General principle & isolation of elements. ①

Mineral :-

→ Metal in combained state in other impurities present in the mines are known as Minerals.

Ex :- Bauxite → $Al_2O_3 \cdot 2H_2O$.

Haematite → Fe_2O_3

Magnesite → $MgCO_3$.

Dolomite → $MgCO_3 \cdot CaCO_3$

Epsom salt → $MgSO_4 \cdot 7H_2O$

Rock salt → $NaCl$.

Chile salt petre → $NaNO_3$.

Copper glance → Cu_2S

Copper Pyrite → $CuFeS_2$

Cinabar → HgS.

Pyrolusite → MnO_2

Ore :-

Ore is a mineral from which metal can be extracted economically.

Ex :- Bauxite → $Al_2O_3 \cdot 2H_2O$.

Haematite → Fe_2O_3.

Dolomite → $MgCO_3 \cdot CaCO_3$.

Copper pyrite → $CuFeS_2$.

From the above definition it is clear that all ores are minerals but all minerals are not ore.

General Metalurgical Operation :—

General metalurgical operation involved following steps.

→ Ore dressing. crushing and Grinding

→ Ore, concentration.

→ Conversion of concentrated ore in to Metal oxide

→ Reduction of metal oxide in to metal.

→ Metal refining.

→ Ore dressing, crushing & Grinding :—

→ At first the ore obtained from mines it processed for dressing, followed by crushing in a jaw crusher, to form small pieces of ore.

→ The small pieces of ore is allowed to entered a ~~bulb in~~ ball mil or stamp mill to form powder ore. (Grinded).

Concentration of Ore :—

→ The phenomenon of removal of maximum gangue. (impurities) from the ore is known as concentration of ore. It can be done by the any of the following process.

~~Gravitation~~ → Gravity separation process.

→ Magnetic separation process.

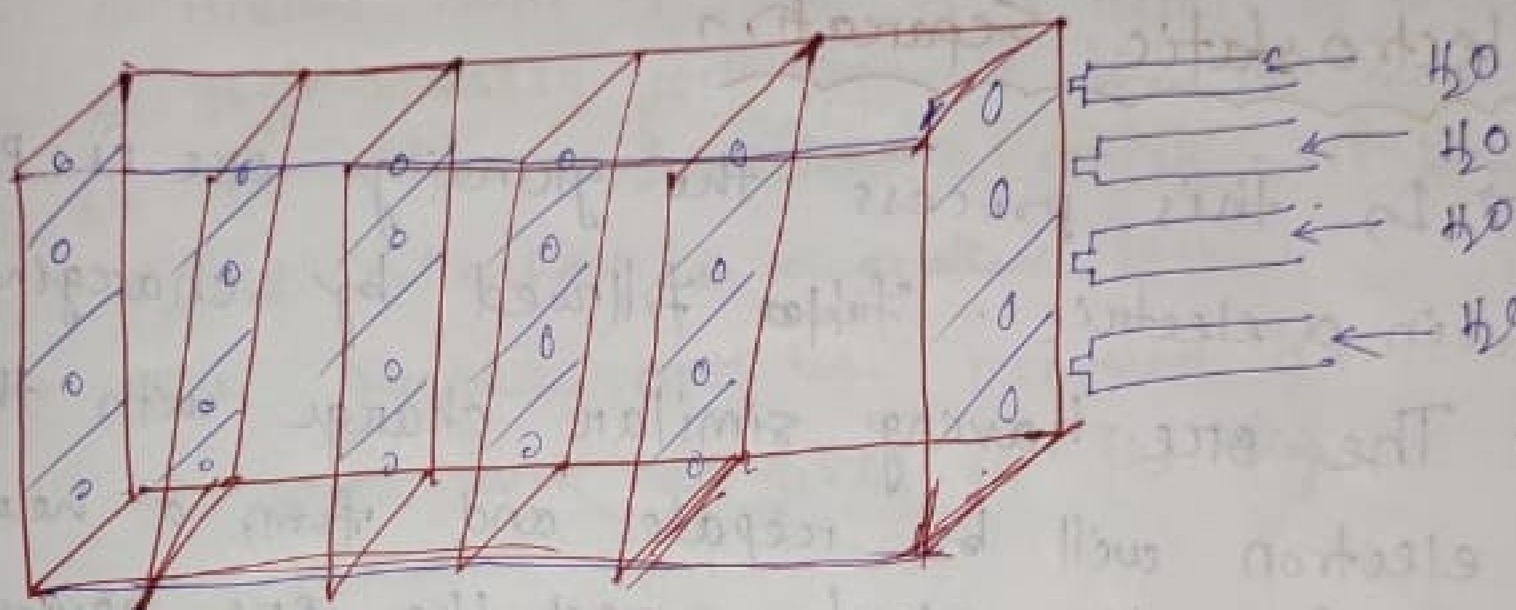
→ Electrostatic Separation process.

→ Froath & Floatation. Process.

→ Liquation Process.

→ Chemical Process.

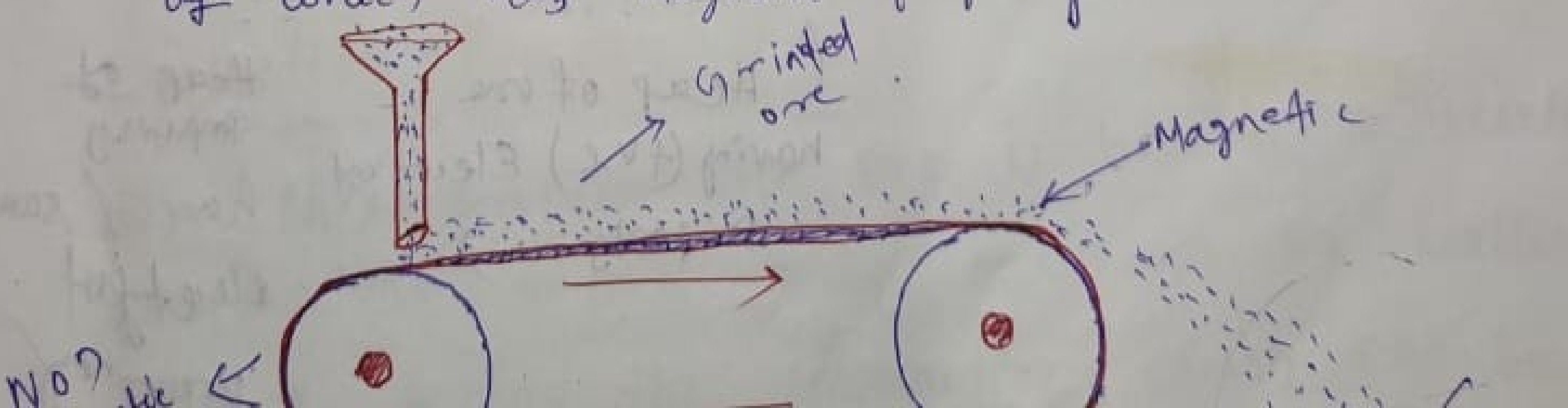
on a large concretey table having transverse ridges, Water with high pressure will be supplied from one end, as a result of which light impurities will be wash out leaving the concentrated one at the bottom of the ridges.



Ex:- The ores like Fe_2O_3 (Haematite), Tin stone (SnO_2) etc. can be concentrated by this process because here the ore differ in specific gravity (Weight) from its impurity.

Magnetic separation Process :-

→ In this process the grindend ore is placed on a wide belt moving between two pully. One of which has magnetic property.



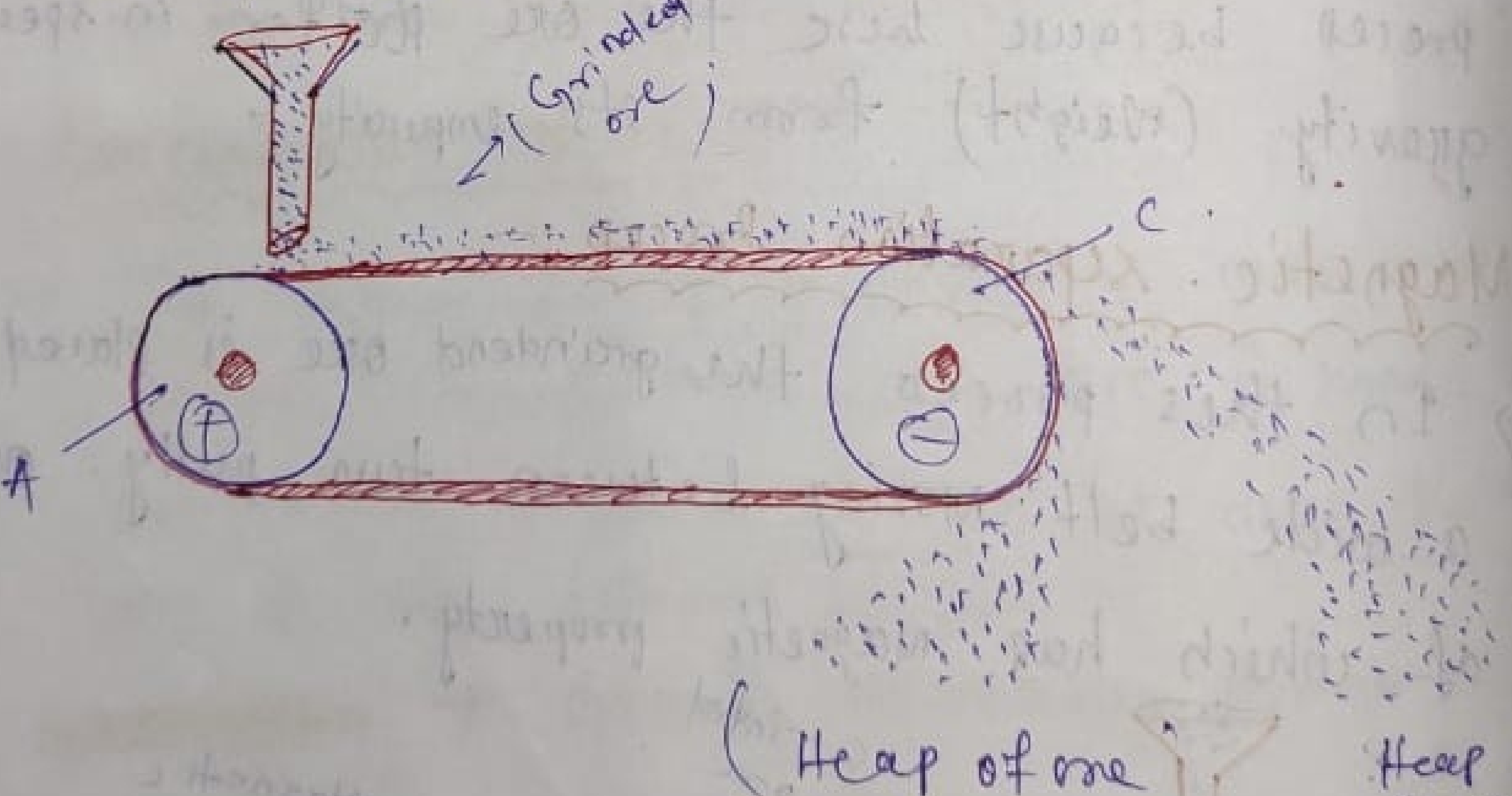
→ The grinded ore having ... away from it to produce heap of impurities away from it to.

Ex:- $FeWO_4$ (Iron Tongstate) $MnWO_4$ — $FeO\,Cr_2O_3$ (chromite), can be separated by this process because the ore differ by magnetic property from gangue.

Electrostatic Separation

→ In this process the grinding ore is placed in a electric field followed by charging

→ The ore having similar charge with the electron will be repale and from a heap away from the electro, and the ore having opposite charge will be attracted and from a heap near it. as given in the figure.



(Heap of one having (+ve) Electrical property)

Heap of impurity having same electrical

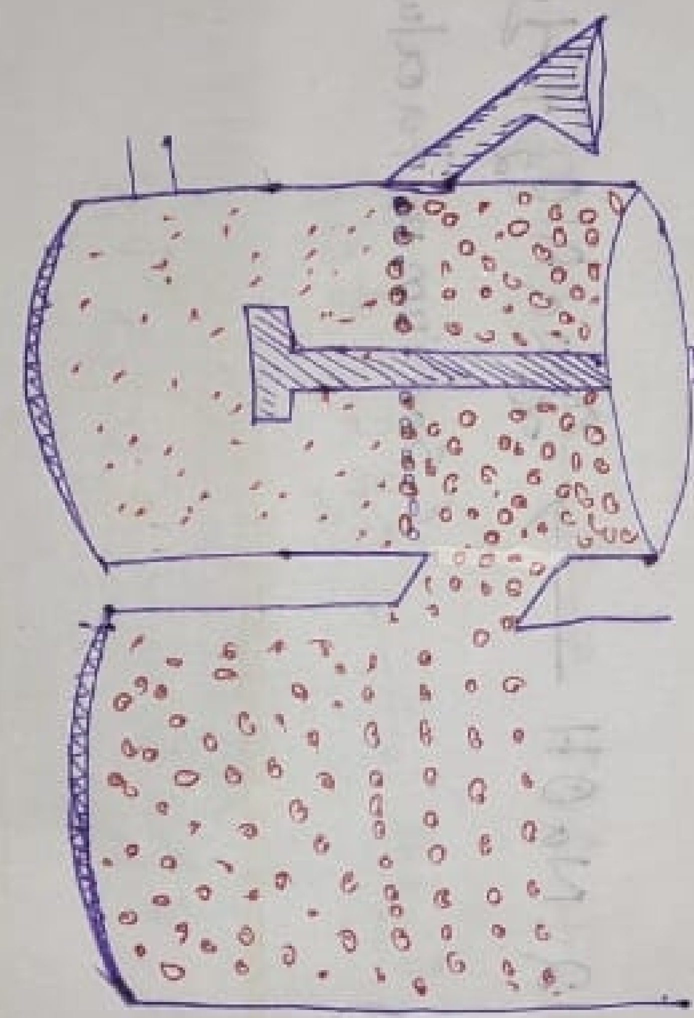
Pbs attracted by elect

Frooth Floatation Process :-

In this process the grinded ore will be mixed with water some pine oil and few acetic acid in a tank.

→ The mixture will be constant-ly agitated by continuous supply of air as a result of which sulphide ores will come out from its surface in the form of frooth which will be ~~collect~~ collected in a another tank.

→ The gangue will be removed at the bottom of same tank as given in the figure.



Sulphides ores like copper pirites ($CuFeS_2$)

Liquation Process:-

In this process the ore is heated with certain temperature where only ore will be malted. leaving behind the impurities. which can be collected and separated by any physical process..

Ex:- Ores of antimony, arsenic etc can be concentrated by this process.

Chemical Process (Leaching)

In this process the ore will be treated with a suitable reagent in which ore will be desolved and the impurities remain as such.

→ After suitable physical process like filteration the filtrate containing ore will be reprocessed ~~will be filtrate~~. to get concentrated ore.

Ex Impure alumina can be purified and concentrated by addition of NaOH followed by treatement with water and heating.

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$

(Impure) (Sodium metaaluminate)

Conversion of concentrated ore into Metal oxide:-

→ Concentrated ore can be converted in to metal oxide by any of the following process.

→ Calcination

→ Roasting.

Calcination:-

→ The phenomenon by virtue of which concentrated ore will be heated strongly in limited supplied of air to form metal oxide. is known as calcination.

→ Calcination can be carried out in riverberatory furnace.

→ Generaly the ore containing oxygen undergoes calcination.

Ex

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$
(Calcium oxide)

$$CuCO_3 \xrightarrow{\Delta} CuO + CO_2$$
(Cupric oxide)

$$FeCO_3 \xrightarrow{\Delta} FeO + CO_2$$

$$Al_2O_3 \cdot 2H_2O \rightarrow Al_2O_3$$

$$2Fe_2O_3 \longrightarrow 4FeO + O_2$$

→ During the process of calcination.

1) Volatiles materials; water of crystalisation.

2) Concentrated ore will be converted in to its metal oxide.

3) The impurities like sulphure, As, P, Sb. will be removed as their oxide

$SO_2 \uparrow$, $As_2O_3 \uparrow$, $P_2O_3 \uparrow$, $Sb_2O_3 \uparrow$.

→ The ore becomes porous.

Roasting:—

→ The phenomenon by virtue of which concentrated ore will be heated strongly in sufficient supplied of air to form metal oxide is known as.

→ Non-oxide ore will be normally carried out by roasting.

Ex:– $2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$

$2FeS + 3O_2$

The process of roasting following changes occure

1) Volatile materials moisture, water of crystal etc. will be removed.

2) The impurities like sulphur, As, Sb will be combine with oxygen to form their volatile oxide which can be remove as follows.

$S + O_2 \longrightarrow SO_2 \uparrow$.

$4As + 3O_2 \longrightarrow 2As_2O_3 \uparrow$.

$P_4 + 3O_2 \longrightarrow 2P_2O_3 \uparrow$.

$4Sb + 3O_2 \longrightarrow 2Sb_2O_3 \uparrow$.

The ore become porous . or pass of air.

Conversion of metal oxide in to metal :-

Metal oxide can be converted in to metals by any of the following process

- → Reduction by Carbon & CO.
- → Reduction by hydrogen. (H_2).
- → Reduction by water gas (H_2 + CO)
- → Reduction by Na & Mg.
- → Reduction by Al.
- → self reduction.
- → Electrolysis reduction.

Reduction by carbon & CO.

Metals like Ca, Fe, Zn, Cu can be reduced by carbon, & CO. as follows.

$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$.

$FeO + C \rightarrow Fe + CO$.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

$$FeO + CO \rightarrow Fe + CO_2$$

$$ZnO + C \rightarrow Zn + CO$$

$$ZnO + CO \rightarrow Zn + CO_2$$

$$CaO + C \rightarrow Ca + CO.$$

$$CaO + CO \rightarrow Ca + CO_2$$

Metals like WO_3 can be reduced by hydrogen as follows.

$$WO_3 + 3H_2 \longrightarrow W + 3H_2O$$

Reduction by Water gas :-

The metals like nickel can be reduced by water gas as follows.

$$NiO + H_2 \longrightarrow Ni + H_2O$$

$$NiO + CO \longrightarrow Ni + CO_2$$

$$2NiO + (H_2 + CO) \longrightarrow 2Ni + H_2O + CO_2$$

(water gas)

Reduction by Na & Mg.

The metals like Ti, V etc can be reduced by sodium or magnesium from their chlorides as follows.

$$TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$$

$$VCl_4 + 2Mg \longrightarrow V + 2MgCl_2$$

Reduction by aluminium

The metals like chromium, manganis etc can be reduced their metal from their oxide.

$$Cr_2O_3 + 2Al \longrightarrow 2Cr + Al_2O_3$$

$$3Mn_3O_4 + 8Al \longrightarrow 9Mn + Al_2O_3$$

Self Reduction

→ Metals like copper can be reduced from its oxide ore in presence of sulphite ore that means cuprous oxide will be mixed with cuprous sulphide to form Cu. as follows;

$$2Cu_2O + Cu_2S \longrightarrow 6Cu\downarrow + SO_2$$

$$2HgO + HgS \longrightarrow 3Hg + SO_2$$

Electrolytic Reduction

Metals like Na, Al etc can be reduce by electrolytic process as follow.

$$NaCl \rightarrow Na^+ + Cl^-$$

At cathode

$$Na^+ + e \rightarrow Na \downarrow$$

Metal Refining

The phenomenon of gating pure metal from impure metal is known as refining it occure by any of the following cases.

1) Distillation
2) Liquation
3) Poling
4) Cupellation
5) Electrolytic refining
6) Vapour phase refining
7) Zone refining
8) Van Arkel's Method.

In this process low melting metals can be purified the impure metal will be heated to a certain temperature as a result of which only metal will be vapourise leaving behind the impurities

→ The vapours of Metal will be condensed to get pure Metal.
→ Metals like Zn, Hg, etc. will be refined by this process.

Liquation :-

→ In this process impure Metal will be treated with a suitable reagent which can dissolved only metal leaving behind the impurities.
→ After filtration and subsequent processing we will get pure metal.

Ex Metals like Pb, Bi, etc will be refined by this process.

Poling :-

→ In this process reducible oxide present in the metal can be removed. Where the impure metal will be heated in a shallow hearth reverberatory furnace and a log of wood is deeped in to & constantly agitated. As a result of which Metal oxide will be reduced, to get 100% pure Metal.

Ex:- Cu can be refined by this process.

Cupellation :-

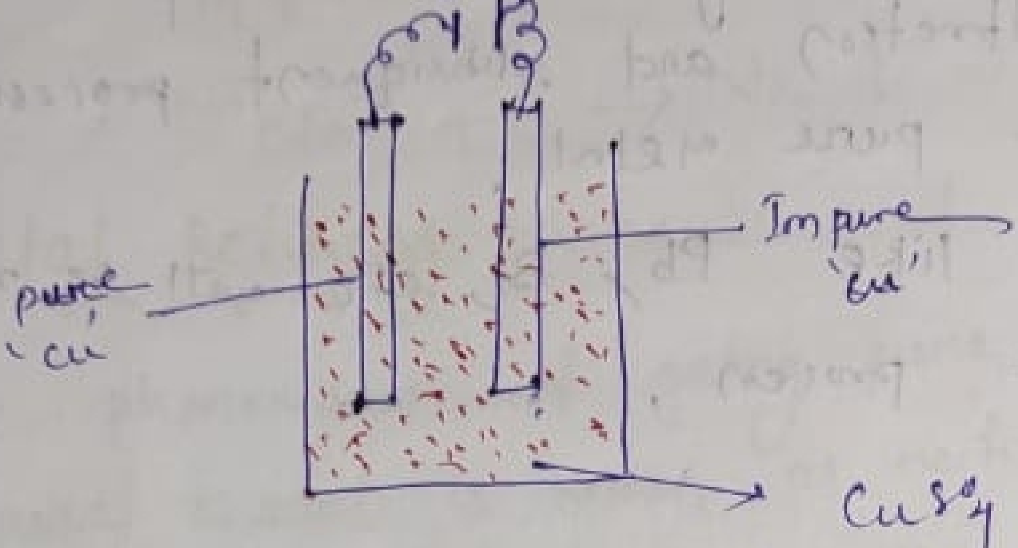
→ In this process the metals are heated strongly in small boat shaped dish. where the impurities will be oxidised to volatile oxide. leaving behind the pure metal.

Ex: Gold, Pt, Si, etc will be refined by this process

Electrolytic Refining

In this process impure metal is taken at anode and pure metal is taken as cathode and electrolyte is used containing that metal. By the passage of electricity metal from anode migrate to cathode, leaving behind the impurities.

→ Cu, Zn etc can be refined by this process.



Vapour phase Refining :— (Mond's process)

→ The impure metal in this process the impure metal will be reaction with a suitable reagen in vapour phase where only metal will react to form a compound which will be reprocessed to form pure metal.

Ex :— The metals like Ni, can be refined by this process.

Zone Refining :—

In this process metals which are required in very purity can be refined.

Ex- Si, Ge, B etc..

→ In this process the impure metal is cast in to a thin bar . Zone of bar is malted by circular mobile heater. in the atmosphere of inert gas like Ar

→ As the heatter moves ~~slowly~~ slowly the impurities also move in to the adjcent molten part. and Finally in to one end.

→ Thus the metal will be purified.

Van Arkel's Method :—

In this method metals like Ti, Zr, etc. can be purified. or refined where the impure metal will be treated with a suitable reagent which only react with the metal to form a compound.

→ Such compound will again re process to get pure metal.

$$\underset{\text{(Impure)}}{Ti(s)} + 2I_2(s) \xrightarrow{573\,K} TiI_4$$

$$TiI_4 \xrightarrow{1200\,K} \underset{\text{(Pure)}}{Ti} + 2I_2$$

$$\underset{\text{Impure}}{Zr(s)} + 2I_2 \xrightarrow{673\,K} ZrI_4 \xrightarrow{2073\,K} \underset{\text{Pure}}{Zr} + 2I_2$$

INORGANIC CHEMISTRY

ALLOY (মিশ্ৰধাতু)

Alloys :- An alloy is a homogeneous solid obtained by melting two or more metals or metals and non metals.

Classification :-

The alloys are classified under two heads.

(i) **Ferrous alloy :-** The alloys which contain iron as major component are called ferrous alloys.
Ex:- Ferrochrome (Fe + Cr), steel

(ii) **Non ferrous alloys :-** The alloys which do not contain iron are called non ferrous alloys.
Ex:- Brass (Zn + Cu), Bronze (Cu + Sn)

* **Amalgam :-**
When one of the constituent metal of an alloy is mercury, it is known as amalgam.

Importance of alloy :-
Pure metal posses few important physical and metallic properties such as melting point, boiling point, density, high malleability, ductility and heat and electrical conductivity. These properties can be modified and enhanced by alloying it with some other metal or nonmetal according to the need.

(17) Composition and uses of some important alloys :-

(1) Alnico :- Composition → Iron = 50%
Aluminium = 8 - 12%
Nickel = 15 - 25%
Cobalt = 5 - 24%

Uses :- Alnico magnets are widely used where strong permanent magnets are needed.
→ It is used as electric guitar pickups, microphones, loud speaker, magnetron tubes etc.

(2) Duralumin :- Composition → Aluminium = 94
Copper = 4.5 - 5%
Magnesium = 0.5 - 1.5%
Manganese = 0.5 - 1.5%

Uses :- It is used as automobile and aircraft body part.
→ It is also used as military equipment.

(3) Brass :- Composition
Copper = 65 - 90%
Zinc = 10 - 35%
Uses :- It is used as door locks and bolts, brass musical instruments, central heating pipes.

(4) Bronze:- Composition (18)

Copper = 78-95%
Tin = 5-22%

Uses: It is used as decorative statues and musical instruments.

(19)

FUEL

Fuel may be defined as any substance which on combustion release a large amount of heat energy without producing excess residue.

Classification:-

1→ Natural or primary fuels:- Such fuels are found in nature as such.
Ex:- wood, coal, petroleum, natural gas etc.

2→ Artificial or secondary fuels:- Such fuels are prepared from primary fuels.
Ex:- coke, Kerosene petrol, coal gas, water gas, producer gas etc.

Another classification (based on Physical state) -

1→ Solid fuel. wood coal etc.
2→ Liquid fuel. Diesel, petrol Kerosene etc.
3→ Gaseous fuel. water gas, LPG, CNG etc.

Calorific value:-

The amount of heat energy released by the complete combustion of one gram of the fuel.

Units of calorific value:-

The calorific value is generally in calories/gram or Kilocalories/Kilogram or British Thermal unit (BTU).

Characteristics of good fuel:-

1→ It should have high calorific value.
2→ It should leave only small amount of residue or ash when burnt.
3→ The ignition temperature should be moderate.
4→ It should contain minimum quantity of moisture.
5→ It should have controllable combustion rate.
6→ product of combustion should not be harmful.
7→ It should be cheap and easy to transport.

Solid fuel:-

1) **Wood:-** Wood is a very common Solid fuel.

(21) composetion:-

Carbon = 50 %
Oxygen = 35 %
Nitrogen = 7 %
Hydradgen = 6 %
Ash = 2 %

Calorific value :- 3500 - 4500 KCal/kg

2-> Coal:- Coal is formed on the materials of vegetable origen under the solid durcng millions of years under the influence of high temp. and pressure. Coal usually contains carbon, Hydrogen, oxygen along with the small amount of nitrogen and sulphur.

Defferent types of coals are:-

1-> Peat:- carbon = 60 %
Hydrogen = 6 %
Oxygen = 34 %

Calorific value = 5400 KCal/Kg

(22)

2) Lignite:- It is called brown coal.
Carbon = 67%
Hydrogen = 5.2%
Oxygen = 27.8%.

Calorific value:- 5500 - 7000 KCal/Kg

3) Bituminous:- Carbon = 90%.
Hydrogen = 5%.
Oxygen = 5%.

Calorific value - 8000 - 8500 KCal/Kg

4) Anthracite:- It is very hard.

Carbon = 94%.
Hydrogen = 3.5%.
Oxygen = 2.5%.

Calorific value:- 8600 - 8700 KCal/Kg

Liquid fuel:

Petroleum or crude oil:-

Carbon = 79.5 - 87.1 %.
Hydrogen = 11.5 - 14.8 %.
Sulphur = 0.1 - 3.5 %.
Nitrogen & oxygen - 0.1% - 0.5%.

(23) **Petrol:-** C = 84 %
H = 15 %
N + S + O = 1 %
Calorific value :- 11250 Kcal/kg

Kerosene: C = 84 %
H = 16 %
S ≤ 1 %

Calorific value :- 11100 Kcal/kg

Diesel :- C = 85 %
H = 12 %
Rest = 3 %

Calorific value :- 11000 Kcal/kg

Gaseous fuel :-

Producer gas :-
It is essentially a mixture of combustible gases, carbon monoxide and hydrogen associated with large percentage of non combustible gases, N_2, CO_2 etc.

→ It is prepared by passing air mixed with a little steam over a red hot coal or coke bed maintained ~~with~~ at about 1100°C in a special reactore.

Average compositeon:-

$CO = 22 - 30\%$

$H_2 = 8\text{-}12\%$

$N_2 = 52 - 55\%$

$CO_2 = 3\%$

calorific value = 1300 Kcal/m^3

Uses:- It is used

(i) for heating open hearth furnaces

(ii) as a reducing agent in metallurgical operations.

Water gas:- It is a mixture of combustible gases CO, and H_2 with a little non combustible gases CO_2 & N_2.

→ It is made by passing alternatevely steam and little air through a bed of red hot coal or coke maintained at about 900°C to 1000°C in a reactor.

composition:- $H_2 = 51\%$

$CO = 41\%$

$N_2 = 4\%$

$CO_2 = 4\%$

(25) Calorific value - 2800 Kcal/m^3

Uses:- It is used as
(i) a source of hydrogen gas
(ii) an illuminating gas
(iii) a fuel gas
(iv) used for welding purposes.

Liquefied Petroleum Gas (LPG):-

LPG can be obtained as a by product during cracking of heavy oils or from natural gas.

Average composition:-

n-butane = 27%
iso butane = 25%
Butene = 43%
Propene = 2.5%
Propane = 2.5%

Uses:-

→ It is mainly used as a domestic fuel and industrial fuel.
→ Now a days it is also used as a motor fuel.

Compressed Natural Gas:- (CNG)

(26)

It is a natural colourless gas and ~~col~~ odourless mixture of gases which is obtained from the upper portion of the petroleum deposition.

Average composition:

Methane (CH_4) = 70-90 %
Ethane (C_2H_6) = 4-9 %.

Traces of propane and butane

Uses:

→ It is used as a fuel for vehicles
→ It is also used as domestic and industrial fuel.
→ It is used as a source of carbon used in tyre industry.
→ It is used for the production of hydrogen gas needed in the fertiliser industry.

D. POLYMERS

(1) What is polymers?

Ans- The process in which a large no. of simple molecule (called monomers) get united or condensed to form of a high molecular mass compound is called polymerisation. The high molecular mass compound form is called a polymer.

Ex:-

1) $[H_2C=CH_2] \xrightarrow[\text{Polymerisation}]{\text{Addition}} [CH_2-CH_2]_n$

(Ethene) (Monomer) — (Polyethene) (Polymer)

(2) How polymers are classified.

Ans- On the basis of origine, polymers are of two types (i) Natural polymer
(ii) Syntetic polymer.

(i) Naturcal Polymers

→ These are the polymers having natural origine

Ex:- Starch, cellulose, protein, coir, jute, natural rubber etc.

(ii) Syntetic Polymers

→ These are the man made polymers that havebeen synthesized in the labrotory.

Ex:-

Polyethene(PE), Polyvinylchloride (PVC), Bakelite Polytetrafluoroethene(PTFE) or teflon.

On the basis of their mode of formation polymers are of two types

(i) Addition Polymers

These polymers which are obtained from their monomers through simple chemical union without elimination of H_2O / HCl etc like in organic molecules are called addition polymers

Ex:-

Polyethene (PE), Polyvinylchloride (PVC) Poly tetrafluoroethene(PTFE) teflon, Polychloroprein (Neoprene), Buna-S, Buna-N, Polyacrylonitrile (PAN/ORLON)

Condensation Polymer:

Those polymer which are obtain their monomer with elimination of of H_2O / HCl etc like in organic molecules are called condensation polymer.

Ex:- Nylon 6,6, Nylon 6,10, Terrylene, Bakelite (PF resin), Nylon 6 (Perlon-L), MF resin (Melmac)

On the basis of the nature of monomeric units, polymers are of two types

(i) Homopolymers

Those polymers which are obtained from only one type of monomeric units are called homo-polymers.

Ex:-
PE, PVC, Teflon, Neoprene (Polychloroprene) PAN etc.

(ii) Copolymer:-

those polymers which are obtained from more than one monomer are called co-polymers

Ex:- Buna-S, Buna-N, Nylon-6,6, Nylon 6,10, Bakelite (PF resin), Terylene etc.

On basis of strength of intermolecular force among polymer change these are of 4 types

(i) Elastomers:-

In such type of polymers, the force of attraction among polymer chains is weakest. So these are stretchable.

Ex:-
Buna-S, Buna-N, Polychloroprene (Neoprene) etc.

(ii) Fibres

In such type of polymes very strong intermolecular force is found among polymers chains. So these are not stretchable.

Ex:-
Nylon 6,6, Nylon 6,10, Nylon 6, terylene etc ORLON.

(iii) Thermoplastics

In this type of polymers strength of intermolecular force among polymer chains is in bet elastomers and fibres.

Ex:
PVC, teflon etc.

→ Such polymers on heating becomes a resinous mass and hence can be remolded.

(iv) Thermosetting Plastics

→ In this type of polymers strength of intermolecular force among polymer chains is in betⁿ fibres and thermoplastics.

→ Such polymers when heated sets to a hard mass.

Ex:
Bakelite (PF resin), Melmac (MF resin).

N.B.
The order of force of attractions among polymer chains

{fibres > Thermosetting plastics > Thermoplastics > Elastomers}

(B) Write down the formula and give uses of following polymers.

(i) Nylon 6,6.

Formula:

$$-\left[NH-(CH_2)_6-NH-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}\right]_n-$$

Uses
(i) As a synthetic fibre
(ii) for making Nylon grip tyre chords
(iii) for making blisters on brushes
(iv) for making ropes, nets, of high tensile strength

Refan

$$n\,H_2N-(CH_2)_6-NH_2 + n\,HO-\overset{}{\underset{O}{\underset{\|}{C}}}-(CH_2)_4-\underset{O}{\underset{\|}{C}}-OH$$

(Hexamethylene diamine) (Adipic Acid)

↓ Condensation Polymerisation $-n\,(H_2O)$

$[-NH-(CH_2)_6-NH-\overset{O}{\overset{||}{C}}-(CH_2)_4-\overset{O}{\overset{||}{C}}-]_n$

nylon-6,6

(ii) Nylon 6,10

formula

$[NH-(CH_2)_6-NH-\overset{O}{\overset{||}{C}}-(CH_2)_8-\overset{O}{\overset{||}{C}}-]_n$

Uses

Same as nylon 6,6

Ref

$n[H_2N-(CH_2)_6-NH_2] + n[Cl-\underset{O}{\underset{||}{C}}-(CH_2)_8-\underset{O}{\underset{||}{C}}-Cl]$

(Hexamethylene diamine) — Sebacoyl chloride

↓ condensation polymeraition $-n(HCl)$

Nylon 6,10 $[NH-(CH_2)_6-NH-\overset{O}{\overset{||}{C}}-(CH_2)_8-\overset{O}{\overset{||}{C}}-]_n$

(iii) Nylon 6 (Perlon-L)

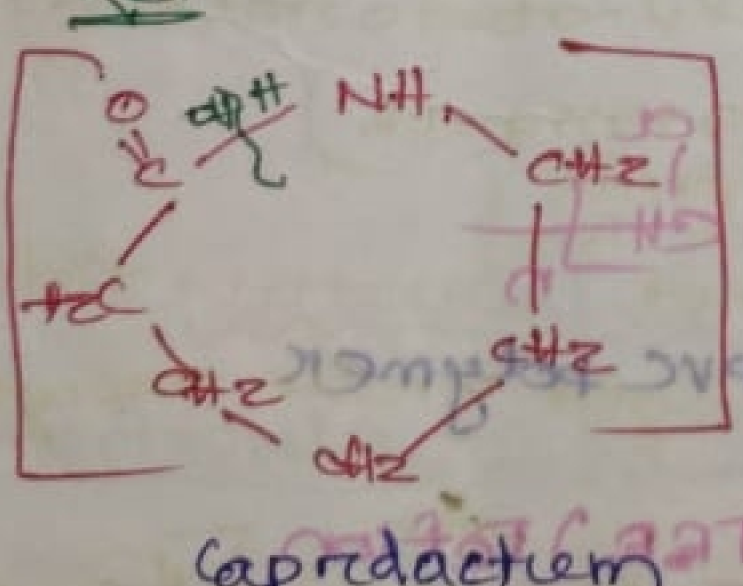
formula

$[NH-(CH_2)_5-\overset{O}{\overset{||}{C}}]_n$

Uses

Same as nylon 6,6

Ref



Caprolactam

$\xrightarrow{H_2O}$ $n[H_2N-(CH_2)_5-\overset{O}{\overset{||}{C}}-OH]$

amino caproic acid

↓ condesation polymerasation $-n(H_2O)$

Nylon 6 $[NH-(CH_2)_5-\overset{O}{\overset{||}{C}}]$

N.B-

Nylon-6 / Nylon 6,6 / Nylon 6,10 are some polymers belonging the class of polyamides.

(iv) Polyethene (PE)

formula

$[CH_2-CH_2]_n$

Use

(i) As a packing material.
(ii) for making polyethenes bags,
(iii) for making Rainy coats
(iv) for making water proofing substances
(v) for making electrical insulating materials

(v) Poly vinyl chloride (PVC)

formula

$[CH_2-\underset{|}{\overset{Cl}{CH}}]_n$

Use

(i) for making PVC pipes
(ii) for making PVC doors
(iii) for making electrical insulating materials
(iv) for making sanitary goods

Ref

$n\,(H_2C=\overset{Cl}{CH}) \xrightarrow{\text{Add}^n \text{ Poli}^n} [CH_2-\overset{Cl}{CH}]_n$

Vinyl chloride (Monomer)   PVC polymer

(vi) Polytetrafluoroethene (PTFE) Teflon

formula

$[CF_2-CF_2]_n$

Uses

(i) For making gasket material (which can withstand high temp)
(ii) For making teflon tape
(iii) For non-stick coating on cooking utensils.

Ref

$$n(F_2C = CF_2) \xrightarrow{\text{Add}^n \text{ Poly}^n} [CF_2 - CF_2]_n$$

(1,1,2,2 - tetrafluoro ethene) — (Polytetrafluoroethene PTFE) (Polymer teflon)

(VII) Polychloroprene (Neoprene)

Formula

$$[H_2C - \overset{Cl}{\overset{|}{C}} = CH - CH_2]_n$$

Use

(i) For making tyres, tubes, oil seals.
(ii) For making seat cover, seat belts
(iii) It is synthetic rubber.

Ref

$$n(H_2C = \overset{Cl}{\overset{|}{C}} - CH = CH_2) \xrightarrow{\text{Add}^n \text{ Poly}^n} [H_2C - \overset{Cl}{\overset{|}{C}} = CH - CH_2]_n$$

(2-chlorobuta-1,3-diene) (chloroprene) — (Polychloroprene or neoprene)

(VIII) Natural Rubber (Polyisoprene)

Formula

$$[H_2C - \overset{CH_3}{\overset{|}{C}} = CH - CH_2]_n$$

Use

Same as (vii)

$n(H_2C=\overset{CH_3}{\overset{|}{C}}-CH=CH_2) \xrightarrow{\text{Add}^n\text{.Poly}^n} [H_2C-\overset{CH_3}{\overset{|}{C}}=CH-CH_2]_n$

(2-Methylbuta-1,3-dien) · Poly isoprene
(Isoprene) (or natural rubber)

(IX) Buna-S

Molecular formula

$n[H_2C=CH-CH=CH_2] + n[\underset{C_6H_5}{CH}=CH_2]$

Buta-1,3 diene styrene

$-[CH_2-CH=CH-CH_2-\underset{C_6H_5}{CH}-CH_2]_n-$

Buna-S

Use-
Same as Neoprene

(X) Buna-N

formula

Use- same as neoprene

Ref

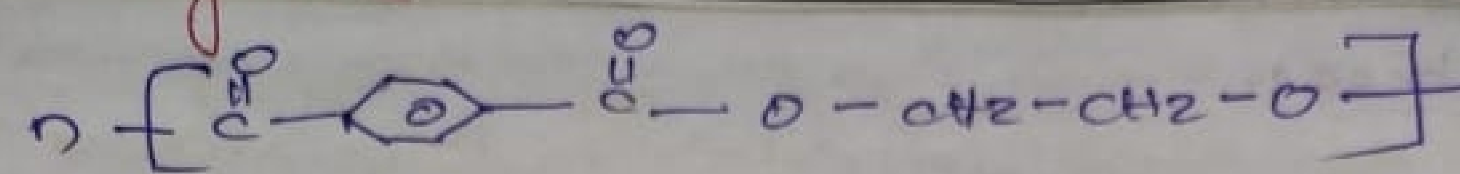
$n[H_2C=CH-CH=CH_2] + n[\underset{CN}{CH}=CH_2]$

Buta-1,3 diene (Acrylonitrile)

$-[CH_2-CH=CH-CH_2-\underset{CN}{CH}-CH_2]_n-$

(x) Terylene

M.F

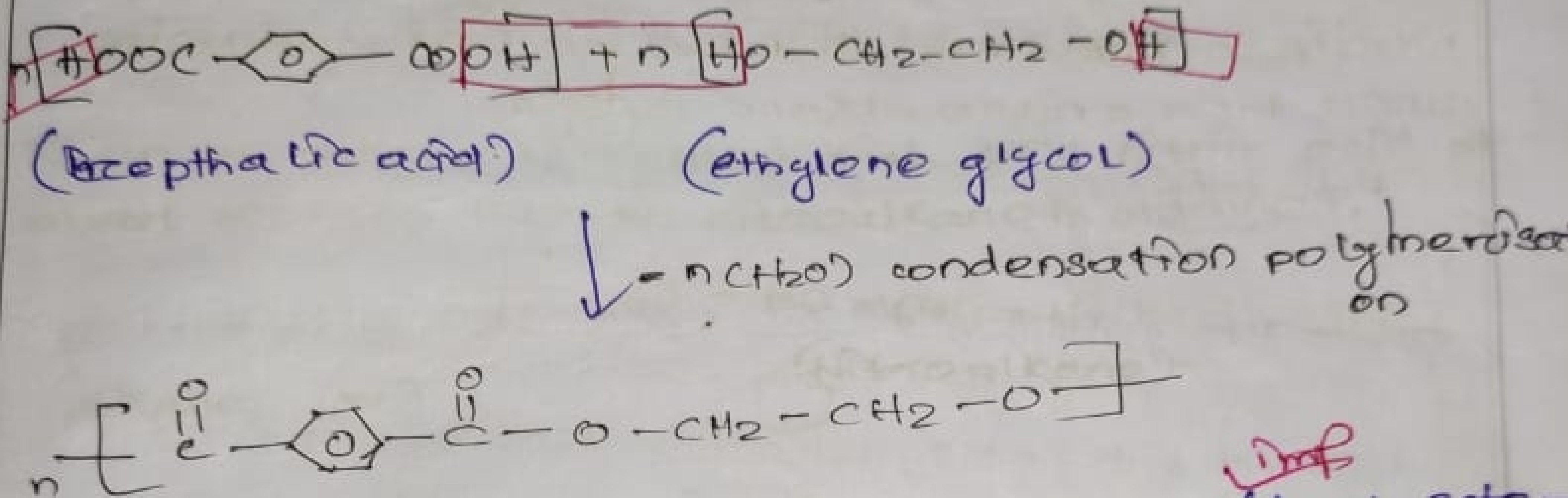


Use

a) for making roaps & nets.

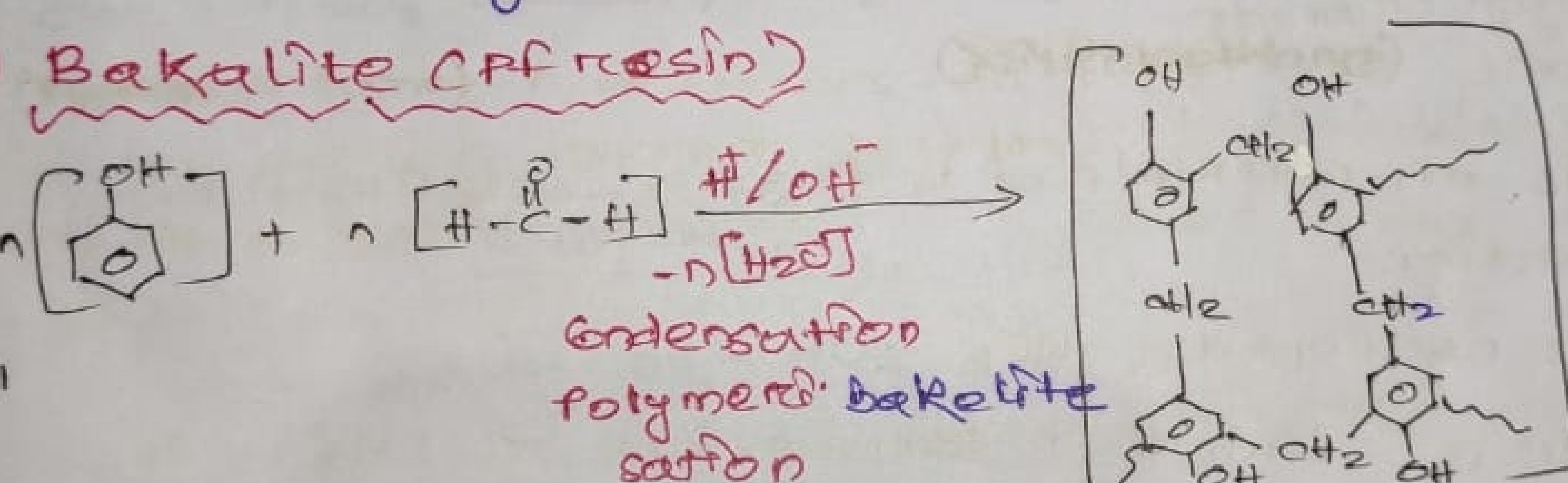
(a) It is blended with cotton to form tericot which is used in textile industries for making fabrics

Ref



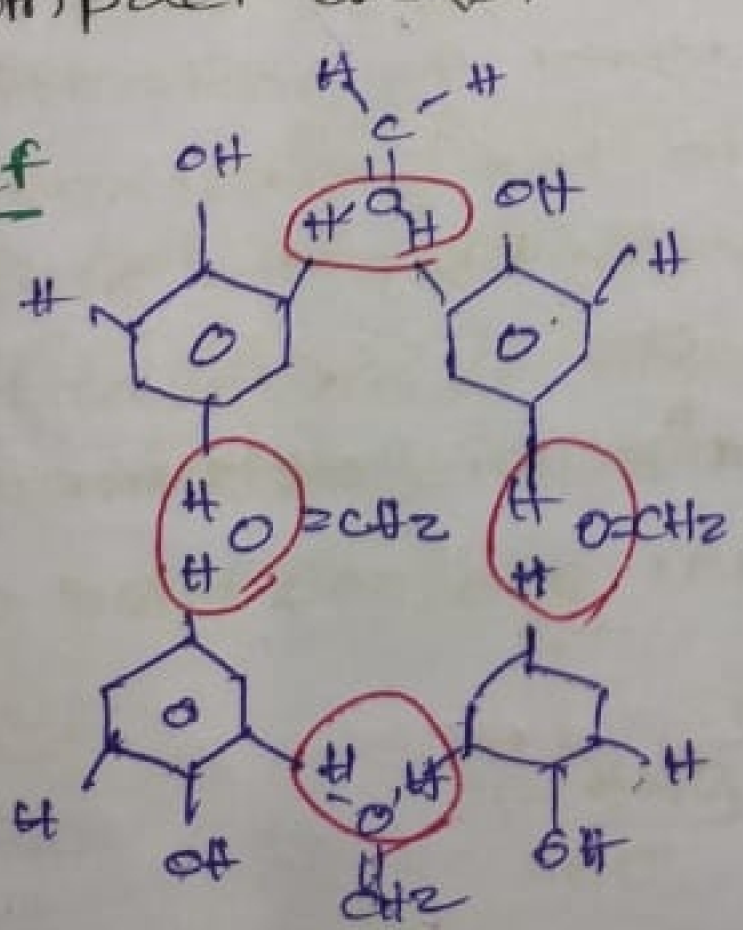
Terylene / decaron / decron [A polyester] Imp

(xi) Bakalite (PF resin)



(i) for making electical switches, fountain pens, compact disks, varioues non breakable plastic crockery.

Ref



UNIT-1 CH-4

ELECTROCHEMISTRY

Defⁿ: It is the branch of chemistry which deals with the study of interconversion of electricity and chemical substance leading to energy change.

⇒ Based on conductivity substances may be insulator or conducter.

⇒ Insulators are the substances which do not conduct electricity.

Ex
Wood, rubber, plastic etc.

⇒ Conducter are the substances which conduct electricity. Two types of conducter are there

(1) Metallic conductor
(2) Non metalic condcuter / electrolyte.

⇒ In case of metalic conductor free electrons are responsible for the conduction of electricity

Ex
Gold, Iron, silver, Bronze, copper, Aluminium etc.

⇒ Silver is the best metalic conductor due to low ionisation potential.

⇒ The condance of metallic conductor with raise is temp.

⇒ As there is obstruction in the flow of electron due to the vibration of kernel.

Electrolyte

⇒ An electrolyte is a substance which conducts electricity either in the molten state or in the aqueous sol^n state.

⇒ Free ions are responsible for the conduction of electricity.

* Electolyte are of two type:-

(1) strong Electrolyte
(2) weak Electrolyte

⇒ The electrolyte which undergoes complete ionisation at any dilution is called strong electrolyte.

Ex- NaCl (aq), HCl(aq), H_2SO_4(aq), KCl(aq) etc

⇒ The electrolyte which undergoes partial ionisation even at ∞ dilution is called weak electrolyte.

Ex- HCOOH (aq), CH_3COOH(aq), NH_4OH(aq), H_2CO_3(aq) etc

☆ The degree of ionisation α is given by the relⁿ

$$\alpha = \frac{\text{no. of molecules ionised}}{\text{total molecules taken}}$$

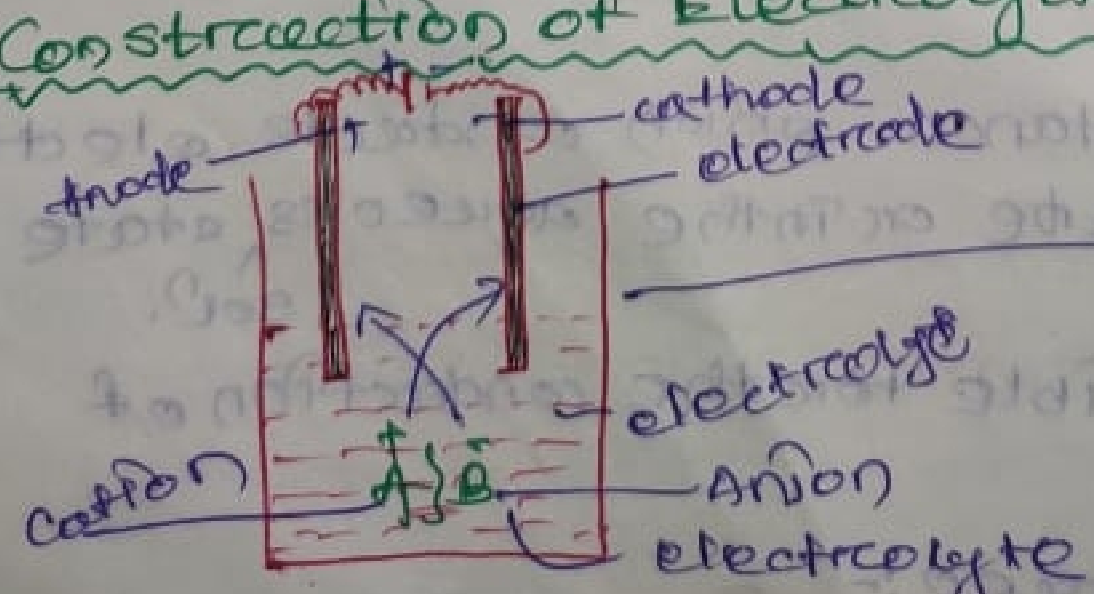
⇒ for strong electrolyte α = 1
⇒ for weak electrolyte α << 1

Electrolysis

⇒ The process of decomposition of an electrolyte and the movement of oppositely charged ions their respective electrode by the passage of electricity is called electrolysis.

⇒ The container where electrolysis is carried out is called electrolytic cell or tank.

Construction of Electrolytic cell



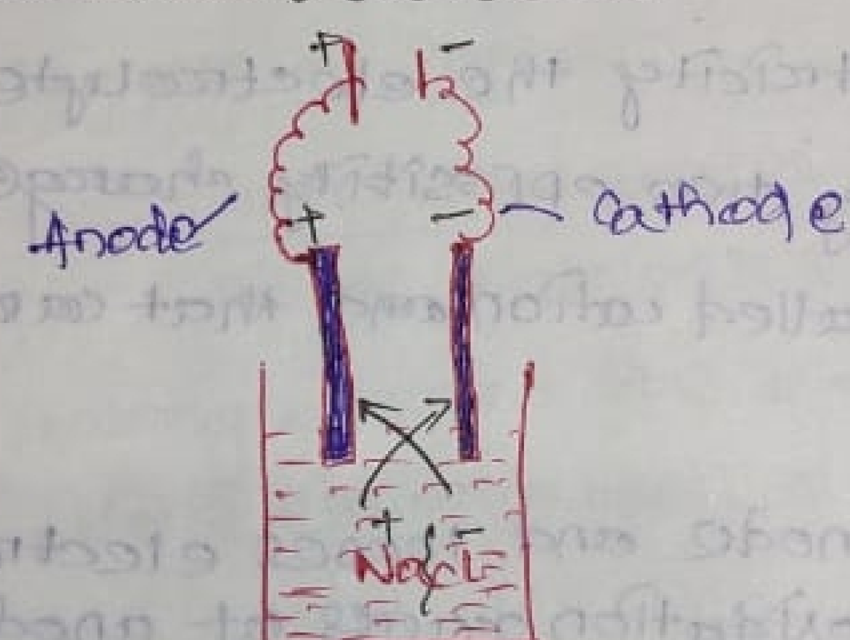
At cathode(-) (Redⁿ)

$A^+ + e \longrightarrow A$ (1° change)

☆ The different applications of electrolysis are
 (1) Electroplating
 (2) Electrotyping, Electrolytic refining in metallurgy etc.

2) The electrolysis of molten NaCl, Aqueous NaCl, $CuSO_4(aq)$ using platinum electrode, Aqueous $CuSO_4$ using copper electrode are given below

Electrolysis molten NaCl



Electrode reaction

At anode(+) (Oxⁿ)

$Cl^- - e \longrightarrow Cl$ (1° change)

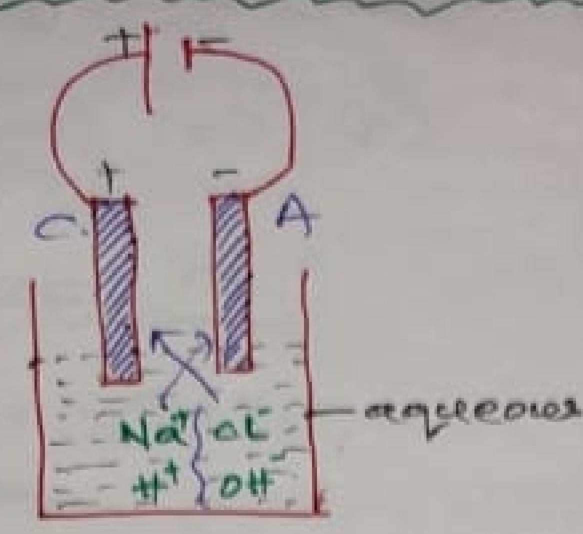
$Cl + Cl \longrightarrow Cl_2\uparrow$ (2° change)

At cathode(-) (Redⁿ)

$Na^+ + e^- \rightarrow Na(s)$ (1° change)

2) During the electrolysis of molten NaCl chlorine gas is liberated at anode and sodium metal is deposited at cathod.

Electrolysis of aqueous NaCl



⇒ During the electrolysis of aqueous NaCl two types cation (Na^+, H^+) and two types of anions (Cl^- and OH^-) are produced.

⇒ Both the cations migrate towards cathode but H^+ ion is preferencially discharge as it is higher discharge potencial than Na^+.

⇒ Similarly both the anions move towards anode. but Cl^- ion is preferencially discharge as it is higher discharge potencial than OH^-

★ The discharge potencial of

$K^+ < Ca^{++} < Na^+ < Mg^{++} < Zn^{++} < Fe^{++} < Pb^+ < H^+ < Cu^{++} < Ag^+$

★ The discharge potencial of

$I^- > Br^- > Cl^- > OH^- > NO_3^- > SO_4^{--}$

At cathode (-) (Redn)

$H^+ + e \longrightarrow H \ (1^\circ)$

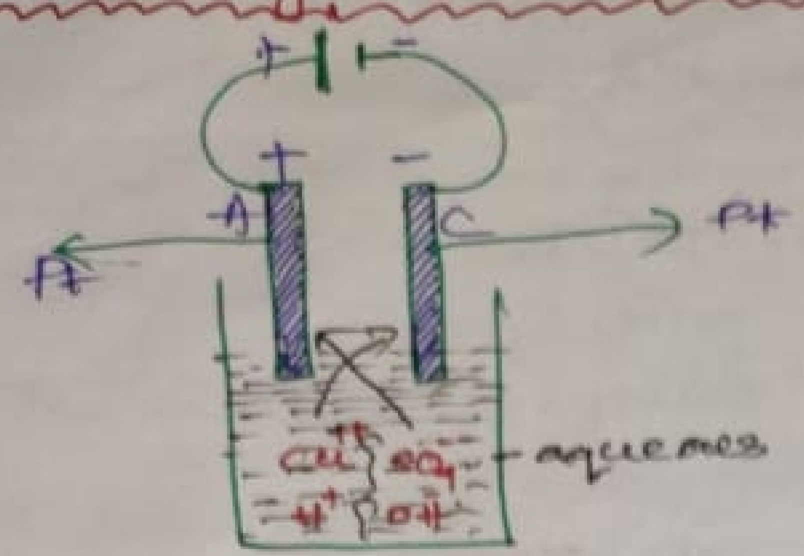
$H + H_2 \longrightarrow H_2\uparrow \ (2^\circ)$

At anode (+) (Oxdn)

$Cl^- - e \rightarrow Cl \ (1^\circ)$

$Cl + Cl \rightarrow Cl_2\uparrow \ (2^\circ)$

Electrolysis of aqueous $CuSO_4$ using Platinum



1) The platinum electrode use is inert i.e not attacted electrolyte.

At cathod (-) (Red^n)

$Cu^{++} + 2e \longrightarrow Cu(s)$ (1°)

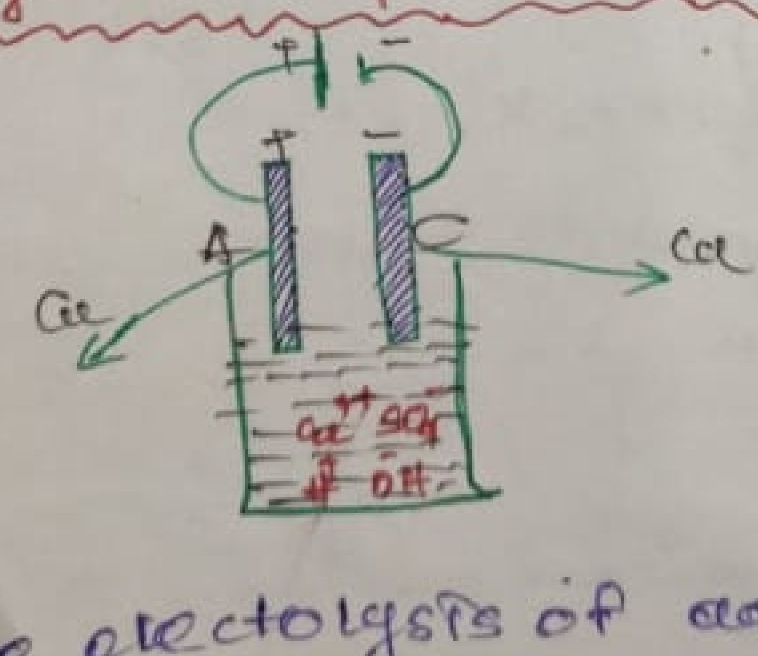
At anode (+) (Oxd^n)

$OH^- - e \longrightarrow OH$ (1°)

$OH + OH \rightarrow H_2O + \frac{1}{2} O_2$

2) During the electrolysis of aqueous soln of copper sulphate using platinum electrode, Cu metal is deposited at cathod and O_2 gas liborated at anode.

Electolysis of aqueous $CuSO_4$ using copper electrode



3) During the electolysis of aqueous $CuSO_4$ using copper electrode (attacable) copper metal is deposited at cathod and equivalent amount of copper ion from copper electrode is dissolved from anode as copper has higher oxidation potencial than OH^-.

At cathode (-) (Red)

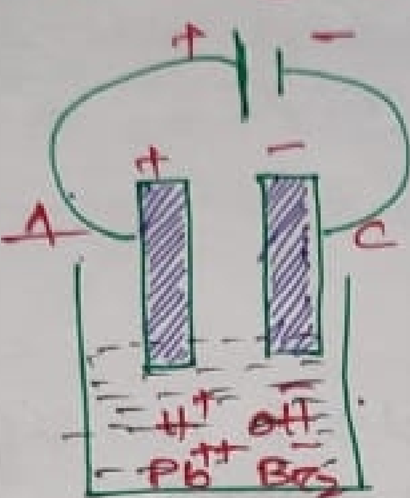
$Cu^{++} + 2e \longrightarrow Cu(s)$ (1°)

At anode (+) (Oxd)

$Cu \longrightarrow Cu^{++} + 2e^-$

Ex-5

Electrolysis of aqueous lead bromide ($PbBr_2$)



⇒ During the electrolysis of of aqueous $PbBr_2$; hydrogen gas is liberated at cathod and bromine is produced at anode.

At cathode (-)

$H^+ - e \rightarrow H$ (1°)

$H + H \longrightarrow H_2$ (2°)

At anode (+)

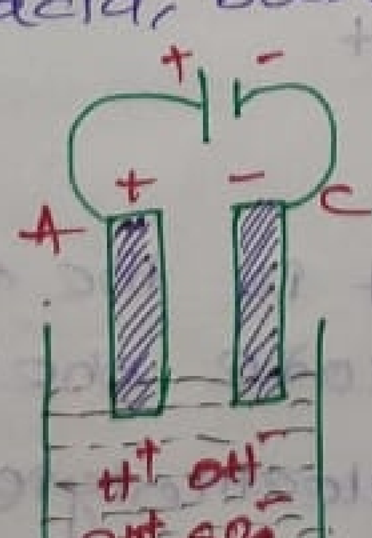
$Br^- - e \longrightarrow Br$ (1°)

$Br + Br \rightarrow Br_2$ (2°)

Ex-6

Electrolysis of Acidulated water

⇒ Water is a poor conductor of electricity. However the addition of acid, base and salt makes it good conductor



2) During the electrolysis of Acidulated water hydrogen gas is liberated at cathod and oxygen liberated at anode.

At cathode (-)

$H^+ + e \longrightarrow H$ (1°)

$H + H \longrightarrow H_2$ (2°)

At anode (+)

$OH^- - e \longrightarrow OH$ (1°)

$OH + OH \longrightarrow H_2O + \frac{1}{2}O_2$ (2°)

FARADAY'S LAWS OF ELECTROLYSIS

1st Law

Statement

The states that during the electrolysis of an electrolyte the amount of substance produced at an electrode is directly propotional to the quantity of electricity supplied.

Mathmetically

$W \propto Q$

$\Rightarrow W = ZQ$

where

W = amount of substance produced in gram

Q = quantity of electricity supplied in coulomb

Z = Propotionality (ratio) constant called electro-chemical equivalent

When $Q = 1C$ then, $Z = W$

2) Thus electrochemical equivalent is the amount of substance produced at an electrode when 1C electricity passes through the electrolyte.

Again

$q = It$

$\Rightarrow W = ZIt$

where

I = current in ampere

t = time in second.

When $I = 1A$ and $t = 1s$ then, $Z = W$

→ When electrochemical equivalent is the amount of substance produced at an electrode when 1A current pass through the electrolyte for 1s.

→ charge on 1 electron $= 1.6 \times 10^{-19} C$

→ charge on 1 mole of electron $= 1.6 \times 10^{-19} \times 6.023 \times 10^{23}$

$= 96500 C$

$=$ 1 faraday.

96500C electricity produces = 1gm of of electrolyte

= chemical equivalent (E)

1C " " = $E/96500$

$\Rightarrow Z = E/96500$

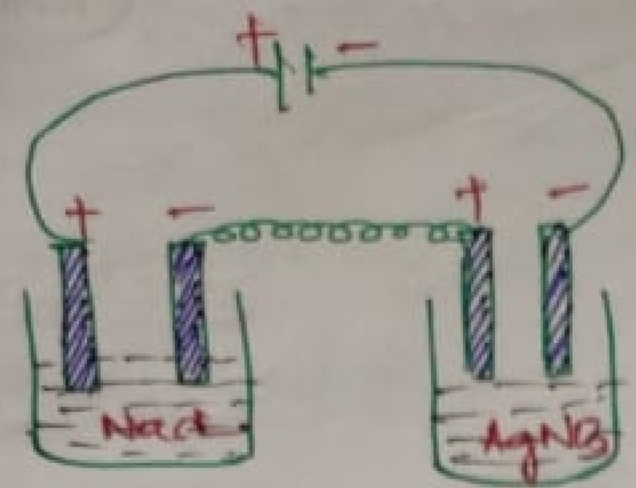
$\Rightarrow Z \propto E$

23/02/16

Second Law

Statement

→ The law states that when two or more electrolytic cells are connected in series, the amount of substances produce at different electrodes is directly proportional to their equivalent masses.



1) Let's consider two electrolytic cells containing the electrolytes Molten aq NaCl and aq $AgNO_3$.

2) The two cells are connected in the series for which both of them get equal electricity

Applying faraday's second law.

★ Amount of substance produced ∝ Equivalent mass

→ $W_{Na} \propto E_{Na}$

$W_{Ag} \propto E_{Ag}$

⇒ $\frac{W_{Na}}{W_{Ag}} = \frac{E_{Na}}{E_{Ag}}$

⇒ $\frac{Z_{Na}}{Z_{Ag}} = \frac{E_{Na}}{E_{Ag}}$

⇒ $\boxed{\frac{Z_1}{Z_2} = \frac{E_1}{E_2}}$

⇒ $\boxed{Z \propto E}$

H - 1 → 1
C - 12 → 4
N - 14 → 3
O - 16 → 2
Na - 23 → 1
Mg - 24 → 2
Al - 27 → 3
K - 39 → 1
Cl - 35.5 → 1
Ca - 40 → 2
Fe - 56 → 2,3
Cu - 63.5 → 1,2
Zn - 65 → 2

H = +1
Na, K = +1
Ca, Mg = +2
O = -2
F, Cl, Br, I = -1