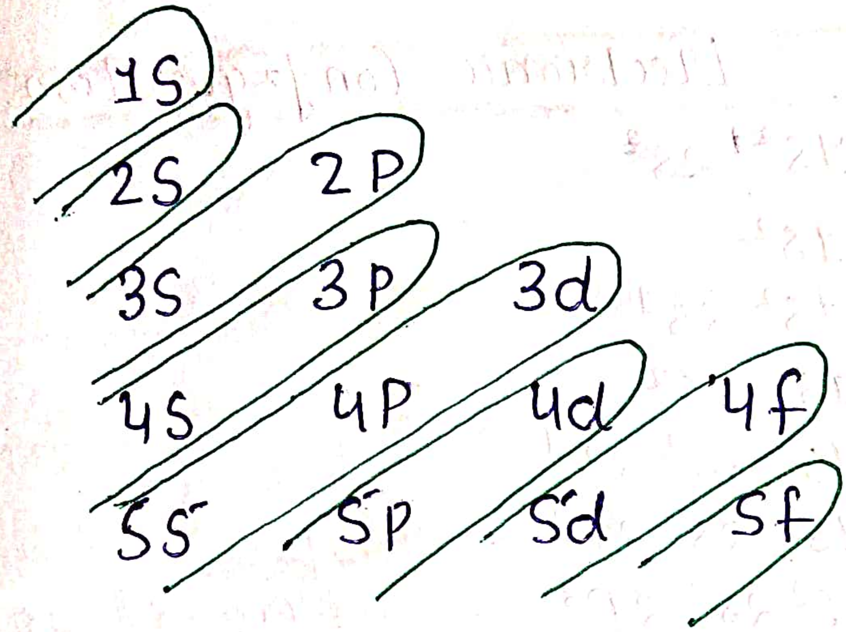
METHOD OF ELECTRONIC CONFIGUR-ATION



1S 2S 2P 3S 3P 4S 3d 4P 5S

ELECTRONIC CONFIGURA-TION

H (Atom)	Atomic No°	Electronic Configuration
H	1	$1s^{1}$ ~~$2s^{2}$~~
He	2	$1s^2$
Li	3	$1s^2\ 2s^1$
Be	4	$1s^2\ 2s^2$
B	5	$1s^2\ 2s^2\ 2p^1$
C	6	$1s^2\ 2s^2\ 2p^2$
N	7	$1s^2\ 2s^2\ 2p^3$
O	8	$1s^2\ 2s^2\ 2p^4$
F	9	$1s^2\ 2s^2\ 2p^5$
Ne	10	$1s^2\ 2s^2\ 2p^6$
Na	11	$1s^2\ 2s^2\ 2p^6\ 3s^1$
Mg	12	$1s^2\ 2s^2\ 2p^6\ 3s^2$
Al	13	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$
Si	14	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$
P	15	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$
S	16	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$
Cl	17	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$
Ar	18	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
K	19	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1$
Ca	20	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$
Sc	21	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$
Ti	22	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$
V	23	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$
Cr	24	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5,\ 4s^1$
Mn	25	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^7$
Fe	26	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8$
Co	27	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9$
Ni	28	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

MOLECULAR ORBITAL THEORY
UNIT-I

- This theory is given by Hund & Mulliken.
- it is just Modification of Valance bond theory (V.B.T)

- Main Assumptions of M.O.T are :

- Atomic orbital of same energy and suitable Symmetry combine and form molecular orbitals.
- These molecular orbitals may be homoatomic M and hetroatomic Mo.

Homo atomic M.O → formed by same atoms ($H_2, N_2,$

Hetro atomic M.O → formed by different atoms. e.g → (NO, CO, Hf)

- In this theory bonding should be Delocalize i.e. Should be spread over whole molecule.
- No° of Molecular orbitals should be equal to atomic orbitals. But Molecular orbitals are classified as:

$2s^2$

- Bonding Molecular orbital [BMO] • They have lower energy then Parental orbital. and represented as (σ, π)

elec ✓
proth ✓
P.P ✓

- Anti Bonding Molecular orbital [AMO] : They have. higher energy than. Parental orbital. It is represented as → (σ^*, π^*)

Linear Combination of Atomic Orbital [LCAO]:

Molecular orbitals formed by Linear Combination of atomic Orbital. For this Combination atomic orbitals must follow some conditions.

(a) Conditions :-

(A) Atomic Orbital must have same energy.

(B) Atomic Orbital must have Proper Symmetry

(c) Overlapping of Atomic orbital should be in such extent (Mannage) to Minimize the repulsion b/w molecules / orbitals.

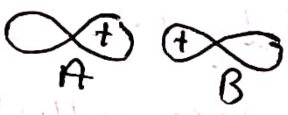
(d) Bonding Molecular orbital [BMO] supports there formation thus, they are Stable. And AMO oppose their formation thus, they are Unstable.

"In this way Provability of finding an electron is greater in BMO then ABMO"

(e) LCAO represented as ψ

ψ = Wave function

$\psi_b = \psi_A + \psi_B \equiv$



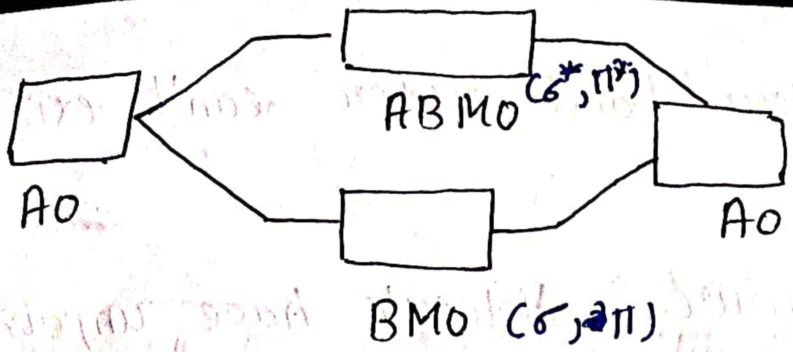
≡ Bonding MO

$\psi_a = \psi_A + (-\psi_B) \equiv$

≡ Antibonding MO

$\psi_a^2 = \psi_A^2 + \psi_B^2 + 2\psi_A\psi_B$

$\psi_b^2 = \psi_A^2 + \psi_B^2 - 2\psi_A\psi_B$



APPLICATION OF MOT

a) Electronic Configuration:

①

Case Ist

- upto 14e⁻ in molecule (N_2, CO, C_2, B_2,)

$$\left[\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, \pi 2p_x = \pi 2p_y, \sigma 2p_z, \pi^* 2p_x = \pi^* 2p_y, \sigma^* 2p_z\right]$$

- Above 14e⁻ in molecule (O_2, NO)

$$\left[\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, \sigma 2p_z, \pi 2p_x = \pi 2p_y, \pi^* 2p_x = \pi^* 2p_y, \sigma^* 2p_z\right]$$

B.) Bond Order

- Half of difference of bonding e⁻ — Antibonding

$$\left[\text{Bond order [BO]} = \frac{N_b - N_a}{2}\right]$$

N_b = No. of bonding of electron

N_a = No. of Antibonding of electron.

- Relation b/w Bond order & bond length.

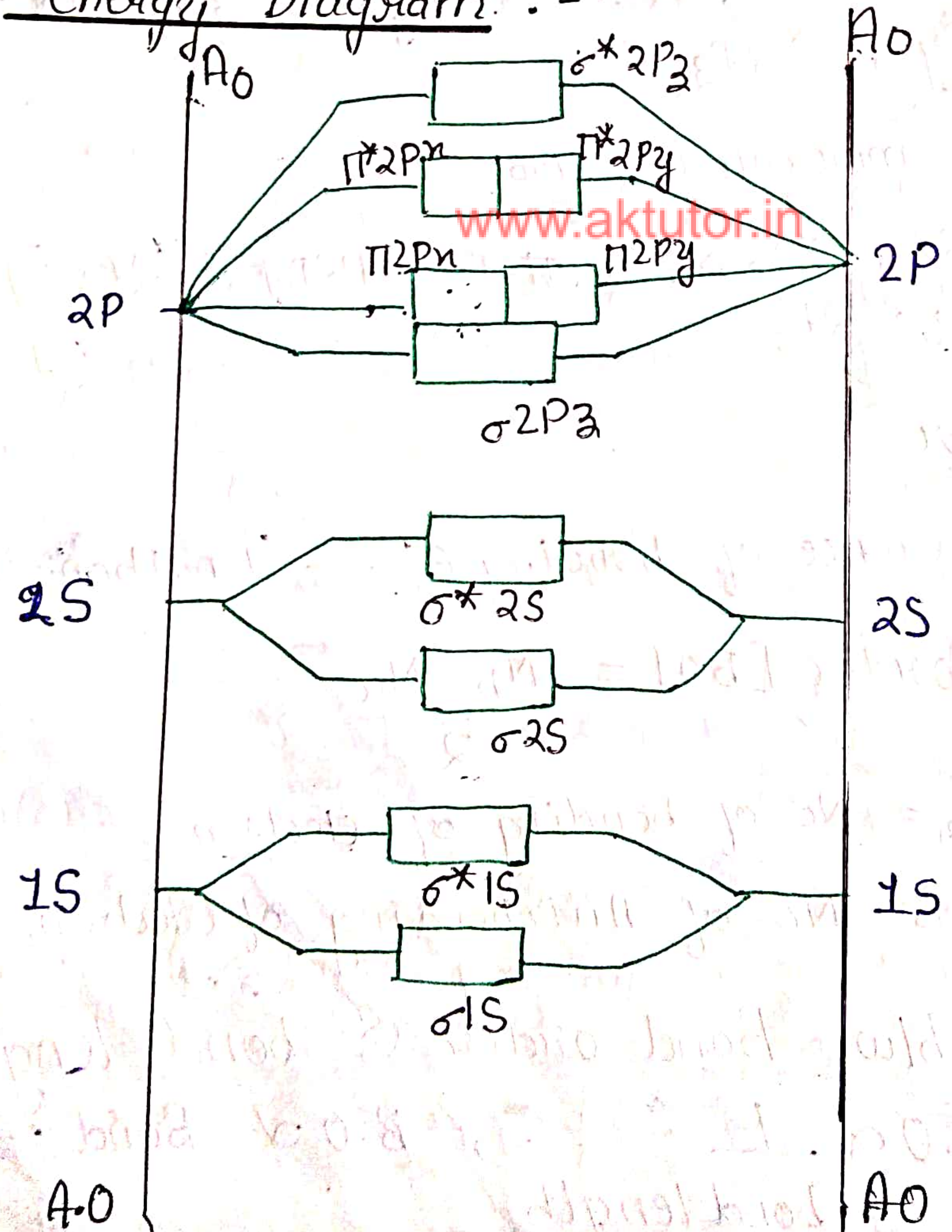
$$\left[B.O \propto \frac{1}{\text{bond length}}\right], \left[B.O \propto \text{Bond streng}\right.$$

- Molecule have zero bond order can't exist. (e.g → He)

c] **Magnetic Behaviour** : Molecule have unpaired electron in configuration are "Paramagnetic." [react in magnetic field]

- Molecule have paired electron in configuration are "Diamagnetic" [neutral in Magnetic field]

d]. **Energy Diagram** :-



- In D group of element the last orbital of electron go in d orbital

$80 \rightarrow 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 4s^2, 3d^{10}, 4s^2, 4p^6, 4d^{10}, 4f^{14}, 5s^2, 5p^6,$ ~~5f~~ $5d^{10}$

Ex. $H_2 = 2 = \sigma 1s^2, \sigma^* 1s^0$

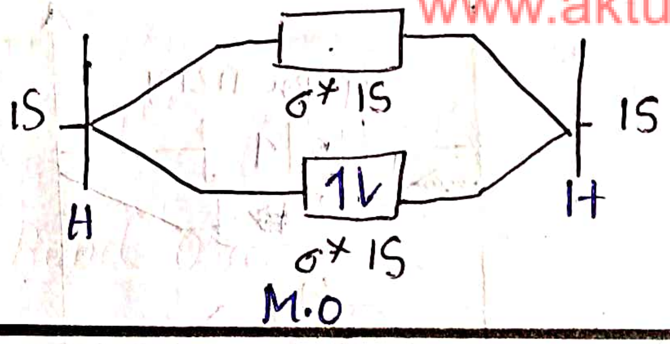
$[H_1 + H_1]$

2.) $B.O = \frac{N_b - N_a}{2}$

$B.O = \frac{2-0}{2}$, $B.O = 1$

3.) Diamagnetic

4.)



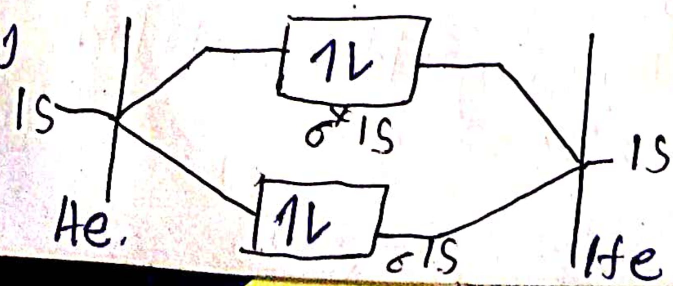
Ex $He_2 = 4 = \sigma 1s^2, \sigma^* 1s^2$

Step-2

$B.O = \frac{2-2}{2} = 0$

3.) Diamagnetic

4.)



Ex = $Li_2 = 6 =$

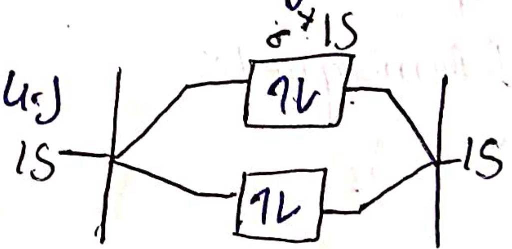
$= \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^0$.

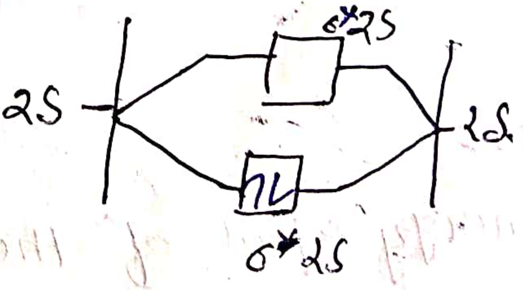
$B.O = \frac{4-2}{2} = \frac{2}{2} = 1$

$B.O = 1$

3.) Diamagnetic

4.)





$Be_2 \rightarrow 8 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2$

Step-2

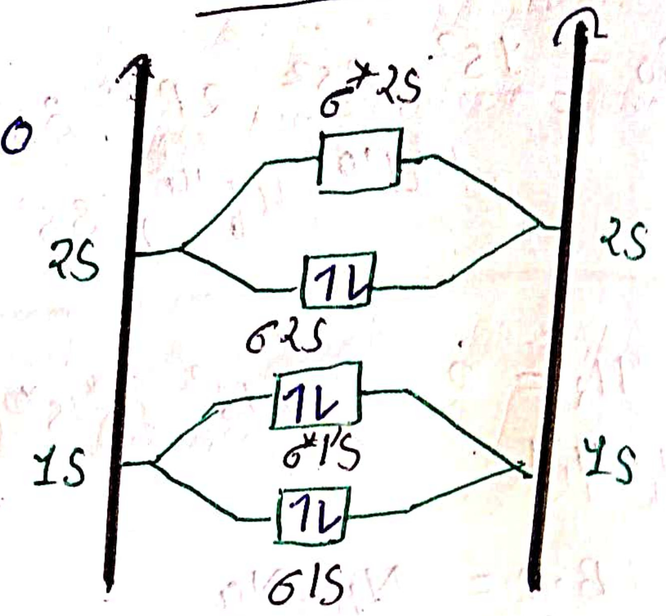
Bond order = $\frac{4-4}{2} = 0$

Step-3

Diamagnetic

~~Step-4~~

Step-4



S.) $B_2 = 10 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^1 = \pi 2p_y^1$

Step-2

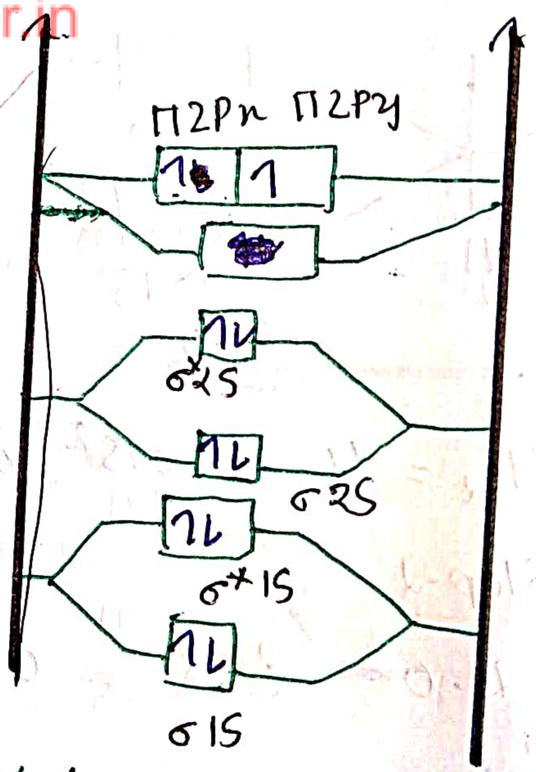
Bond order → $\frac{6-4}{2} = \frac{\cancel{2}}{\cancel{2}}$

Bond order = 1

Step-3

Para ~~Dia~~magnetic

Step-4



notes :

If energy equal of the orbitals then share equal electrons.

Ex→ $C_2 \rightarrow 12 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2$
$= \pi 2p_y^2$

Step-2

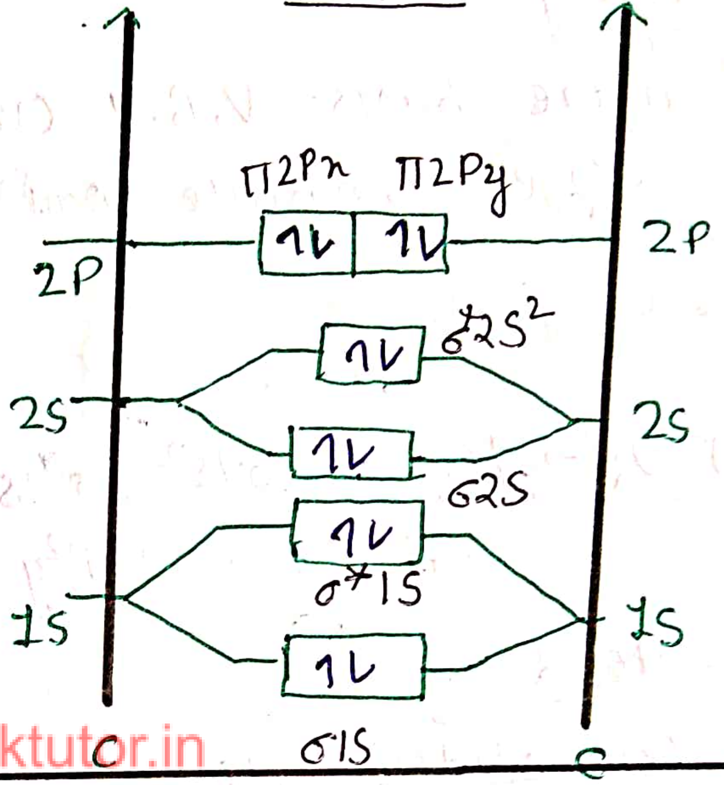
Bond order $= \frac{8-4}{2} = \frac{4}{2} = 2.$

B.O=2

Step-3

Diamagntic

Step-4



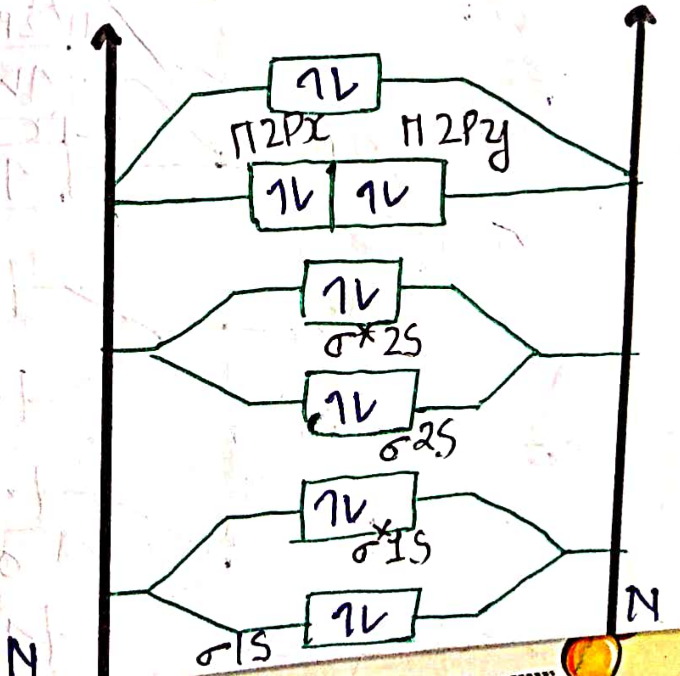
Ex= $N_2 \rightarrow 14 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2$
$= \pi 2p_y^2 ; \sigma 2p_z^2$

Step-3

Bond order $= \frac{10-4}{2} = \frac{6}{2} = 3$

Step-3

Diamagnetic



Oxygen Molecule

Paramagnetic behaviour of oxygen molecule explain On the basis of Molecular orbital theory

[On the basis V.B.T (valance bond theory) oxygen molecule was diamagnetic)]

Above $14e^-$

1.) $O_2 \rightarrow 16e^- \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_y^1$

Step-2

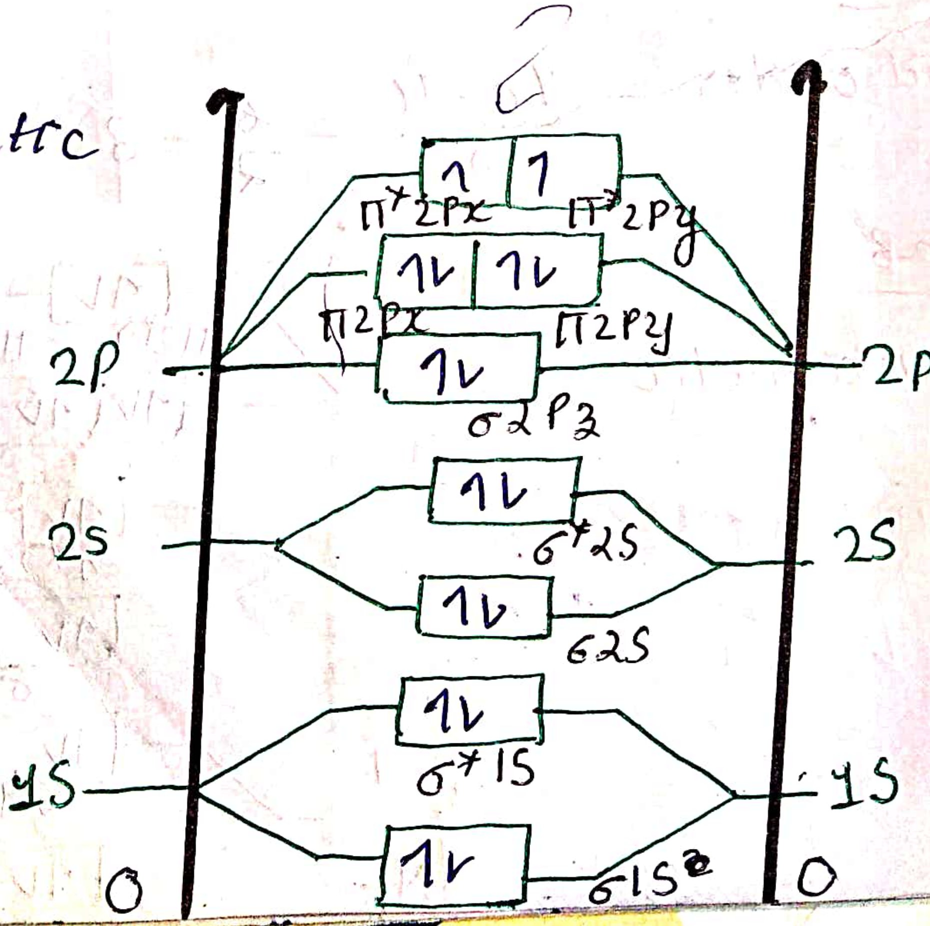
Bond order = $\frac{10-6}{2} = \frac{4}{2}$

Bond order = 2

Step-3

Paramagnetic

Step-4



2] $F_2 \rightarrow 18 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_z^2$
$, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$

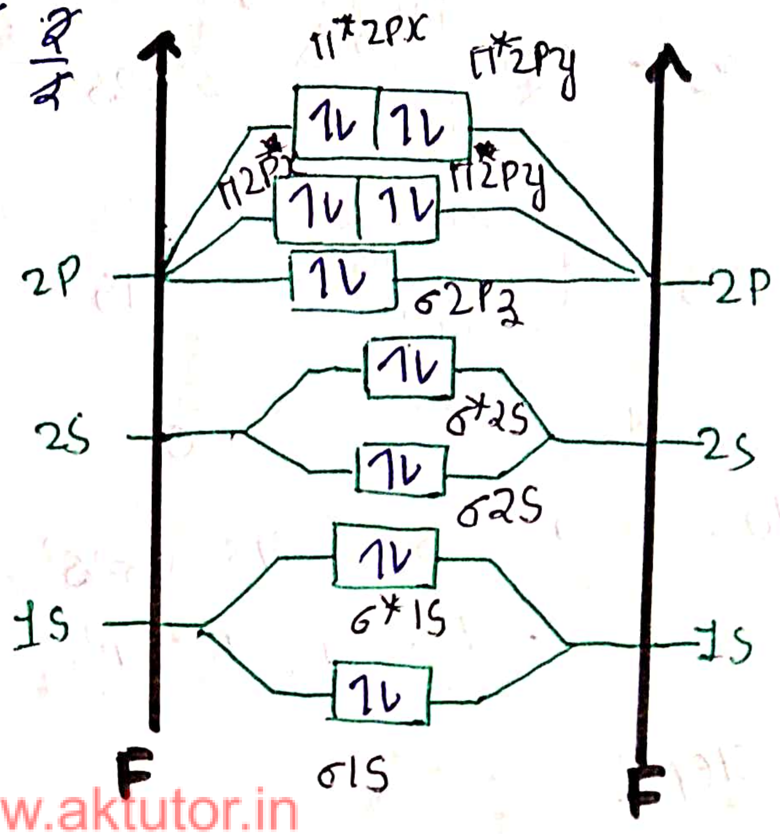
Step-2

$B.O = \frac{10-8}{2} = \cancel{\frac{4}{2}}\ \frac{2}{2}$

$B.O = \cancel{2}\ 1$

Step-3

Diamagnetic



HETROATOMIC

e.g. CN, NO, CO, CO⁺, HF
exception.

1) CN $\rightarrow 6+7 = 13 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \cancel{\sigma 2p_z^2}$
$, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^1$

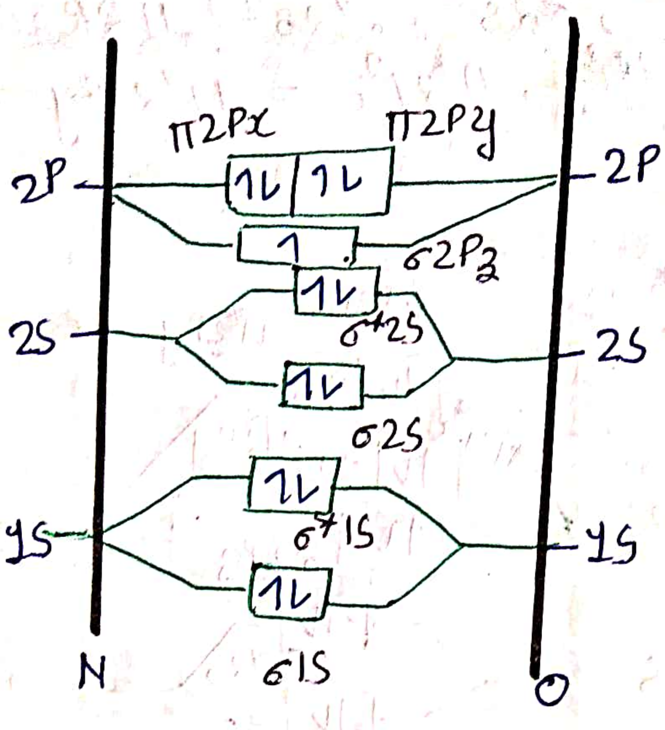
Step. 2

Bond order $= \frac{N_b - N_a}{2} = \frac{9-4}{2} = \frac{5}{2}$

Bond order $= \frac{5}{2} = 2.5$

Step-3

Paramagnetic.



NO : 15 → $\sigma 1S^2, \sigma^* 1S^2, \sigma 2S^2, \sigma^* 2S^2, \sigma 2P_z^2, \pi 2P_x^2 = \pi 2P_y^2, \pi^* 2P_x^1$

Step-2

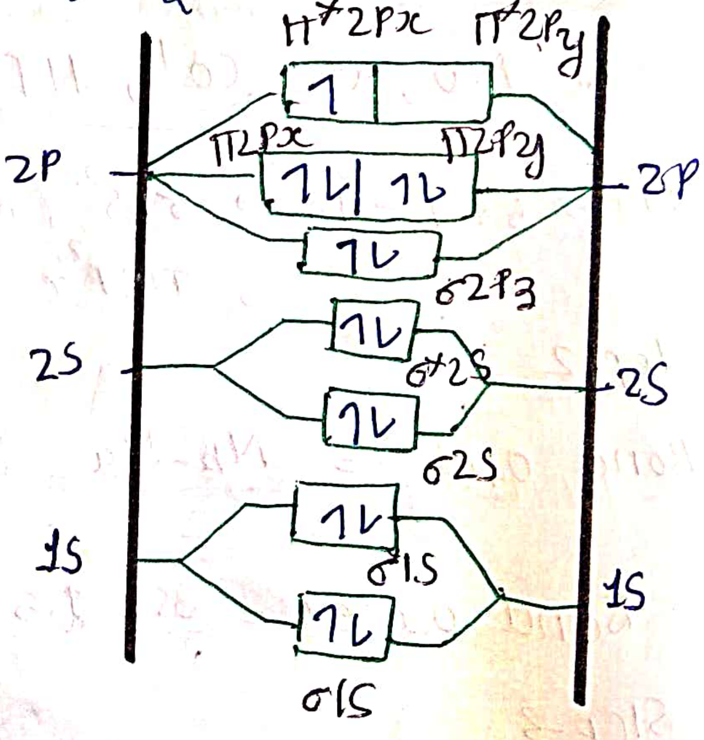
Bond order : $\frac{N_b - N_a}{2} = \frac{10-5}{2} = \frac{5}{2}$

B.O = 2.5

Step-3

Paramagnetic.

Step-4



$NO^+ = 14 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2$
(above 14e⁻) $= \pi 2p_y^2$

Step-2

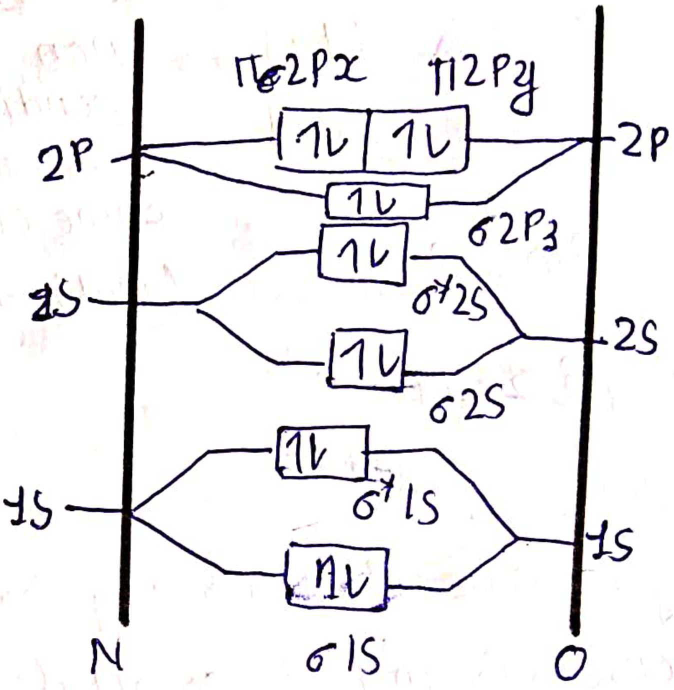
Bond order $= \frac{N_b - N_a}{2}$

$= \frac{10-4}{2} = 3$

Step-3

Diamagnetic

Step-4



- **Special case Exception**

$CO \rightarrow 14 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2, \sigma^* 2s^2$

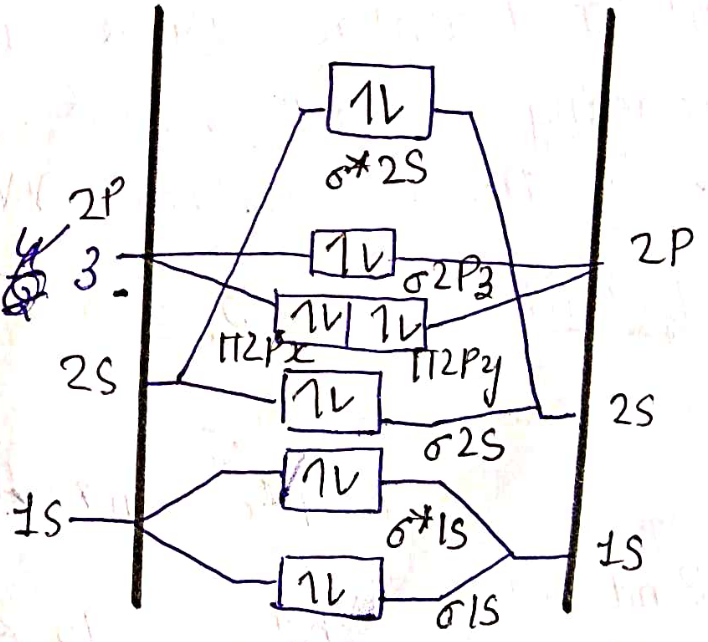
Step-2

Bond order $= \frac{N_b - N_a}{2}$

$= \frac{10\cancel{8}-4}{2} = \cancel{4}\ 3.$

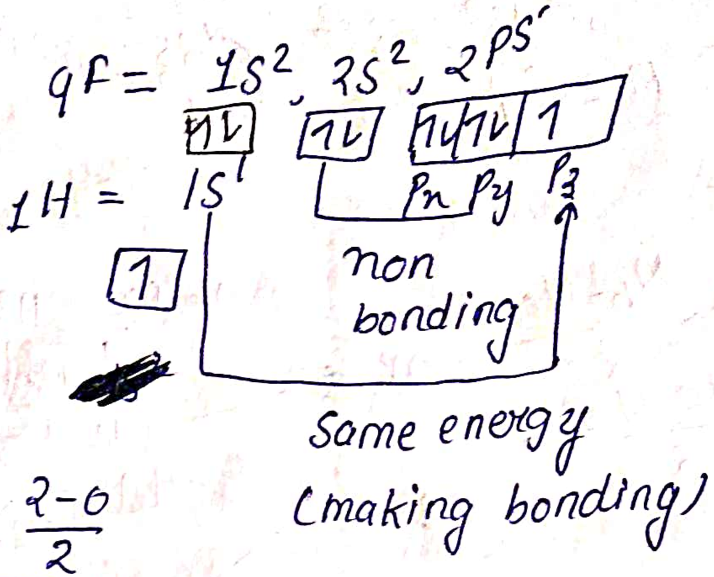
Step-3

Diamagnetic



- Co is exception case becouse $\sigma^* 2s^1$ is highly energy so that's why shifted after $\sigma 2p_z^2$
- Co^+ is also exception but nature is Paramagnetic

$Hf \to 10 \to$



$$B.O = \frac{2-0}{2}$$

$$\boxed{B.O = 1}$$

Reason:

why P_z and 1s making bonding
Becouse P_z and 1s orbital have same energy
that's why its making bonding

V.B.T

- In V.B.T Parental orbital retain their identity
- According to V.B.T follow LCAO
- In V.B.T Atomic orbital are Monocentric

Differentiate b/w O_2 and O_2^- find Strength

$O_2 \to 16 \to \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_y^1$

- Bond order: $\frac{N_b - N_a}{2} = \frac{10-6}{2} = 2$

- Paramagnetic

$O_2^- = 17 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^1$

$B.O = \frac{N_b - N_a}{2} = \frac{10-\cancel{8}7}{2} = \frac{3}{2} = 1.5$

$\boxed{B.O = 1.5}$

$\boxed{B.O \propto \text{Molecule stability}}$

- Paramagnetic

We know that

- Bond order ∝ strength

$\boxed{O_2 > O_2^-}$

- find the bond strength of N_2, N_2^-, N_2^+

- $N_2 \rightarrow 14 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2$
  $, \sigma 2p_z^2$

Step-IInd

Bond order $= \frac{N_b - N_a}{2} = \frac{10-4}{2} = \frac{6}{2} = 3$

$\boxed{\text{Bond order} = 3}$

Step-4

Step-IIIrd

Diamagnetic

- $N_2^- \rightarrow 15 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 =$
  $\pi 2p_y^2$, ~~$\sigma 2p_z^2$~~ $\pi^* 2p_x^1$ = ''

Step-IInd

Bond order $= \frac{N_b - N_a}{2} = \frac{10-5}{2} = 2.5$

$\boxed{\text{Bond order} = 2.5}$

Step-IIIrd

Paramagnetic

Bond strength

$\boxed{N_2 > N_2^- > N_2^+}$

- $N_2^+ = 13 \rightarrow \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^1$

IInd step: Paramagnetic

IIIrd step: B.order $= \frac{9-4}{2} = 5/2 = 2.5$

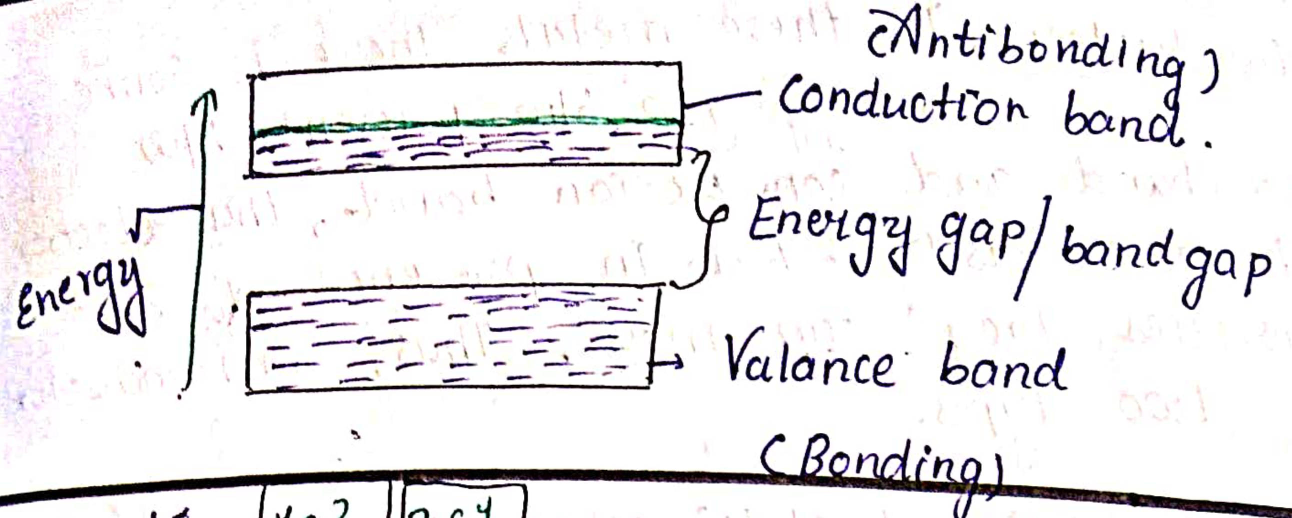
• BAND THEORY OF METALS

- In M.O.T Atoms overlap and form bonding non-bonding and Antibonding orbitals. But metals are composed of Large no of Atoms and the no of Molecular orbitals ~~are~~ becomes so large. Thus they are merge into a band of energy levels.
- In these bands space is minimum and they are highy close together.
- The no of Individual molecular orbitals within -band is equal to the no of contributing atomic orbitals.

- There are two ~~bands~~ types of bands are formed → Conduction band, valance band.
- Valance band: This is bonding band. and completely fullfilled.
- Conduction band: This is Antibonding band and will be empty. (vaccant)

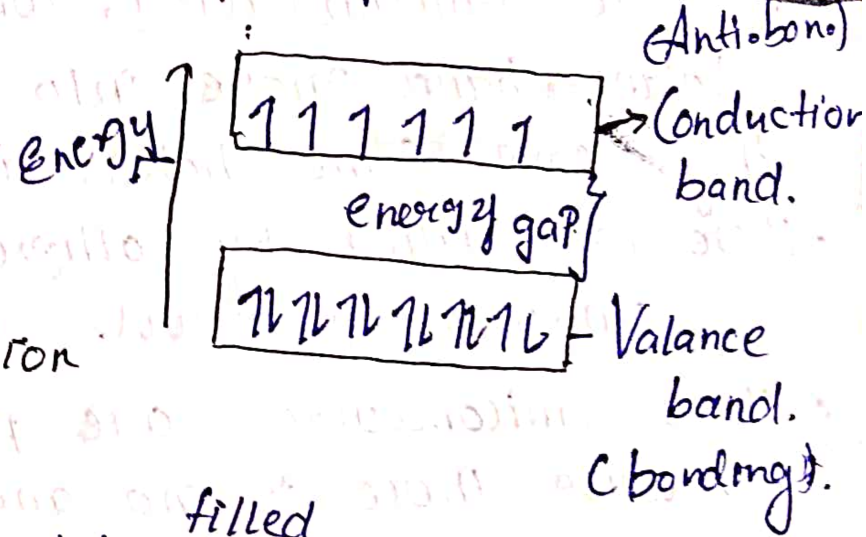
Note:

There are same gap occurs b/w these two bands and is known as, Energy gap. or band gap.



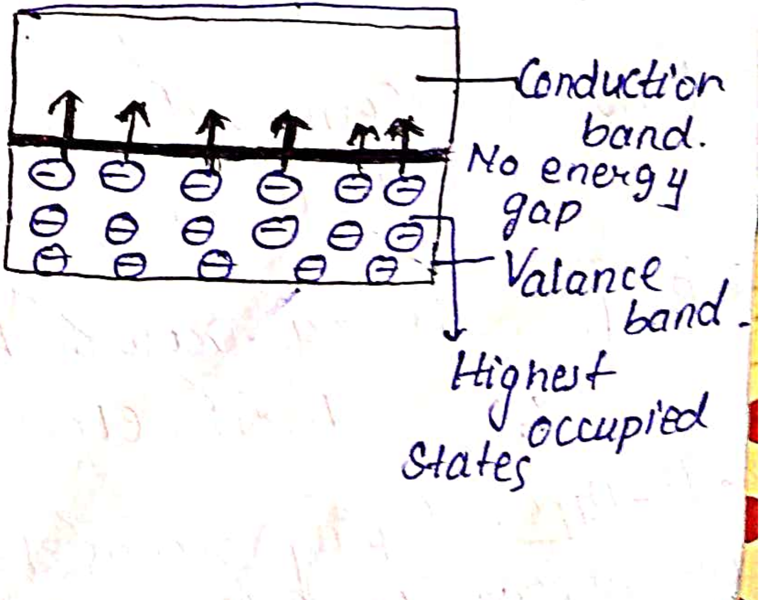
e.g.:→ Li → 1s², 2s¹
Li → 1s² 2s¹
Li → 1s² 2s¹
Li → 1s² 2s¹

Valance band Conduction band.



Conductor: In these metals ~~field~~ filled valance band and overlap with empty or half filled conduction band. There is no band gap b/w valance band and conduction band. thus they are good electrical conductors.

- In these metals empty or ~~unfilled~~ half filled energy states available just above the highest occupied states.

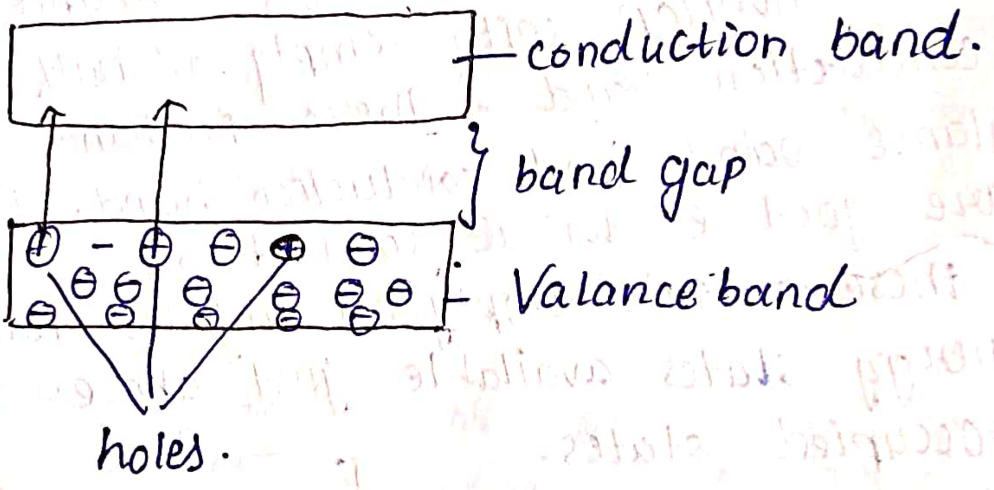


Semiconductor: In these metals there is some energy gap ~~b/w~~ present b/w Valance band and conduction band, thus electron can't move easily. But in presence of some impurities they can move. Thus, Semiconductor of two types.

Intrinsic Semiconductor: when some electrons of Valance band move into conduction band they leave some holes. in Valance band.

- These are filled by other particles and conductivity occurs.

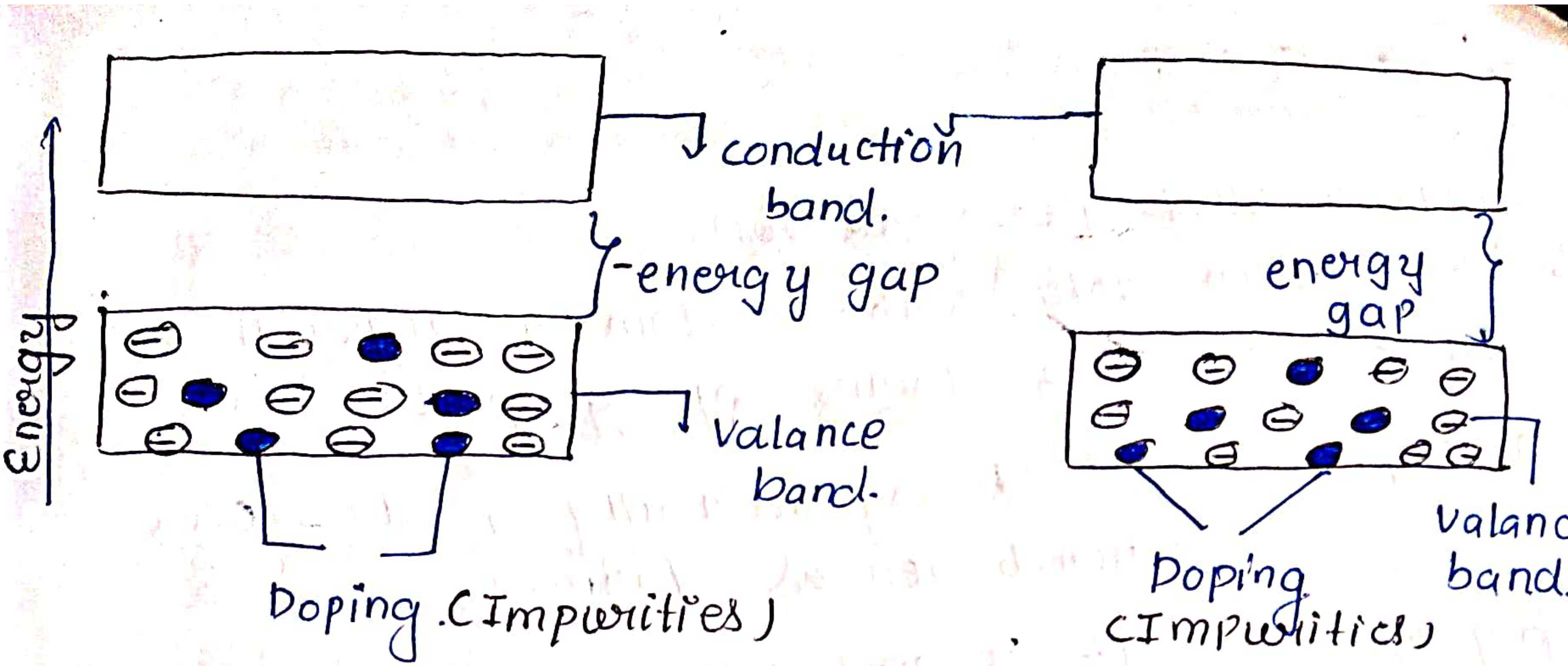
• These semiconductor are pure semiconductor becouse there is no ~~any~~ impurity occurs.



• **Exitrinsic Semiconductor:** They are impure semiconductor form by Doping of some elements

• **P-type:** Doping occurs by group 3rd element B, Al etc

• **N-type:** Doping occurs by group 5th elements.
Eg) Atimony, Bi, P, As. etc

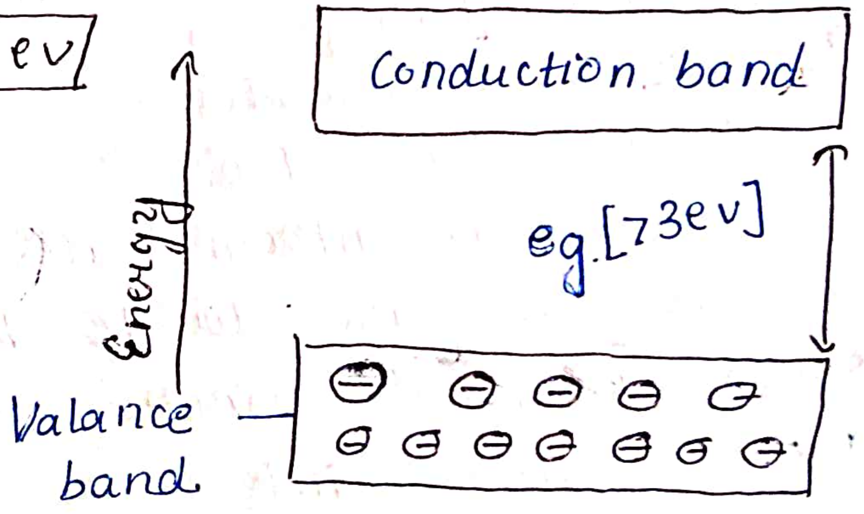


P-type (B, Al, etc)

N-type (Bi, P, As)

Insulator : In these electron can't move from Valance band to conduction band.. Becouse energy gap ~~occurs~~ b/w them is greater than 3 electron volt

$\boxed{eg >> 3\,ev}$



• STRUCTURE OF GRAPHITE

It is a allotrope of carbon.

· It contain only carbon atom arranged in layers.

There are two forms of graphite.

α-graphite : It is synthetically produce occurs in Rhombohedral form.

β-graphite : It is naturally occurs in hexagonal form.

∴ β-graphite has hexagonal carbon atoms occurs in Layers Loosely bonded by Vander walls forces

- There are –

→ sp^2 hybridization.

→ network is 2-dimensional.

→ Bond angles are 120°

→ Bond length is Intermediate b/w (C–) and C=) or Single bond and double bond.

→ Shows Resonance structure.

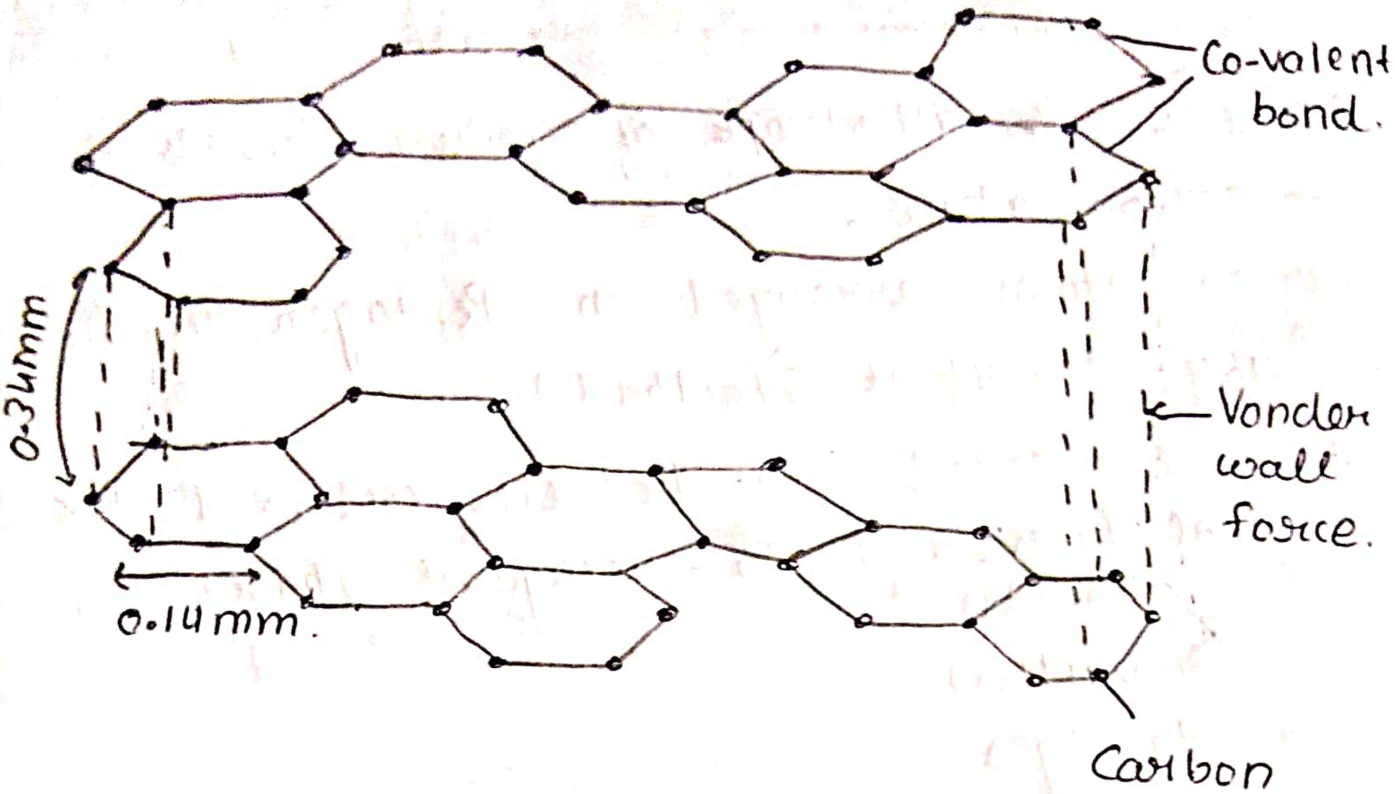
→ High Melting Point

→ Graphite is Soft and Slippery substance, Layers can slide over one another.

• APPLICATIONS / CONDUCTVITY

→ Graphite Largally used in Pencils.

→ Graphite is good conductor of heat and electricity because. Delocalization of electron form a ~~pipe~~ π- cloud, conduct electricity.



- **Structure of Graphite.**

FULLERENS:

- In 1985 Robert curl, harrold croto, Richard ~~Stanney~~ smelley discovered a new form of carbon. Known as fullerenes Or Richard Buckminster (C_{60}).
- Fullerenes occurs in three forms.

fullerenes

- Spherical fullerenes. (Bucky balls)
- Cylindrical fullerenes (Bucky tubes) (Nano tubes)
- Planner fullerenes. (Plane sheet)

• STRUCTURE OF FULLERENS

- fullerenes is Allotrope of carbon. Consists of 60 carbon atoms.
- Carbon atoms arranged in Pentagon and hexagon Like Soccerball (Football)
- it is Truncated Icosahedron - contain 12 Pentagonal ~~faces~~ Phases. and 20 - hexagonal phases
  - → 60 vertices
  - → 90 edges.
- it is ~~Sp~~ SP^2 hybridized.
- it is non-planner
- Bond angle is 101·6°
- Molecule has two bond length - hexagonal ring considered as <u>(=) double bond</u>, shorter than <u>Pentagonal bonds</u>.
- Poor electron delocalization Occurs. thus, Conductivity occurs but it behave as electron deffecient alkene..

• SYENTHESIS : It can be Synthesis by Laser ~~viprat~~ Vaporisation of Carbon in Inneret atmosphere.

- In kraitchmer Synthesis fullerenes obtained from graphite.

PROPERTIES OF FULLERENES.

- It is odourless (smelless)
- C_{60} is Black solid.
- It is Subblime at 800k.
- It is Soluble in Benzene, Toluene, and chloroform
- It occurs in hexagonal cubic Crystal form.

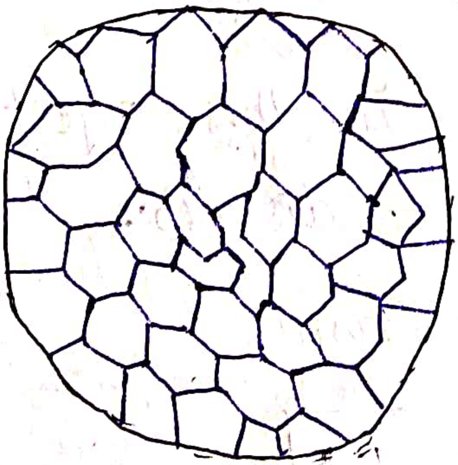
Applications of fullerenes

→ Fullerene Nanotube has greater tensile strength.
→ than other alloys

→ It have Super Conductive property. thus, it can be used → Computer Memory, electronic wire, Material Sience.

→ It is Light wated thus. It can be used in Composite → Carbon fiber, epoxy resin, golf club, Tennis racket, bicycles frame etc.

→ Due to very small Diameter of tube could leads to high conductivity, use as nanowires



Football Structure (fullerenes)

note:

Q-1 why ~~&~~ fullerenes ~~is~~ have Sp^2 hybridized ? or Conductivity in Organic compound.

Ans- ∵ Fullerenes have Sp^2 hybridized becouse. Due to delocalization of π electron.

• Point Defect Imperfection in Solids / Crystals.

note: Crystal have definite geometry of ions.

- ~~Any~~ Any deviation from the perfect atomic arrangment (geometry) in a crystal is known as Imperfection or defects.

- Point defect Occurs when one or more atoms of crystal Solid Leave their original site or foreign atom Occupy the interstitial Space of crystal.

* Types of Point defect.

- **Stoichiometric:** In this effect the ratio of units does not disturb.
- It occurs in two forms

frankel defect

Shottky defect

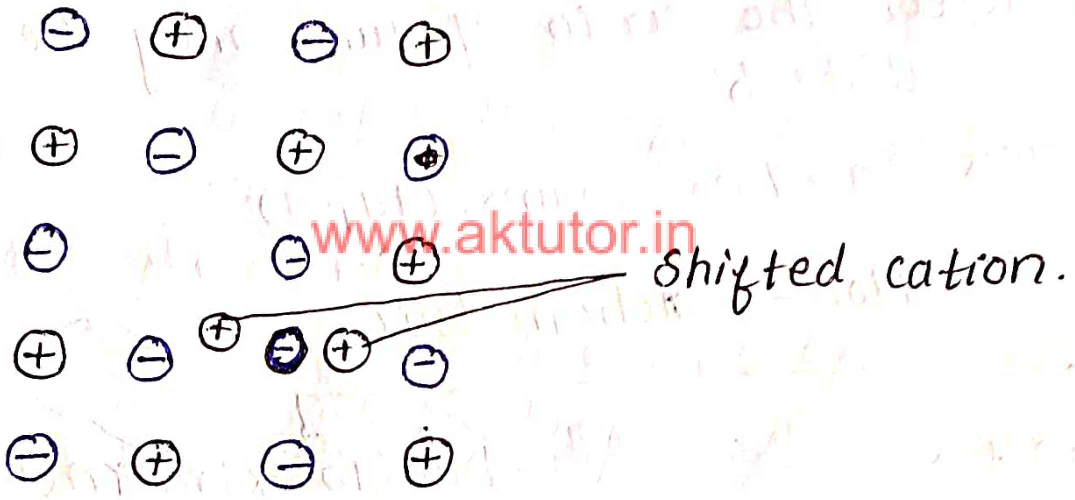
Frankel: It occurs in those ionic Solids were the size of anion is larger than size of cation.

Thus, a cation

a) Cation leave their original position. and occupies. In interstitious space of same crystal

- The overall density of the crystal remains unchanged.

Ex: ZnS (zinc sulphide), AgCl (silver chloride)

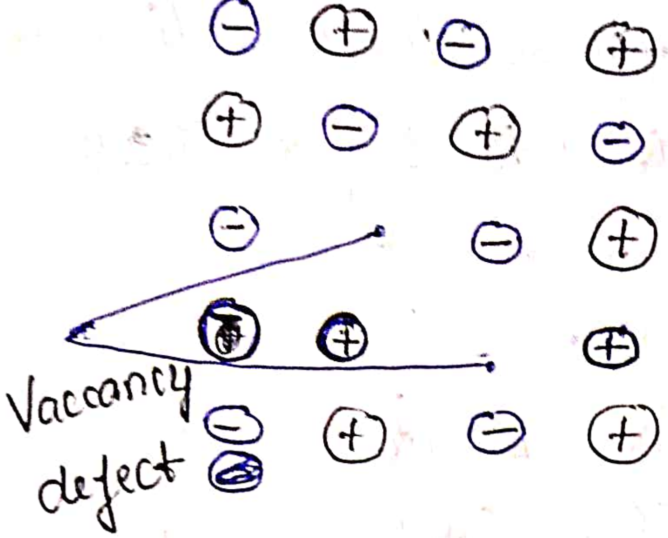


• Frankel defect

• Schottky Defect

It occurs in those ionic solid/crystal were size of anion and cation almost always same.

- In this defect both cation and anion leave their position and create Vaccancy defect.
- Thus, Overall density of crystal reduces. (decreases) e.g.→ NaCl, KCl



~~Sh~~ • Schottky defect

• Non-Strichometric Defect

- In this defect the ratio of unit may be disturb.
- It occurs in two forms. (types)

Non-Strichometric

Metal excess defect

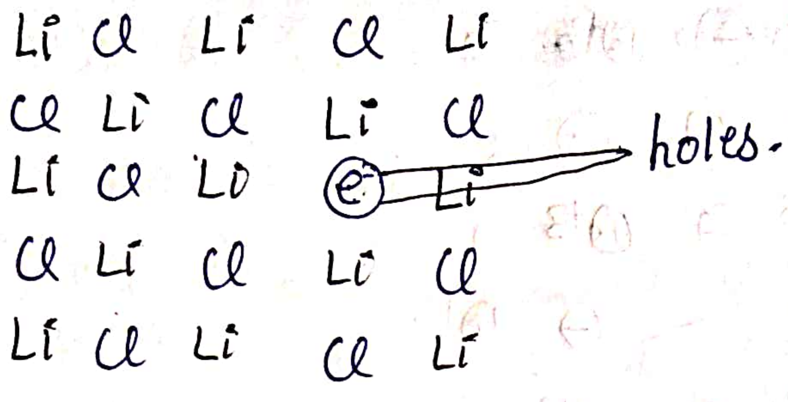
~~Due to extra cation.~~ metal Deficiency defect

• Metal Excess defect :

A.) Due to anionic Vaccancy : (i) Negative (-ve) cions, Leave holes. By missing there position In crystal.

- Eg: Excess of Lithium (Li) make LiCl crystal Pink (LiCl crystal Pink)

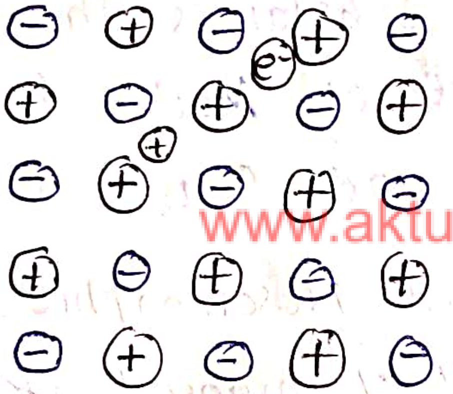
eg: Excess of Pottasium (K) makes KCl violet.



(Excess of Li)

B) <u>Due to extra cation</u>: In this defect extra cation. Occupy in Interstitial Space in these cations leave their electron behind (remove e^-)

eg: ZnO (zinc oxide)

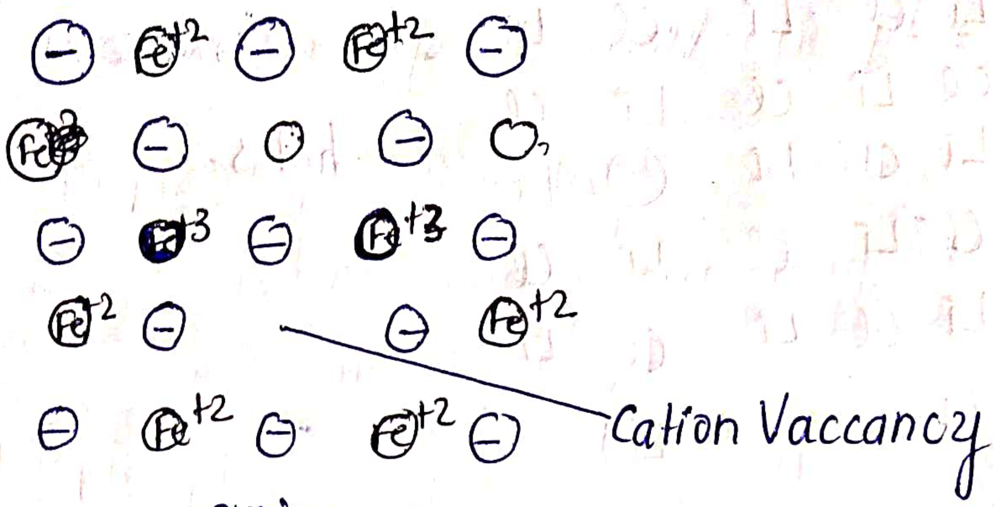


2.) **Metal Deficiency defect**: They contain less no of (+ve) ions than (-ve) Ions.

- They occurs in two forms.

A.) **Cation Vaccancy**: (+ve) ions may be missing from their ~~(+v~~ Lattice site (exact Position) and this Vaccancy balanced by near-by metal ion acquire more (+ve) charge.

- Thus, this defect Occurs In metals shows Variable Valancy.



B.) Extra ~~Cation~~ anion in interstitial Spaces

- These are rare & complicated.

Liquid Crystal

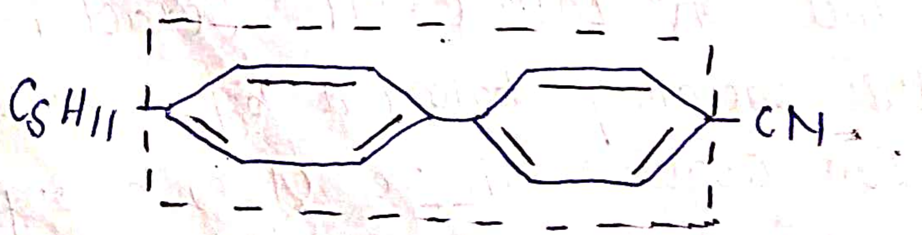
→] Liquid crystal are substances that exhibit (exact Position) a phase of Matter have Properties b/w Liquid and Crystal (solid)

→] These phases are called Mesomorphic phases.

→] Liquid crystal are made / composed of two parts → The rigid part → alligns in one direction. and Contain aromatic (hard) compound known as. Mesogen.

→ ~~Ca~~ Flexible part + A Liquid part contain. organic ions

→]



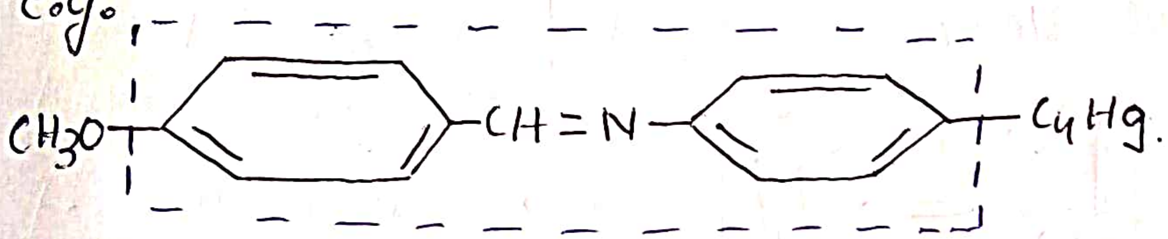
Mesogen

• Classification of Liquid Crystal.

→ On the basis of Mesogen.

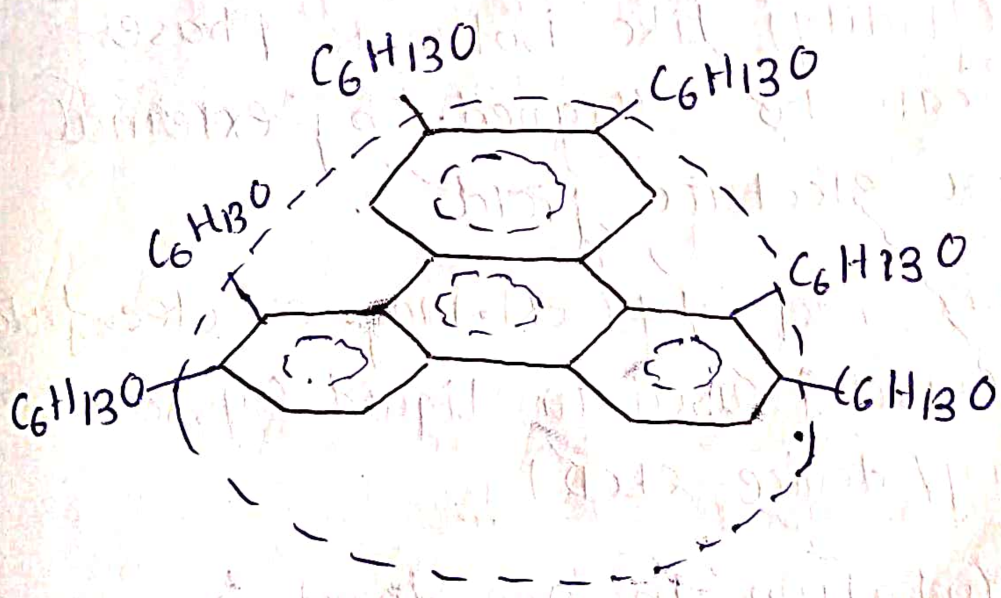
(i) **Calamitic Liquid crystal:** Mesogen is rod like structure composed of two or more Aromatic and Aliphatic rings Connected in one direction.

e.g.,



Rod like Mesogen.

(ii) **Discotic L.C** → Mesogen is flat shaped aromatic core that make molecule stack (चिपकना) in one direction.



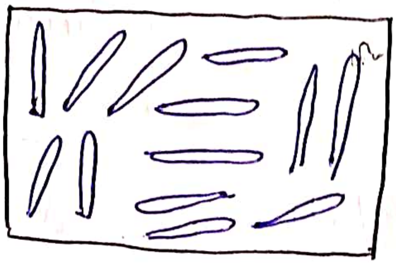
• Disc Like Mesogen

- **On the basis of Transition phase**

1.] **Theormotropic: Liquid Crystal**: Transition Occurs On the basis of change in tempreture

- Again divided in four phases.:

(A) **Isotropic phase**: Molecules Alligned randomly This phase has Low Viscosity. But it is Crystal clear.

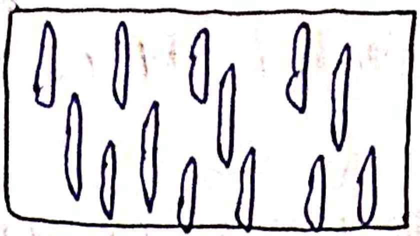


(B) **Nematic phase**: These are polarisable a rod like Organic Molecules, 20 Angestrom (20A°)

- There flow (fludity) Like isotropic phases. But they can be alligned by external magnetic or electric field.
- Due to this Property (ext. mag. or elec. field) they are widely used in Liquid Crystal display/ device (LCD)
- There Oreintation in One direction e.g. Telescope lenses

Q= ~~why~~ which Liquid Crystal used LCD.

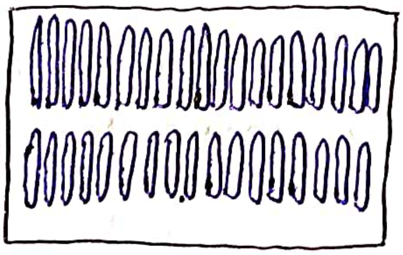
Ans= They are Polarisable. and they can alligned by ext. magn. or elect. field.



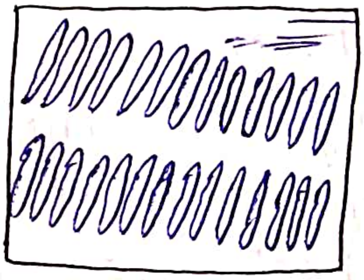
- **Smectic phase:** ~~It~~ They found at Low tempretu ~~then~~ than Nematic
- They farm layers (welldefine layers), Slide over one another. Like Soap.
- They allign in one direction But in two forms.

Smectic A → Molecule alligned prependicular. to Layers./ Planes.

Smectic C → Molecule alligned orbitrary angle (any angle) to layers/ Planes.

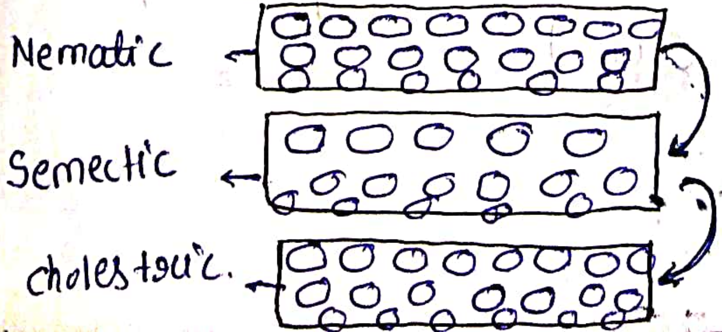


Semectic A



Semectic C

- **Chiral phase : (cholestric) :** Molecules twist (मुड़) ~~Slidely~~ Slightly from one layer to next, resulting in Spiral formation.



e.g.→ cancer cells detect
, tumer cells
, blockage in the Veins.
(thermography)

- They have no ~~and~~ oreintational order and no positional order
- They have different oreintation in each Layer
- They are changed colour with tempreture Variation.
- They are arranged in Layers.

APPLICATION OF LIQUID CRYSTAL

1.) **LCD (Liquid crystal displays)** = Orientataion of Molecule and optical properties are the features; make L.C useful in → Wrist watches, Laptop, LCD, LED, Digital calculat

LCD → react in electric field.

2.) **LC Thermometer** : chiral Nematic Liquid crystal
/In Medical
reflect light with a wave length equal to pitch. (Base).

- Pitch is depend on tempreture. change in temp. Looking by colour of thermometer.
- chiral LC is also useful in → Moodring
  - [Display acc. to mood, sad, happy etc)
  - Tumours [Tumour cells have high temp. than other cells]

3) OPTICAL IMAGING → when

Liquid crystal cells. is ~~play~~ placed b/w shells
Photoconductor, this Increases (↑) Material's
conductivity.

- Other Applications : RF → [Radio frequency]
  CAD → [Computer added drawing]
  Sensor →, Colour electronic Imaging

• UNIT-5 (GRIGNARD REAGENT
• ORGANOMETALLIC COMPOUND)

$RMgX$ ⟶ Halogen.
Allkyl.

PREPARATION: Grignard Reagent Prepared by action of activated Magnesium on. Organic halide Or Allkyl halide in Solevent like diethyl ether.

$$R-X + Mg \xrightarrow[\text{ether}]{\text{Diethyl}} \boxed{RMgX}$$

e-g:

$$\underset{\text{Methyle chloride}}{CH_3Cl} + Mg \xrightarrow[\text{ether}]{\text{Diethyl}} \underset{\text{Grignard Reagent}}{CH_3MgCl}$$

- Organometallic (Grignard) obtained by reaction of Metallic halide With Alkali metal or Other other Grignard reagent.

$$SnCl_4 \xrightarrow{RMg} SnCl_3R \xrightarrow{RMg} SnCl_2R_2 \xrightarrow{RMg} SnClR_3 \xrightarrow{RMg} SnR_4$$

(APPLICATION)/

- **(PROPERTIES):** Grignard reagent are highly basic (Bases) thus it react with Water, Acid, Alchole, gives Alkanes.

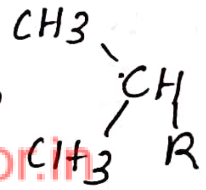
1) $RMgX + H_2O \longrightarrow RH + MgXOH$

2.) $CH_3MgCl + CH_3OH \longrightarrow CH_3CH_3 + MgClOH$

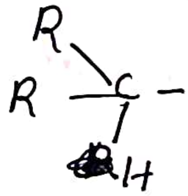
3.) $CH_3MgCl + CH_3COOH \longrightarrow CH_3COCH_3 + MgClOH$
(Acetone)

- $CH_3COCH_3 \xrightarrow{[H]} CH_3CH_2CH_3.$
Propane.

With Carbonic Compound [Aldehyde (CHO), ketone (CO)]
It form ~~Alcholes~~ Alkane.

- $HCHO + RMgX \xrightarrow{HOH} RCH_3 + MgXOH$
(farmeldehyde)
- ~~CH3CH~~ $CH_3CHO + RMgX \xrightarrow{HOH} CH_3CH_2R + MgXOH$
(Aceteldehyde)
- $CH_3COCH_3 + RMgX \xrightarrow{HOH}$  $(CH_3)_2CHR$ $+ MgXOH$
(Acetone)

- With Easter (COOR) Grignard Reagent form
Alchole.

- $RCOOR + RMgX \xrightarrow{HOH}$  $R_2C(OH)H$ $+ RMgX.$

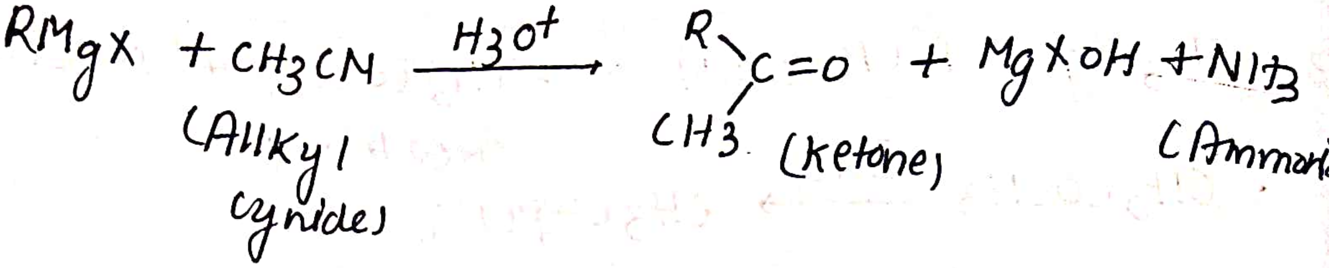
- With Carbon di-oxide Grignard reagent form
Acid.

$CH_3MgCl + CO_2 \xrightarrow[\text{(hydronium ionide)}]{H_3O^+} CH_3COOH + MgClOH$
(Methyl Magnesium Chloride) (Acetic Acid)

- With chloramine Grignard reagent it form.
allkyl amine.

$RMgX + NH_2Cl \longrightarrow R\text{-}NH_2 + MgXCl$
(Chloraamine) (Allkyl Amine)

- With alkyl cynide (R-CN) Grignard reagent form ketone (CO) and Ammonia (NH_3)

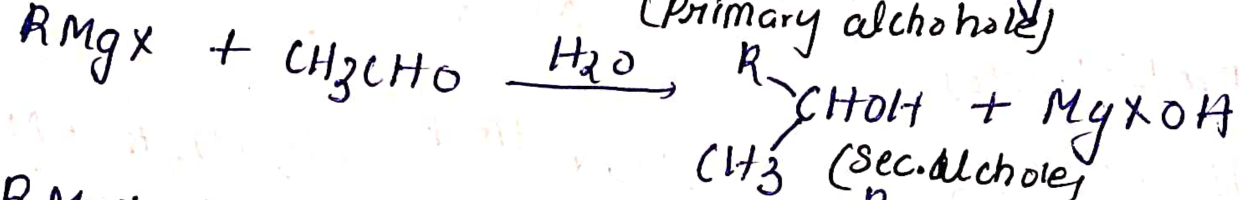


$$RMgX + CH_3CN \xrightarrow{H_3O^+} \underset{CH_3}{\overset{R}{>}}C{=}O + MgXOH + NH_3$$

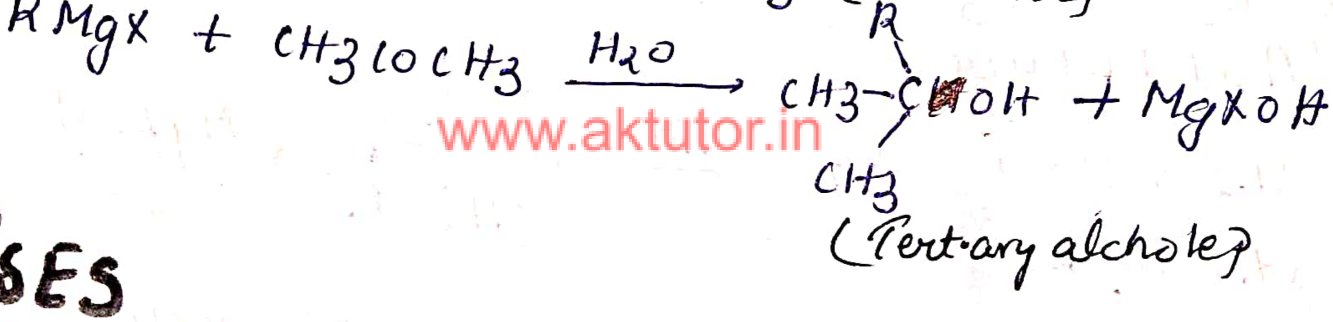
(Alkyl cynides) (ketone) (Ammoni

- **Reaction of Grignard Reagent with carbonyl compound** they form Alcholes

- $RMgX + HCHO \xrightarrow{H_2O} RCH_2OH + MgXOH$
(Primary alchohole)



- $RMgX + CH_3CHO \xrightarrow{H_2O} \underset{CH_3}{\overset{R}{>}}CHOH + MgXOH$
(Sec. Alchole)



- $RMgX + CH_3COCH_3 \xrightarrow{H_2O} CH_3-\underset{CH_3}{\overset{R}{C}}OH + MgXOH$
(Tertiary alchole)

•USES

- Grignard reagent react with halide phosphate form alkyl phosphate & Uses in Vitamin Synthesis.

$$PCl_3 \xrightarrow{RMgX} R_3P.$$

(halide Phosphate) Alkyl phosphate [vitamin synthesis].

Polymer:

• CLASSFICATION OF POLYMER

On the basis of
- Chemical Structure.
- Polymer structure.
- Tacticity
- Termal behaviour
- Arrangement of Monomers
- Existence

Chemical Structure
- Homo polymer e.g: PE
- Co-Polymer e.g: PS ~~PVC~~

Polymer Structure
- Linear eg. PE
- Branched e.g. PS
- Cross Linked. e.g. Bakelite

Tacticity
- Atactic eg. PS
- Isotacatic e.g: PolyProplene
- Syndio tactic. e.g: Guttaparcha

Thermal Behaviour
- Thermosetting eg: PVC, Teflon
- Thermoplastic eg: PE

Arrangement of Monomers:
- Block Polymer eg. PMMA
- Graft Polymer eg. PET

Existence
- Fibre eg. Nylon
- Elastomer eg. Rubber
- Plastic eg. PVC

- Polymer can classified in Various groups.
- On the basis of chemical Structure:
- **Homopolymer:** Polymer consist of Identical / Same monomers. Known as. Homopolymer. ex: Polyethylene (PE)
- **Co-Polymer:** Polymer is a mixture of more than one type of monomer. is known as co polymer or ~~hetro polymer~~. ex: ~~PVC (Poly Vinyl chloride)~~, Polystyrene. (PS).

On the basis of Polymer structure:

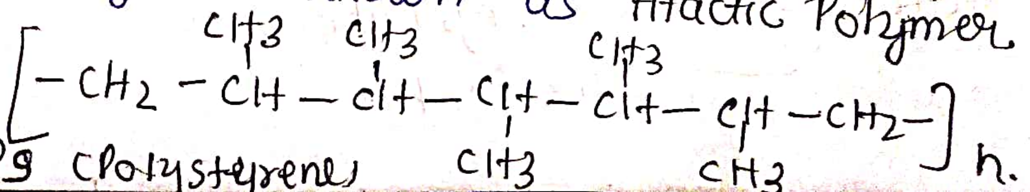
- **LINEAR:** Monomers attached in. Linear manner, known as Linear Polymer. e.g. PE (Polyethylene)

- **BRANCH:** Monomers attached in Linear manner but they have Some branches. eg. PVC, PS (Polystyrene, Poly vinyl chloride)
- They have three dimensional
- **CROSS LINKED:** They have 3-Dimensional network. eg: Bakelite.

On the Basis Of Tacticity:

- **Atactic:** When in polymer side groups arrange In. irregular Or random manner (randomly) # known as Atactic Polymer

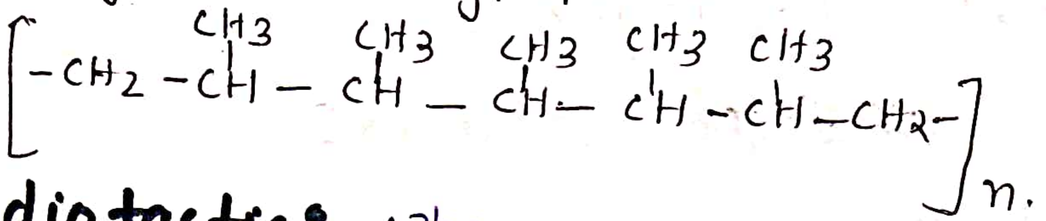
e.g:



$$\left[-CH_2-\overset{CH_3}{CH}-\overset{CH_3}{CH}-\underset{CH_3}{CH}-\overset{CH_3}{CH}-\underset{CH_3}{CH}-CH_2-\right]_n$$

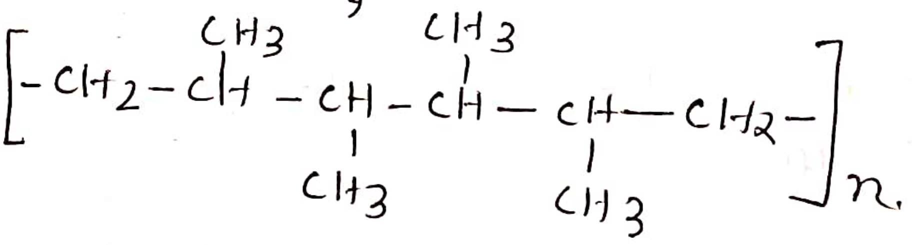
eg: PS (Polystyrene)

Isotactic: when in polymer side groups arrange in same side of chain is known as Isotactic Polymer. ex: Polypropelene



$$\left[-CH_2-\overset{CH_3}{CH}-\overset{CH_3}{CH}-\overset{CH_3}{CH}-\overset{CH_3}{CH}-\overset{CH_3}{CH}-CH_2-\right]_n$$

-Syndiotactic: when an polymer side groups are arrange in alternate manner. is known as Syndiotactic. Polymer
ex: Gutta parcha.



$$\left[-CH_2-\overset{CH_3}{CH}-\underset{CH_3}{CH}-\overset{CH_3}{CH}-\underset{CH_3}{CH}-CH_2-\right]_n$$

On the basis of thermal Behaviour:

- **THERMOSETING:** These polymers cannot be reshaped or ~~molded~~ mulded (melt) ~~becouse~~ on heating becouse they have ~~a~~ 3-Dimensional cross-linked network.
- They are hard strong and brittle.
- They cannot be re-used from waste becouse they retain their shape and structure.
- They are insoluble in organic Solvents

ex: PVC, Teflon

- **THERMOPLASTIC:** These polymers can be reshaped or remulded on heating becouse they are long chain linear polymers
- They are weak, soft and less brittle.

- They can be reused. (recycle) from waste.
- They are soluble in organic solvent.

  eg: PE, PVC, PS, Polypropylene.

• On the basis of Monomer:

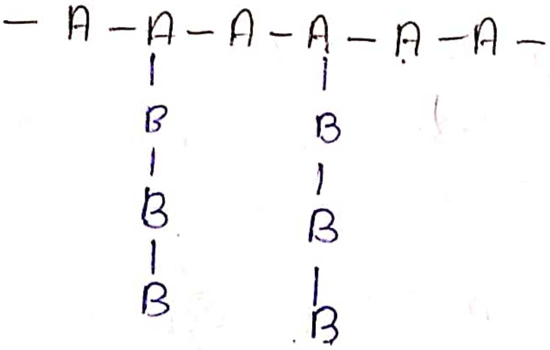
- BLOCK POLYMER: LINEAR Polymers in which identical units occurs in long sequences known as Block Polymer. or Block co-Polymers.

  —A—A—A—B—B—B—B—A—A—A—

- eg: PMMA

- Graft Polymer: These are branched co-polymers in which back bone is form from one type of monomer and branches from other. i.e. Back bone & branches have different monomers.

  e.g: PET



• On the Basis Of Existence.

- ~~Fibres~~ ~~Rubber~~:
- Elastomers: These are the polymers are capable of being stretched at least 150% of original length without breaking and Return to

there original shape. on release of stress.
ex: Rubber,

PLASTIC: Plastic these are the materials Occurs in the form of resin molecules. These are synthesized materials occurs in different forms as Thermosetting, Thermoplastic.

Fibre: A thread from which a tissue, mineral substance or textile is formed.
ex:

• POLYMERISATION

This is the Process of attachement of one or more than one identical units in repeating manner. As a result of this process heavy molecule (macro-molecule) ~~Produce~~ form ~~to~~ heavy moleculer weight greater than 10,000 known as polymer..

- This repeating units are monomers.

DEGREE OF POLYMERISATION: The no of repeating Units in polymer is Degree of Polymerisation.

- Polymer have high degree of polymerisation, known as ~~poly~~ high polymer.
- Polymer have low degree of polymerisation, known as oligo polymer.

- **FUNCTIONALITY:** it represents Reactive sites of polymer.
- it should be at least 2. (two) sites.
- functional group, Multiple bond (double bond), Lone pair make reactive sites
- On the basis of functionality: molecules are Bifunctional and Polyfunctional

$$\underset{\substack{\text{ethene} \\ \text{(Bifunctional)}}}{CH_2=CH_2} \longrightarrow \underset{\text{Polyethene}}{[-CH_2-CH_2-]_n}$$

• TYPES OF POLYMERISATION

- **ADDITIONAL POLYMERISATION (CHAIN POLYMERISATION):** This process Occurs Via (के द्वारा) self Addition of monomers without any loss. ex:

$$\underset{\text{ethene}}{CH_2=CH_2} \longrightarrow \underset{\text{(Polyethene)}}{[-CH_2-CH_2-]_n}$$

MECHANISM OF ADDITION POLYMERIZATION

: Occurs in three Steps:

- Initiation: $R-R \xrightarrow{h\nu} 2R^{\bullet}$

free Radical $R^{\bullet} + CH_2=CH_2 \longrightarrow R-CH_2-\dot{C}H_2$

- Propagation:

$$R-CH_2-CH_2^{\bullet} + CH_2=CH_2 \rightarrow R-CH_2-CH_2CH_2-\dot{C}H_2$$

. Termination ⇒

$$R-CH_2-CH_2-CH_2-CH_2+R^{\circ} \longrightarrow R-CH_2-CH_2-CH_2-CH_2-R$$

Or

$$n[R-CH_2-CH_2-CH_2-\dot{C}H_2] \longrightarrow R-[CH_2-CH_2-CH_2-CH_2-R]_n$$

CONDENSATION POLYMERISATION:

CONDENSATION POLYMERISATION: This polymerization Occurs with elimination of Some small molecules like H_2O and NH_3 (Ammonia) etc

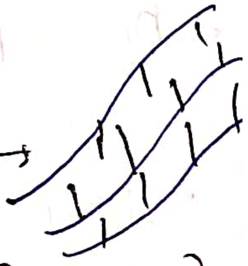
ex → Formation of Nylon-6,6

POLYETHENE:

- **PREPARATION:** It is prepared as :-

$$nCH_2=CH_2 \xrightarrow[1000\,Atm/350^{\circ}C]{free\ radical} [-CH_2-CH_2-]_n \longrightarrow$$

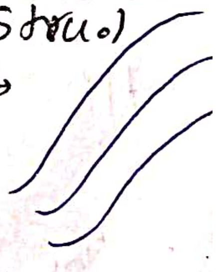
LDPE
(Low Density Polythene) (Branched Struc.)



$$\xrightarrow{7atm/100^{\circ}C/(Et)_3Al + TiCl_4} [-CH_2-CH_2-]_n \longrightarrow$$

(Et → Ethyl)

HDPE
High density Polythene.



(Linear Structure)

- **PROPERTIES:**

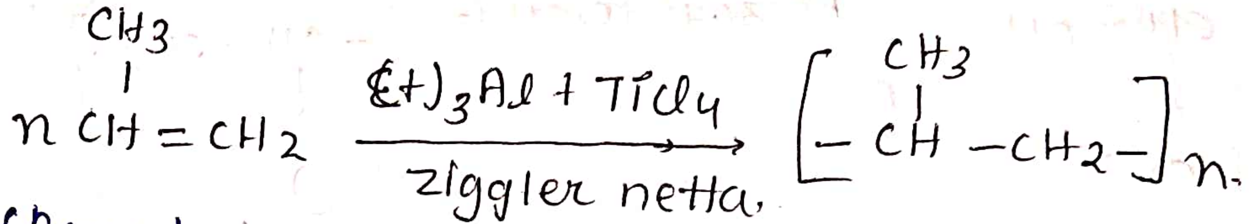
LDPE (Low Density Polythene): They have low density. (0.91g/cm³)

- They are 50% crystalline.
- They are transparent polymer.
- They are chemically inert (react not)
- They are poor electrical conductor.
- They are moisture resistant.

- HDPE: (High density Polythene): • They have high density (0.965 g/cm^3) • They have high tensile Strength.
- They are chemically resistant.
- They have low gas and water permeability
- They are insulator.
- They are 90% crystalline.
- Uses:
- LDPE: ~~There~~ Their films use for packing and WRapping. frozen foods.
- Due to poor conductivity they are use ~~for~~ as Insulation of electric wire and cables.
- Due to chemical resistant they are use in. Squeeze bottles.
- They are use for making pipe ~~of~~ for agriculture and chemical plants.
- HDPE: Use in toys, caps, buckets, due ~~to~~ to its toughness.
- Use for domestic gas piping. Due to low Permeability.
- Use in manufacture of water tank.
- Use ~~in~~ for manufacturing of bottles for mik, and housholds chemical.
- Use for drug packaging..

POLYPROPYLENE:

PREPARATION: It is prepared by polymerizing ~~in~~ ~~Poly~~ proprylene. in presence of ziggler -Netta



$$n\,\overset{CH_3}{\overset{|}{CH}}=CH_2 \xrightarrow[\text{ziggler netta,}]{(Et)_3Al + TiCl_4} \left[-\overset{CH_3}{\overset{|}{CH}}-CH_2-\right]_n$$

(Propylene)

(Polyproplene)

PROPERTIES: it is is isotactic polymer.. (I.P.P).

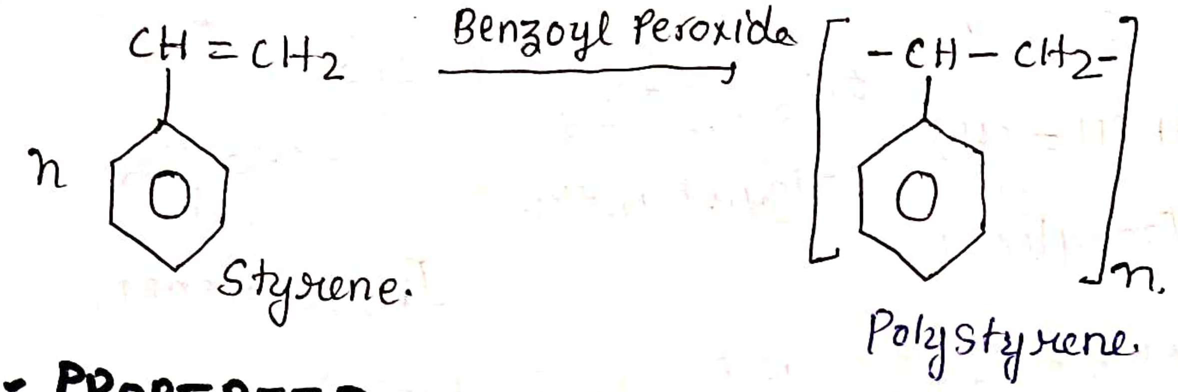
- Melting Point 170°C.
- it is highly stiff (hard)
- ~~M~~ it is moisture resistant

APPLICATION:

- Due to high melting point it can be. steam ([illegible] sterlized. thus used in Babby bottles.
- Due to high tensile strength use in making Robes & filaments.
- Use in the prepreation for textile machinary parts.
- Due to high clearity (transperency) use in Wrapping bread and biscuits (confectionary items)

• POLY-STYRENE :

PREPARATION: it is prepared by Polymerisation of styrene in presence of Benzyl Peroxide.



• PROPERTIES

- it is transparent. it cannot be sterlized in Steam
- Resistant to alkalis, Acid, oxidizing agent, and Reducing agent

- High moisturing resistant
- it is insulator. it can be dyed (colours)
- it have property of transmitting light of all wave length.

• Application (USES)

- In the ~~mois~~ manufacturing of foam for packing materials.
- EPS (Expandable Polystyrene) is used in disposles.
- HIPS (highly impact Polystyrene) and SBR used in door liners and inner linners of refrigerator
- Preparing Synthetic ion exchange resin.

- In the formation of Jar, bottle, comb, Brush, handle, Radio, hand telvision cabinate.

• POLYVINYL CHLORIDE [PVC]:

- it can be prepared by polymerization of Vinyl chloride in presence of Benzoyl Peroxide

$$n\,\overset{Cl}{\overset{|}{C}}H=CH_2 \xrightarrow[\text{Peroxide}]{\text{Benzoyl}} \left[-\overset{Cl}{\overset{|}{C}}H-CH_2-\right]_n.$$

Vinyl chloride.

PROPERTIES

- It is Low crystalline
- It degrade (decomposition) at 200°c
- It is water proof and washable.
- It is Lighter than glass.
- it is moisture resistant, inpremeable;
- it is insulator.

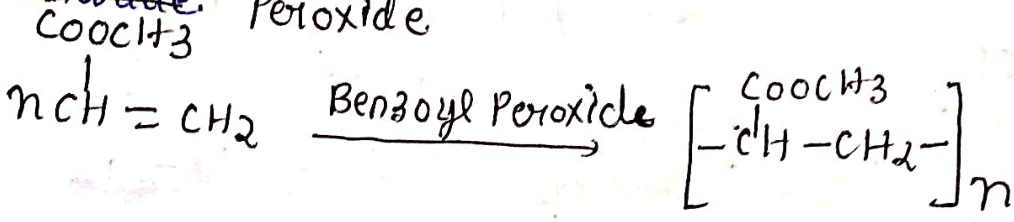
USES:

- **Rigid PVC USED in** → Tank Linings., Saftey helmet, mutguard, Window frame, Container for cosmetics., mineral water.
- Due to oil resistant property use for storing edible oil.

- **PLASTICIZED PVC Use in:** Bathroom ~~[illegible]~~ curtain, hand bag, Insulating material, Transparent vehicle's ~~Sheets~~ Seats, Membrane Sepration technology.

• Polyvinyl Acetate

PREPARATION: it can be prepared by polymerization of vinyl Acetate in presence of benzoyl ~~Chloride.~~ Peroxide



$$n\,\overset{COOCH_3}{\overset{|}{C}H}=CH_2 \xrightarrow{\text{Benzoyl Peroxide}} \left[-\overset{COOCH_3}{\overset{|}{C}H}-CH_2-\right]_n$$

PVA

PROPERTIES:

- It is Solid and clear resin
- It is Soft, sticky materials
- Not absorb by digestive system.
- Resistant to air, water, chemicals.

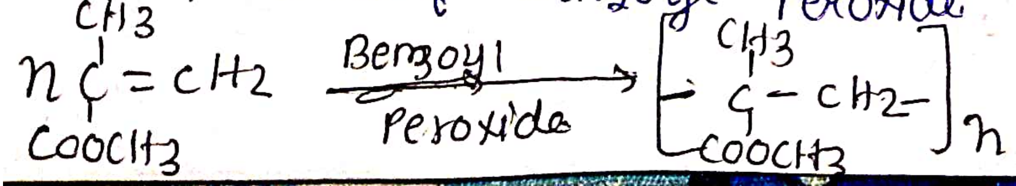
USES:

- its Used as adhesive. in textile leather, Paper Industry.

- Use as a basic material for ~~chin~~ chewing gums
- finishing of Textile fabric's
- Preparation of polyvinyl alchole.
- Surgical dressing
- In the Polyvinyl butyral, used in Laminating Saftey glass.

POLYMETHYL METHA ACRYLATE [PMMA]

PREPARATION: It is prepared by Polymerization of ~~methyl~~ methyl metha Acrylate in presence of Benzoyl Peroxide



$$n\,\underset{COOCH_3}{\overset{CH_3}{\overset{|}{C}}}=CH_2 \xrightarrow[\text{Peroxide}]{\text{Benzoyl}} \left[-\underset{COOCH_3}{\overset{CH_3}{\overset{|}{C}}}-CH_2-\right]_n$$

PROPERTIES

- Amorphous in nature.
- Optical transperency.
- Good mechanical properties.
- High chemical resistance but low resistant to acids and alkalie's.

USES

- Alternate of glass.
- making contact lenses.
- Bath tub making, in making Tv screen, Artifidial eyes, jwellery

TEFLON: (Polytetra Fluro Ethylene)

~~it~~ **PREPARATION:** It is prepared by Polymerization of tetra fluro ethylene in presence of Benzoyle peroxide.

$$n\,CF_2 = CF_2 \xrightarrow[\text{Peroxide}]{\text{Benzoyl}} \left[-CF_2-CF_2-\right]_n$$

TFE Teflon

PROPERTIES

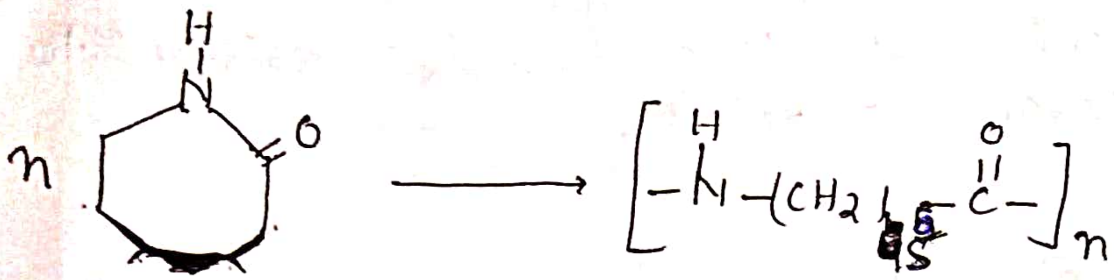
- Highly crystalline
- Highly tuff
- Dense polymer.
- chemicaley inert
- Slippery and Vaxy. (चिकना)

USES

- Non stick cookware (pots)
- Gas~~get~~cats chemicalk pipe, belt, cablewire, Transformers

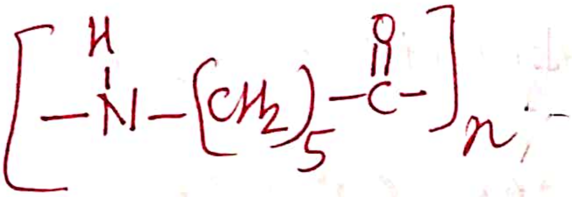
POLYAMIDE :-

NYLON-6 : It is prepared by polymerization of caprolactum.



Caprolactum

Nylon-6, [Perlon]



$$\left[-\overset{H}{N}-(CH_2)_5-\overset{O}{\overset{\|}{C}}-\right]_n$$

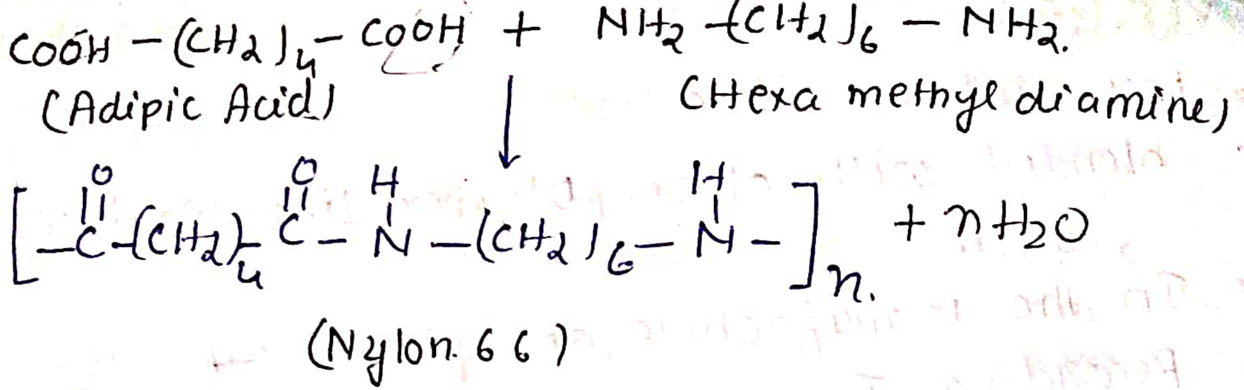
PROPERTIES:

- High Elastic.
- Highly tuff. (Tough
- ~~where~~ very ~~&~~ flexible
- Due to presence of hydrogen bonding its is Water Senstive (reactive).

USES:

- Use as a fiber in rope, thread, dresses, shoks
- ~~Paracsut~~ Parasuits fabric.
- Due to ~~biogo~~ biological resistant used for make insects screen.
- Nylon have high melting point is known as. Kevlar.

NYLON-66 : It is prepared by Poly condensention ~~polymerization~~ of Adipic acid and Hexamethyl diamine.



$$COOH-(CH_2)_4-COOH + NH_2-(CH_2)_6-NH_2 \rightarrow \left[-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-\overset{H}{\overset{|}{N}}-(CH_2)_6-\overset{H}{\overset{|}{N}}-\right]_n + nH_2O$$

(Nylon 6 6)

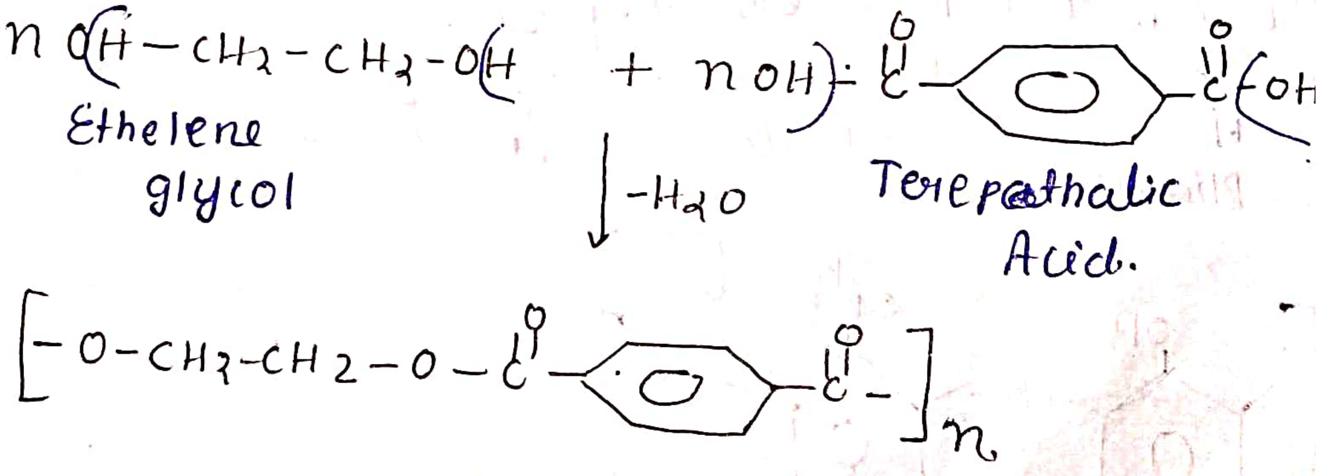
- **~~Us~~ PROPERTIES:** Same as nylon 6
- **USES:** Same as nylon-6, 6

• TERYLENE OR DECRON [PET]

(PET→ Poly ~~Easter~~ Ethelene Terepthalate)

[Thermosetting → Ex: Polyeaster]

- It is prepared by condensention polymerization of Ethelene glycol & Terepathalic acid.



PET

• PROPERTIES

- Presence of polar groups
- good Mechanical strength
- Resistant to insect Attack
- Wrinkles resistant
- Oxidant Resistant

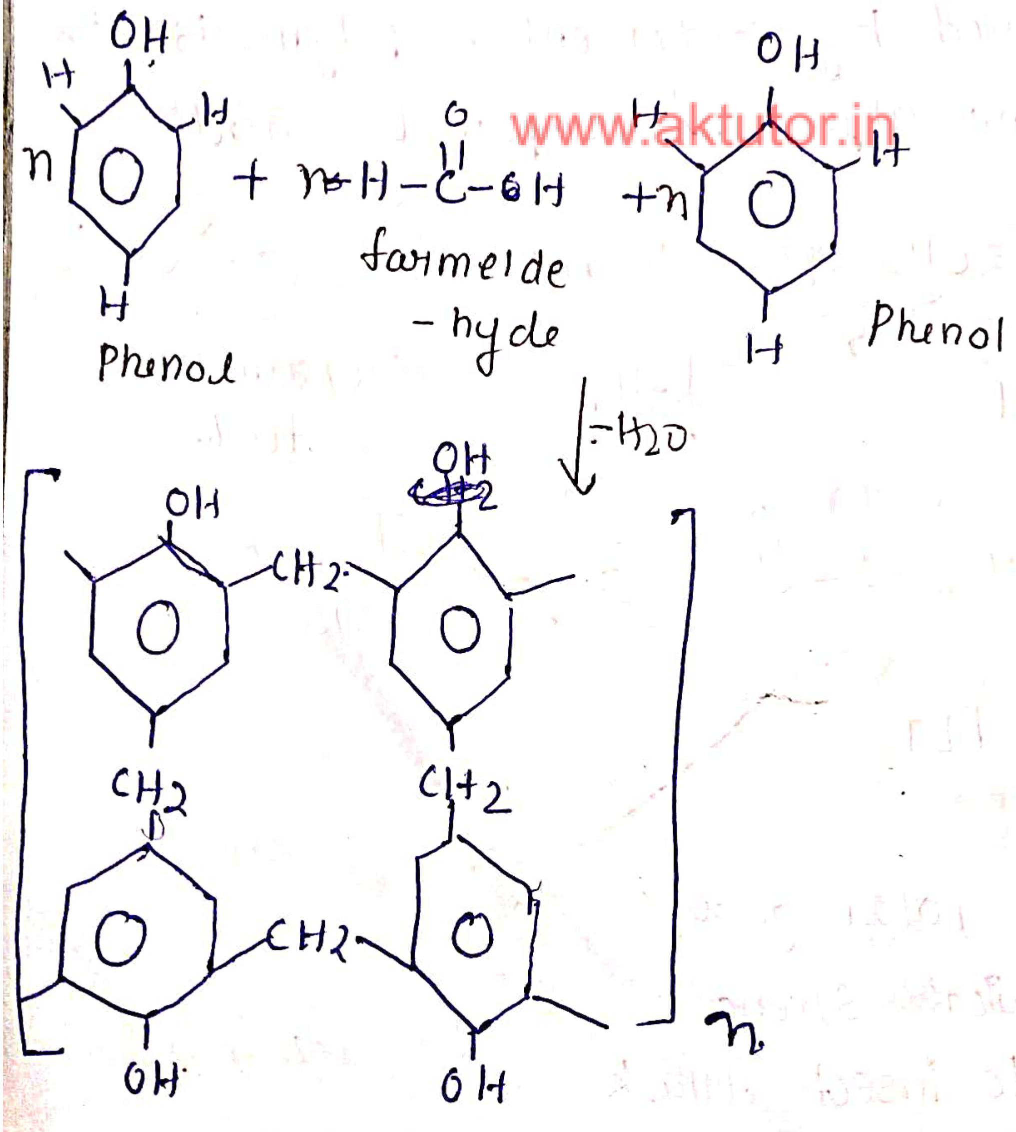
• USES

- For making fibre
- blended with other polymer like ~~wood~~ wool, cotton
- In the manufacture of plastic ~~bot~~ bottle
- Recording Tape
- In cofee machines, car heater, toaster.

• BAKELITE

• (Phenol formeldehyde Resign)

Preparation: it is prepared by condensention polymerisation of phenol and formeldehyde.



Bekelite

PROPERTY

- High resistant to electricity, resistant to chemical
- High ~~den~~ dimensional stability.
- Good dielectric properties.
- Excellent adhesive properties, and bonding strength
- it is scretch resistant.

• USES

- Uses in Automobiles
- Uses in Electrical Appliances
- Used in Space shuttle.
- Telephone parts.
- Switches, Plug, switch board, handle, paints.etc.

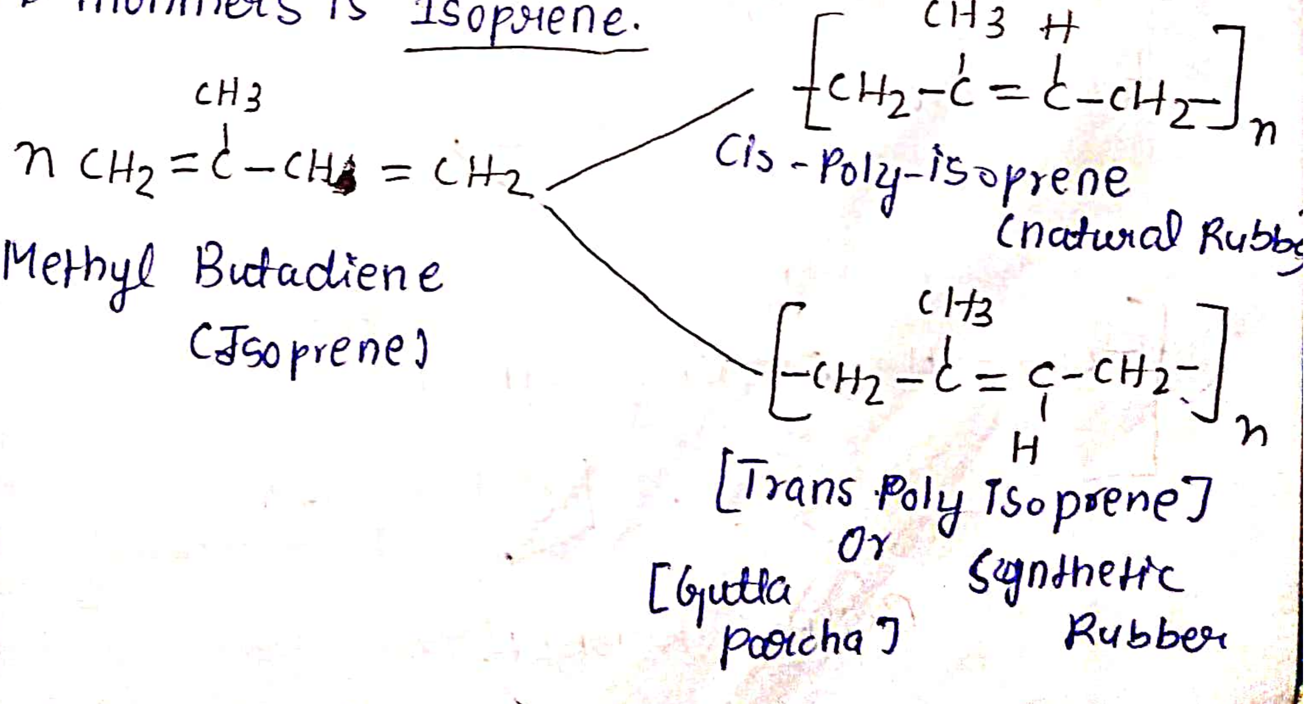
RUBBER

- It occurs in two forms.

natural

Synthetic

- It ~~s~~ monmers is Isoprene.



$$n\,CH_2=\overset{CH_3}{C}-CH=CH_2$$

Methyl Butadiene (Isoprene)

$$\left[-CH_2-\overset{CH_3}{C}=\overset{H}{C}-CH_2-\right]_n$$

Cis-Poly-isoprene (natural Rubb

$$\left[-CH_2-\overset{CH_3}{C}=\underset{H}{C}-CH_2-\right]_n$$

[Trans Poly Isoprene] Or [Gutta parcha] Synthetic Rubber

• Vulcanisation of Rubber:

The Introduction of sulphur links in polymer chain is known as Vulcanization of Rubber.

Advantages/ Benefits of Vulcanisation: It Stopped / ~~RS~~ Restrict the intermolecular movement and increase → tensile strength.,

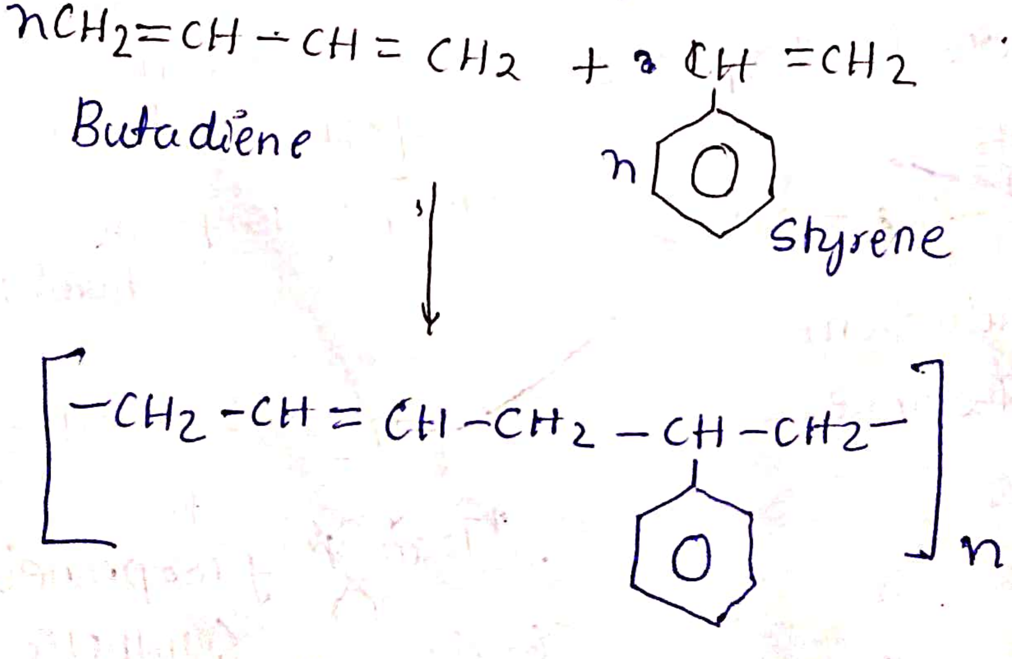
- → stiffness,
- → Water absorption capicity
- → Insulation
- → Elasticity

• TYPES OF SYNTHETIC RUBBER

1) SBR or BUNA-S-RUBBER:

(Styrene Butadiene Rubber)

Preparation: it is prepared by polymerisation of Butadiene and Styrene.

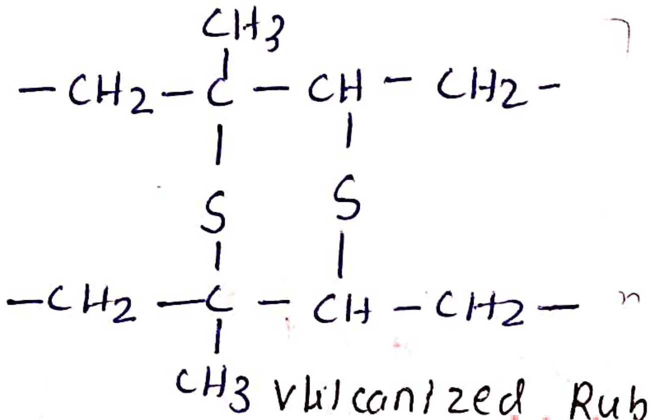


BUNA-S-RUBBER

Properties

- It swell (फूलना) in oil
- It is frictionless / ~~Ar~~ Abrasionless.
- It have load bearing capicity
- Easily oxidize in ozone atmosphere.

↘ Vulcanization of Rubber

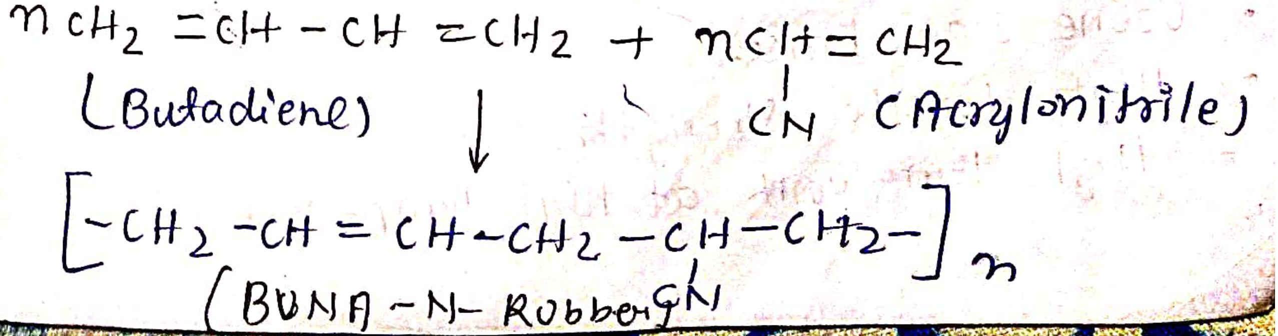


Vulcanized Rubber

- USES
- Uses in Manufacturing of tyre, shoe shoes,
  - → floor tiles
  - → Tank Liming
  - → Insulation.

(2). BUNA-N-RUBBER OR NBR (Nutrile Butadiene Rubber)

- it is prepared by polymerisation of Butadiene and acrylonitrile.



$$n\,CH_2=CH-CH=CH_2 + n\,\underset{\displaystyle CN}{\underset{|}{CH}}=CH_2 \;\downarrow\; \left[-CH_2-CH=CH-CH_2-\underset{\displaystyle CN}{\underset{|}{CH}}-CH_2-\right]_n$$

(Butadiene) (Acrylonitrile)

(BUNA-N-Rubber)

PROPERTIES

- Oil Resistance
- Sunlight Resistance
- High tensile strength.
- friction resistance. ~~ffri~~

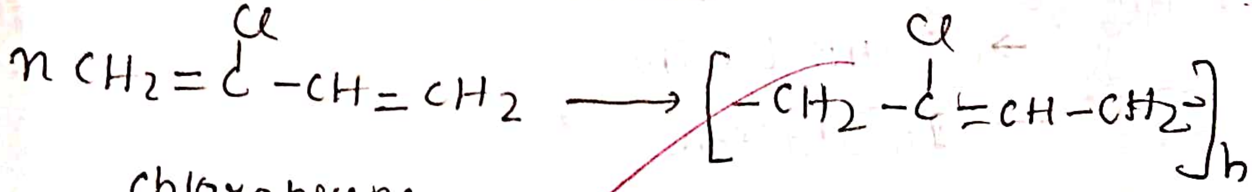
USES:-

- Used in ~~fuel~~ fuel tank.
- priting roller.
- Aircraft
- Anti-freeze
- Textile and leather
- Blend component.

Polychloroprene or Duprene

- Neoprene or ~~Duprene~~ or Polychlorobutadiene

Prepared: it is prepared by polymerisation of chloro butadience.



$$n\,CH_2=\overset{Cl}{\overset{|}{C}}-CH=CH_2 \longrightarrow \left[-CH_2-\overset{Cl}{\overset{|}{C}}=CH-CH_2-\right]_n$$

chloroprene.

Neoprene

[Polychloroprene]

Properties: Vegetable and mineral oil resistance

- Soluble in polar Solvent.
- Ozone resistance.
- High tensile strength.
- ~~High tem~~ Work at high temp. concern.

USES: cable coating.

- gloves and fabric manfacture.
- ~~sponzes~~ sponges and belt manfacturing
- Tube for carrying oil

Conducting Polymer

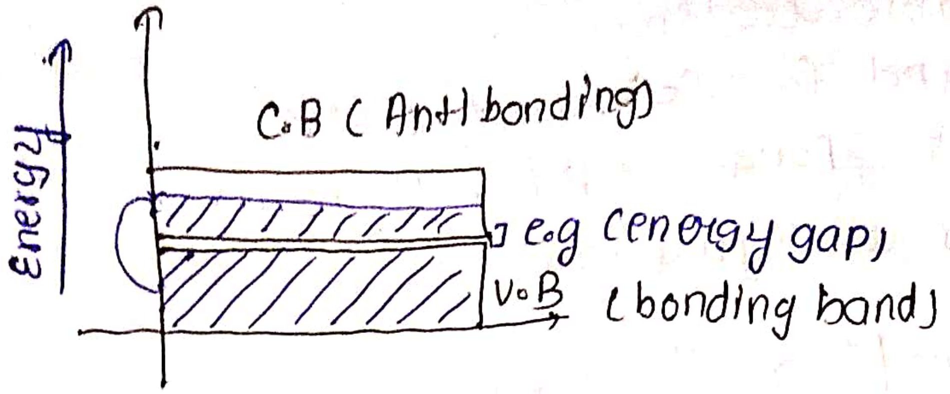
Polymers are insulators. But In Some Conditions they conduct electricity. known as Conducting polymers. "Thus Conducting polymers are conjugated π e^- system. along the polymer chain. Or Ring Structure"

Ex: PolyAcetelene, Polypyrol, PolyAnelene.

- The Process of transforming Polymer To conductiv form ~~the~~ Occurs Via chemical oxidation ~~and~~ Or reduction. (Doping)

CLASSFICATION / TYPES OF POLYMER
CONDUCTING

- Conjugated π electron Conducting Polymer: The Orbitals of Conjugated π electrons Overlapped the entire backbone of Polymer, form Valance band and Conduction band.
- Highest Occupied band is Valance band.
- Lowest Unoccupied band is Conduction band.
- Some gap occurs b/w Valance band and conduction band is known as energy gap



- In electric field conjugated π-electron excited and get sufficient energy to jump the gap. ex: PolyAcetelene., PolyAnelene.

$$n\,CH \equiv CH \longrightarrow [-CH=CH-]_n$$

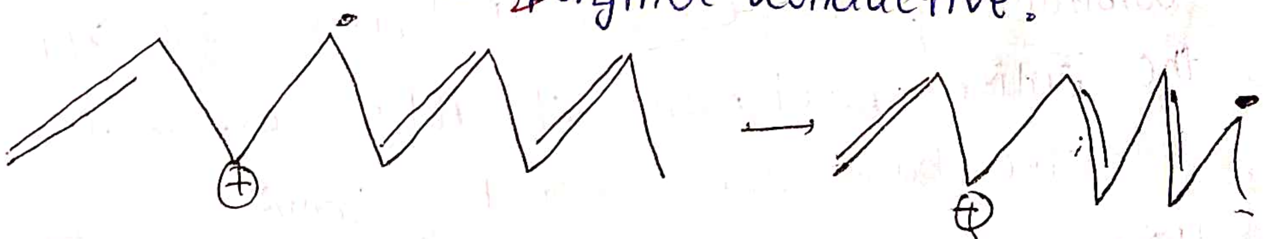
Acetelne PolyAcetelene

- **DOPED CONDUCTING POLYMER**

- ~~Conductivity~~ Conductivity of polymer highly increase 10^7 to 10^{12} times in Alkali metal through doping

- Doping carried out (occurs) in two methods:

(i) Oxidation: Oxidation Remove e⁻ creates holes. They can move along the molecule, make polymer conductive.



PolyAcetelene.

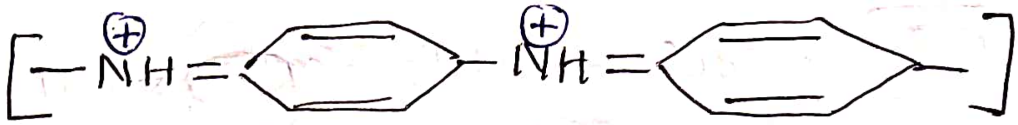
~~PolyAcetel.~~ Polaron

- **REDUCTION**

- This Process carried out (occurs) by adding Lewis Base they have high e⁻ affinity.
(इलेक्ट्रान बाहरी कोष मे इलेक्ट्रान प्रवेश कराने की energy)

Ex: ClO_4, B in polypyrol - (Adding reaction)

2) Poly Aniline



~~APPLICATIO~~N

3.) Carbon black. Mettalic Fiber Metal oxide.

4) Blended conducting Polymer.

APPLICATION

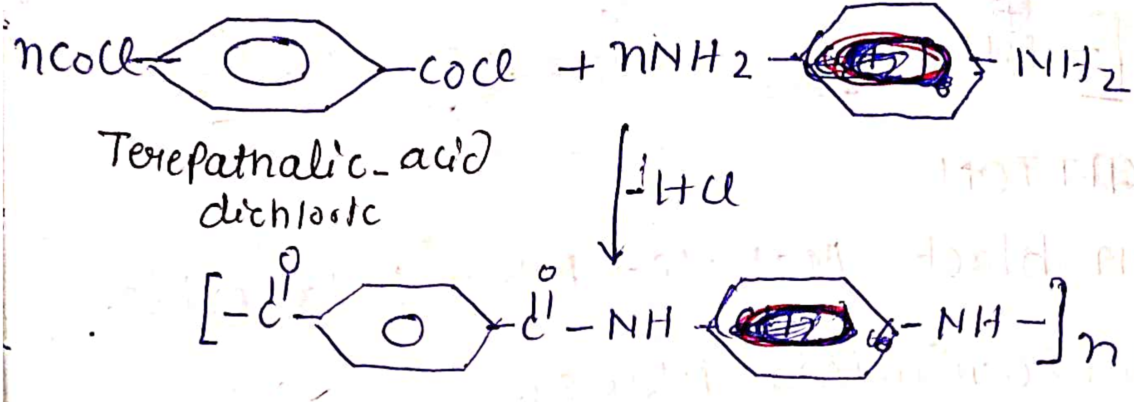
- These are Lighter, Flexible, than other polymers.
- Thus they are use as
  - → Rechargeable battriess.
  - → Smart window
  - → Analytical sensors
  - → Light Emitting Diode.
  - → Photo Voltaic devices.
  - → Electroluminisence
  - → Electrochromic display.

• BIODEGRADEABLE POLYMER

: BIO PLASTICS, BIO POLYMERS.

1

·KEVLAR



Kevlar

BIODEGRADEABLE POLYMER

, BIOPLASTICS , BIOPOLYMER

- Biodegradation is a chemical degradation of materials by the action of microOrganisms like, Backteria, virus, fungi, etc.

- Thus Biodegradeble polymer can be broken -down by nature By hydrolytic Process or Enzymatic Process. Produce non-toxic products.
- These polymers can be Synthetic ~~and~~ or natural.

NATURAL POLYMER

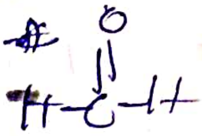
- Natural polymer are available in hugh quantity from Renewable. Sources.

SYNTHETIC POLYMER

- Synthetic Polymers produce from non Renewable Petroleum Sources.

- Biopolymers, polysacride, starch, cellulose, proteins, lipids, polyesters, are the example of natural or Agro-polymers
- Alliphatic polyestors., PHB, PLA, PCL, PHBV are the example of synthetic polymer.

HCHO



• PROCESS / MECHANISM OF BIO DEGRADATION POLYMER

- Occurs in two steps.

(i) <u>Foregmentation of Polymer</u>: Occurs by the Process of A-Biotic, or Biotic reaction.

(ii) <u>Bioassimilation of Polymer</u>: occurs by Microorganisms convert in minerals.

<u>Aerobic oxidation</u>:

$$\text{Polymer} + O_2 \longrightarrow CO_2 + H_2O + \text{Residue}$$

<u>Anaerobic oxidation</u>.

$$\text{Polymer} \longrightarrow CH_4 + H_2O + \text{Residue}$$

Biopolymer: Biopolymers are bioplastics present or created by living organisms. These are also known as green plastics.

APPLICATIONS:

- Cellulose: cellulose occurs in plants synthesize from. proteins. included wood, cotton, corn, etc.

- 40% of all organic materials is cellulose, use as; derivative ~~of~~ in the form of Carbohydrates:
- Soya Protein: It occurs in plant protein Use for: making : adhesives and coating for paper and cardboards..
- Starch: It occurs in potatoes, corn, papioca, wheat
- Use in: Use in non-food purpose, ~~Pak~~ making paper, textile, cardboard, etc,

• POLYEASTER

- Produce by bacteria via fermentation process from cows milk. Use in: Biomedical Applications:

• LACTIC ACID

Occurs in corn, potatoes, Beets,
Use: use to produce plastics.

• TRIGLIGCERIDES

Occurs in Soyabeans
Use: in plastics.

• POLYMER BLEND

- Polymer blends are mixture of two or more micro molecular Species.
- It is the technology make possible to re-buil degraded polymers, and produce high performmance polymers have excellent properties of all existening polymer.

• TYPES OF BLEND

(a) Miscible Polymer blend: They are homogenous and ~~so~~ there is no distinct phase.

- Properties: There heat of mixture [$\Delta H \leq 0$] i.e negative. Thus mixing must be exothermic (releases heat)

ex: PS/PPO combine the heat resistance and toughness of PPO with Low cost of PS

(b) Partially Miscible: In this one blend componen dissolved in other.

e.g: PC/ABS: combine and the relases heat resistance and toughness of PC with Low cost and Stress cracking resistance of ABS.

(c) In MISCIBLE POLYMER BLEND: There interphase is very sharp thus these blends are useless.

~~so~~ most of the polymer blend ~~are~~ have low Entropy with Specific Additives. These additives are hydrophobic and hydrophilic.

Sections allign along the liquid phases to reduce interfacial tension. and increase the miscibility of polymers.

- APPLICATION / ADVANTAGES.
- It is the new Processing method
- Increase Scale of Production.
- They use Multicomponent and multiphase material. . Thus develop new polymeric
- ~~Thes~~ ~~material~~ - material .
- They change Semicrystalline into Amorphous.
- Provide material of desired properties at Lowest prize.. .
- Enhance waste recycling.
- Improve Specific qualities :→ brittleness
  - → rigidness / toughness
  - → Heat resistant
  - → chemical resistant
  - → Biodegredablity
  - → Strength / durablity.
  - → Solvent resistant.

✓ POLYMER COMPOSITE

- Composite material is a combination of two Or more materials. that exhibit significant properties of all the constituent materials.

e.g: Wood is a fiber composite made up of strong and flexible cellulose. fiber. in stiffer liginin matrix c dissolving properties)

CONDITION For COMPOSITES:- It is prepared artificially (synthetically)

- It consist of two or more physically or chemically distinct phases. (maintain identity) Sp separated by interphase.
- Enchance properties not ~~detect~~ showed by any of individual component.
- Constituent Of composites. ~~ma~~

Matrix phase: Matrix form the body of composite they - 1.) Binds the disper~~se~~se Phase together

2.) Protect disperse phase from surface damage.

3.) it Seperate the particles of disperse phase

4.) It prevent the Propagation of ~~pac~~ cracking

- matrix is a medium by which extern a load is transmitted and distributed to the disperse phase.

e.g.: ~~PMC (Polymer cermat Material~~

PMC (Polymer matrix Composite)

CMC (Ceramic matrix Composite)

MMC (Metal matrix Composite)

- DISPERSE PHASE: (REINFORCING MATERIAL
- It is structural constituent of composites to improve the strength of Matrix.
- On the basis of Reinforcing material composites are ⟶

(1) Particle Reinforce Composite:

(a): LARGE PARTICLE COMPO~~NENT~~SITE: when the Reinforcing material is in the form of large (particles ~~& Atom~~ > Atom or molecule) Suspended in matrix known as. large particle components

- They have Varaiety of geometry distributed throughout the matrix.

e.g: Concrete → Cement ~~matrix~~ with sand and gravel.

(b) **Strengthened Composite:** Very Smale Particle ~~of the~~ (10-100nm) are used as Strengthening material. they may be mettalic and non-mettalic.

Ex: High temp. strength of (Ni) Nickel alloy is improve by adding Thoria in the form of disperse particle

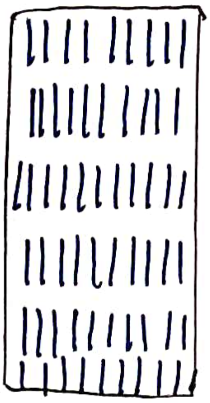
(2). "FIBER Reinforce Composite":

Fibers are highly flexible, provide high strength and stiffness

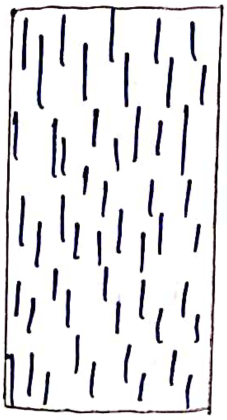
- They are:
- Continous and Allign Fiber Composites:
- A uniform fiber distribution. give better result of composite properties. (An Isotropic)
- ex: Longitudional direction give maximum Strength. But tranverse direction give

least strength.

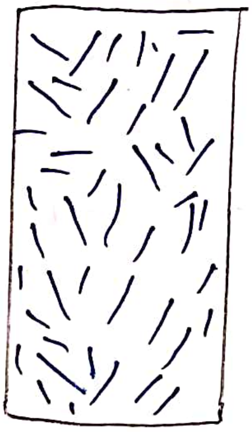
- Discontinous Fiber Composite: They are lower than continous. But they ~~b~~ are cheap (low cost)



Continous and Allign.



Discontinous. and allign.



Discontinous and Random.

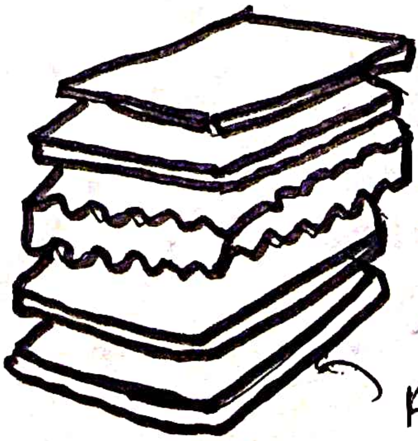
(3) ~~Str~~ STRUCTURAL REINFORCE COMPOSITE

(a) **Laminar Composite:** Two Dimensional layers of different materials stacked together. to form composite structure.

ex: Plywood.

Structure of Laminar

(b) **Sandwitch:** These composite consists of two strong outer sheets Seperated by a layer of dense material (core).
ex: foamed polymer.



USES | APPLICATION

1.) glass Fiber

II.) Building and construction Industries: →

- → Chemical Industry
- → transport Industry
- → Airospace Industry

(II) Carbon fiber: Commercial aircraft ~~(Boy~~ing)

- → chassis part (In trucks)
- → turbine
- → Wind mill

(III) Aramid fiber: kevlar is used in tyres., ropes., cable, ~~many~~ marine Industry.

(III) Boron fiber: Military Aircraft components →

- → helicoptor bleds
- → Tennis racket
- → bicycle frame.

⑩

1/1/22

WATER

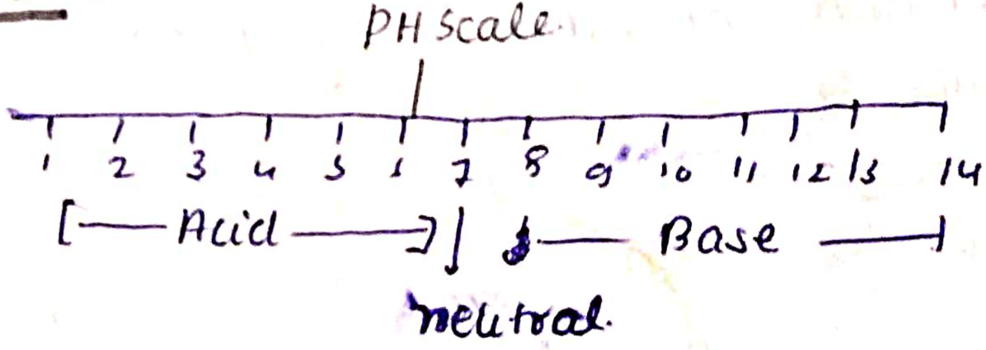
- **Hard water** : Does not consume Soap / Doe not give leather | Does not give foam |
- ~~Salt water~~ :
-

- **Soft water** : It consume soap. / It give lather

- **Digital Water** : Mineraless water / Does not use in drinking.
- only use for testing.

- **pH of water** : [7] → neutral.

PH order :



- **WATER HARDNESS**: Soap consuming capicity of water is known as hardness of water.
- It occurs in two forms.

- **TEMPROARY HARDNESS**: It occurs due to presence of Bicarbonate of calcium and magnesium.

$Ca(HCO_3)_2$ → Calcium bicarbonate

$Mg(HCO_3)_2$ → Magnessium bicarbonate

- it is also known as carbonate hardness. it can remove by boiling of water.

• PERMANENT HARDNESS

- It occurs due to presence of Sulphide and chloride of calcium and magnesium.

$CaCl_2$ → calcium chloride

$MgCl_2$ → magnesium Chloride

$CaSO_4$ → Calcium Sulphate

$MgSO_4$ → Magnesium Sulphate

- It can not remove by boiling
- Hardness of water express in terms of equivalent $CaCO_3$ becouse its molecular weight is 100 (Easy calculation) and its precipitate easy and clear

$$\text{Equivalents of } CaCO_3 = \frac{\text{Mass of Substance}}{\text{molar mass of substance}/2} \times 50$$

• UNITS OF HARDNESS

- PPM. P.P.M means of parts of ~~Per~~ $CaCO_3$ (calcium carbonate) 10^6 parts of water.

• Mg/ Litre

• it is the milligram of calcuim carbonate ($CaCO_3$) per Litre of water. (/L)

• CLARKE'S DEGREE

• it is the no of calcium carbonate ($CaCO_3$) (1gallon) Per gallon (70,000 * parts of water)

• DEGREE FRENCH

◦ It is the parts of $CaCO_3$ 10^5 Parts of water.

$1PPM = 1 Mg/L = 0.1°fr = 0.07°cl.$

• WATER SOFTENING TREATMENT / REMOVING OF HARDNESS OF WATER

1) ZEOLITE PROCESS/ BASE EXCHANGE:/ SYNTHETIC ZEOLITE = PERMUTIT

The chemical structure of Sodium zeolite

$Na_2O \cdot Al_2O_3 \cdot xSiO_2 \cdot yH_2O$ Or Na_2Z

(a) PRINCIPLE OF ZEOLITE PROCESS:- Zeolite is hydrated Sodium Almuninium silicate, Capable of exchange its Sodium ions. Z is insoluble thus when hard water is passed via (through) a bed of active ~~N to Z~~ Na_2Z (sodium zeolite) ~~to~~, calcuim Ca^{2+} and Mg^{2+} (calcuim and magnesium ion) Remove by Na^+ (sodium ion)

$$\underset{\text{Hardwater}}{Ca(HCO_3)_2} + \underset{\text{Zeolite.}}{Na_2Z} \longrightarrow \overset{Na(HCO_3) + CaZ}{\cancel{2Na + Ca^{+2} + 2(HCO_3)_2}}$$

$$Mg[HCO_3]_2 + Na_2Z \longrightarrow Na(HCO_3) + MgZ$$

$$CaCl_2 + Na_2Z \longrightarrow NaCl + CaZ$$

$$MgCl_2 + Na_2Z \longrightarrow NaCl + MgZ$$

$$CaSO_4 + Na_2Z \longrightarrow Na_2SO_4 + CaZ$$

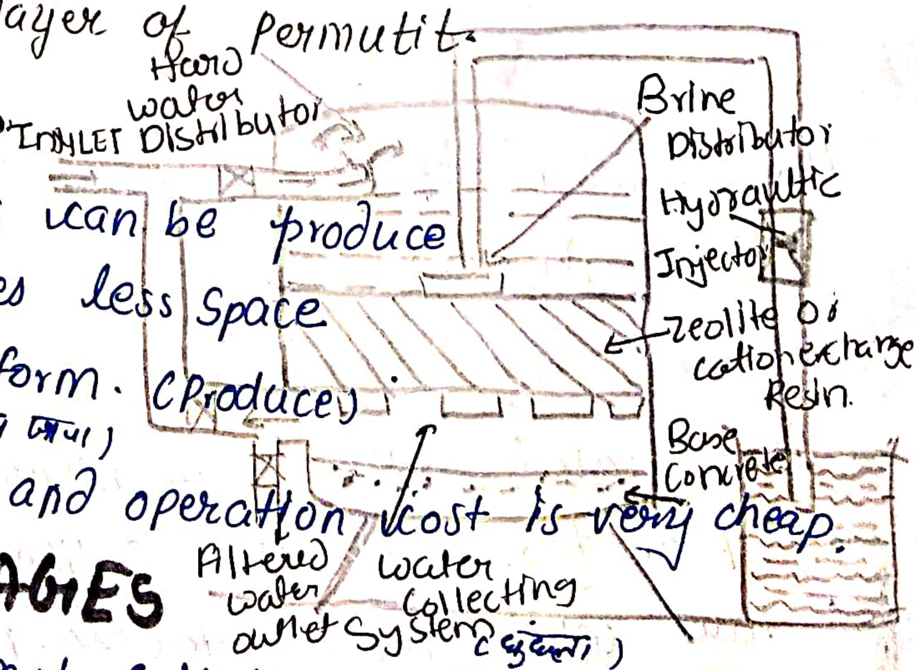
$$MgSO_4 + Na_2Z \longrightarrow Na_2SO_4 + MgZ$$

- REGENERATION

- The Zeolite bed. Regenerated by passing concentrate sodium chloride (NaCl) Solution through (Brine solu^n) it.

$$CaZ + \underset{\text{(Brine solution)}}{NaCl} \longrightarrow Na_2Z + CaCl_2$$

- A zeolite Softner consists of steel tank packed with thick layer of permutit.



• ADVAYAGES.

- Zero hardness can be produce
- 2. Plant Occupies less Space
- No Sludge form. (Produce) (कोई कचरा जमा नया)
- Maintenance and operation cost is very cheap.

• DISADVATAGES

- it is ~~Suitable~~ not Suitable of Turbit water.
- Treated Water contains more salt then lime soda process.

·Ion Exchange or Deionisation Or Dimineralization

In this process ~~To~~ ~~Arrom~~ Organic Compounds involve used they have Various functional groups responsible for Ion-Exchange.

Cation Exchange Resin: Resin contain ~~Acidic~~ Acidic group like $-COOH$, $-SO_3H$ use for cation Exchange. They Exchange their hydrogen ion $(H^{\oplus})$ with cation of hard water.

$$RH + CaCl_2 \longrightarrow R_2Ca + HCl$$

$$RH + MgCl_2 \longrightarrow R_2Mg + HCl$$

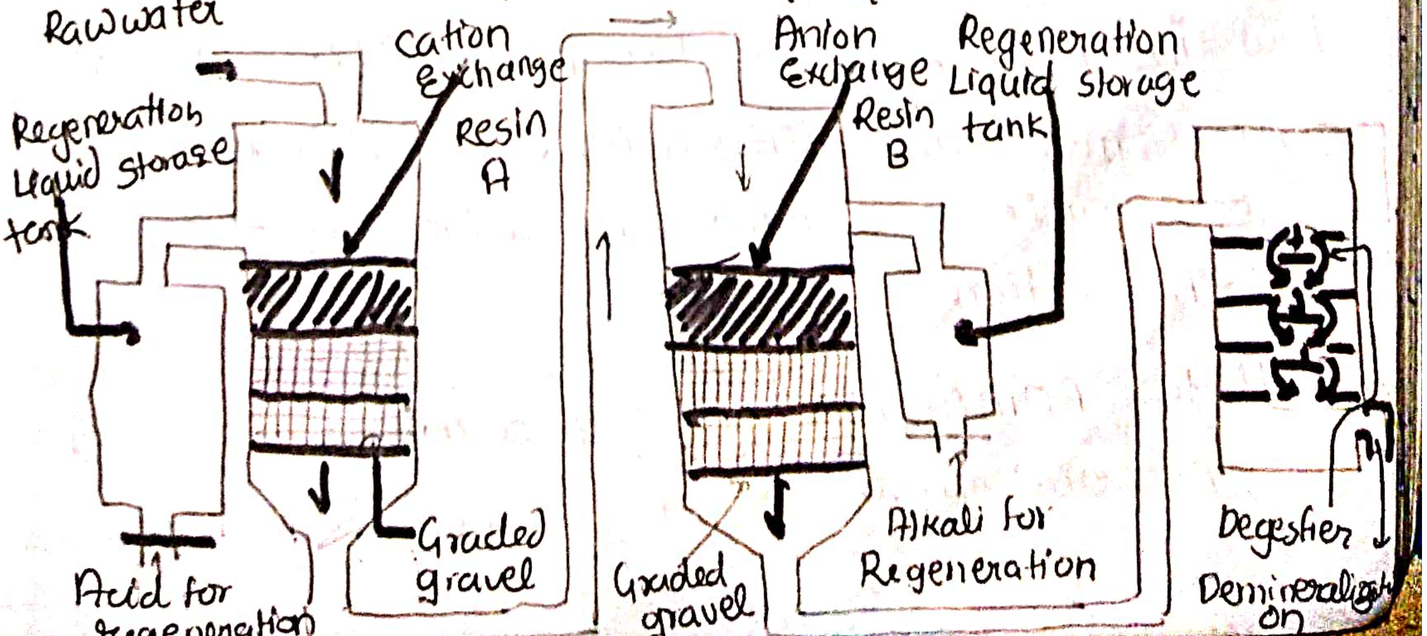
$$RH + CaSO_4 \longrightarrow R_2Ca + H_2SO_4$$

$$RH + MgSO_4 \longrightarrow R_2Mg + H_2SO_4.$$

Anion Exchange Resin: Resins contain. Basic function group like NH_2, Exchange their Ions with hard water

$$ROH + Cl^- \longrightarrow RCl + OH^-$$

$$ROH + SO_4^{--} \longrightarrow R_2SO_4 + OH^-$$



ADVANTAGES

- Highly Acidic or Alkine water can be Softened
- Very Low hardness produce
- Anion and cation both Removed to avoid corrosion.

• Disadvantages

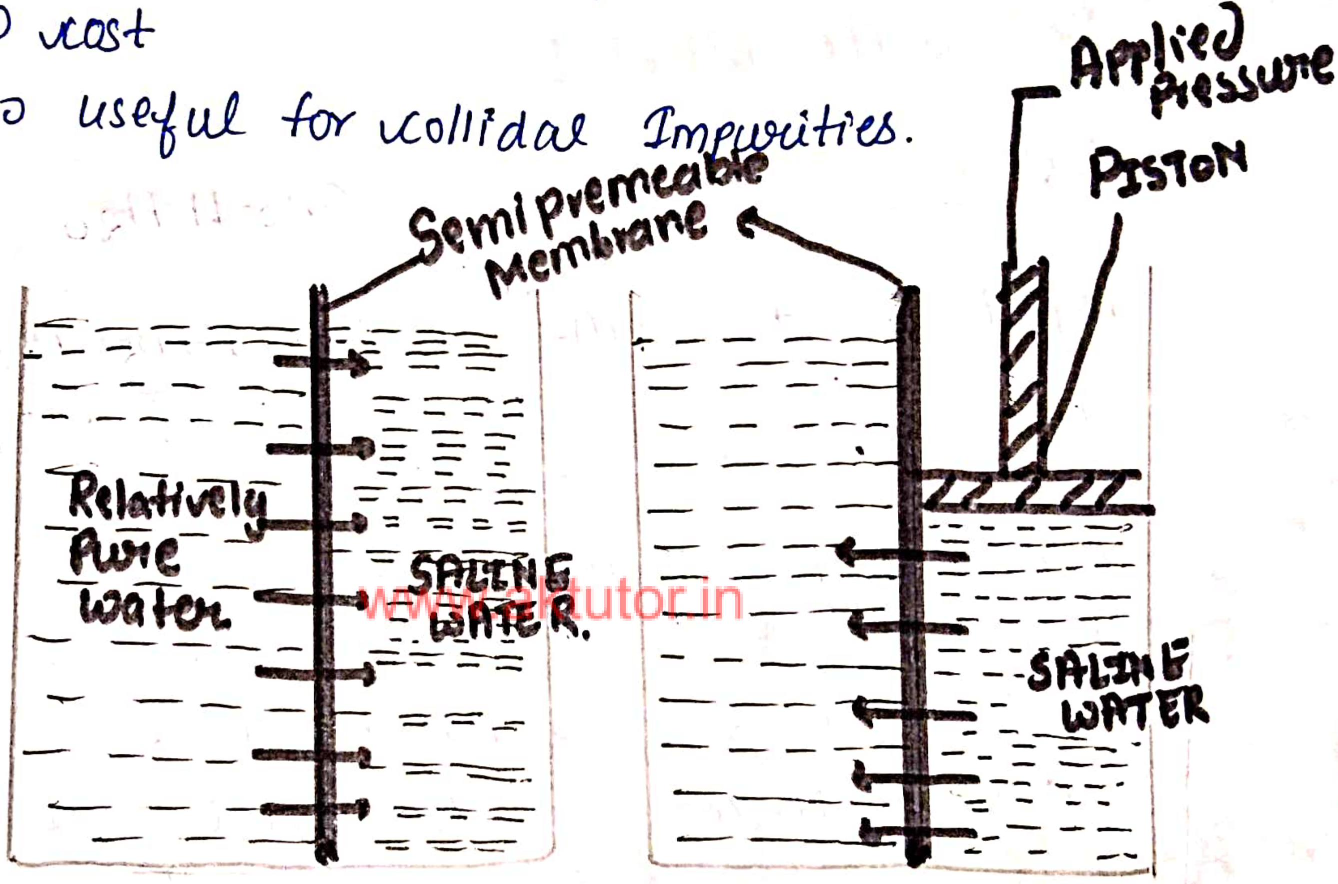
- Process is costly ~~not Suitable for~~
- Not Suitable for turbit water.

• REVERSE OSMOSIS

- Two Solutions Seperated by semipermeable membrane ~~bel~~ have flow of Solvent from Low concentration to high concentration. ·Process is known as Osmosis
- Thus, the Process of Reversing the flow of Solvent by Applying hydrostatic pressure (osmotic Pressure) is known as Reverse Osmosis
- Thus in R.O process water is purified through /via membrane filteration. is this is also called as hyper filteration ~~and~~ or Super-filteration
- Nylon, PMMA and cellulose a use ~~&~~ for Preperation of Semipremeable membrane

ADVANTAGES.

- No chemical use in this process.
- Low cost
- Also useful for collidal Impurities.



REVERSE OSMOSIS DIAGRAM

LIME SODA PROCESS. ①

This process involve the conversion of Soluble Hardness. Into insoluble precipitates. Removed by filterlation.

$Ca(OH)_2$, Na_2CO_3 are used.

Reaction With Lime :

$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow CaCO_3 \downarrow + H_2O$

$Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow CaCO_3 \downarrow + \underbrace{H_2O + MgCO_3}_{Ca(OH)_2}$

$CaCO_3 + Mg(OH)_2$

$MgCl_2 + Ca(OH)_2 \longrightarrow CaCl_2 \downarrow + Mg(OH)_2$

$MgSO_4 + Ca(OH)_2 \longrightarrow CaSO_4 \downarrow + Mg(OH)_2.$

Reaction With Soda

$CaCl_2 + Na_2CO_3 \longrightarrow NaCl + CaCO_3 \downarrow$

$CaSO_4 + Na_2CO_3 \longrightarrow Na_2SO_4 + CaCO_3 \downarrow$

Reaction with Lime

$FeSO_4 + Ca(OH)_2 \longrightarrow Fe(OH)_2 + CaSO_4$

$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$

$Al_2(SO_4)_3 + Ca(OH)_2 \longrightarrow Al(OH)_3 + CaSO_4$

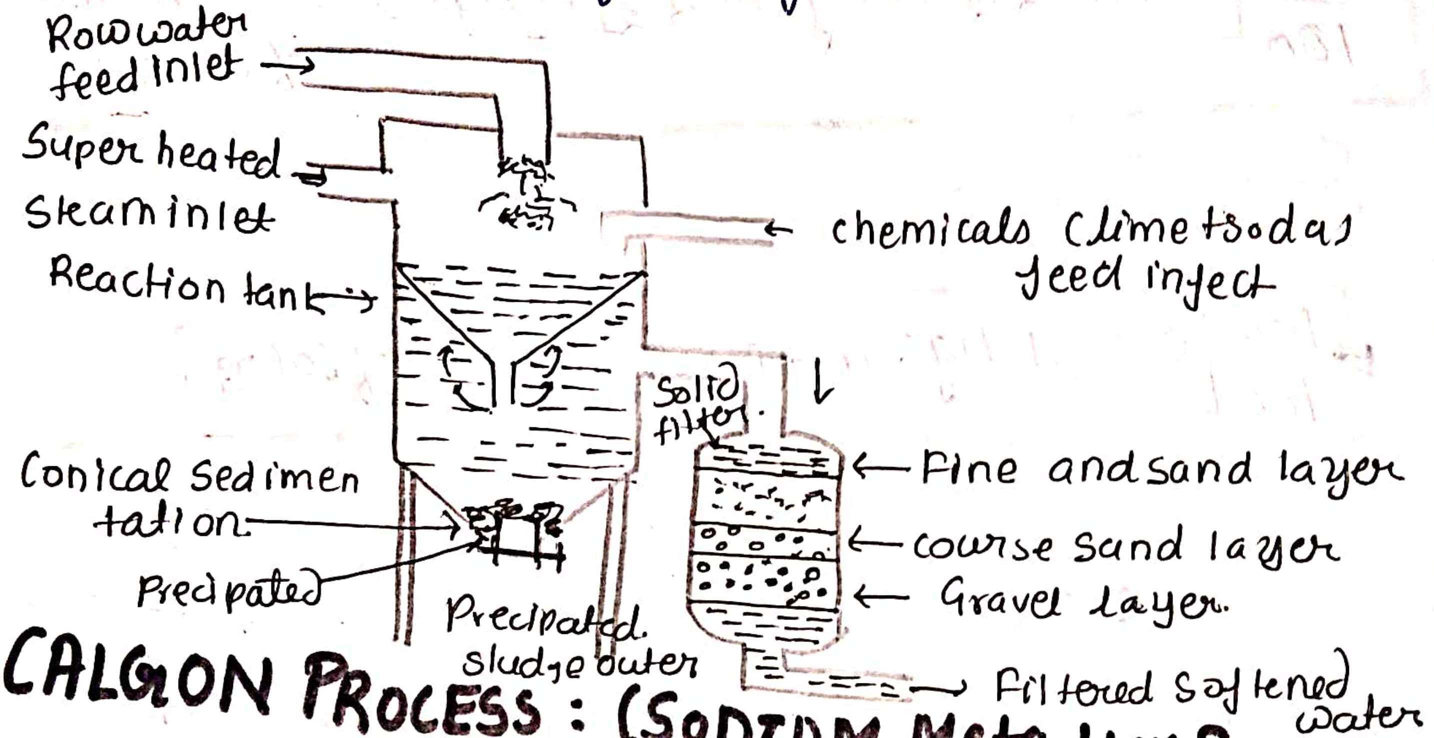
$H_2SO_4 + Ca(OH)_2 \longrightarrow CaSO_4 + 2H_2O$

ADVATAGES OF LIME SODA PROCESS

- This process can also other than calcium and magnesium ions like Fe^{+2}, Mn^{+2}, Al^{+3}
- This process also help. in killing bacteria by increasing pH.

② DISADVATAGES OF LIMESODA PROCESS

- Can't produce zero hardness.
- A large quantity of sludge produce.



CALGON PROCESS : (SODIUM Meta HexA PHOSPHATE : $Na_2[Na_4(PO_3)_6]$

- It can ~~Remove~~ replace calcium and magnesium anion from Hard water with its sodium ion and convert it in Soft water.

$$CaCl_2 + Na_2[Na_4(PO_3)_4] \longrightarrow Na_2[\overset{Ca_2}{\cancel{Na_4}}(PO_3)_6] + NaCl$$

$$MgCl_2 + Na_2[Na_4(PO_3)_4] \longrightarrow Na_2[\overset{Mg_2}{\cancel{Na_4}}(PO_3)_6] + NaCl$$

$$CaSO_4 + Na_2[Na_4(PO_3)_4] \longrightarrow Na_2[Ca_2(PO_3)_6] + Na_2SO$$

$$MgSO_4 + Na_2[Na_4(PO_3)_4] \longrightarrow Na_2[Mg_2(PO_3)_6] + Na_2SO_4$$

LIME Required:

$$\boxed{= \frac{74}{100}\left[Ca(HCO_3)_2 + 2Mg(HCO_3)_2\right] + \left[MgSO_4 + MgCl_2 \text{ in terms of } CaCO_3\right]}$$

SODA REQUIRED:

$$\boxed{\frac{106}{100}\left[CaSO_4 + MgSO_4 + MgCl_2 \text{ in terms of } CaCO_3\right]}$$

• FUEL

- The Substance can release heat and energy on combustion (burning)

CALORIFIC VALUE: It is the total amount of heat releases when a unit mass of fuel is burnt completely.

(a) UNITS: (i) Calorie: It is the amount of heat required to raise (↑) the tempreture of one gm of water through 1°C

$$1 \text{ calorie} = 4.185 \text{ jouls} = 4.815 \times 10^7 \text{ ergs}$$

(ii) Kcalorie: It is amount of heat required to raise (↑) the tempreture of one kilogm of water through 1°C

$$\boxed{1 \text{Kcal} = 1000 \text{calorie}}$$

④ • **BRITISH THERMAL UNIT:-** it is the amount of heat required to raise the temp. of 1 Pound of water through 1°F

$$\boxed{1\ B.Th.U = 252\ cal}$$

• **CENTIGRADE HEAT UNIT:** it is the amount of heat required to raise the temp. of 1 pound of water through 1°C

$$\boxed{1\,Kcal = 2.2\ CHU}$$

• **CALORIFIC VALUE TYPES:**

• **GROSS CALORIFIC VALUE: (G.C.V): or (H.C.V):**

it is the total amount of heat liberated when a unit quantity /~~one gram~~ / one gram of fuel is totally burnt in oxygen. And product are cooled down to the room tempreture There is no loss of heat occurs.

• **NET CALORIFIC VALUE (N.C.V): → L.C.V**

It is the total amount of heat releases when 1 gm of fuel. It is complotely burnt and products are allowed to escape. then Some amount of heat loss. ~~The~~ is know net calorific value.

• This amount of heat known as <u>Latent heat</u>

$$\boxed{G.C.V = L.C.V + L}$$

L = Latent heat

L = wt of Hydrogen × 9 × Latent heat of steam

$$\boxed{L = \text{wt of Hydrogen} \times 9 \times 587}$$

- DETERMINATION OF CALORIFIC VALUE

• BOMB CALORIMETER:

Construction: (Apparatus): It consists of —

- Steel bomb: It consists of A cylindrical container provided with two holes for electrodes and one oxygen Velve

- Copper calorimeter: It contain unknown amount of water provided with Therma meter.
- Air Jacket / Water Jacket: It prevent any loss of heat.
- Crucible: it is made up of nickel (Ni) and Silica (Si) contain fuel.

WORKING: Fuel is taken in crucible (Silica crucible) Magnesium wire stretched across the electrode with touching the fuel sample.

⑥ Bomb is field with oxygen at 25 atm.

- Bomb is placed inside calorimeter which contain ~~unk~~nown amount of water
- Initial tempreture of water is noted. now burn the fuel.
- With the help of electrodes connected with 6V battrey.
- The heat produce is transferred in water
- And note (record) the tempreture of water

CALCULATION:

- GCV can calculate as.

$$\boxed{GCV = C = \frac{(W+w)(t_2-t_1)}{x}}$$

t_1 = Initial temp.

t_2 = Final temp.

w = water equivalent of calorimeter

W = wt. of water

x = Wt. of fuel

~~Bo~~: Sludge and Scale

In boiler feed water.

Ca^{++} Mg^{++} } - Hardwater

↓

P.i.P. + Boiler — soft stuck – sludge / Hard stuck – Scale }

Loss

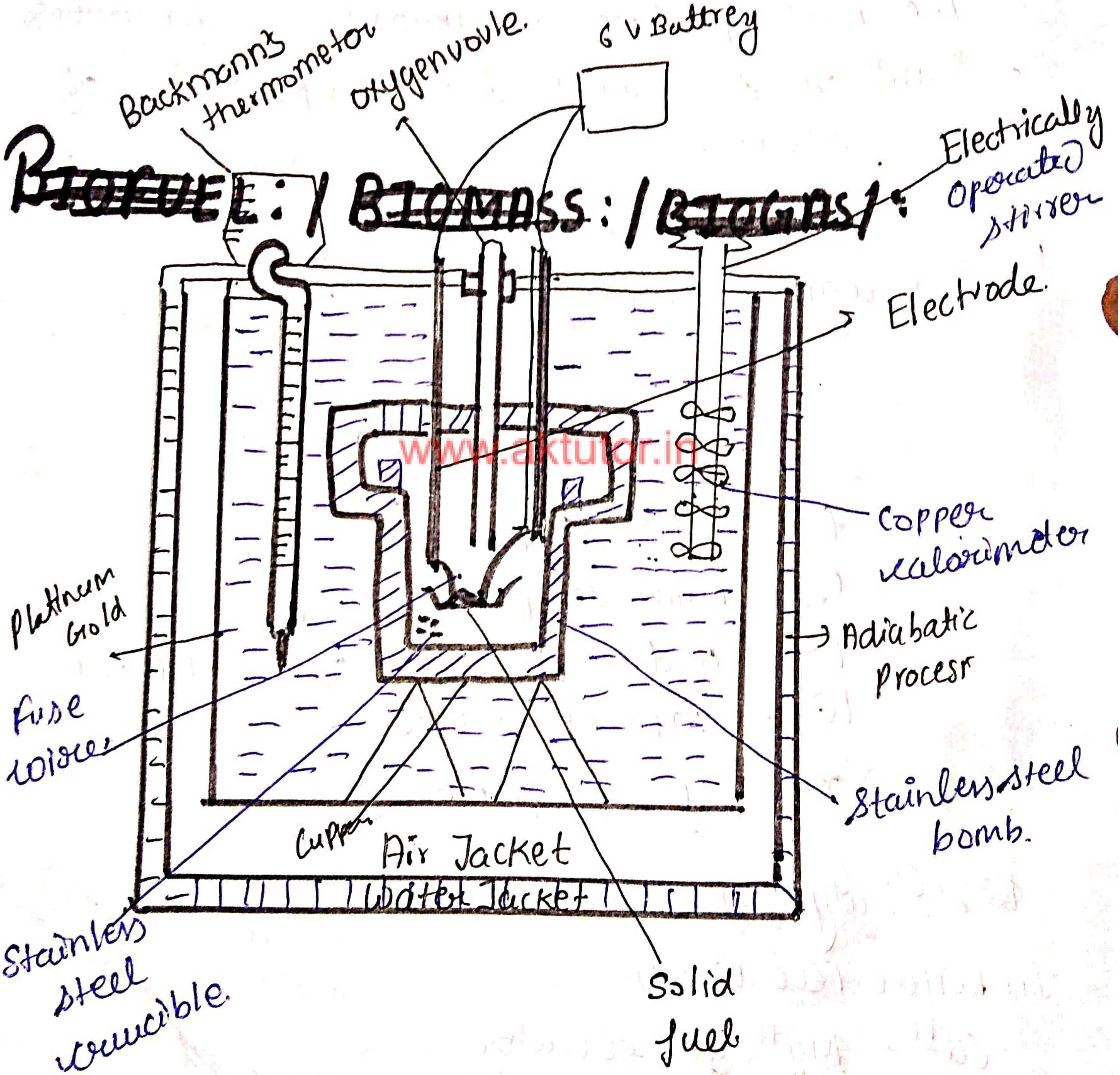
Boiler damage

Heat loss

Corrosion ↑

PH ↓

~~BIOFUEL~~: / ~~BIOMASS~~: / ~~BIOGAS~~/:



Bomb calorimeter

⑧ BIOFUEL : / BIOMASS / BIOGAS / :—

Biomass refers living waste material includes plants, animals and there products These are biodegradable waste.

- These are Renewable Source.
- These are also called bio fuel.
- Bio gas produce by decomposition of Organic matter~~metal~~ in absense of ~~oxidation~~ oxygen (Anerobic ~~oxid.~~ fermentation)
- **COMPOSITION OF BIOGAS:**

CH_4 = 50% – 60%
CO_2 = 30% – 40%
H_2 = 5% – 5%
N_2 = 2% – 2%
H_2S = Traces – Traces

30

- Biogas plant consist of —

(a) Fermentation tank: It is airtype container or tank. ~~field with~~ filled with liquid slurry of animal waste and water (cow dung)

(b) GAS HOLDER: It is a airproof steel container collect gas provided with overflow pipe

ADVANTAGES:

1) ~~A~~ Electricity Production
2) Cooking
3) Water heating, Space heating

5.) not Polluted

- calculate temproary and permanet and total hardness.

$Mg(HCO_3)_2 = 7.3$ mg/l

$Ca(HCO_3)_2 = 8.1$ mg/l

$MgCl_2 = 9.5$ mg/l

$CaSO_4 = 6.8$ mg/l

- Calculate temporary and ~~term~~ Permanent and total hardness of Water Sample

$Mg(HCO_3)_2 = 9.3$ mg/l

$Ca(HCO_3)_2 = 17.4$ mg/l

$MgCl_2 = 8.7$ mg/l

$CaSO_4 = 12.6$ mg/l

Solution We know that

$$Mg(HCO_3)_2 = \frac{9.3 \times 100}{146} = 6.36 \text{ mg/l}$$

$$Ca(HCO_3)_2 = \frac{17.4 \times 100}{\cancel{146}\ 162} = \frac{1740}{\cancel{146}\ 162} = 10.74 \text{ mg/l}$$

$$MgCl_2 = \frac{8.7 \times 100}{95} = 9.15 \text{ mg/l}$$

$$CaSO_4 = \frac{12.6 \times 100}{136} = 9.264 \text{ mg/l}$$

4-132+88

108
32

Temporary Hardness = 6.36 + 10.74 = 17.10 mg/l

Permanent Hardness = 9.15 + 9.26
= 18.41 mg/l.

Total Hardness = 35.51 mg/l

Solun. $Mg(HCO_3)_2 = \frac{7.3 \times 100}{146} = \frac{730}{146} = 5 mg/l$

$Ca(HCO_3)_2 = 8.1 mg/l = \frac{8.1 \times 100}{162} = \frac{810}{162} = 5 mg/l$

$MgCl_2 = \frac{9.5 \times 100}{95} = \frac{950}{95} = 10 mg/l$

$CaSO_4 = \frac{6.8 \times 100}{136} = \frac{680}{136} = 5 mg/l$

Temporary hardness = 5mg/l + 5mg/l = 10mg/l

Permanenent hardness = 10mg/l + 5mg/l = 15mg/l

Total hardness = 10 + 15 = 25mg/l

Q= Calculate the amount of lime and soda required for Softening 30000 litres of waters using 20 ppm of sodium aluminate as coagulant Impurities in water are as follows:
$Ca^{2+} = 160$ ppm, $mg^{2+} = 96$ ppm, dissolved $CO_2 = 34$ ppm and $HCO_3 = 403$ ppm)

Soln Volume of Water = 30,000 litres.

23 + 26 + 32

$Ca^{2+} = \frac{160 \times 10\cancel{0}}{4\cancel{0}} = \frac{\overset{400}{\cancel{1600}}}{\cancel{4}} = 400 ppm$

$mg^{2+} = \frac{96 \times 100}{24} = 400 ppm$

$CO_2 = \frac{34 \times 100}{44} = 77.27 ppm$

$HCO_3^- = \frac{403 \times 100}{61 \times 2} = 330.33$ p.pm

$2 NaAlO_2 = \frac{20 \times 100}{82 \times 2} = 12.19$ ppm

Lime Required $= \frac{74}{100}\left[Mg^{2+} + HCO_3^- + CO_2 + NaAlO_2\right]$

$= \frac{74}{100}\left[400 + 330.33 + 77.27 + 12.19\right]$

$= 606.64 \text{ g/l}$

Lime requirement for Softening 30,000L

$= \frac{606.64 \times 30{,}000}{10000} \text{ g} = 18199.34 \text{ g}$

Soda requirement.

$= \frac{106}{100} [Ca^{2+} + Mg^{2+} + NaAlO_2 - HCO_3^-]$

$= \frac{106}{100} [400 + 400 + 12.19 - 330.33] = 510.782 g/l$

Soda requirement for softening 30,000 L

$= \frac{510.782 \times 30,000}{1000} g = 15323.46 g$

Q = A sample of water contain the following Impurities

Ca^{2+} = 20 PPm, mg^{2+} = 18 PPm

HCO_3^- = 183 PPm, SO_4^{-2} = 24 PPm

Calculate the lime and soda needed for softening.

Solun

$Ca^{2+} = \cancel{\frac{20 \times 40}{100}} = \frac{20 \times 100}{40}$

$Ca^{2+} = \frac{200}{4} = 50 PPm$

$mg^{2+} = \frac{18 \times 100}{24} = 75 PPm$

$HCO_3^- = \frac{183 \times 100}{2 \times 61} = 150 PPm$

$SO_4^{2-} = \frac{24 \times 100}{96} = 25 PPm.$

lime required $= \frac{74}{100} [mg^{2+} + SO_4^{-2} + HCO_3^-]$

$= \frac{74}{100} [75 + 25 + 150]$

$= 185 PPm.$

Soda required $= \frac{106}{106} [Ca^{2+} + mg^{2+} + SO_4^{2-} - HCO_3^-]$

$= \frac{106}{100} [50 + 75 + 25 - 150]$

$= 0 PPm$

Q- Calculate the Lime and soda for Softening 50,000 L of water

$CaSO_4 = \frac{13.6 \times 100}{136} = \frac{1360}{136}$

$= 10 PPm$

$MgCl_2 = \frac{9.5 \times 100}{95} = \frac{950}{95} = 10 PPm$

$Mg(HCO_3)_2 = \frac{7.3 \times 100}{146} = 5 PPm$

$Ca(HCO_3)_2 = \frac{16.2 \times 100}{162} = 10 PPm$

lime required $= \frac{74}{100}$

$[Ca(HCO_3)_2 + 2 Mg(HCO_3)_2 + MgCl_2]$

$= [10 + 10 + 10]$

$= 30$

~~Soda required =~~

for 50,000 L of water $= \frac{30 \times 50000}{1000}$

$= 1.11 kg$

Soda required $= \frac{106}{100} [10 + 10]$

$= \frac{106}{100} \times 20$

$= 21.2 mg/l$

for 50,000 L $= \frac{50,000 \times 21.2}{1000} = 1.06 Kg$

Analysis of coal.

- Proximate Analyisis : In this process data varies with Procedure adopted. It determine the presence of Moisture, ash, Volatile matter and fix carbon.

MOISTURE CONTENT: It is determine by heating a known amount of coal in oven .. about one hour. loss in weight of coal is reported as Moisture content (%)

$$\% \text{ moisture} = \frac{\text{Loss in weight}}{\text{Total amount of coal}} \times 100$$

• Significance / BENEFITS :

[1.] Excess ~~of~~ moisture undesirable in coal.

[2.] Excess Surface moisture may cause Difficulty in handling the coal. (Analysis)

• VOLATILE MATTER

(1.) Volatile matter consists of gaseous and liquid mixture resulting from thermal decomposition of coal.

(ii) It can be determined as:

$$\% \text{ volatile Matter} = \frac{\text{Loss in weight due to removal of Volatile matter}}{\text{known Amount of coal}} \times 100$$

• SIGNIFICANCE :

- A High percent of volatile matter Indicate Loss of ~~weight~~ fuel.
- High volatile content gives long flame, high smog

• Ash

- It consists of Silica, Alumina, Iron oxide, lime etc (SiO_2, Al_2O_3, FeO, $Ca(OH)_2$)
- content is determine by heating the residue left after the removal of volatile matter for 1 hour.

$$\%\,\text{Ash} = \frac{\text{Weight of Residue left}}{\text{Known Amount of Coal}} \times 100$$

• SIGNIFICANCE

- In boiler the fusion tempreture of Ash is very significant
- The High percent of Ash ~~effect~~ affect the efficiency of coal.

• FIXED CARBON

- Carbon content increase ~~tono~~ low ranking coal (Lignite) to high ranking coal (Anthracite)

$$\%C = 100 - [\text{Moisture } \% + \text{Volatile Matter } \% + \text{Ash } \%]$$

SIGNIFICANCE:

- The percent of fixed carbon increases the calaric value

• ULTIMATE Analysis [Dulong Formula]

- It carroted out /calculate to certain composition of coal.
- It include the ~~estim~~ calculation / Analysis of

CARBON AND Hydrogen: Coal combuse. and carbon, hydrogen (C, H) converted into CO_2 and H_2O (cardo di-oxide and water)

- CO_2 and H_2O absorbed by KOH and $CaCl_2$.

$$\boxed{\%C = \frac{12}{44} \times \frac{\text{increa. in weight of KOH}}{\text{wt. of coal}} \times 100}$$

$$\boxed{\%H = \frac{2}{18} \times \frac{\text{Increa. wt of } CaCl_2}{\text{wt. of coal}} \times 100}$$

Significance: High percentage of carbon & Hydrogen increase the caloric value of coal.

- They also reduces the size ~~the~~ of chamber

• NITROGEN (kzeldahl process)

- A known weight of coal heated ~~with~~ / Analyze with H_2SO_4 (sulphuric Acid), nitrogen ~~conv~~ converted in NH_2SO_4 (Ammonium Sulpha

Do

$$\underset{(\text{coal})}{\text{Nitrogen}} + H_2SO_4 \xrightarrow[HgSO_4]{\Delta} (NH_4)_2SO_4$$

$$\downarrow$$

$$NH_3 + H_2O + Na_2SO_4$$

- This ~~fibo~~ liberated Ammonia ~~asts~~ absorb by Known volume of Acid. and percentage of nitrogen calculated.

$$\boxed{\% N = \frac{14}{1000} \times \frac{N \times V \times 100}{W} = \frac{1.4NV}{W}}$$

N = Normality of Acid
V = volume of Acid used
W = wt. of coal

- **SIGNIFICANCE:** It is useful in carbonization industries

SULPHER

- Sulphur in coal is oxidized in Sulphuric Acid and precipated as Barium Sulphate ($BaSO_4$). The p.p.t is filtered and heated to constant Weight.

$$\% S = \frac{32}{233} \frac{W_1}{W}$$

W = wt. of coal
W_1 = wt. of $BaSO_4$

SIGNIFICANCE: It is undesirable. ~~they~~ cause Pollution.

oxygen Analysis

- It is determine by difference.

$$\boxed{\%O = 100 - [\%C + \%H + \%S + \%N + ash]}$$

- SIGNIFICANCE
  - Less oxygen percentage
  - The calorific value of coal is high.

- **Dulong formula:-**

$$\boxed{HCV = \frac{1}{100}\left[8080\,C\% + 34500\left[H\% - \frac{O\%}{8}\right] + 2{,}240\%S\right] \text{ Kcal/kg}}$$

∴ Minimum air required for combustion of 1 kg - ~~coal~~ Coal

$$= \text{wt. of}\left[C \times \frac{32}{12} + H \times \frac{16}{2} - O\right] \times \frac{100}{23}$$

$$\boxed{LCV = HCV - 0.09\,H\% \times 587 \text{ kcal/Kg}}$$

Q- A coal has following ultimate Analysis data carbon 84% Sulphur 1.5% nitrogen 0.6% or Hydrogen 5.5% and oxygen 8.4% find the G.C.V and N.C.V with the help of Dulong formula

$$G.C.V = \frac{1}{100}\left[8080 \times 84 + 34500\left[5.5 - \frac{8.4}{8}\right] + 2240 \times \text{[illegible]}\right]$$

$$= 8356.05$$

~~N.CV = G.C.V - L~~

=

$$L.C.V = 8356.05 - 0.09 \times 5.5 \times 587$$

$$= 8\cancel{355.55 \times 587}$$

$$\boxed{L.C.V = 8065.485}$$

Q2 The percentage composition of coal sample is $C = 70\%$, $H_2 = 10\%$, $O_2 = 1\%$, $S = 5\%$, $ash = 0.5\%$ and $N = 0.3\%$

(i) calculate the quantity of air needed for complete of 1Kg of coal, if 60%, excess of air is supplied

(ii) Calculate the G.C.V and N.C.V of coal using Dulong formula.

$$G.C.V = \frac{1}{100}\left[8080 \times 70 + 34500\left[10 - \frac{1}{8}\right] + 2240 \times 5\right]$$

$$G.C.V = 9174.87$$

N.C.V =

• PHASE RULE:

- This rule is given by Gibbs according to this rule
" In hetrogenous system the sum of no. of phase and degree of freedom is greater than ~~then~~ the no. of component by two.

$$F+P = C+2$$

$$\{F = C-P+2\}$$

F = degree of freedom
C = component
P = phase

• Application of phase Rule:-

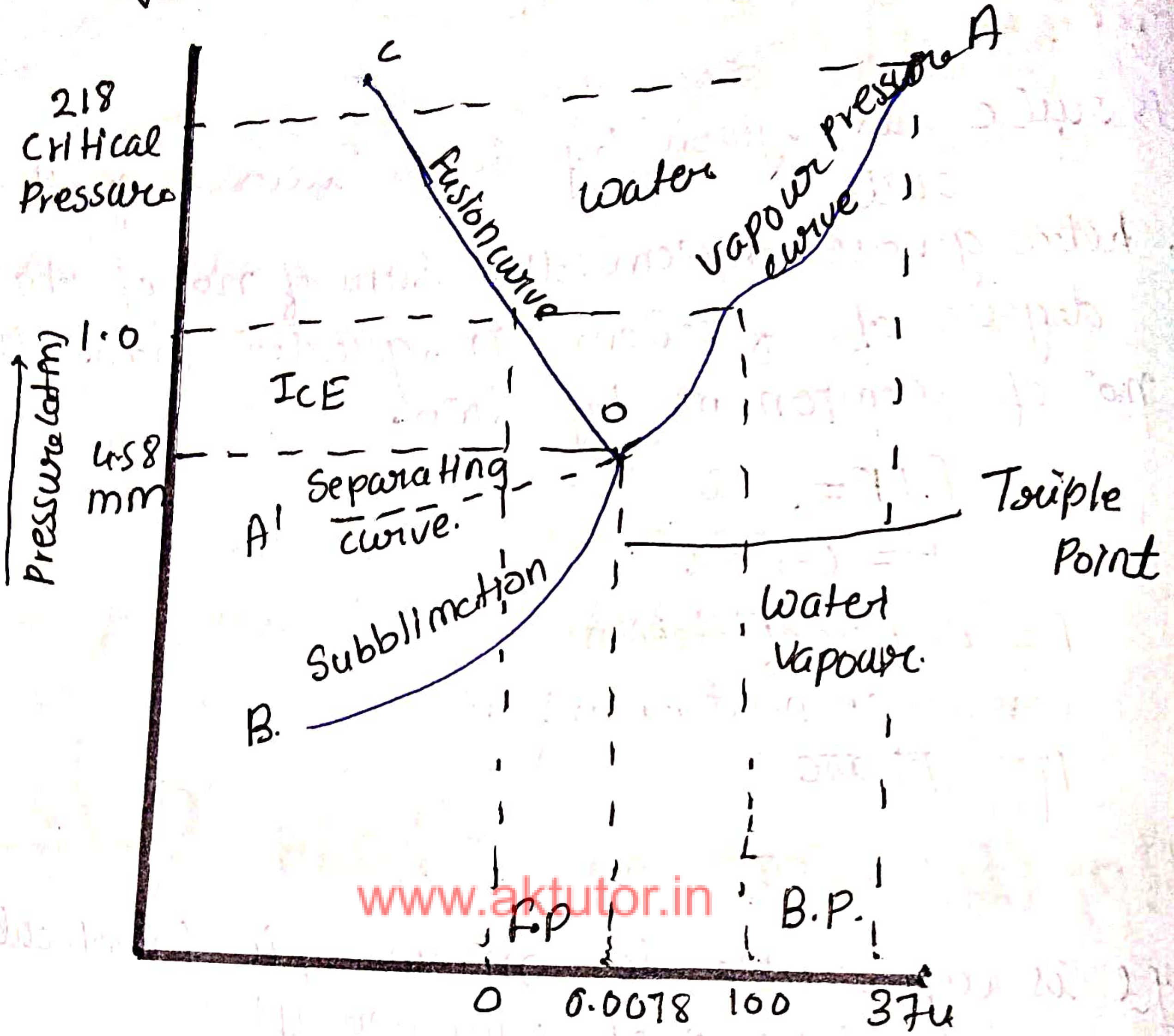
- It is applicable to macroscopic [molecular structure not compulsory]
- It is applicable to physicable as well as chemical equilibrium.
- It explain the behaviour of system when allow to changes in variable like, pressure, temprature ~~and~~.

Phase: It represent the state of matter uniform through out.

Component: It is smallest no of independent constituent.

Degree of freedom: It define the no. of independent variables like pressure, temprature, composition concentration

One component :⇒
(Water System)



. Water System can explain in following three steps:

- Single phase equilibrium: [Area ~~curve~~] :
  - Solid: represented by BOC or (OB C'C)
  - Liquid: represented as COA (Water)
  - Gas: represented by BOA (Vapour)

. All above area shows

$$C = 1$$
$$P = 1$$

Then $F = C - P + 2$
$= \cancel{1} - \cancel{1} + 2$

$\boxed{P = 2}$ Bivariant. (Tempreture or pressure

.Two Phase Equilibrium (curve) :

- Solid/Liquid: represented by curve OC or CO
- Liquid/vapour: represented by curve OA or AO
- Gas/Solid: represented by curve OB

All above area shows

$$C = 1$$
$$P = 2$$

$F = C - P + 2$
$= 1 - \cancel{2} + \cancel{2}$

$\boxed{F = 1}$ <u>monovarient</u> or <u>univarient</u>

. Curve OC represent melting or fusion curve
curve OA is vapour pressure curve.
and curve OB is sublimation curve.

- Triple point
- At this point all the curves (phases) are meet. thus.

$C=1$

$P=3.$

$F= C-P+2$

$F = 1-3+2 = \boxed{F=0}$ nonvariant.

- Metastable curve. / Supercooling curve.
- It is the state in which liquid below its frezzing point is in supercooled state. (Unstable)

Supercooled liquid $\rightleftharpoons$ Vapour.

$C=1$

$P=2$

Then $F= C-P+2$

$=1-2+2$

$\boxed{F=1}$ monovariant.

Corrosion: corrosion is a degradation of a metal by chemical reaction.

- **Reason:** 1) Rough Surface of metal.
- Presence of Impurities on metal.
- Moisture and air presence on metal surface

ex: rusting of iron → Reddish powder or layer (Fe_3O_4)

- ex: green layer on carbon → ($CuCO_3 + Cu(OH)_2$)
- ex: Turnishing of Silver → (Black coating formed on Silver)

, metals are in higher energy state (unstable) wants to converts in stable natural combined form (stable) minerals.

EFFECT OF CORROSION

- Decrease efficency of machine.
- Cause leakage in pipe line
- To release toxic and inflameable products
- Cause ~~contemention~~ contimenation of water
- Cause accidents due to decayed/rusting in Architecture, brizzes, buildings etc

ELECTROCHEMICAL CORROSION / WET CORROSION / Rusting of Iron / Immersed corrosion.

- In this corrosion metal is oxidized to a soluble form or ionic state.
- A corrosion cell (galvanic cell) is formed where following reaction takes place.
- Anodic Reaction: At anode metal loss their electrons (oxidation).
- Cathodic Reaction: The electron released from anode consumed at cathode.

They causes → evolution of hydrogen.

→ Absorption of oxygen.

ex: Rusting of iron

$$Fe \longrightarrow Fe^{++} + 2e^{-} \quad \text{(Anodic reaction)}$$

$$\frac{1}{2}O_2 + H_2O + 2e^{-} \longrightarrow 2OH^{-} \quad \text{(cathodic reaction)}$$

$Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2 \downarrow$

$Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 4Fe(OH)_3$ or $2Fe_2O_3 \cdot 3H_2O$ [Rust]

- corrosion occurs at anode and rust is formed near cathode becouse smaller Ferous ion Fe^{+2} produce at anode diffuse rapidly towards the cathode as compare to diffusion of larger OH^- ions towards the anode.

Prevention of corrosion by Anodic Protection

1.) Cathodic Protection or Electrochemical Protection
Cathodic Protection is to force the metal to be Protected to behave like a cathode as a result of which it is not corroded

- cathodic protection can be acheived in two ways.

A.) Galvanic or Sacrificial Anodic Protection: In galvanic or Sacrificial Anodic Protection the metal structure to be protected is made the cathode by connecting a wire to a more anodic material

(ii) A a result, the corrosion takes place at anodic material and the metal structure is saved from corrosion.

(iii) The more active ~~material~~ metal used for the purpose is known as Sacrificial anode

(iv) Most commonly metals used for the Sacrifical anodic protection are Mg, Zn, Al and their alloys.

ex Zinc metal in ship: In ship a sacrificial anode (sheets of zinc metal) electrically linked to the ship (cathodes) to be protected, that is more reactive Surrounding of an environment

Ques-1

- why does corrosion occur in steel pipe connected to copper plumbing ?
- Bolt and nut made of same metal is prefered explain.
- Iron corrose faster than alumunium, even iron is placed below alumunium on the electro chemical series
- Impurities increase the rate of corrosion. Explain (metals)

Ans-1

- Steel is an alloy of iron which is higher on the electrochemical series. Hence Iron under goes oxidation and gets corroded when steel pipe is connected to copper plumbing is exposed to be a corroding envoirnment

Ans-3

- Alumunium is more reactive than iron but it does not corode easily becouse it forms a layer of aluminium oxide which prevents it form further reaction with air. On the other hand iron keeps on reacting with air and keeps on corroding

Ans-2

- Nuts and bolt made up of same metal becoua they have same stress and same strength resistence

Which part of an electrochemical cell formed by two metals, Suffer corrosion cathode or anode?

Q-2 Presence of moisture increases the corrosion rate but metals do not rust . if covered with ice

Q-3 Wire mesh corrodes factor at joints why?

Ans-1

- It occurs in Galvanic corrosion. it is also called bimettalic corrosion or disimillar metal corrosion
- It is an electrochemical process. when two Dissimillar metals and alloys have different electrode potential and when two or more metal come into contact with electrolyte. One metal (high reactive) ~~and~~ Work as anode and other are metal (less reactive work as cathode

Ans-2

- Presence of moisture increase the corrosion rate but metals do not rust. But if covered with ice. firstly we know that Corrosion Occurs in liquid, air, gasses. In the condition with ice when the temp. of ice is high then corrosion rate increases. But temp. of ice low then Corrosion decreases

Q-1 Differentiate pitting corrosion & crevice corrosion.

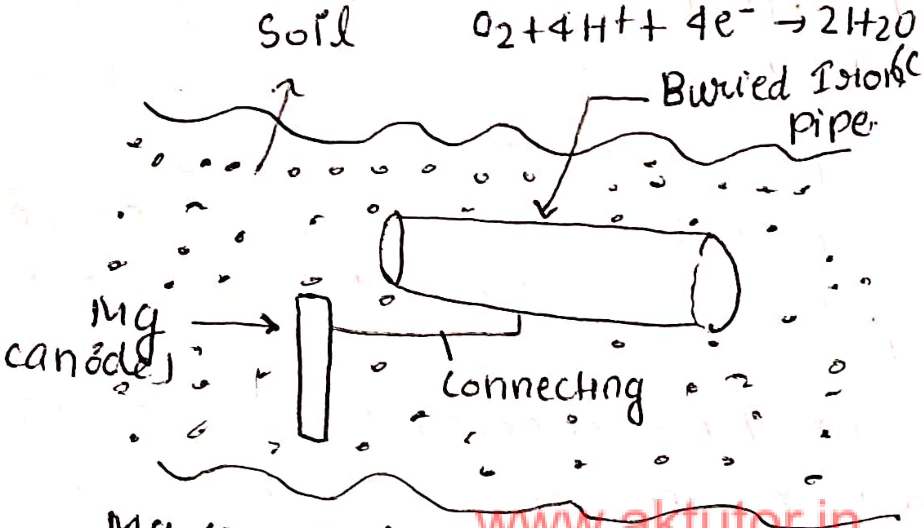
Q.2 Can we store $CuSO_4$ in iron vessel ? why

Q3 chemical energy is converted into electrical ~~energy~~?
energy than cell is
& vice versa.

Pitting corrosion.

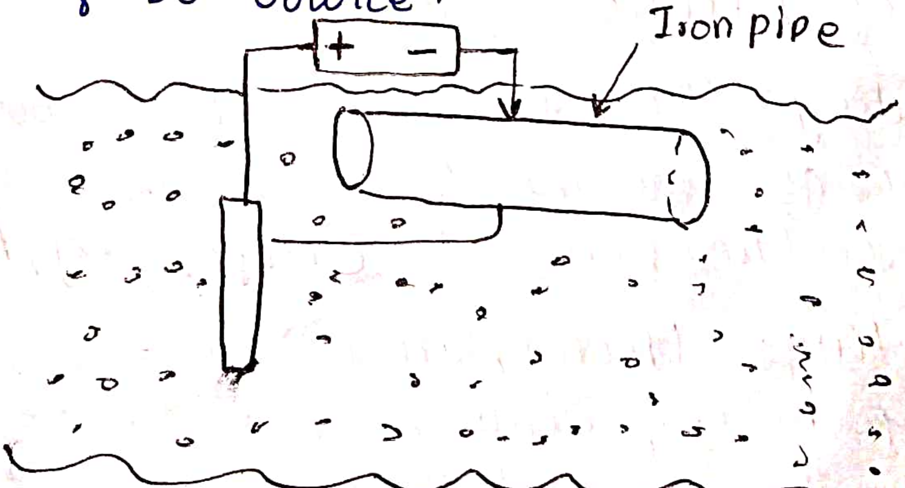
Crevice corrosion.

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ (cathodic reaction)



$Mg(s) \rightarrow Mg^{2+} + 2e^-$

b) Impressed current cathodic protection: The method known as electrolytic method of cathodic Protection, the object to protected is made cathode by connecting it to negative terminal of DC Source.



- The (+ve) terminal is connected to the insoluble anode like graphite or scrap iron, platinum.

(iii) The impressed current cathodic Protection has been applied.
a.) Buried pipelines, transmission line towers
b.) water pipes., water tanks., marine piers etc

(iv) This kind of technique is particularly useful for large structures which require long term applications

2.) Anodic Protection: Anodic Protection is applicable to the metals which can be passivated by the deposition of oxide films

(ii) In Anodic protection. oxide film is grown on the surface of the metal structure to be Protected.

(iii) This is done by electrochemical means i.e by applying current in a direction that makes the metal structure more anodic.

(iv) Under these condition, the metal structure is passivated when required potential is maintained and hence rate of corrosion decreases.

- five factors of prevention of corrosion:

- Metal cladding: Metal cladding is the process of coating of base metal by a dense homogenous layer of cladding materials (Ni, Pb, Ag, Pt, cu)
- Electroplating: Electroplating is the process of of deposition of coating metal on the base metal by passing a direct current in a electrolytic solution which contains the soluble salt of coating metal

3) Proper design: The contact b/w diff. metals and alloys should not made especially If they are far apart in the galvanic series

- **LEAD STORAGE BATTERY:** Lead storage battrey (or lead acid battrey) is the oldest type of rechargeable battrey and one of the common storage energy devices
- The Batteries used in automobiles for ex: in cars, buses. trucks, etc are lead storage batterey.
- Construction: The cell consists of a lead grid filled with ~~as~~ a spongy lead as anode and a lead grid packed with lead oxide as cathode.
- A solution of H_2SO_4 is used as an electrolyte.
- This is the battrey acid which one can buy at service stations.
- The Battrey consists of 6 such cells connected in series, each cells having an emf 2V, means total emf 12V.

Working

1- Discharging: when the battrey is discharging i.e when all it is supplying a current reaction

At the anode:

$$Pb + SO_4^{2-}(aq) \longrightarrow PbSO_4(s) + 2e^-$$

At the cathode:

$$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \longrightarrow PbSO_4 + 2H_2O$$

The overall reach during discharge

$$Pb + PbO_2 + 2SO_4^{2-} + 4H^+ \longrightarrow 2PbSO_4 + 2H_2O(l)$$

1) The electrolyte is sulphuric acid which is used.

2) Both electrodes become coated with an Insoluble layer of layer sulphate which being an Insulator, would eventually ruin the battrey

- Charging: when the battrey is being charged electrons are supplied to the anode of the battrey and this converts the lead sulphate to lead
- At the same time, the lead sulphat at the anode is converted to lead di-oxide
- This is the cell reach are reversed.

At cathode:

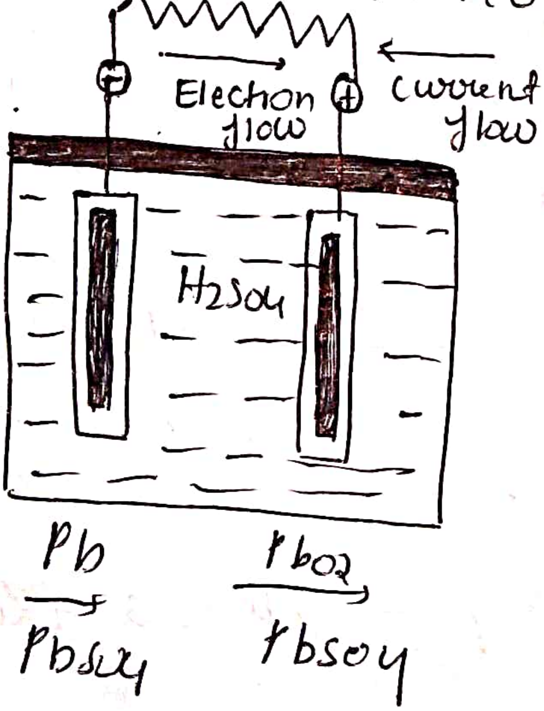
$$PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$$

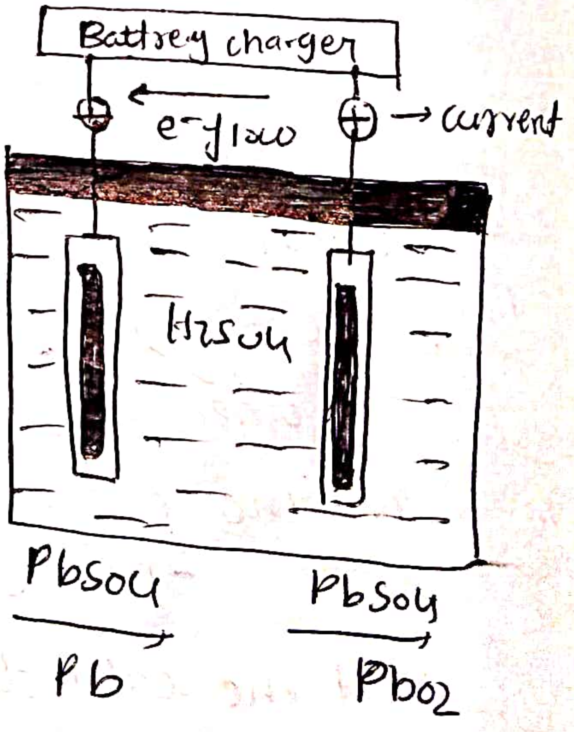
At anode:

$$PbSO_4 + 2H_2O(l) \rightarrow PbO_2 + 4H^+ + SO_4^{2-} + 2e$$

Overall reach during charging:

$$2PbSO_4 + 2H_2O \rightarrow \cancel{2} Pb + Pb + 4H^+ + SO_4^{2-}(aq)$$





• SPECTROSCOPY

- It is the branch of science deals with determination of structure and properties of compound through the interaction of electromagnetic radiation with the matter.

• ADVANTAGES OF SPECTROSCOPY

1.) Require less time
2.) required a very smale amount of substance
3.) Substance remains unchanged during test/ examination and can again used.

• Electromagnetic Radiation

it is a form of energy, tansmitted through space it has dual character exhibit particle as well as wave.

Ex: Visible light, UV-radiation, IR-radiation.

• PROPERTIES OF ELECTROMAGNETIC RADIATION:

- Wave length: It is the distance b/w two adjacent peak (crests) of particular wave.
- Wave Number: it is the reciprocal of wave length expressed in cm.
- frequency: It is the no of wave which can pass through a point in 1 second.

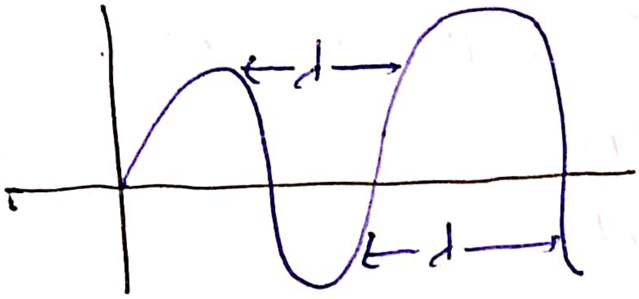
- **Energy:** Electromagnetic radiation consists of packets of pure energy called quanta or photon

$$\boxed{\nu = \frac{c}{\lambda}}$$

$$\boxed{\bar{\nu} = \frac{1}{\lambda}}$$

$$\boxed{E = h\nu = mc^2}$$

ν = frequency
c = velocity of light
$\bar{\nu}$ = wave no.
λ = wave length
E = energy, h → plank constant
$h\nu$ = packets of energy
m = mass of particle.



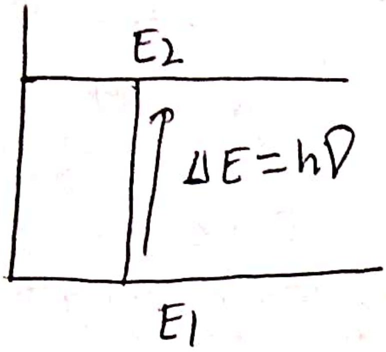
Wave motion

- The electromagnetic Spectrum is the arrangement of electromagnetic radiation.
- In order of there increasing wave length or decreasing frequency.
- Visible light: Visible light occurs in. (4300Å – 6900Å)

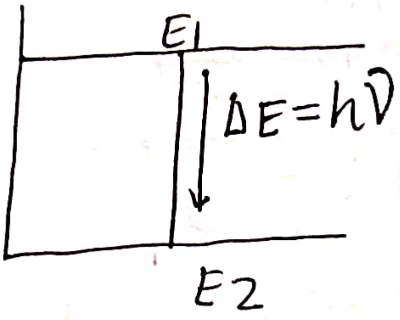
- **ORIGIN OF SPECTRA:** when light radiation is passed through a sample of an compound then some wave length absorbed have certain / fix frequency.
- But in some transition energy emitted. Thus they form emission Spectrum and absorption

Spectrum.

- In absorption Spectrum some dark line (band)



Absorption spectrum



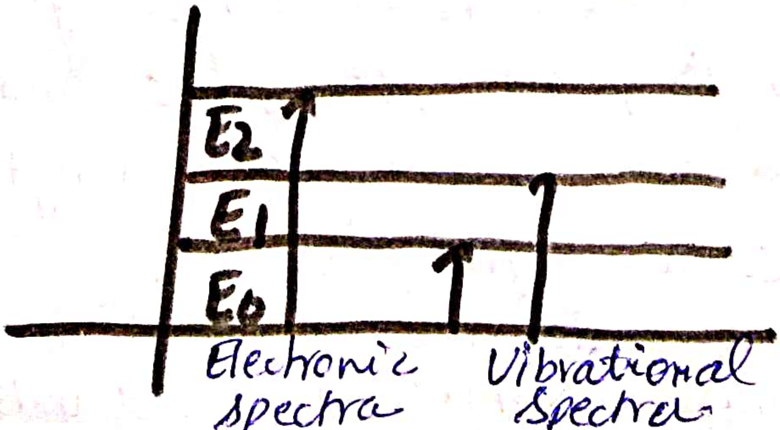
Emmision Spectrum

• TYPES OF ENERGY

The total energy of molecule in the sum of

1.) Transistional energy (E_t)
2) Rotational energy (E_r)
3.) Vibrational energy (E_v)
4.) Electronic energy (E_e)

- E_r arrises when molecule rotate about an axis
- E_v is due to and fro motion of the molecule
- E_e is arrises transition of an electron from ground state energy level to excited state energy.
- E_t is very small thus it is not ~~envol~~ envolve in spectrum.



Types of Spectroscopy

Ultraviolet or Visible Spectroscopy

- it is use to measure the no of conjugated double bonds in molecules.
- It's region - 200-750nm.
- It envolve the transition of electrons from ground state to excited state.

(a) Electronic Transition: ~~This~~ It envolve absorption of ultraviolet radiation shows / carriedout following Transition.

(i) σ to σ^* Transition: It require large energy and absorption occurs b/w 120 to ~~12~~ 200nm range.

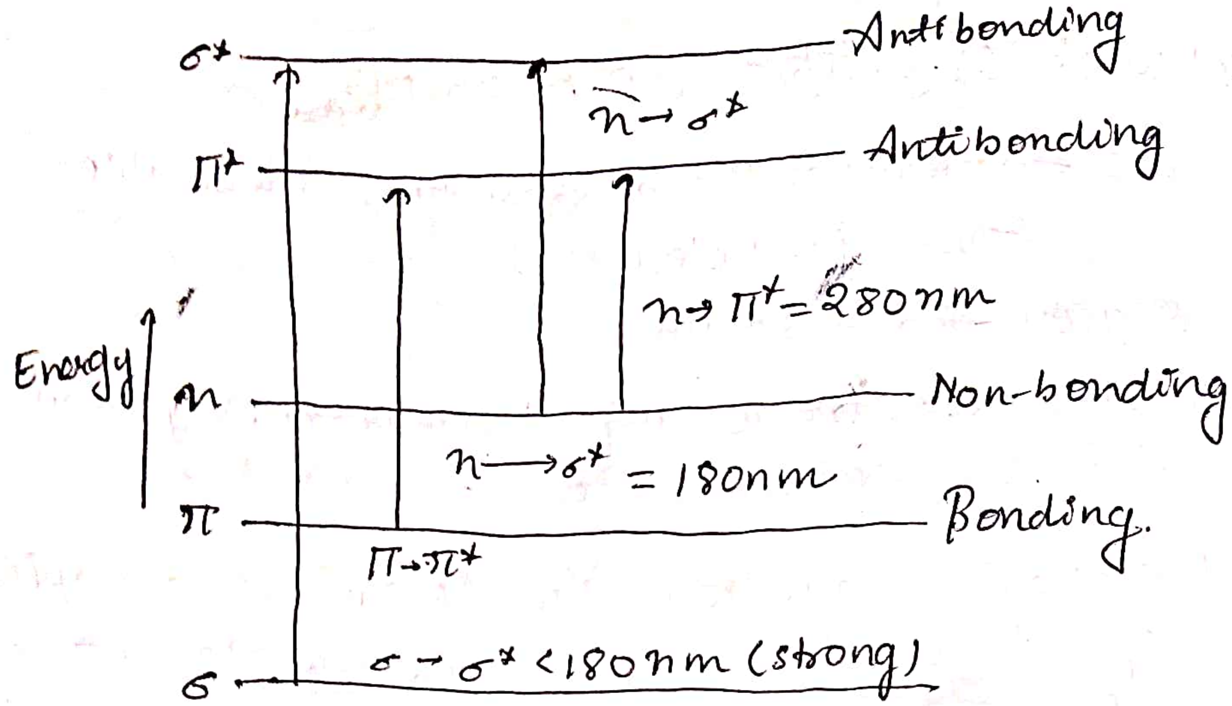
(ii) π to π^* Transition: It occures in compounds having double (=) or triple bond (≡). It require smaller energy thus occures b/w 170 to 190nm range.

(iii) n to π^* Transition: It occurs in compounds containing double bond (=) and hetro atoms: (Anilene, pyrol). It required smaller energy and longer wave length becouse non-bonding electrons are held loosely (ढीले)

They occurs b/w 180-280nm range.

(iv) n to σ^* Transition: It envolve the transition of electron of unshared pair thus it occurs in saturated halodes. alchole OH, ether, R-O-R etc.

- It require lesser energy.



- ~~Oxochrome~~:

(b) Chromophores: They are colourcarrier, defined as co-valent Unsaturated Species that shows a characterstricks absorption in U-V region.—

→ ~~ex~~ choromophores which contain π electron undergo π to π* transition. ex: $C=C$, $C \equiv C$

→ Chromophores Contains. π e- aswell as non-bonding electrons. undergo ~~ex~~ n to π*, $C=O$, $C \equiv N$

(C) Oxochrome:/ Auxochrome: They are defined as the Species brings a shift of absorption band ~~when~~ to longer wave length.

- They are colour Enhancing group.

ex: $-OR$, $-NH_2$

ex: Benzene shows absorption at 255 ~~a~~nm ~~at~~ With ϵ_{max} 203. But in Anilene it is at

Emax 280 nm with Emax 1430. Thus Amino group is Oxachrome.

(i) Absorption shift:

(i) Bathochromic Shift: It occurs due to the Presence of oxochrome or change in polarity of solvent. En: Conversion to phenol to phenolate ion causes. Bathochromic shift (n to π* transition)

(ii) Hypsochromic shift (blue shift): It occurs due to Increase in Polarity of solvent or removal of conjugation.

- It causes shift of absorption maximum to (Emax) Shorter wave length.

ex: Aniliene absorbed at 280nm. But In acidic solution blue shift occurs. and absorption occurs at 203 nm.

(iii) Hyperchromic shift: It occurs due to increase in Intensity of absorption maximum (Emax) ex: β band (π→π* Transition) for pyridine at 257 nm with Emax 2750 shift to 262nm with Emax 3560 (methyl pyridine)

(iv) Hypochromic Shift: It occurs due to decrease in intensity of absorption maximum (Emax) ex: Benzene absorb 230 nm with Emax 11600 shift to 224 nm with Emax 8700 (Benzoate)

Cont

Q- ~~Predict~~ Give the Basic principle. of Uv spectroscopy explain Various types of Electronic Transition
9 predict electronic transition in Acetaldehyde

CH_3CHO

**

• Lamber't Beer Law -

It explain the quantitative Analysis of Uv spectroscopy. it is represented as

$$\boxed{A = \varepsilon c l}$$

A = absorbance at specific wave length
ε = molar Absorptivity
C = concertation.

• <u>for two Solution</u>

$$\boxed{\frac{A_1}{A_2} = \frac{C_1}{C_2}}$$

• For a Solution of campher in hexane in a 10cm cell the absorbance(A) was found to be 2.52 at 295 nm with $\varepsilon_{max} = 14$ what is the concentration of campher

we know that
$A = \varepsilon c l$

$l = 10cm$
$A = ?$
$\varepsilon_{max} = 14$

~~$A = 14x$~~

$$\frac{A_1}{A_2} = \frac{C_1}{C_2} = \frac{2.52}{295} = C$$

$C = 8.5 \times 10^{-3}$ M.

~~A =~~

$A = 14 \times 8.5 \times 10^{-3} \times 1.0$

$A =$

• -IR (INFRARED) SPECTROSCOPY
[VIBRATION SPECTROSCOPY]

- It used for detection of functional groups in pure compounds and mixtures.
- It envolve Transition ~~b/w~~ shifting vibrational and rotateonal energy level of molecule in range of (650- 4000cm^{-1})
- Infra red radiation do not have sufficient energy to cause the excitation of electrons.
- It causes atoms and groups of atoms ~~of~~ to vibrate.
- Some find structures obtained known as do