

CHEAT NOTES

HALF YEARLY EXAMS

CHEMISTRY

Telegram ➤ Bharat Panchal Sir

► CHEMISTRY GURUJI 2.0

With Love for #BPARMY

in Only 12 Pages

Chapterwise one shot of Class 12 Chemistry



Chapterwise P.Y.Q. q
Class 12 Chemistry

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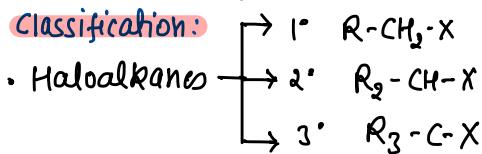
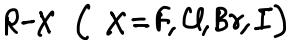
Haloalkanes and Haloarene-	1-3
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To help in our
Journey , you
can donate



Haloalkanes

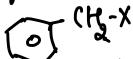
Hydrogen atom in aliphatic hydrocarbons replaced by halogen.



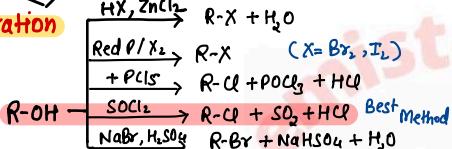
Allylic Halide



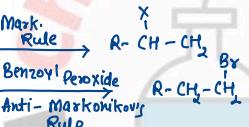
Benzyl Halide Vinyl Halide Aryl Halide



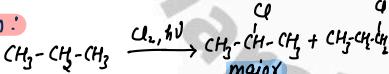
Preparation



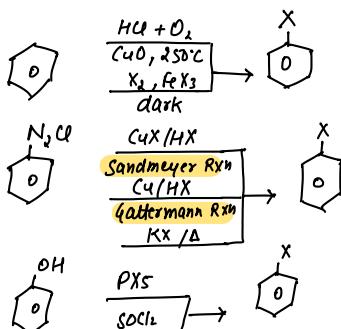
From Alkene



Halogenation:



Preparation of Haloarenes



Physical Properties

B.P. \propto Mol. Mass

B.P. \propto Surface Area

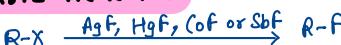
B.P. \propto 1/ Branching

- B.P. Order $\rightarrow R-I > R-Br > R-Cl > R-F$
- M.P. of p-isomer is more than that of ortho and meta due to symmetry.
- The density increases with increase in no. of carbon atoms, halogen atoms and atomic mass of the halogen atom.
- Solubility Although Haloalkanes are polar but they can not form Hydrogen bond with water molecule hence they are insoluble in water and soluble in organic solvents.

Finkelstein Reaction

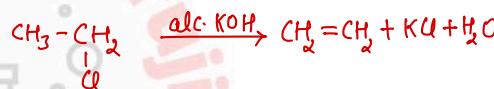


Swarts Reaction



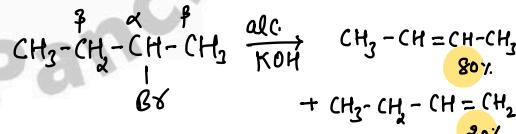
Chemical Properties

Elimination Reaction



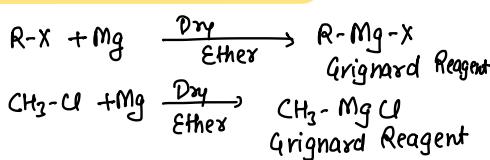
Acc. to Saytzeff Rule

In elimination reaction, preferred alkene is one in which double bonded C-atom are more alkylated



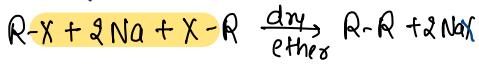
$R-X \xrightarrow{\text{Aq. KOH}}$ alcohol \rightarrow High Polarity
 $R-X \xrightarrow{\text{AIC. KOH}}$ Alkene \rightarrow low Polarity.

Reaction with Metal

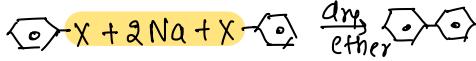


Grignard reagent are highly reactive and react with any source of proton to give hydrocarbons

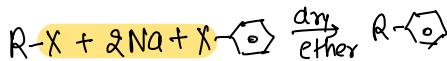
WURTZ REACTION



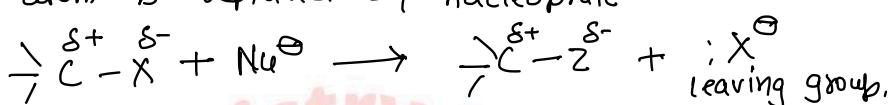
FITTIG REACTION



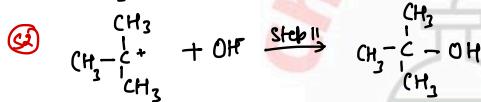
WURTZ FITTIG REACTION



Nucleophilic Substitution Reaction: when an atom or group of atom is replaced by nucleophile

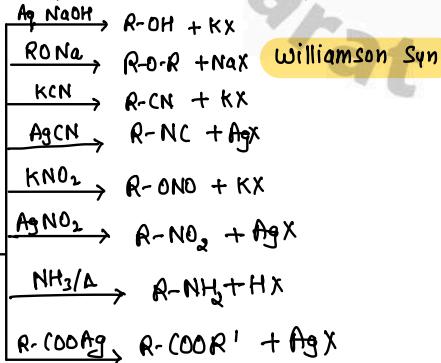


$\text{S}^{\text{N}}\text{I}$ (Unimolecular Nucleophilic)



Reactivity order $3^\circ > 2^\circ > 1^\circ$

- Polar Protic solvent is used
- Racemisation takes place

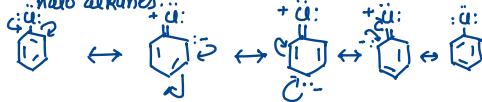


KCN is predominantly ionic, the attachment takes place mainly through carbon atom and thus form cyanide

AgCN is covalent in nature nitrogen is free to donate the e^- pair forming isocyanide.

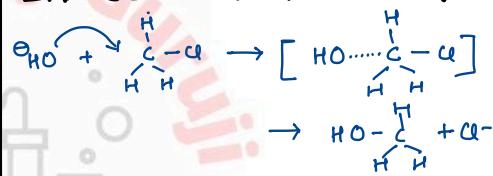
Resonance in Haloarenes:

Aryl Halides are less reactive towards Nucleophilic substitution reaction because C-Cl bond acquire partial double bond due to resonance as a result the bond cleavage in Haloarenes is difficult than halo alkanes.



when an atom or group of atom is replaced by nucleophile

$\text{S}^{\text{N}}\text{2}$ (Bimolecular Nucleophilic)

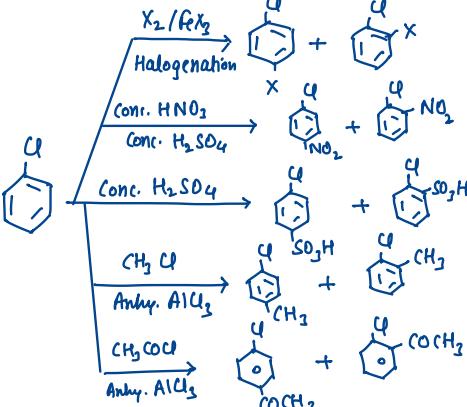


Reactivity Order $1^\circ > 2^\circ > 3^\circ$

- Inversion of Config. takes place
- Nucleophile attack from opp. side

Electrophilic Substitution Rxn

Halo group on benzene ring is ortho and para directing due to $+R$ effect

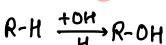


Para isomer is the major product

Alcohol, Phenol and Ethers

(3)

Alcohol

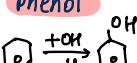


Str.

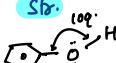


due to $\delta p - \delta p$ repulsion

Phenol

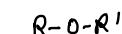


Str.



due to double bond character and sp^2 hybridised

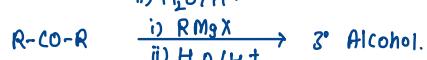
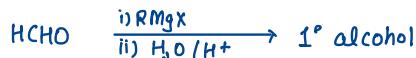
Ether



Str.

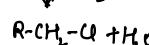
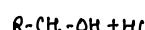


due to bulky alkyl group.



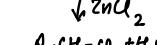
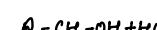
Lucas Test **C Lucas Reagent** $HCl + ZnCl_2$

1° alcohol



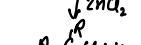
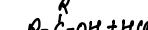
Turbidity appears on heating

2° alcohol



Turbidity appears in 5 min.

3° alcohol



Turbidity appears immediately.

Types of Alcohol

1°



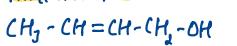
2°



3°



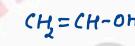
Allyl Alcohol



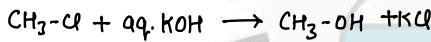
Benzyl Alcohol



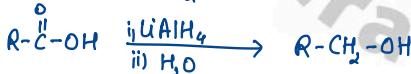
Vinyl Alcohol



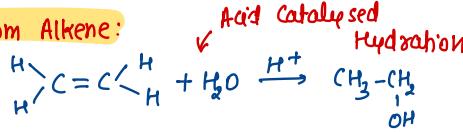
Methods of Preparation



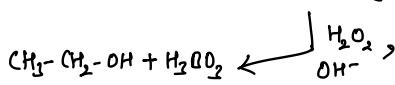
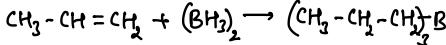
from Carbonyl Compound



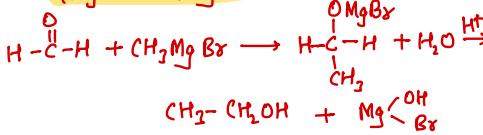
From Alkene:



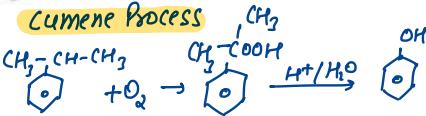
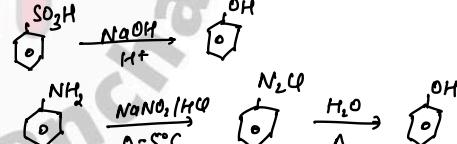
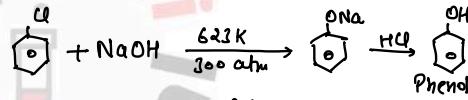
Hydroboration- Oxidation Rxn



From Grignard Reagent:



Preparation of Phenol



Physical Properties

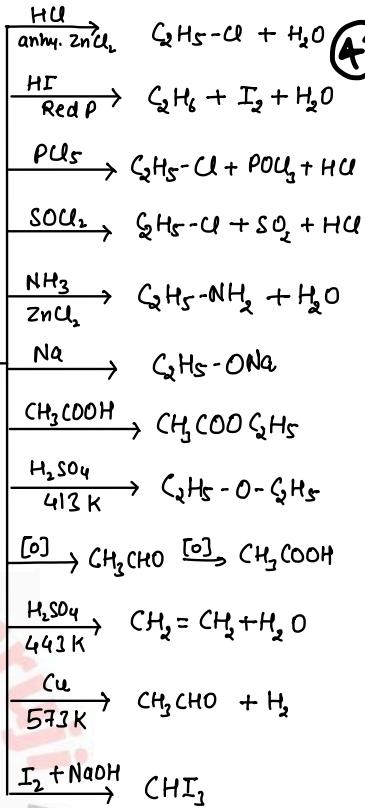
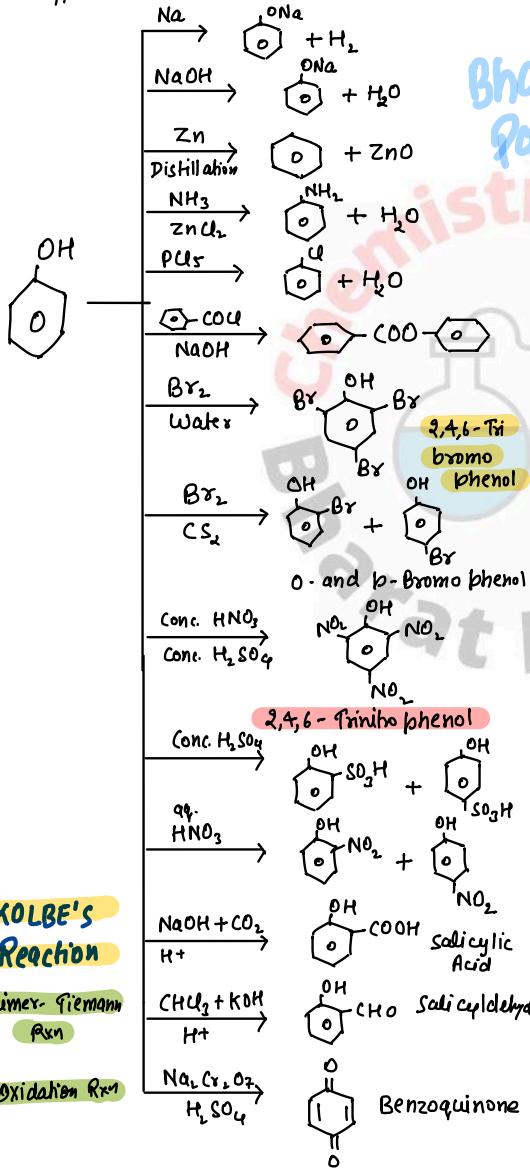
- Due to strong hydrogen bonding b/w molecules of alcohol, they have higher b.pt as compared to molecules of alkane having same molecular mass.

- As molecular weight increases surface area also increases and there is increase in Van der Waal force. As a result m.pt increases.

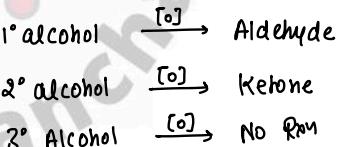
The b.p.t of phenol increases with increase in no. of C-atoms.

Nature of Phenol:

order of acidity $\text{C}_6\text{H}_5\text{-OH} > 1^\circ > 2^\circ > 3^\circ$
 electron withdrawing group like $-\text{NO}_2$, $-X$, $-\text{CHO}$, $-\text{COOH}$ increase acidic strength due to $-I$ effect while electron donating group like $-\text{R}$, $-\text{OR}$ decrease acidic strength due to $+I$ effect



Oxidation



Ethers



Preparation

- Dehydration of Alcohol

$$2(\text{C}_6\text{H}_5\text{-OH}) \xrightarrow[\text{413 K}]{\text{Conc. H}_2\text{SO}_4} \text{C}_6\text{H}_5\text{-O-C}_6\text{H}_5$$
- $2(\text{C}_6\text{H}_5\text{-Cl}) + \text{Ag}_2\text{O} \xrightarrow{\Delta} \text{C}_6\text{H}_5\text{-O-C}_6\text{H}_5$
- Williamson Synthesis (SN^2)

$$\text{R-X} + \text{Na-O-R}' \longrightarrow \text{R-O-R}' + \text{NaX}$$
 - If alkyl halide is 1° ether will form
 - If alkyl halide is 2° alkene will form

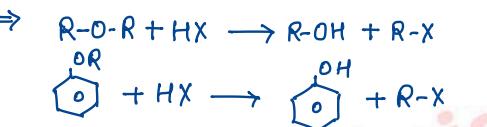
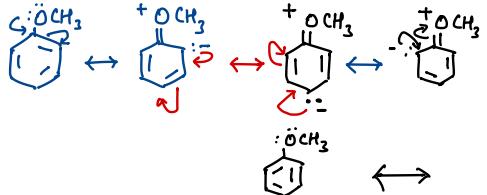
KOLBE'S Reaction

Reimer-Tiemann Rxn

Oxidation Rxn

Chemical Properties

- Ethers are less reactive than alcohols
- Alkoxy ion is ortho and para directing it activates the benzene ring towards electrophilic Sub.



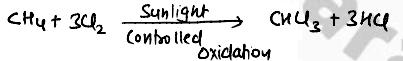
Order of reactivity $\text{HI} > \text{HBr} > \text{HCl}$

for Help
you can do this

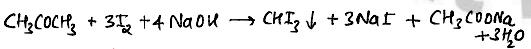


Polyhalogen Compounds

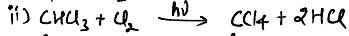
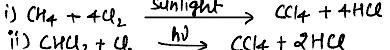
→ Chloroform (Trichloromethane, CHCl_3)



→ Iodoform (triiodomethane, CHI_3)



→ Carbon Tetra chloride [CCl_4]

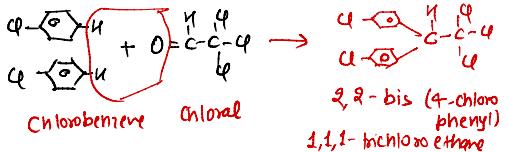


CCl_4 is a colourless, non-inflammable, poisonous liquid, soluble in alcohol and ether.

→ Uses

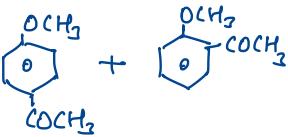
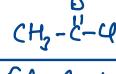
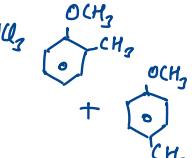
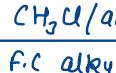
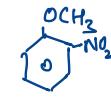
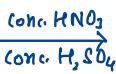
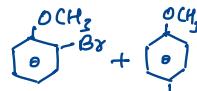
- as a solvent for oils, fats, resins
- in dry cleaning
- as fire extinguisher

DDT ($\text{p,p}'$ -Dichloro Dibenzyl trichloroethane)



(S)

Br_2 in CH_3COOH
Bromination



SOLUTIONS

It is a homogeneous mixture of two or more pure substance

Solute \rightarrow Dissolved in smaller Quantity.
e.g. Sugar, Salt

Solvent \rightarrow Dissolved in larger quantity.
e.g. Water, Milk.

Type of Solution	Solute	Solvent	Common Examples
Gaseous Solutions	Gas	Gas	Mixture of oxygen and nitrogen gases
	Liquid	Gas	Chloroform mixed with nitrogen gas
	Solid	Gas	Camphor in nitrogen gas
Liquid Solutions	Gas	Liquid	Oxygen dissolved in water
	Liquid	Liquid	Ethanol dissolved in water
	Solid	Liquid	Glucose dissolved in water
Solid Solutions	Gas	Solid	Solution of hydrogen in palladium
	Liquid	Solid	Amalgam of mercury with sodium
	Solid	Solid	Copper dissolved in gold

→ Solution exist in Single phase

→ Particle size in solution is less than 1 nm

Dilute Solution: Large amount of Solvent

Concentrated Solution: Small amount of Solvent

Aqueous Solution Solvent is water

Non-Aqueous Solution: Solvent is other than water

$$\text{Mass Percentage } (\frac{w}{w}) = \frac{\text{Mass of Solute in soln}}{\text{Mass of Solution}} \times 100$$

$$\text{Volume Percentage } (\frac{V}{V}) = \frac{\text{Volume of Solute in soln}}{\text{Volume of Solution}} \times 100$$

$$\text{Mass by Volume Percentage } (\frac{w}{v}) = \frac{\text{Mass of solute in soln}}{\text{Volume of soln}} \times 100$$

$$\text{Parts per million (ppm)} = \frac{\text{No. of parts of component}}{\text{all component of soln}} \times 10^6$$

$$\text{Mass fraction } (x) = \frac{\text{Mass of Solute}}{\text{Mass of Solution}}$$

$$\text{Mole fraction } (x) =$$

$$x_A = \frac{n_A}{n_A + n_B} \quad x_B = \frac{n_B}{n_A + n_B}$$

$x_A + x_B = 1$, mole fraction is a ^{Unities} quantity.

Molarity (M): Number of moles of solute per litre of solution.

$$M = \frac{\text{no. of moles of solute}}{\text{Volume of soln (in L)}} \Rightarrow \frac{W_B}{M_B} \times \frac{1000}{V(\text{ml})}$$

Unit = mol L⁻¹ or M or Molar

Molality (m): Number of moles of solute per kg mass of solvent

$$m = \frac{\text{no. of moles of solute}}{\text{mass of solvent in kg}} \Rightarrow \frac{W_B}{M_B} \times \frac{1000}{w_A(\text{kg})}$$

Relationship b/w Molarity and Molality:

$$M = \frac{md}{1 + m M_B (\text{in kg})} \quad M \rightarrow \text{Molarity} \quad m \rightarrow \text{molality} \quad M_B \rightarrow \text{Molar Mass (kg)} \quad \text{in kg}$$

SOLUBILITY: Maximum amount that can be dissolved in a specific amount of solvent at a specific temperature.

Factors Affecting Solubility

Nature of Solute and Solvent → Polar solutes dissolve in polar solvents and non-polar solutes dissolve in Non-polar solvents. i.e like dissolve like.

Effect of Temperature

Exothermic $\Delta H = -ve$

Solubility decreases with increase in temperature

Endothermic $\Delta H = +ve$
Solubility increases with increase in temperature

Pressure No significant effect.

HENRY'S LAW The partial pressure of the gas in vapour phase is proportional to the mole fraction of gas in solution.

$$p = K_H x$$

K_H is Henry's Constant.

- Value of K_H increases with increase in temp.
- Solubility decrease with increase in K_H .

Effect of temperature:

As dissolution is an exothermic process i.e solubility of gases in liquid decrease with increase in temperature.

Vapour Pressure: The pressure exerted by the vapour in equilibrium with the liquid / solution at a particular temperature

factor. Weaker intermolecular forces greater is the vapour pressure.

Temperature ↑, V.P also increases.

→ Molarity depends upon temperature but molality doesn't

Application of Henry's Law

- Scuba divers suffer from bends
- Climbers suffer from anoxia.

RAOULT'S LAW: The partial vapour pressure of a component is equal to the vapour pressure of that component in pure state multiplied by the mole fraction of that component.

$$p_A = p_A^0 x_A \quad p_B = p_B^0 x_B$$

for Volatile Solute

$$P_T = P_A + P_B$$

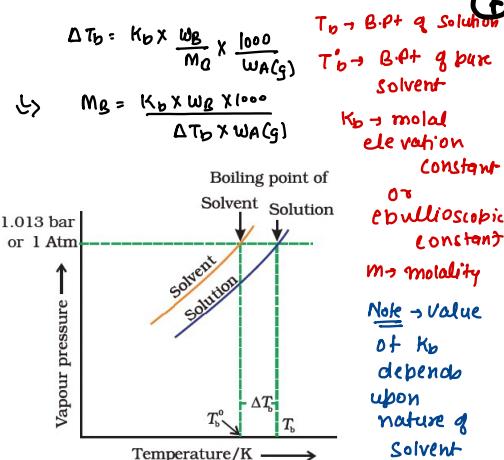
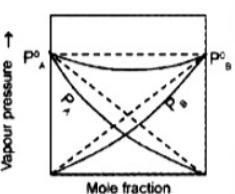
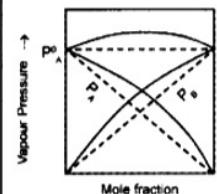
for Non-Volatile Solut

$$P_T = P_A$$

$$P_T = P_A^0 x_A$$

Ideal Solutions	Non-Ideal Solutions
The interactions between the components are similar to those in the pure components.	The interactions between the components are different from those of the pure components.
There is no volume change and enthalpy change on mixing the components	$\Delta V \neq 0, \Delta H \neq 0$
Each component obeys Raoult's law.	They do not obey Raoult's law.

S.No.	Positive deviation	Negative deviation
1.	Vapour pressure of solution and partial pressure of the components are more than those expected by Raoult's law. $\Delta H_{mix} \neq 0$ and it is positive. $\Delta V_{mix} = \text{Positive}$.	Vapour pressure of solution and partial pressure of the components are less than those expected by Raoult's law. $\Delta H_{mix} \neq 0$ and it is negative. $\Delta V_{mix} = \text{Negative}$.
2.	Forms minimum boiling azeotrope.	Forms maximum boiling azeotrope.
3.	On mixing intramolecular attraction decreases e.g., $\text{CH}_3\text{COCH}_3 + \text{CS}_2$ $\begin{array}{c} \text{O} \\ \\ \text{e.g., } \text{CH}_3-\text{C}-\text{CH}_3 + \text{CS}_2 \end{array}$	On mixing intramolecular attraction increases e.g., $\text{CH}_3\text{COCH}_3 + \text{CHCl}_3$ $\begin{array}{c} \text{O} \\ \\ \text{e.g., } \text{CHCl}_3 + \text{CH}_3-\text{C}-\text{CH}_3 \end{array}$
6.		



Azeotrope: These are liquid mixture which distil over without change in composition

+ve deviation are known as min. boiling azeotropes e.g. $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$

-ve deviation are known as max. boiling azeotropes e.g. $\text{HNO}_2 + \text{H}_2\text{O}$

COLLIGATIVE PROPERTIES

Depends upon number of moles of solute.

Relative lowering of vapour pressure Relative lowering of vapour pressure is equal to the mole fraction of solute in the solution.

$$\frac{P_i - P_s}{P_i} = x_2 = \frac{w_B}{M_B} \times \frac{M_A}{w_A}$$

- Lowering of V.P is not a colligative property
- RLVP is a colligative property

$$P_i - \text{v.p. of pure solvent} \quad w_2 - \text{Mass of solute}$$

$$P_s - \text{v.p. of solution} \quad M_1 - \text{Molar Mass of solvent}$$

$$w_1 - \text{Mass of solvent} \quad M_2 - \text{Molar Mass of solute.}$$

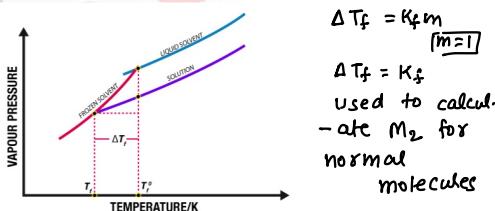
Elevation in Boiling Point \Rightarrow B.pt of solution containing a non-volatile solute is always higher than boiling point of pure solvent and this difference in boiling point is called elevation in boiling point $\Delta T_b = T'_b - T_b$

$$\Delta T_b = K_b m \quad \text{if } m=1$$

$$\Delta T_b = K_b$$

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Depression in freezing Point (ΔT_f) F.pt of a solution containing a non-volatile solute is always lower than F.pt of pure solvent and this difference in freezing point is called depression in freezing point.



$K_f \rightarrow$ molal depression or cryoscopic constant

$$\Delta T_f = T_f - T_f^o$$

T_f^o = Freezing point of pure solvent

T_f = Freezing point of solution

$$\Delta T_f = K_f \times m$$

$$= K_f \times \frac{w_B}{M_B} \times \frac{1000}{w_A(g)}$$

$$M_B = \frac{K_f \times w_B \times 1000}{\Delta T_f \times w_A(g)}$$

OSMOTIC PRESSURE:

External pressure used to stop osmosis

$$\Pi = \frac{nRT}{V}$$

$$M_B = \frac{w_B \times R \times T}{V}$$

$$\Pi = \text{Osmotic pressure} \quad T = \text{Temperature}$$

$$V = \text{Volume} \quad R = \text{Gas Constant}$$

Used to calculate M_2 for macromolecules

ISOTONIC SOLUTION:

Two solution have same osmotic pressure (Π)
e.g. Saline Solution (0.9%) and Blood.

$$\Pi_A > \Pi_B$$

↑ ↓

Hyper tonic Soln Hypotonic Solution

have High osmotic pressure have low osmotic pressure

Reverse Osmosis

when a pressure more than the osmotic pressure is applied to the solution, the solvent may pass from solution, into the solvent through the semi-permeable membrane
e.g. desalination of sea water.

ABNORMAL MOLECULAR MASS

In some cases, observed colligative properties deviate from their normal calculated values due to association or dissociation of molecules

$$\text{Colligative Property} \propto \frac{1}{M_2}$$

Higher values observed in case of association e.g. benzene
Lower values observed in case of dissociation e.g. KCl

VANT HOFF FACTOR (i)

ratio of observed value of colligative property to the calculated value of colligative property.

$$i = \frac{\text{Observed Colligative Property}}{\text{Calculated Colligative Property}}$$

$$\text{or } i = \frac{\text{Normal molecular mass}}{\text{Observed molecular mass}}$$

$$\text{or } i = \frac{\text{No. of particles after association or dissociation}}{\text{Number of particles initially}}$$

Colligative Property and Vant Hoff factor

$$\Delta T_b = i K_b m$$

$$\Delta T_f = i K_f m$$

$$\Pi = i CRT$$

$$\frac{P_A - P_s}{P_A} = i \chi_B$$

i for strong electrolyte like

$$\text{KCl} = 2, \text{ NaCl} = 2, \text{ MgSO}_4 = 2$$

$$\text{K}_2\text{SO}_4 = 3, \text{ Al}_2(\text{SO}_4)_3 = 5$$

Degree of Dissociation (α) and Vant Hoff factor (i)

If one molecule of a substance gets dissociated into n particles and α is the degree of dissociation then

Initially	1 mol	0
At eq.	$1-\alpha$	$n\alpha$
Total no. of moles at equilibrium	$= 1-\alpha+n\alpha$	

$$\left. \begin{aligned} i &= \frac{i-1}{n-1} \\ \alpha &= \frac{i-1}{n-1} \end{aligned} \right\}$$

Degree of Association (α) and Vant Hoff factor (i)

If n molecules of a substance A associate to form A_n and α is the degree of association, then

$$\begin{array}{lll} \text{Initially} & nA \xrightarrow{\text{1 mol}} & A_n \\ \text{At equilibrium} & 1-\alpha & \alpha \\ \text{Total no. of moles at equil.} & = 1-\alpha + \frac{\alpha}{n} & \end{array}$$

$$\begin{aligned} i &= 1-\alpha + \frac{\alpha}{n} \\ \alpha &= \frac{i-1}{n-1} \end{aligned}$$

$i=1$	no association or dissociation
$i>1$	particles undergo dissociation
$i<1$	particles undergo association

- Calculate the molarity of 9.8% (w/w) solution of H_2SO_4 if the density of the solution is 1.02 g mL^{-1} Molar mass of $\text{H}_2\text{SO}_4 = 98 \text{ g mol}^{-1}$

$$\text{Mass of Solute} = 9.8 \text{ g}$$

$$\text{Mass of Solution} = 100 \text{ g}$$

$$\text{Density of Solution} = 1.02 \text{ g mL}^{-1}$$

$$\therefore \text{Vol. of Soln} = \frac{\text{Mass of Soln}}{\text{Density of Soln}}$$

$$= \frac{100}{1.02 \text{ g mL}^{-1}} = 98.039 \text{ mL} = 0.098 \text{ L}$$

$$\text{Number of moles of Solute, } n = \frac{9.8}{98} = 0.1 \text{ mol}$$

$$\text{Molarity} = \frac{\text{Number of moles of Solute}}{\text{Vol. of Soln (in L)}}$$

$$= \frac{0.1}{0.098} = 1.02 \text{ M}$$

- For a 5% solution of urea (Molar Mass = 60 g/mol) calculate the osmotic pressure at 300 K
[R = $0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$]

Ans. → Molality (m) of urea solution

$$\Rightarrow \frac{W \times 1000}{M_2 \times \text{Mass of Solvent}}$$

$$= \frac{5 \times 1000}{60 \times 98} = 0.877 \text{ m}$$

$$\text{Osmotic pressure} (\Pi) = CRT$$

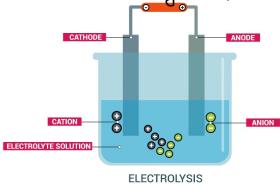
$$= 0.877 \times 0.0821 \times 300 = 21.6 \text{ atm}$$

- Calculate the solubility of CO_2 in water at 298 K under 760 mm Hg.
(K_h for CO_2 in water at 298 K is $1.25 \times 10^6 \text{ mm Hg}^{-1}$)

$$\text{Solubility of } \text{CO}_2 = \frac{P}{K_h} = \frac{760}{1.25 \times 10^6} = 6.08 \times 10^{-4}$$

{ Electrochemistry }

Electrolyte: Those substance which dissociate into ions in their aqueous soln on passing electricity are known as electrolyte. e.g. NaCl, KCl



Non-Electrolyte:

Those substance which doesn't dissociate into ions in their aqueous solution on passing electricity is known as non-electrolyte e.g. Sugars, Urea, Glucose.

Strong Electrolyte

which dissociate completely into ions.

e.g. HCl, HNO₃, H₂SO₄ etc.

Weak Electrolyte

which dissociate partially into ions.

e.g. NH₄OH, Ca(OH)₂, CH₃COOH etc.

CONDUCTORS

Metallic Conductors

- flow of electricity is due to the flow of e^-
- Also known as electronic conductors.
- flow of electricity takes place without the decomposition of substance
- The electrical conduction decreases with increase of temperature. because kernels start vibrating which produce hindrance in the flow of electrons.
- Low as well as high voltage of current can pass through metallic conductors e.g. Fe, Al, Ag etc.

Electrolytic Conductors

- flow of electricity is due to the flow of ions.
- Also known as ionic conductors.
- flow of electricity takes place by the decomposition of substance.
- The electrical conduction increases with increase of temp. because increase of temp., increase in dissociation or decrease in interionic attraction.
- Only low voltage of current can pass through electrolytic conductor e.g. NaCl, NaOH etc.

Factors Influencing Electrolytic Conduction :

→ Nature of Electrolyte: Larger the no. of ions, more is conductance

→ Nature of Solvent: The electrolytes ionize in water but not in organic solvents like benzene because water is polar whereas benzene is non-polar. So, electrolytic conductance increase in polar solvents.

→ Solute-Solvent attractions/Solvation or Hydration: Larger the solvation of ions, lesser is conductance

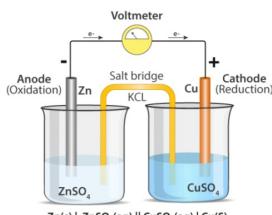
→ Temperature: As the temp. increases, the conductivity also increases because the dissociation of electrolyte increases. So, number of ions as well as the speed of ions increases.

→ Dilution: As dilution increases, the number of ions of a weak electrolyte as well as their speed increases and so conductivity also increases.

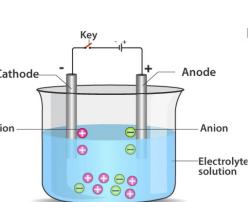
Q. What is Cell?

Ans: It is a device which used to convert one form of energy into another form of energy.

ELECTROCHEMICAL CELL



ELECTROLYTIC CELL.



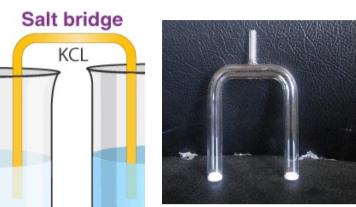
Changes chemical energy into Electrical energy .

- Anode is -ve
- Cathode is +ve
- Spontaneous reaction occurs.
- Does not require external voltage source.

Changes electrical energy into Chemical reaction.

- Anode is +ve
- Cathode is -ve
- Non-spontaneous reaction occurs.
- Requires external voltage source.

⇒ Salt Bridge & its functions:

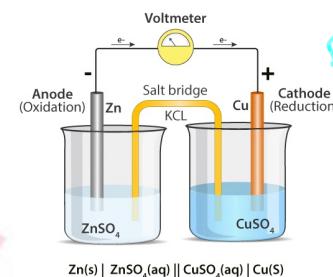


Function

- Prevent the passage of one electrolyte into another.
- It completes the inner cell circuit.
- It maintains the electrical neutrality of soln in both half cells.
- Used to connect both the beakers.

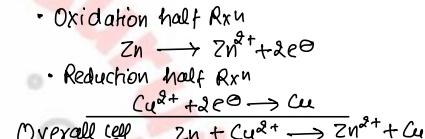
Electrochemical Cell / Galvanic Cell / Voltaic Cell:-

It is used to convert chemical energy into electrical energy.



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- We take two beakers.
- In 1st beaker we take Zn rod dipped in ZnSO₄ soln.
- In 2nd beaker we take Cu rod dipped in CuSO₄ soln.
- Salt Bridge is used to connect both the beakers.
- Oxidation takes place at Zn rod in 1st beaker.
- Reduction takes place at Cu rod in 2nd beaker.



Electrode Potential ⇒

The tendency of an electrode to either lose or gain e^- when it is placed in its own solution.

Oxidation Potential

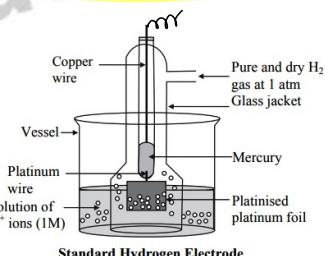
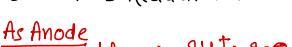
The tendency of an electrode to lose e^-

Reduction Potential

The tendency of an electrode to gain e^-

STANDARD HYDROGEN ELECTRODE (S.H.E) Device which is used to calculate standard electrode potential of any electrode.

→ It can act as both oxidation as well as reduction potential.



Electrochemical Series

Arrangement of various electrodes in the increasing order of standard reduction potential.

Li → Lithium	-3.05V
Ca → Calcium	-2.87V
Al → Aluminium	-1.66V
Zn → Zinc	-0.76V
Fe → Iron	-0.44V
Ni → Nickel	-0.25V
Pb → Lead	-0.13V
H → Hydrogen	0.00V
Cu → Copper	+0.34V
Ag → Silver	+0.80V
Br → Bromine	+1.08V
Au → Gold	+1.50V

Application

- Comparison of Relative Reducing Power or Oxidising Power.
- Predicting the feasibility or spontaneity of a Redox Reaction.
- Predicting whether a metal will react with dilute mineral acids and will evolve Hydrogen gas or Not.
- Activity or Reactivity of metals.
- Calculation of the EMF of a cell.

$$\text{EMF} = E_{\text{cell}}^{\circ} = E_{\text{R}}^{\circ} - E_{\text{L}}^{\circ}$$

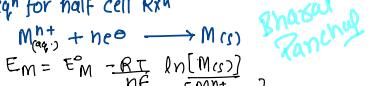
$$= E_{\text{cathode}}^{\circ} - E_{\text{Anode}}^{\circ}$$

$$= E_{\text{Reduction}}^{\circ} - E_{\text{Oxidation}}^{\circ}$$

Nernst Eqn

Dependence of EMF on concentration of electrolyte and temperature

Nernst eqn for half cell Rxn



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E_m = electrode potential of metal under given condition

E_m° = electrode potential of metal under standard condition

R = gas constant = $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$

T = Temp in Kelvin

F = faraday constant (96500 C mol^{-1})

n = no. of e⁻ loss or gain in reaction

$$E_m = E_m^{\circ} - \frac{0.0591}{n} \log \frac{1}{[\text{M}^{n+}]}$$

For cell:- $aA + bB \rightleftharpoons cC + dD$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[\text{C}]^c [\text{D}]^d}{[\text{A}]^a [\text{B}]^b}$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[\text{Oxi}]}{[\text{Red}]}$$

$$\Rightarrow E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log Q_c$$

where Q_c is concentration quotient

equilibrium
constant

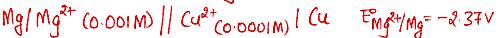
At equilibrium $E_{\text{cell}} = 0$ and $Q_c = K_c$

$$E_{\text{cell}}^{\circ} = \frac{0.0591}{n} \log K_c \text{ (at } 298 \text{ K)}$$

Standard Gibbs Free Energy by cell

$$\Delta G^{\circ} = -nF E_{\text{cell}}^{\circ}$$

Calculate the emf of following cell at 298 K:



$$E_{\text{Mg}^{2+}/\text{Mg}}^{\circ} = -0.37 \text{ V}$$

$$E_{\text{Cu}^{2+}/\text{Cu}}^{\circ} = 0.34 \text{ V}$$

$$\text{Ans. } E_{\text{cell}} = E_{\text{R}}^{\circ} - E_{\text{L}}^{\circ} \Rightarrow 0.34 - (-0.37) = 0.71 \text{ V}$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[\text{Oxi}]}{[\text{Red}]}$$

$$= 0.71 - \frac{0.0591}{2} \log \frac{[\text{Mg}^{2+}]}{[\text{Cu}^{2+}]}$$

$$= 0.71 - \frac{0.0591}{2} \log \frac{10^3}{10^2}$$

$$= 0.71 - 0.02955 = 0.68 \text{ V}$$

Calculate standard Gibbs free energy change for the given reaction: $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$ Given $E_{\text{cell}}^{\circ} = 1.10 \text{ V}$

$$\Delta G^{\circ} = -nF E_{\text{cell}}^{\circ}$$

$$= -2 \times 96500 \text{ J mol}^{-1} = -212300 \text{ J mol}^{-1} = -212.3 \text{ kJ mol}^{-1}$$

Conductance of Electrolytic Solutions

Resistance: It is the obstruction to the flow of electric current through the conductor. It is directly proportional to its length (l) and inversely proportional to area of cross-section (A)

$$R \propto \frac{l}{A} \quad \text{or} \quad R = \rho \frac{l}{A}$$

specific Resistance or Resistivity.

Unit of Resistance = ohm (Ω)

Unit of Resistivity = ohm metre ($\Omega \text{ m}$)

Conductance: The inverse of resistance

$$G = \frac{1}{R} = \frac{A}{\rho l} = K \frac{A}{l}$$

Unit of conductance is ohm⁻¹ or mho or Ω^{-1} or siemens

CONDUCTIVITY: The inverse of resistivity is called conductivity (specific conductance) Unit = ohm⁻¹ cm⁻¹

$$G = K \frac{A}{l} \quad \text{when } A = 1 \text{ cm}^2 \quad l = 1 \text{ cm}$$

Fig: Expression of Specific Conductance (Conductivity)

conductivity of a material is its conductance when it is 1cm long and its area of cross section is 1cm².

MOLAR CONDUCTIVITY: It is the conductivity of all the ions produced by dissolving 1g mole of an electrolyte in soln. It is denoted by Λ_m

$$\Lambda_m = K \times V \quad \text{or} \quad \Lambda_m = K \times \frac{1000}{C} = K \times 1000 \text{ Molarity.}$$

Units: ohm⁻¹ cm² mol⁻¹ or S cm² mol⁻¹

Note: $R = \rho \frac{l}{A} = \frac{1}{K} \cdot \frac{l}{A}$ $\frac{l}{A}$ is called cell constant denoted by κ

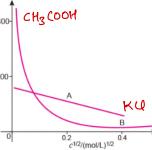
$$\kappa = \frac{l}{A} = \frac{1}{K} = R \kappa$$

Q. Discuss the variation of conductivity and molar conductivity with concentration (INCERT).

An. In case of strong electrolytes the molar conductivity increases slightly with dilution, as mobility of ions increase.

In case of weak electrolytes the degree of ionisation increases with dilution therefore, there is a large increase in molar conductivity with dilution.

Conductivity is conductance between two opposite faces of one centimetre cube. On dilution, no. of ions per cm³ decreases therefore conductivity decreases on dilution.



Λ_m = limiting molar conductivity when concentration approaches zero, the molar conductivity is known as limiting molar conductivity.

KOHLRAUSCH LAW:- Limiting molar conductivity of an electrolyte is the sum of individual contribution of anion and cation of electrolyte.

$$\Lambda_m^{\circ} \text{ AB} = \Lambda_m^{\circ} \text{ A}^+ + \Lambda_m^{\circ} \text{ B}^-$$

$\Lambda_m^{\circ} \text{ A}^+$ = limiting molar conductivity of cation.

$\Lambda_m^{\circ} \text{ B}^-$ = limiting molar conductivity of anion.

Applications:-

i) calculation of limiting molar conductivity of weak electrolyte.

ii) calculation of the Degree of Dissociation -

$$\text{Degree of Dissociation} (\alpha) = \frac{\Lambda_m^{\circ} \text{ C}}{\Lambda_m^{\circ} \text{ AB}} \text{ molal conductivity at any conc C}$$

$$\frac{\Lambda_m^{\circ} \text{ C}}{\Lambda_m^{\circ} \text{ AB}} \rightarrow \text{limiting molar conductivity}$$

iii) calculation of dissociation constant of weak electrolyte.

$$\text{Dissociation Constant (K}_c\text{)} = \frac{C\alpha^2}{1-\alpha} \quad C = \text{Concentration} \quad \alpha = \text{Degree of Dissociation}$$

Suggest a way to determine the Λ_m° value of water.

Ans: $\Lambda_m^{\circ}(\text{H}_2\text{O}) = \Lambda_m^{\circ} \text{H}^+ + \Lambda_m^{\circ} \text{OH}^-$

We find out $\Lambda_m^{\circ}(\text{CH}_3\text{COO}^-)$, $\Lambda_m^{\circ}(\text{NaOH})$ and $\Lambda_m^{\circ}(\text{NaCl})$ Then

$$\Lambda_m^{\circ}(\text{H}_2\text{O}) = \Lambda_m^{\circ}(\text{CH}_3\text{COO}^-) + \Lambda_m^{\circ}(\text{NaOH}) - \Lambda_m^{\circ}(\text{NaCl})$$

Q. The conductivity of 0.20 M solution of KCl at 298 K is 0.0248 S cm⁻¹. Calculate its molar conductivity (NCERT)

Ans: $\Lambda_m = \frac{K \times 1000}{\text{Molarity}} = \frac{0.0248 \times 1000}{0.20} = 124 \text{ S cm}^2 \text{ mol}^{-1}$

Q. Λ_m for NaCl, HCl and CH_3COONa are 126.4, 425.9 and 91.0 S cm² mol⁻¹ respectively. Calculate Λ_m° for CH_3COOH .

Ans: $\Lambda_m^{\circ}(\text{NaCl}) = \Lambda_m^{\circ}(\text{Na}^+) + \Lambda_m^{\circ}(\text{Cl}^-) = 126.4 \text{ S cm}^2 \text{ mol}^{-1} \quad \text{(1)}$

$$\Lambda_m^{\circ}(\text{HCl}) = \Lambda_m^{\circ}(\text{H}^+) + \Lambda_m^{\circ}(\text{Cl}^-) = 425.9 \text{ S cm}^2 \text{ mol}^{-1} \quad \text{(2)}$$

$$\Lambda_m^{\circ}(\text{CH}_3\text{COONa}) = \Lambda_m^{\circ}(\text{CH}_3\text{COO}^-) + \Lambda_m^{\circ}(\text{Na}^+) = 91.0 \text{ S cm}^2 \text{ mol}^{-1} \quad \text{(3)}$$

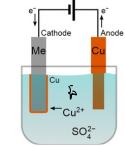
we have to calculate $\Lambda_m^{\circ}(\text{CH}_3\text{COOH}) = \Lambda_m^{\circ}(\text{CH}_3\text{COO}^-) + \Lambda_m^{\circ}(\text{H}^+)$

operating (3) + (2) - (1) $\Rightarrow 390.5 \text{ S cm}^2 \text{ mol}^{-1}$

Faraday's Law of Electrolysis:

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First Law:



The mass of substance deposit or liberated at any electrode during electrolysis is directly proportional to the amount of charge passed.

Mathematically $W \propto Q$

$$W \propto I \times t$$

$$W = Z \times I \times t$$

$$E = \frac{Q}{t}$$

$$[I \times t = Q]$$

w = mass of substance deposit / liberate
Z = electrochemical equivalent
I = Current t = time

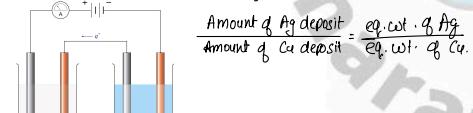
Q. What do you mean by Faraday Constant?

Ans: Charge of one mole g e⁻

$$= 6.022 \times 10^{23} \times 1.6 \times 10^{-19} \Rightarrow 96487 \text{ C mol}^{-1}$$

$$\approx 96500 \text{ C mol}^{-1}$$

Second Law:- when same amount of electricity passed through two different electrolyte connected in series, amount of substance deposited at electrodes is directly proportional to their equivalent weight.



Q. A solution of CuSO_4 is electrolysed for 10 minutes with a current of 1.5 amperes what is the mass of copper deposited at cathode? (NCERT)

Ans: Acc. to Rxn $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$

$$W = Z \times I \times t = \frac{\text{Mol. Mass} \times I \times t}{nx96500} \Rightarrow \frac{63.5 \times 1.5 \times 600}{2 \times 96500} \approx 0.2938 \text{ g}$$

A solution of $\text{Ni}(\text{NO}_3)_2$ is electrolysed between platinum electrodes using a current of 5.0 ampere for 20 minutes. what mass of nickel will be deposited at the cathode? (At. mass of Ni = 58.7) (NCERT)

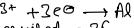
Ans: Acc. to Reaction $\text{Ni}^{2+} + 2e^- \rightarrow \text{Ni}$

$$W = Z \times I \times t \Rightarrow \frac{\text{Mol. Mass}}{nx96500} \times I \times t \Rightarrow \frac{58.7}{2 \times 96500} \times 5.0 \times 1200 = 1.825 \text{ g}$$

Q. How much charge is required

(i) 1 mol of Ag^{2+} to Al

The electrode reaction is



$$\text{Charge required} = 3F$$

$$= 3 \times 96500 \text{ C} = 289500 \text{ C}$$

(ii) 20.0 g of Ca from molten CaCl_2

The electrode reaction is $\text{Ca}^{2+} + 2e^- \rightarrow \text{Ca}$

$$40 \text{ g of Ca required} = 2F$$

$$20 \text{ g of Ca required} = 1F$$

Your Support Matters

BATTERIES

These are source of electrical energy which may have one or more cells connected in series.

Good quality battery should be light, compact and its voltage should not vary during its use.

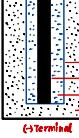
11

PRIMARY BATTERIES

the reaction occur only once and after use over a period of time, battery becomes dead and can't be reused again.

DRY CELL OR LECLANCHE CELL

This cell consist as Zn rod act as anode and cathode is carbon rod which is surrounded by powdered MnO_2



At Anode -



At Cathode -

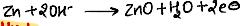


This cell has a potential of 1.5V.

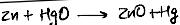
MERCURY CELL

It consist of zinc-mercury amalgam as Anode. The cathode is a paste of mercuric oxide (HgO) and carbon powder. The electrolyte consist of a mixture of KOH and ZnO

At Anode



At cathode



The potential of a mercury cell is approximately 1.35V. It remains constant as in the overall cell reaction no ions are involved in solution thus it lasts longer.

USES OF MERCURY CELL

It is suitable for low current devices like watches, hearing aids, toys etc.

SECONDARY BATTERIES

A secondary cell after use can be recharged by passing current in opposite direction so that it can be used again. A good secondary cell can undergo a large no. of discharging and charging cycles.

e.g. Lead Storage Battery, Nickel-Cadmium battery, Li-Ion battery.

LEAD- STORAGE BATTERY :-

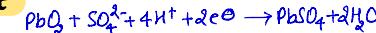
it consist of a lead anode and lead oxide cathode. A 28% solution of sulphuric acid acts as electrolyte. Each cell give the voltage of 2V so this cell is sufficient to give the voltage of 12 V. These voltage cells are separated by thin fibre glass sheet.

During Discharging, the cell reactions are

AT ANODE



AT CATHODE



The Overall Cell Rxn :-

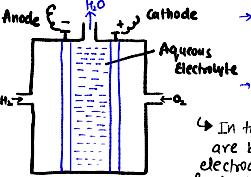


During charging, current is passed through the terminal from external source. The reactions are reversed

Used it is commonly used in automobiles, power inverters.

FUEL CELL:-

Chemical energy from combustion of fuels like hydrogen, methane and methanol is converted into electrical energy.

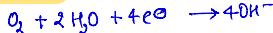


→ It is highly efficient (~70%) method when compared to the efficiency of thermal power plant (~10%).
→ Side product is water which doesn't cause pollution.

→ In the cell, hydrogen and oxygen are bubbled through porous carbon electrodes into aqueous sodium hydroxide solution. finely divided platinum or palladium acts as a catalyst.

* It was used for providing electrical power in Apollo space programme. The water vapours were produced condensed and added to the drinking water supply for astronauts.

At Cathode



At Anode



CORROSION The eating away of a metal by atmospheric gases, moisture etc is called corrosion e.g.

- 1) Silver turns black due to formation of silver sulphide
- 2) Copper turns green due to formation of a basic layer of copper hydroxide $Cu(OH)_2$ and copper carbonate $CuCO_3$
- 3) Rusting in iron i.e. the formation of reddish brown covering on iron of hydrated ferric oxide $(Fe_2O_3 \cdot xH_2O)$

factors which affect corrosion: Prevention of corrosion

- 1) Presence of Impurities in Metals
- 2) Presence of electrolytes in water
- 3) Presence of CO_2 in water
- 4) Position of metal in EMF Series
- 5) Presence of Protective Coatings.

Prevention of corrosion

- 1) Barrier Protection
- 2) Bacterial Protection
- 3) Cathodic Protection
- 4) Using Anti-Rust Solution

when one or more substance undergo a change which results in the formation of a new product, called chemical reaction.

CHEMICAL KINETICS, is the branch of chemistry which deals with the study of rates of chemical reaction their mechanism and the conditions in which rates can be altered.

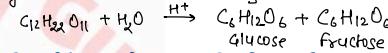
ON THE BASIS OF SPEED

i) **VERY FAST REACTION**: Some reaction such as ionic reactions occurs very fast e.g. $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

ii) **VERY SLOW REACTION**: Some reactions are very slow i.e. takes months to years in completion e.g. Rusting of iron in the presence of air and moisture formation of coal and petroleum

iii) **MODERATE REACTION**: Those reactions which are neither very slow nor very fast but takes place at moderate speed.

e.g. inversion of cane sugar



ON THE BASIS OF NUMBER OF STEPS

COMPLEX REACTIONS

when a sequence of elementary reactions gives us the product called complex reaction, each step in a complex reaction is called elementary rxn. slowest step is called rate determining step.

RATE OF CHEMICAL REACTION:

It is the change in molar concentration of species taking part in the chemical reaction per unit time.

For the reaction $A \rightarrow B$

Rate of disappearance of A

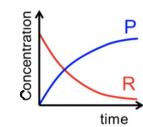
$$= \frac{\text{Decrease in conc. of } A}{\text{Time taken}} = - \frac{\Delta[A]}{\Delta t}$$

Rate of disappearance of B

$$= \frac{\text{Increase in conc. of } B}{\text{Time taken}} = + \frac{\Delta[B]}{\Delta t}$$

NOTE

The concentration of reactant decreases, so it is represented by -ve sign, while the conc. of product increases so it is represented by +ve sign.



TYPES OF RATE OF REACTION:

Average Rate

change in molar conc. of reactant and product at a given interval of time.

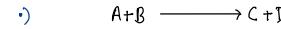
Instantaneous Rate

change in molar conc. of reactant and product at a given instant of time.

$$\text{Avg. Rate of Reaction} \xrightarrow{R} P \quad \text{Inst. Rate of Reaction} \xrightarrow{-\frac{d[R]}{dt}} P$$

$$\frac{-\Delta[R]}{\Delta t} = + \frac{\Delta[P]}{\Delta t}$$

RELATION BETWEEN RATE OF REACTION AND STOICHIOMETRY



$$\text{Rate of Rxn} \quad -\frac{d[A]}{dt} = -\frac{d[B]}{dt} = +\frac{d[C]}{dt} = +\frac{d[D]}{dt}$$

• $2A \longrightarrow C + D$ It is clear from stoichiometry of reaction that the rate of disappearance of A is twice the velocity of formation of C & D.

Chemical Kinetics

Effect of Temperature on rate of reaction:-

The rate of reaction increases with increase in temperature

Arrhenius proposed an equation that related temperature and rate constant for a reaction quantitatively

Acc. to Arrhenius Equation

$$K = A e^{-E_a/RT}$$

where

K = rate constant of the Rxn
 A = Arrhenius factor / Frequency factor / pre exponential factor

E_a = Activation Energy

R = Universal Gas Constant

T = Temp. in Kelvin (Scale)

Taking ln both sides

$$\ln K = \ln A - \frac{E_a}{RT}$$

$$\ln K = -\frac{E_a}{RT} + \ln A$$

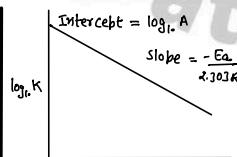
At temp T_1 ,

$$\ln K_1 = \ln A - \frac{E_a}{RT_1} \quad \text{---(1)}$$

At temp T_2 ,

$$\ln K_2 = \ln A - \frac{E_a}{RT_2} \quad \text{---(2)}$$

Operating (2) - (1)



$$\ln K_2 - \ln K_1 = \frac{E_a}{RT_2} - \frac{E_a}{RT_1}$$

$$\frac{\ln K_2}{K_1} = \frac{E_a}{R} \left(\frac{T_1 - T_2}{T_1 T_2} \right)$$

$$2.303 \log \frac{K_2}{K_1} = \frac{E_a}{R} \left(\frac{T_1 - T_2}{T_1 T_2} \right)$$

$$\log \frac{K_2}{K_1} = \frac{E_a}{2.303R} \left(\frac{T_1 - T_2}{T_1 T_2} \right)$$

where

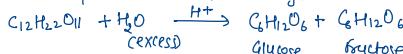
$E_a \rightarrow$ Activation Energy

$R \rightarrow$ Gas Constant

PSEUDO FIRST ORDER REACTION

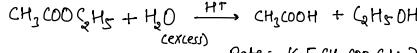
Reactions which are not truly of the first order but under certain conditions become reactions of first order are called pseudo first order reactions.

e.g. Acid catalysed inversion of cane sugar



$$\text{Rate} : K [C_{12}H_{22}O_{11}]$$

Acid catalysed hydrolysis of ethyl acetate.



$$\text{Rate} : K [CH_3COOC_2H_5]$$

Both of the above reactions are biomolecular but are found to be the first order because water is present in such a large excess that its concentration remains almost constant during the reaction.

P.Y.Q

Q. A reaction is second order w.r.t a reactant. How is the rate of reaction affected if the concentration of reactant is doubled? (NCERT (2009, 2012, 2014))

(i) doubled (ii) reduced to half

$$\text{Ans: Rate} = K [A]^2$$

$$[A] = 2a, \text{ rate} = K(2a)^2 = 4Ka^2 = 4 \text{ times}$$

$$[A] = \frac{1}{2}a, \text{ rate} = K\left[\frac{a}{2}\right]^2 = \frac{1}{4}Ka^2 = \frac{1}{4} \text{ th}$$

Q. A first order is found to have a rate constant

$K = 5.5 \times 10^{-14} \text{ sec}^{-1}$. Find half life of the reaction.

Ans: Half life for a first order reaction is (NCERT)

$$t_{1/2} = \frac{0.693}{K} = \frac{0.693}{5.5 \times 10^{-14}} = 1.26 \times 10^{13} \text{ s}$$

Q. The half life for radioactive decay of C^{14} is 5730 years. An archaeological artifact contained wood that had only 80% of the C^{14} found in living tree. Estimate age of the sample (NCERT)

Ans: Radioactive decay follows first order kinetics

$$\text{Decay } [K] = \frac{0.693}{t_{1/2}} = \frac{0.693}{5730}$$

$$t = \frac{2.303 \log \frac{[A]}{[A]_0}}{K} = \frac{2.303 \times 5730 \times 0.0969}{0.693} = 1845 \text{ years.}$$

Q. A first order reaction takes 20 minutes for 20% decomposition. Calculate $t_{1/2} = \frac{0.693 \log \frac{100}{80}}{20} = 0.0969$

$$\text{Ans: } K = \frac{0.303}{t} \log \frac{a}{a-x}$$

$$= \frac{0.303}{20} \log \frac{100}{80} = \frac{0.303}{20} \times 0.0969$$

$$= 0.013158 = 11.158 \times 10^{-3}$$

$$t_{1/2} = \frac{0.693}{K} = \frac{0.693}{11.158 \times 10^{-3}} > 62.1 \text{ min.}$$

All the Best 😊

d- and f-Block Elements

15

d-Block elements

Those elements in which the last electron enters in the d-subshell of penultimate shell

General Electronic Configuration $\rightarrow (n-1)d^{1-10} ns^{0-2}$

Periodic Table of the Elements																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18													
H	Li	Be	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe												
2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19													
He	Li	Be	Na	Mg	Al	Si	P	S	Cl	Ar	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru												
3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20													
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Te	Po	At													
4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21													
Y	Zr	Nb	Mo	Tc	Ru	Pd	Ag	Cd	In	Sn	Sb	Te	Po	At	Rn	Kr	Xe													
5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22													
La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Lanthanides	Actinides													
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23													
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Lu	Yb	Tb	Lu	Y	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Eu	Fm	Md	No	Lr

They are subdivided into four series.

21	22	23	24	25	26	27	28	29	30
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Zn	
39	40	41	42	43	44	45	46	47	48
Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
57	72	73	74	75	76	77	78	79	80
La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
89	104	105	106	107	108	109	110	111	112
Ac	Rf	Db	Sg	Bb	Hs	Mt	Ds	Rg	Cn

The d-block elements in which the atoms or ions have incomplete d-orbitals are called transition elements.

→ Zn, Cd and Hg have completely filled $(n-1)d$ -orbitals so they do not show much resemblance with other transition elements.

→ There are four series of d-block elements.

3d Series (Sc to Zn)

4d Series (Y to Cd)

5d Series (La and Hf to Hg)

6d Series (Ac and Rf to Cu)

Electronic Configuration:

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21. Sc - Scandium

[Ar] $^{18} 3d^1 4s^2$

22. Ti - Titanium

[Ar] $^{18} 3d^1 4s^2$

23. V - Vanadium

[Ar] $^{18} 3d^3 4s^2$

24. Cr - Chromium

[Ar] $^{18} 3d^5 4s^1$

25. Mn - Manganese

[Ar] $^{18} 3d^5 4s^2$

26. Fe - Iron

[Ar] $^{18} 3d^6 4s^2$

27. Co - Cobalt

[Ar] $^{18} 3d^7 4s^2$

28. Ni - Nickel

[Ar] $^{18} 3d^8 4s^2$

29. Cu - Copper

[Ar] $^{18} 3d^9 4s^1$

30. Zn - Zinc

[Ar] $^{18} 3d^10 4s^2$

24. $Cr^{2+} \rightarrow [Ar]^{18} 3d^4 4s^0$

24. $Cr^{3+} \rightarrow [Ar]^{18} 3d^3 4s^0$ (Stable due to half filled t_{2g})

24. $Cr^{4+} \rightarrow [Ar]^{18} 3d^10 4s^0$ (fully filled)

24. $Cr^{4+} \rightarrow [Ar]^{18} 3d^9 4s^0$

23. $Sc^{3+} \rightarrow [Ar]^{18} 3d^0 4s^0$

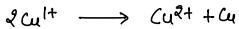
26. $Fe^{2+} \rightarrow [Ar]^{18} 3d^5 4s^0$ (half filled)

Oxidation State:-

Show large number of oxidation state due to the participation of both $(n-1)d$ and ns electrons in bonding in different compounds.

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
+3	+2 +3	+1 +2	+2						
	+4	+4	+4	+4	+4	+4	+4		
		+5	+5	+5	+6	+6	+6		
				+7					

- Mn shows maximum number of oxidation state due to the presence of maximum number of unpaired e^-
- Osmium (Os) show +8 oxidation state
- $\rightarrow \text{Cu}^{2+}$ is more stable than Cu^{1+} because it undergoes disproportionation reaction in aqueous soln



Note The ability of oxygen to stabilise these high oxidation state exceeds that of fluorine because oxygen can form double bond while fluorine form single bond.

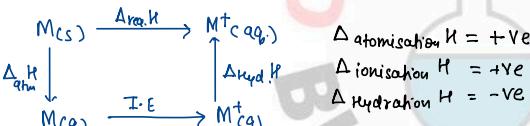
As a result highest Mn fluoride is MnF_3 , whereas the highest oxide is Mn_2O_7 .

Electrode Potential:-

The stability of a compound depends upon electrode potential and it further depends upon:

- Enthalpy of atomisation/sublimation
- Ionisation enthalpy
- Hydration enthalpy

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$$\begin{aligned} \Delta_{\text{atomisation}} H &= +ve \\ \Delta_{\text{ionisation}} H &= +ve \\ \Delta_{\text{hydration}} H &= -ve \end{aligned}$$

Table 8.4: Thermochemical data (kJ mol^{-1}) for the first row Transition Elements and the Standard Electrode Potentials for the Reduction of M^+ to M .

Element (M)	$\Delta_{\text{H}}^\circ (M)$	$\Delta_{\text{H}}^\circ (M)$	$\Delta_{\text{H}}^\circ (M)$	$\Delta_{\text{sub}} H (M^+)$	E° / V
Ti	469	661	1310	-1866	-1.63
V	515	648	1370	-1895	-1.18
Cr	398	653	1590	-1925	-0.90
Mn	279	716	1510	-1862	-1.18
Fe	418	762	1560	-1998	-0.44
Co	427	757	1640	-2079	-0.28
Ni	431	736	1750	-2121	-0.25
Cu	339	745	1960	-2121	0.34
Zn	130	908	1730	-2059	-0.76

There is no regular trend for M^{2+}/M standard electrode potential due to the irregularities in ionisation enthalpies and enthalpy of atomisation.

\rightarrow Copper is the only metal having positive value of E° so it does not liberate the hydrogen gas from acids.

Chemical Reactivity:-

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Chemical reactivity $\propto \frac{1}{E^\circ}$

- $E^\circ (M^{2+}/M)$ is very less (more -ve) except Cu so these metals are highly reactive
- Oxidising power $\propto E^\circ$
- Reducing Power $\propto \frac{1}{E^\circ}$

Oxide Formation:-

Many of the d-block elements forms oxides of different types because of the presence of so many different oxidation state.

Note Acidic character \propto Oxi. State
Ionic character \propto Oxi. State.

F-Block Elements :-

Elements in which last e^- enters in f-orbital of pre-benulminate shell.

General Electronic Configuration = $(n-2)f^{14}(n-1)d^{10}ns^2$

57	138.3	58	140.3	59	140.6	60	144.2	61	145.0	62	156.4	63	152.0	64	157.3	65	158.9	66	162.5	67	164.5	68	167.3	69	168.9	70	173.1	71	175.0	
La	Lanthanum	Ce	Cerium	Pr	Praseodymium	Nd	Neodymium	Sm	Samarium	Eu	Europium	Gd	Gadolinium	Tb	Terbium	Dy	Dysprosium	Ho	Holmium	Er	Erbium	Tm	Thulium	Yb	Ytterbium	Lu	Lutetium			
[227]	[90]	[232]	[91]	[233]	[92]	[234]	[93]	[235]	[94]	[236]	[95]	[237]	[96]	[238]	[97]	[239]	[98]	[240]	[99]	[251]	[99]	[252]	[100]	[257]	[101]	[258]	[102]	[259]	[103]	[262]
Ac	Actinium	Th	Thorium	Pa	Protactinium	U	Uranium	Np	Neptunium	Pm	Plutonium	Bk	Berkelium	Cf	Cerium	M	Curium	Ba	Bamboo	Es	Escherichia	Fm	Fermi	Md	Mendelevium	No	Noberium	Lr	Lanthanum	

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4f-block elements (lanthanides)

Valence shell electronic Configuration $4f^{14}5d^{10}6s^2$

Lanthanoid Series

or

1st Inner Transition Series

57	58	59	60	61	62	63	64
La	Lanthanum	Ce	Cerium	Pr	Praseodymium	Nd	Neodymium
58.905	138.005	140.105	140.905	144.425	144.905	149.905	151.964
4f ¹⁴ 5d ⁶ 6s ²	4f ¹⁴ 5d ⁷ 6s ²	4f ¹⁴ 5d ⁸ 6s ²	4f ¹⁴ 5d ⁹ 6s ²	4f ¹⁴ 5d ¹⁰ 6s ²	4f ¹⁴ 5d ¹⁰ 6s ²	4f ¹⁴ 5d ¹⁰ 6s ²	4f ¹⁴ 5d ¹⁰ 6s ²
65	66	67	68	69	70	71	
Tb	Terbium	Dy	Dysprosium	Ho	Holmium	Er	Thulium
138.925	160.900	164.920	167.420	168.034	173.055	174.967	
4f ¹⁴ 5d ⁹ 6s ²	4f ¹⁴ 5d ¹⁰ 6s ²						

Oxidation State:-

The common oxidation state of lanthanoids is +3 with +2 and +4.

Lanthanoid Contraction:-

The regular decrease in the atomic and ionic radii of lanthanoids with the increase in atomic number from left to right in lanthanoid series is called lanthanoid contraction.

Cause of Lanthanoid Contraction

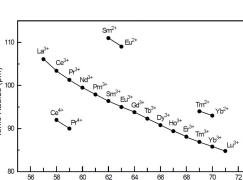
- Increase in effective nuclear charge
- Poor screening effect of 4f electrons.

Consequences of Lanthanoid Contraction

- The separation of lanthanoids is difficult as there is very little difference in their size due to which they have similar chemical properties.
- Basic strength of hydroxides decreases from left to right
- Covalent character of hydroxides increases from left to right
- The size of 3rd transition series elements is similar to the size of 2nd transition series.

By - Bharat Panchal Sir**Use of Lanthanides**

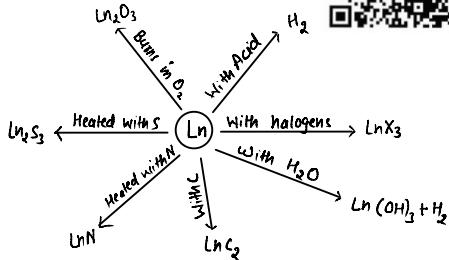
- In glass industry
 - As an oxidising agent
 - In making magnetic and electronic behaviour
 - In making alloy steel which is used in making bullets.
- e.g. Mischmetal
(Lanthanides + Fe + S + C + Ca + Al)



for Help
You can donate



Chemical Reactivity



Uses

- I Lanthanoids are used for the production of alloy steels for plates and bikes.
- ii) Mischmetal alloy of lanthanoid is used in Mg-based alloy to produce bullets, shell and lighter flint.
- iii) Mixed oxides of lanthanoids are used as catalyst in cracking of petroleum.
- iv) Some lanthanum oxides are used as phosphors in television screen.

ACTINIODS

These are the elements in which last ee filled in $5f$ -orbitals. The actinoids are radioactive elements.

Electronic Config.

The general electronic config. $5f^{14}6d^{0-1}7s^2$

Irregularities in the electronic configuration of actinoids is due to stabilities of f^0, f^7, f^{14} occupancies of $5f$ -orbital.

Similarities b/w Lanthanoids and Actinoids

- Both exhibit +3 oxidation state predominantly.
- Both are electropositive and have high reactivity.
- Like lanthanoid contraction, there is actinoid contraction also.

Difference b/w Lanthanoids and Actinoids

Lanthanoids

- They show mainly +3 Ox. State. +2 and +4 Oxidation State also exist.
- They have poor shielding effect.
- They are paramagnetic and their paramagnetic character can be explained easily.
- They have less tendency to form complexes.
- These are non-radioactive except bariumium.

Actinoids

- They show +3 Ox. State. Highly oxidate like +4, +5, +6 and +7.
- They have even poor shielding effect.
- They are also paramagnetic but their magnetic character can't be explained easily.
- They have more tendency to form complexes.
- These are radioactive substance.

Application of Actinoids

- Actinoids are used in nuclear reactors for the production of electricity.
- Actinoids are also used for the synthesis of transuranic elements.

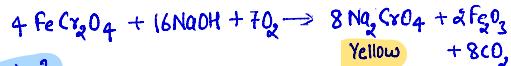
COMPOUNDS OF TRANSITION ELEMENTS

Potassium Dichromate • Potassium Permanganate
($K_2Cr_2O_7$) ($KMnO_4$)

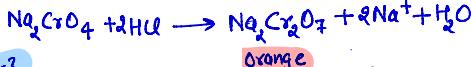
18

→ Potassium Dichromate ($K_2Cr_2O_7$) it is prepared from chromite ore

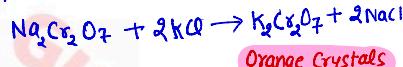
Step-1 Conversion of ferrichromate into sodium chromate



Step-2 Conversion of sodium chromate into sodium dichromate



Step-3 Conversion of sodium dichromate into potassium dichromate



→ Chromates and dichromates are interconvertible



Structure...

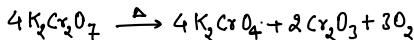
chromate ion (CrO_4^{2-}) dichromate ion ($Cr_2O_7^{2-}$)



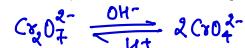
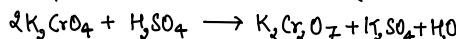
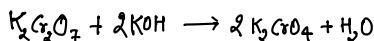
Properties

1) These are orange red crystals, moderately soluble in cold water but readily soluble in hot water.

2) Action of heat



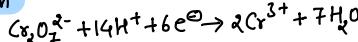
3) Action Of Alkali -



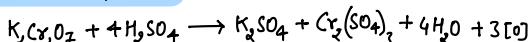
4) Oxidising Property -

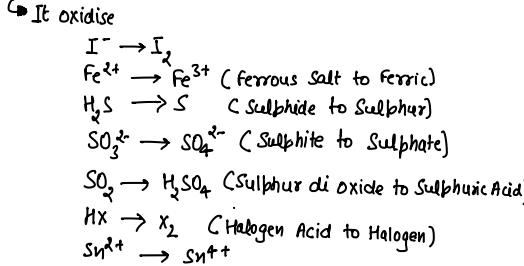
$K_2Cr_2O_7$ behave as a powerful oxidising agent in Cr (II) is changed into Cr (III)

Ionic Reaction



Molecular Reaction

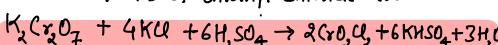




ethyl alcohol \rightarrow acetaldehyde \rightarrow acetic acid

→ CHROMYL CHLORIDE TEST

This test is done for the identification of Cl^- ions during salt analysis, potassium dichromate is heated with conc. H_2SO_4 and a salt having Cl^- (eg NaCl, KCl) and reddish brown vapours of chromyl chloride are obtained.



Uses It is used as an oxidising agent, disinfectant, in volumetric analysis, for tanning in leather and in chromyl chloride test.

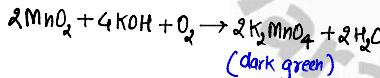
Physical Properties

- crystalline ionic solid having bright, reddish orange colour.
- it is soluble in water and insoluble in alcohol, acetone etc.
- it is odourless, with density around 2.67 g cm^{-3}

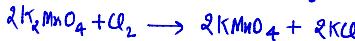
→ Potassium Permanganate ($KMnO_4$)

$KMnO_4$ is prepared from pyrolusite (MnO_2) ore.

Pyrolusite (MnO_2) react with alkali metal hydroxide (KOH) to give potassium permanganate



Potassium permanganate disproportionate in acid or alkali to give potassium bermanganate

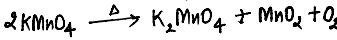


Properties

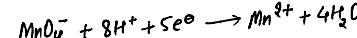
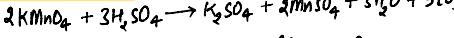
$KMnO_4$ is dark purple-black crystalline solid, soluble in warm water.

2) Action of Heat -

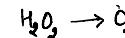
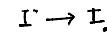
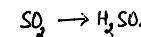
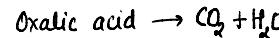
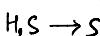
On heating, it decomposes



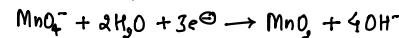
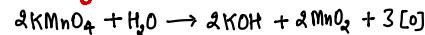
3) In Acidic Medium



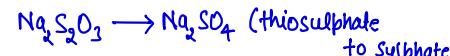
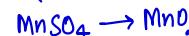
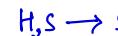
→ It oxidise



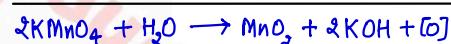
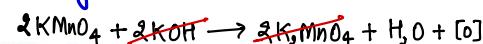
→ Oxidising Reactions in Neutral Medium...



→ It oxidise



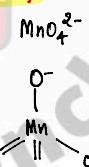
→ Oxidising Reactions in Alkaline Medium



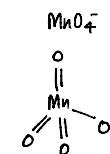
NOTE

The overall reactions in alkaline medium is same as in neutral medium

Structure of



Tetrahedral manganese ion
(green) (paramagnetic)



Tetrahedral permanganate ion
purple (Diamagnetic)

USES

- It is used as an oxidant in the preparation of organic compounds.
- bleaching of wool, cotton, silk, decolorisation of oil.
- in cleaning surgical instruments in hospitals

for Help
You can donate



COORDINATION COMPOUNDS

Transition metals form a large no. of complex compounds in which the metal atoms are bound to a number of anions or neutral molecule by sharing of e^- . Such compound are known as co-ordination compounds.

Difference b/w Double Salt and Co-ordination Compound

Double Salt

They usually contain two simple salts in equimolar proportion

They are ionic compound and do not contain any co-ordinate bond

The properties of the double salts are the same as those of its constituent compounds.

In the double salt metal ions show their normal valency

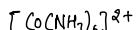
A double salt loses its identity in the solution

e.g. $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 2\text{H}_2\text{O}$

Types of Co-ordination Compounds

Cationic Complex

Complex ion carry +ve charge



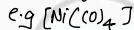
Anionic Complex

Complex ion carry -ve charge



Neutral Complex

Complex doesn't carry any charge



Ligands

The atoms, ions or molecules which can donate the lone pair of e^- to central metal atom by co-ordinate bond in co-ordination compounds are called ligands.

Denticity of ligands:-

The number of donor atoms present in the ligand is called its denticity. On the basis of denticity ligands are of different forms as: monodentate, bidentate, tridentate, tetridentate, polydentate hexadentate etc.

Monodentate Ligands

When a ligand is bound to a metal ion through a single donor atom

e.g. Cl^- , Br^- , CN^-



Bidentate Ligands

When a ligand can bind through two donor atoms.

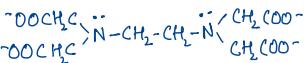
e.g. oxalato, ethane-1,2-diamine, Glycinate (Gly)



Polydentate Ligands

When a ligand have more than two donating sites.

e.g. EDTA (Ethylene Diamine Tetra Acetate Ion)



Donor Atoms $\rightarrow 6$

Hexadentate Ligands

Ambidentate ligands: Those ligands which have two donor atoms but use one atom to attach with a central metal atom. So these are monodentate ligands.

e.g. CN^- (Cyano) & SCN^- (thiocyanato)
 NC^- (isocyano) & NCS^- (isothiocyanato)

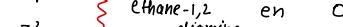
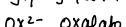
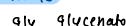
Negative ligands which have negative charge

Symbol of ligands	Name of ligands	charge on ligands
CN^-	Cyano	-1
Cl^-	Chlorido	-1
Br^-	Bromo	-1
I^-	Iodo	-1
NO_3^-	Nitro-N	-1
ONO^-	Nitro-O	-1
OH^-	Hydroxo	-1
NO_2^-	Nitro	-1
SCN^-	Thio-N	-1
HCOO^-	Hydroxyl	-1
CH_3COO^-	Aceto	-1
H_2O	Hydro	-1
O_2^-	Oxo	-2
O_2^-	Bromo	-2
SO_3^{2-}	Sulphito	-2
SO_4^{2-}	Sulphate	-2
CO_3^{2-}	Carbonato	-2

Neutral ligands

NH_3	amine	0
CH_3NH_2	Methylamine	0
H_2O	aqua	0
NO	Nitrosyl	0
CO	Carbonyl	0
CS	Thiocarbonyl	0
PH_3	Phosphine	0
$(\text{C}_6\text{H}_5)_3\text{P}$	Triphenyl phosphine	0
H_2NCSNH_2	Thiourea	0
$\text{C}_5\text{H}_5\text{N}$	Puridine	0
CH_3	Methyl	0

Bidentate



Chelating Ligands:-

It is closed ring type compound formed by polydentate ligands (chelating ligand) on binding to central metal atom

Importance

e.g. $\text{M} \leftarrow \begin{matrix} \text{N} \\ | \\ \text{H}_2-\text{CH}_2 \\ | \\ \text{N} \\ | \\ \text{H}_2-\text{CH}_2 \end{matrix}$ • it forms more stable complex, called chelating effect

Use

- in softening of Hard water
- Detection of metal ion
- separation of f-block elements.

Co-ordination Entity

which are directly attached to it are enclosed in square bracket and called co-ordination sphere or co-ordination entity

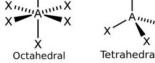
e.g. $[\text{Fe}(\text{CN})_6]^{4-}$ is called coordination sphere.

Counter Ion

The ionisable groups written outside the square bracket and are called counter ions. e.g. $\text{K}_4[\text{Fe}(\text{CN})_6]$ where K_4 ions are called counter ions

Co-ordination Polyhedron

The spatial arrangement of the ligands around the central metal atom is called co-ordination polyhedron e.g.



Octahedral



Tetrahedral

Co-ordination Number

The total number of co-ordinate bond formed by ligands with central metal atom

Co-ordination Number = $\leq (\text{Number of ligands} \times \text{Denticity})$

e.g. $\text{K}_4[\text{Fe}(\text{CN})_6]$

$\text{C.N.} = 6 \times 1 = 6$

$[\text{Co}(\text{Cl}_2(\text{en}))_4]^{4+}$

$\text{C.N.} = 2 \times 1 + 2 \times 2 = 6$

Oxidation Number

The charge present on the central metal atom in a co-ordination compound is called oxidation number. It is always positive.

e.g. $\text{K}_4[\text{Fe}(\text{CN})_6]$

$$\downarrow$$

$$4(1) + x + 6(-1) = 0$$

$$x = 2$$

ON THE BASIS OF LIGANDS

Homoleptic in which only one type of ligands are present
e.g. $K_4[Fe(CN)_6]$

Heteroleptic in which different type of ligands are present
e.g. $[CoCl_2(en)_2]Cl$

Nomenclature of Co-ordination Compounds

- $K_4[Fe(CN)_6] \rightarrow$ potassium hexacyanido ferrate (II)
- $[CrCl_2(H_2O)_4]NO_3 \rightarrow$ tetra aqua dichlorido chromium (III) nitrate
- $[CoCl(CN)_4](NH_3)_4NO_3 \rightarrow$ tetrachlorido chlorido cyanato-N-cobalt (III) nitrate
- $K_2[Fe(C_2O_4)_3] \rightarrow$ potassium tri oxalato ferrate (III) nitrate
- $K_3[Co(CN)_5(NO)] \rightarrow$ potassium penta cyanido nitrosyl cobaltate(II) nitrate
- $[CoCl_2(en)_2]SO_4 \rightarrow$ dichloride bis (ethane-1,2-diamine) cobalt (II) sulphate
- $[CoCl(CO)(en)]^+ \rightarrow$ chlorido bis (ethane-1,2-diamine) nitrito-o-cobalt (III) ion
- $[Ni(CO)_4] \rightarrow$ tetra carbonyl nickel (0)
- $Li[AlH_4] \rightarrow$ lithium tetra hydrido aluminate (III)

Werner Theory

- Metals possess two types of valencies, called primary or ionisable valency (oxidation number) and secondary or non-ionisable valency (Co-ordination Number).
- The primary valencies are non-directional.
- The complex compound do not show any property of the central metal atom and the ligands present in it.

Valence Bond Theory :

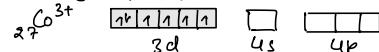
Acc. to this theory, metal-ligand bond arises due to the donation of electron pair from ligands to central metal atom.

the metal atom or ion under the influence of ligands can use $(n-1)d$, ns, np, nd orbitals for hybridisation

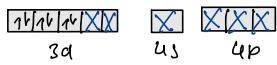
Hybridisation	C.N	Geometry	Example
Sp	2	linear	$[Ag(CN)_2^-]$
Sp ²	3	Trigonal planar	$[HgI_3]^-$
Sp ³	4	Tetrahedral	$[Ni(CO)_4]^{2-}$
dSp ²	4	Square planar	$c[Ni(CN)_4]^{2-}$
dSp ³	5	Square pyramidal	$Fe(CO)_5$
d ² Sp ³	6	Octahedral (inner)	$[Cr(NH_3)_6]^{3+}$
Sp ³ d ²	6	Octahedral (outer)	$[FeF_6]^{3-}$

e.g. $[Co(NH_3)_6]^{3+}$

$Co^{3+} \rightarrow [Ar]^{18} 3d^6$



• NH₃ is a strong ligand so pairing of e₀ takes place



hybridisation $\rightarrow d^2sp^3$

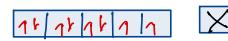
Geometry \rightarrow Octahedral

inner orbital Complex

$$U = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} B.M$$

$[Ni^2+]^{2-}$

$28 Ni^{2+} \rightarrow [Ar]^{18} 3d^8 4s^0$



hybridisation \rightarrow Sp³ Geometry \rightarrow tetrahedral

It is paramagnetic in nature

$$U = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} B.M$$

$[Ni(CN)_4]^{2-}$

$28 Ni^{2+} \rightarrow [Ar]^{18} 3d^8 4s^0$



CN is a strong ligand so pairing of e₀ takes place



hybridisation $\rightarrow dSp^2$

Geometry \rightarrow Square planar

It is diamagnetic in nature.

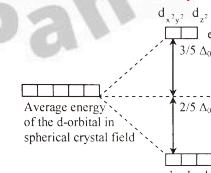
CRYSTAL FIELD THEORY:

Metal-Ligand bond is ionic in nature. So, there is electrostatic force of attraction b/w metal and ligands

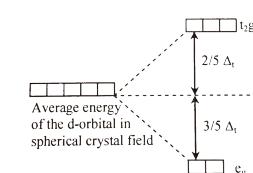
The ligands are treated as negative centres and these negative centres are so arranged around central metal atom that here is minimum repulsion b/w them.

In a free transition metal ion, all the five d-orbitals have equal energies (degenerate orbitals) but when it takes part in complex formation these d-orbitals split in two parts.
it is called d-d transition or crystal field splitting.

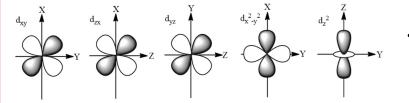
For Octahedral Complex



For Tetrahedral Complex



Shape of d-orbitals



$$\Delta_t = \frac{4}{9} \Delta_o$$

Spectrochemical Series:

arrangement of all ligands in order of increasing CFSE value is called spectrochemical series. The ligands with small value of CFSE are called weak ligands and the ligands with higher value of CFSE are called strong ligands.

$I^- < Br^- < S^{2-} < SCN^- < Cl^- < F^- < OH^- < OX^-$

$< H_2O < NCS^- < NH_3 < en < NO_2^- < CN^- < CO$

ISOMERISM

Two or more co-ordination compounds which have same molecular formula but have different ways of attachment of their ligands to the central metal atom and have different properties. These are called isomers. The phenomenon is known as isomerism.

ISOMERISM

Structural Isomers
arise due to the difference in the str. of co-ordination compounds

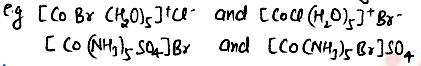
Stereo Isomers
arises due to the different spatial arrangement of ligands around the metal ion

- ↳ Ionisation
- ↳ Hydrate
- ↳ Co-ordination
- ↳ Linkage

- Geometrical isomerism
- Optical isomerism

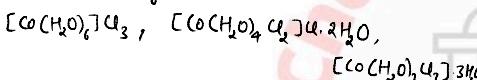
1) IONISATION ISOMERISM

This isomerism arises due to exchange of ionisable anion with anionic ligands. e.g.



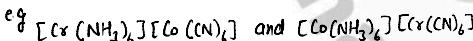
2) HYDRATE ISOMERISM OR SOLVATE ISOMERISM

In this isomerism, water is taken as solvent. It has different no. of water molecule in the co-ordination sphere and outside it. e.g.



CO-ORDINATION ISOMERISM

This type of isomerism occurs when there is interchange of ligands b/w cationic and anionic complexes of different metal ion present in a complex



LINKAGE ISOMERISM

This type of isomerism is shown by the coordination compounds having ambidentate ligands
e.g. $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}$ and $[\text{Co}(\text{NH}_3)_5(\text{ONO})]\text{Cl}$

STEREO ISOMERISM

Geometrical Isomerism

This isomerism is common in complexes with CN 4 & 6. Geometrical isomers are of two type

Cis
Same ligands are present at adjacent position

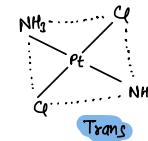
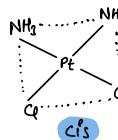
Trans
Same ligands are present at opposite position

Optical Isomerism

These are the complexes which have chiral str. The pair of stereoisomers are the mirror images of each other but may not be superimposed. On the stereoisomers these mirror images are called enantiomers. The enantiomers which rotate the plane polarised light in a clockwise direction is called dextrorotatory (+) or (+) and the enantiomers which rotate the plane polarised light in anti-clockwise direction is laevorotatory (-) or (-)

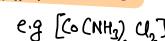
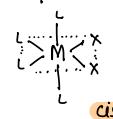
- Tetrahedral complexes do not show geometrical isomerism
- Square planar complexes of formula $[\text{MX}_2\text{L}_2]$ (X and L are unidentate ligands) show geometrical isomerism. The two X ligands may be arranged adjacent to each other in a cis-isomer or opposite to each other in a trans-isomer

22

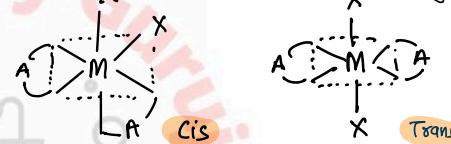
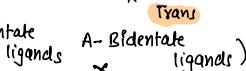


Octahedral complexes with C.N = 6

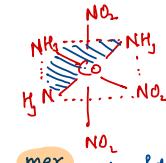
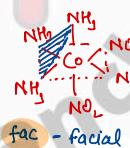
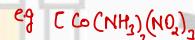
Type - MX_2L_4



Type - MX_2A_2 (X-unidentate ligands)



→ In Octahedral Complexes of the formula $[\text{MA}_3\text{X}_3]$

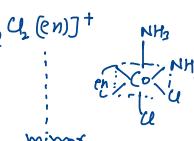
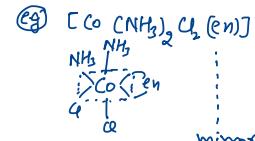
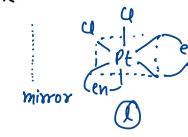


Same ligands occupy one face of an octahedron

same ligands are in one plane

OPTICAL ISOMERS

- optical isomerism is common in Octahedral complexes involving bidentate ligands
- The equimolar mixture of 'd' and 'l' isomer is termed as the racemic mixture
- Trans isomers can't show optical isomers



AMINES

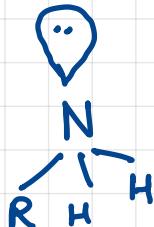
Amines are considered as amino of hydrocarbons or alkyl derivatives of ammonia.

Aliphatic amino compounds are called amino alkanes and aromatic amines are called amino arenes e.g. CH_3NH_2 , $\text{C}_2\text{H}_5\text{NH}_2$, $\text{C}_6\text{H}_5\text{NH}_2$.

$\text{R}-\text{NH}_2$ Primary Amines (1°)

$\text{R}-\text{NH}-\text{R}$ Secondary amines (2°)

$\text{R}-\overset{\text{N}}{\underset{\text{R}}{\text{R}}}-\text{R}$ Tertiary Amines (3°)



Pyramidal Shape of Amine

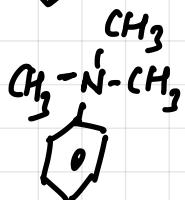
NOMENCLATURE

$\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{NH}_2$ Propan-1-amine

$\text{CH}_3-\overset{\text{NH}_2}{\underset{\text{CH}_3}{\text{CH}}}-\text{CH}_3$ Propan-2-amine

$\text{CH}_3-\text{CH}_2-\overset{\text{N}}{\underset{\text{C}_2\text{H}_5}{\text{N}}}-\text{C}_4\text{H}_9$ N,N-Diethyl butan-1-amine

$\text{CH}_2=\text{CH}-\text{CH}_2-\text{NH}_2$ Prop-2-en-1-amine



N,N-Dimethyl benzenamine

$\text{NH}_2-(\text{CH}_2)_6-\text{NH}_2$
Hexane-1,6-di'amine

Preparation of Amines :-

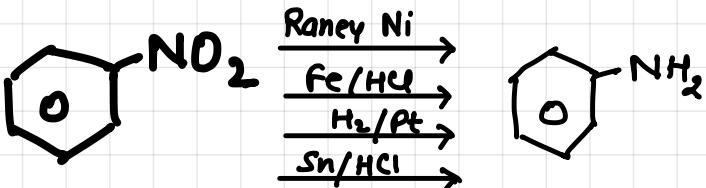
2t

► Reduction of Alkyl Nitrile



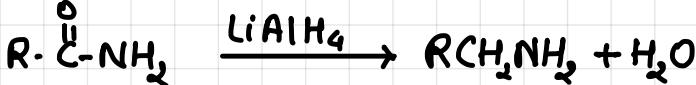
Rxn is used for ascent of amine

► Reduction of Nitroalkane :



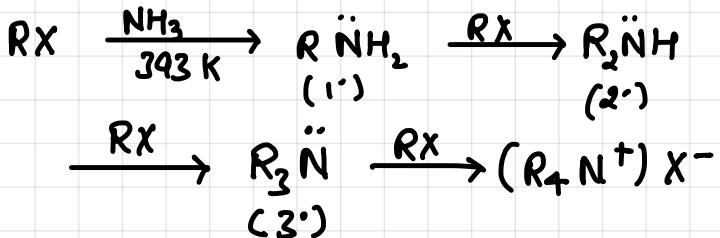
Reduction with Fe/HCl is preferred

► Reduction of Amides :



Reduction of amides give amine with same number of carbons.

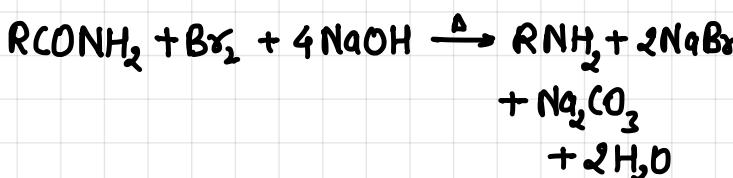
► Hofmann Ammonolysis Method :



Order of reactivity $\rightarrow \text{RI} > \text{RBBr} > \text{RCl}$

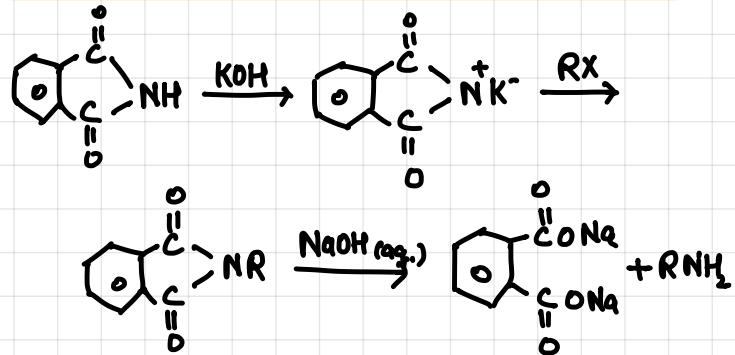
☞ 1° amine is obtained as major product when excess of NH_3 is taken

► HOFMANN BROMAMIDE DEGRADATION :



☞ Amines formed contains one carbon less than that present in the amide.

GABRIEL PHTHALIMIDE SYN.



- ↳ Only 1° amines can be synthesized by this method
- ↳ Aromatic 1° amines can not be prepared by this method as aryl halide do not undergo nucleophilic sub. Rxn with potassium phthalimide

PHYSICAL PROPERTIES :

PHYSICAL STATE ⇒

The lower aliphatic amines are gases with fishy odour, 1° amines with three or more carbon atoms are liquid and higher ones are solid.

COLOUR → Pure amines are colourless but develop colour on keeping in air for long time

SOLUBILITY ⇒ Lower amines are readily soluble in water, which decreases in water and increases in organic solvents with an increase in molecular weight.

BOILING POINT :

1° and 2° amines are engaged in intermolecular association due to hydrogen bonding, while 3° amines do not have intermolecular association (due to absence of H-atoms)

Order of B.Pt of isomeric amines
 $1^\circ > 2^\circ > 3^\circ$

BASIC CHARACTER OF AMINES :

Larger the value of K_b or smaller the value of pK_b , stronger is the base

- Alkyl amines are stronger bases than NH_3
- Basic nature of aliphatic amines increases with increase in the number of alkyl groups i.e. +I effect of alkyl group increases their basicity.

- Order of basicity in gaseous phase...
- $3^\circ \text{ amine} > 2^\circ \text{ amine} > 1^\circ \text{ amine} > \text{NH}_3$

In aqueous phase, solvation effect and steric hindrance, besides inductive effect of alkyl group decide the basic strength of alkyl amines.

↳ When alkyl group is ethyl group
 $(\text{C}_2\text{H}_5)_2\text{NH} > (\text{C}_2\text{H}_5)_3\text{N} > \text{C}_2\text{H}_5\text{NH}_2 > \text{NH}_3$

↳ When alkyl group is methyl group
 $(\text{CH}_3)_2\text{NH} > \text{CH}_3\text{NH}_2 > (\text{CH}_3)_3\text{N} > \text{NH}_3$

► BASIC NATURE of aniline or aryl amine would be less than that of ammonia.

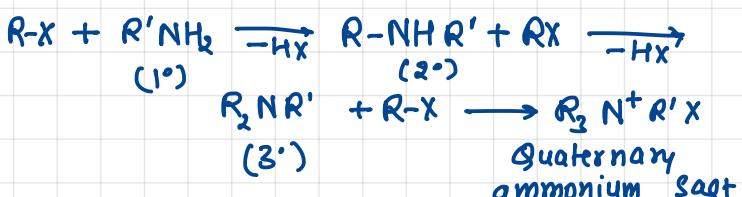
↳ Less basicity of aniline as compared to NH_3 is attributed to -I effect of benzene ring and delocalisation of lone pair of N.

Note ERG like $-\text{OCH}_3$, CH_3 increase basic strength whereas EWG like NO_2 , SO_3H decrease basic strength.

CHEMICAL PROPERTIES OF AMINES

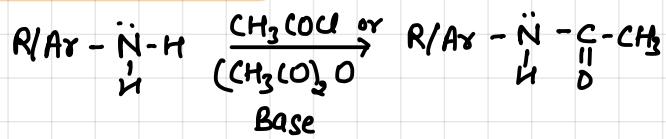
FOR ALIPHATIC AMINES

ALKYLATION



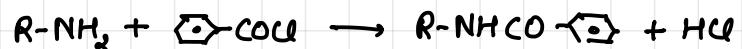
- It yields a mixture of 1° , 2° and 3° amines and also quaternary ammonium salt.
- Major product is obtained when amine is taken in excess.

ACYLATION



The reaction is carried out in presence of a base stronger than (e.g. pyridine) which removes HCl so formed and shifts equilibrium to right side.

BENZOYLATION



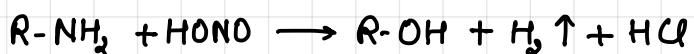
CARBYLAMINE REACTION:



Secondary and tertiary amines do not show this reaction.

It is used as a test for 1° AMINES

REACTION WITH NITROUS ACID:



REACTION WITH ARYL SULPHONYL CHLORIDE $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ HINSBERG REAGENT

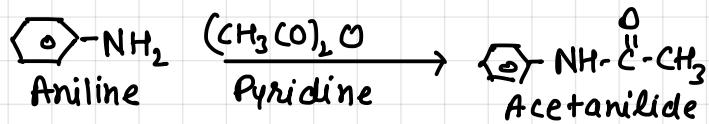
- 1° $R\text{NH}_2 + \text{C}_6\text{H}_5\text{SO}_2\text{Cl} \xrightarrow{-\text{HCl}} \text{C}_6\text{H}_5\text{SO}_2\text{NH-R}$
Soluble in alkali
- 2° $R_2\text{NH} + \text{C}_6\text{H}_5\text{SO}_2\text{Cl} \xrightarrow{-\text{HCl}} \text{C}_6\text{H}_5\text{SO}_2\text{NR}_2$
- 3° $R_3\text{N} + \text{C}_6\text{H}_5\text{SO}_2\text{Cl} \rightarrow \text{No Reaction}$

Reaction is used to distinguish b/w three classes of amines 1°, 2° and 3° amines.

AROMATIC AMINES

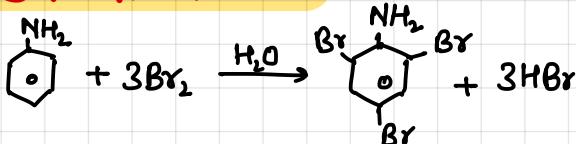
-NH₂ group is ortho and para directing and powerful activating group.

- Activating effect of -NH₂ group in aniline can be controlled by protecting the -NH₂ group by acetylation with acetic anhydride and then carrying out the desired substitution R-nitration.

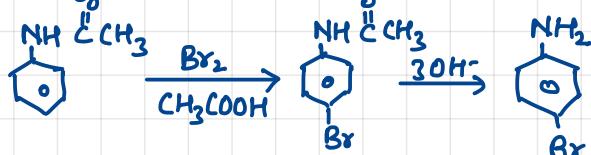


26

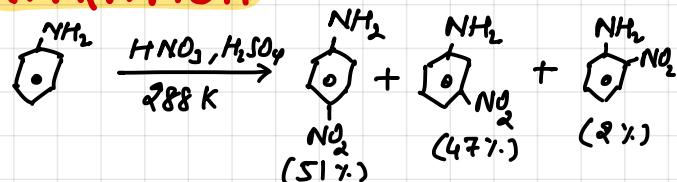
BROMINATION



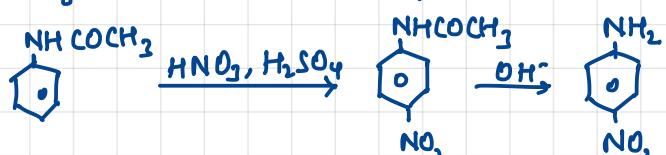
↳ To get monosubstituted derivative



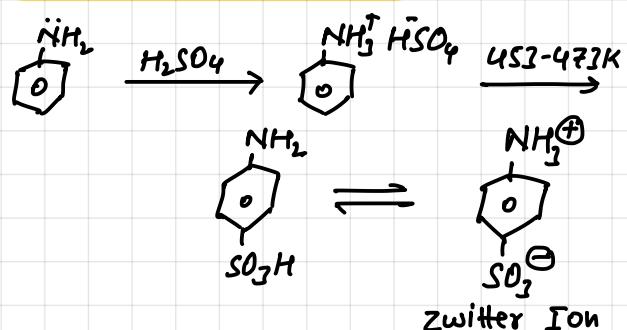
NITRATION



To get mono substituted para derivative



SULPHONATION:



p-amino benzene sulphonic acid is the major product because distance b/w -NH₂ and SO₃H is maximum.

↳ Sulphanilic acid exist in ZWITTER ION FORM.

for Help

You can donate

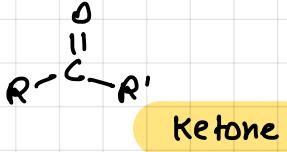
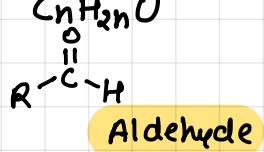


ALDEHYDE, KETONE AND CARBOXYLIC ACID

PREPARATION OF ALDEHYDES AND KETONES:

27

In organic compounds containing carbon-oxygen double bond ($>C=O$) called carbonyl group. Their general formula is $C_nH_{2n}O$



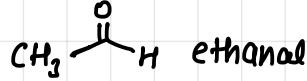
The carbonyl compound in which carbonyl group is bonded to an oxygen atom of hydroxyl group ($-OH$) are known as carboxylic acid



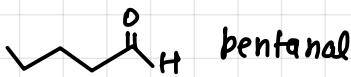
Nomenclature of Aldehydes



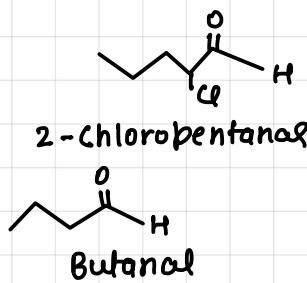
methanal



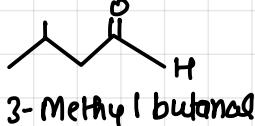
ethanal



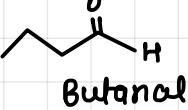
pentanal



2-Chloropentanal

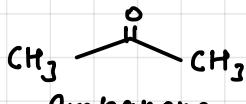


3-Methylbutanal

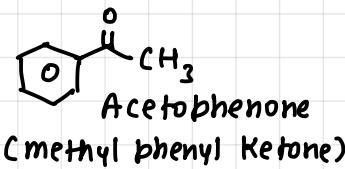


Butanal

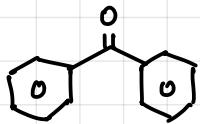
Nomenclature of Ketones



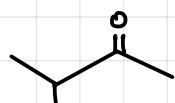
Propanone
(acetone)



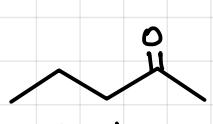
Acetophenone
(methyl phenyl ketone)



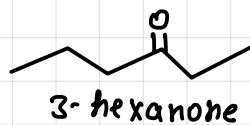
benzophenone



3-Methyl-2-butanone

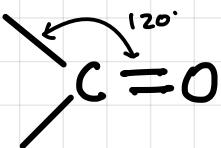


2-pentanone



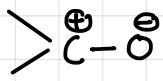
3-hexanone

STRUCTURE OF CARBONYL GROUP



1. $C-Sp^2$ hybridization
2. Bond angle is 120°
3. 3σ bond, 1π bond
4. Carbon - Oxygen

double bond consist 1σ & 1π



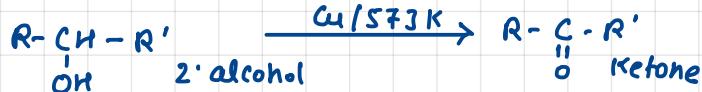
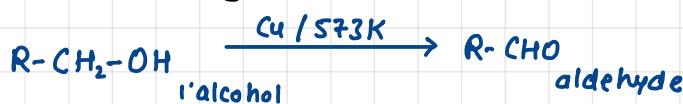
5. Carbon - Oxygen bond is polar in Nature

6. In Carbonyl group C^+ is electrophilic & O^- is nucleophilic

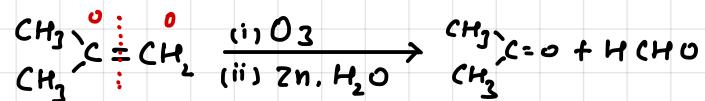
1) By Oxidation of alcohols:



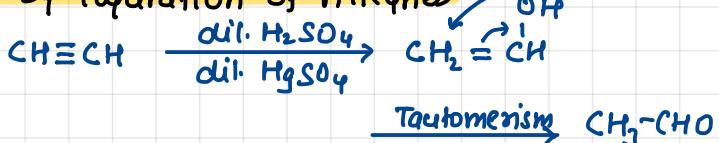
2. By Dehydrogenation of Alcohols



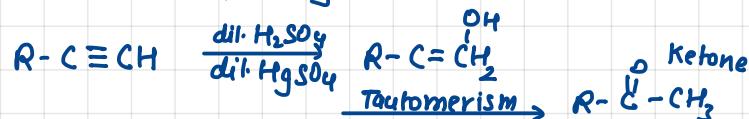
3. By Ozonolysis of Alkenes:



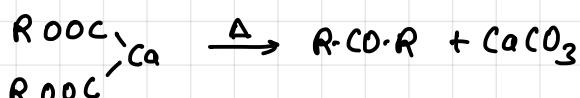
4. By Hydration of Alkynes



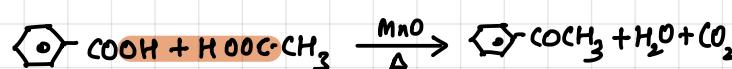
All other alkynes give ketones.



By Heating Ca Salt of Acid

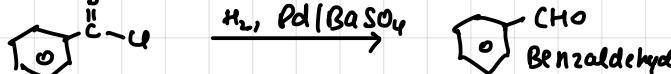
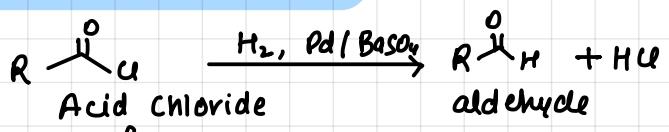


By Decarboxylation and Dehydration of Aromatic Acids

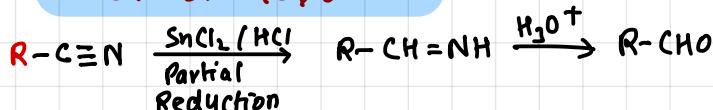


PREPARATION OF ALDEHYDE ONLY

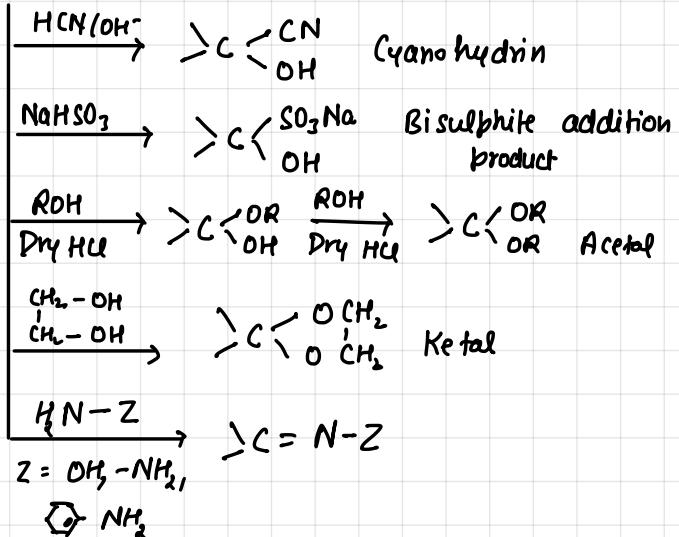
→ ROSEN MUND REDUCTION:



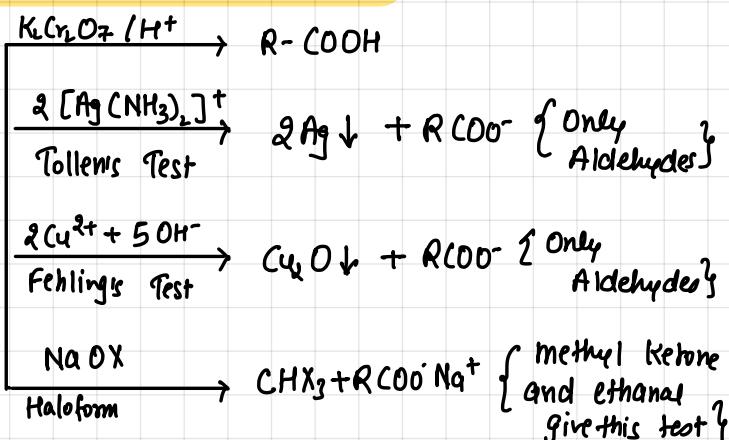
→ STEPHEN REDUCTION



NUCLEOPHILIC ADDITION REACTION

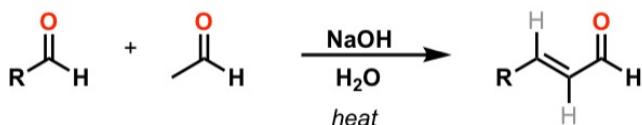


OXIDATION REACTION

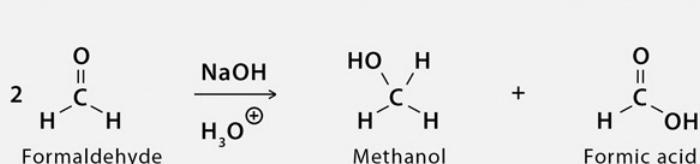
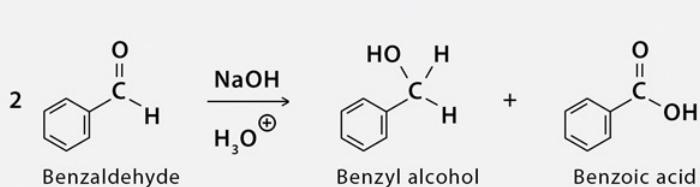


REACTION DUE TO α -HYDROGEN

Aldol Condensation Reaction



Cannizzaro Reaction Examples



CARBOXYLIC ACID (-C=O-H)

20

The carboxyl group, consist of a carbonyl group attached to a hydroxyl group
 Aliphatic ($\text{R}-\text{COOH}$) or Aromatic ($\text{C}_6\text{H}_5-\text{COOH}$)

Their general formula is $\text{C}_n\text{H}_{2n}\text{O}_2$



Methanoic Acid
 (Formic Acid)

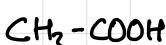


Propanoic Acid

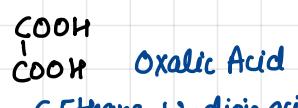


Benzoic Acid

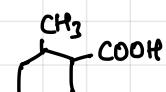
(Benzene Carboxylic Acid)



Ethanoic Acid
 (Acetic Acid)



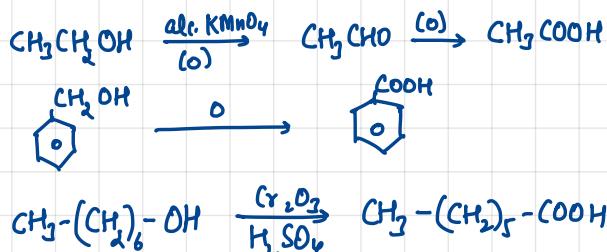
Oxalic Acid
 (Ethane-1,2-dioic acid)



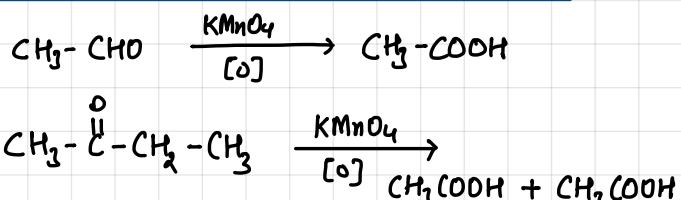
2-Methyl cyclo pentane
 -1-carboxylic acid.

METHODS OF PREPARATION:

From alcohol by Oxidation:

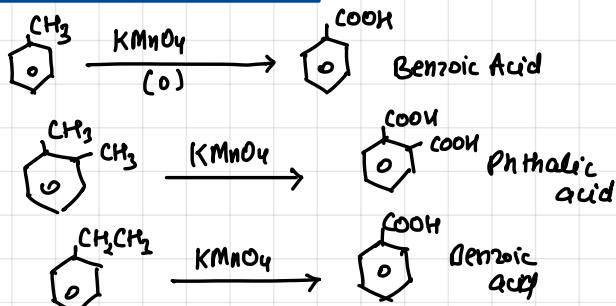


→ OXIDATION OF ALDEHYDE AND KETONE

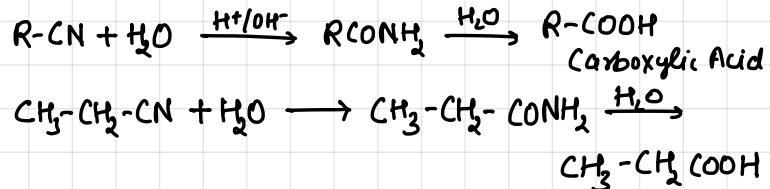


Oxidation of Ketones is done with difficulty acc. to POPOFF'S RULE i.e. Ketonic group remain with smaller group.

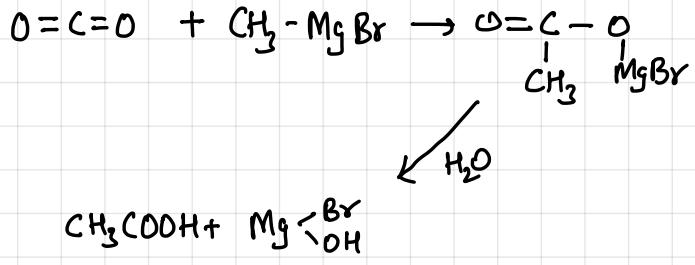
FROM ALKYL BENZENE



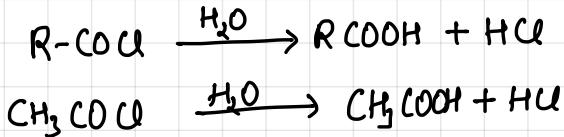
HYDROLYSIS OF NITRILES



FROM GRIGNARD REAGENT



FROM ACYL HALIDE



FROM ACID DERIVATIVE

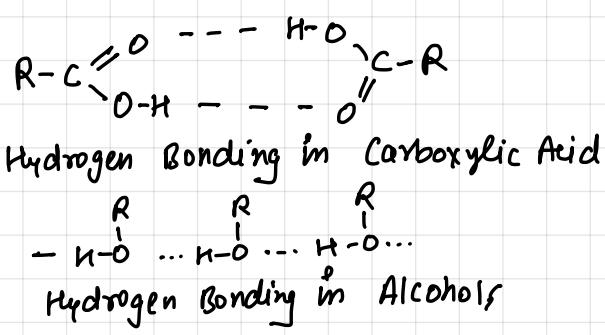


Ease of Hydrolysis

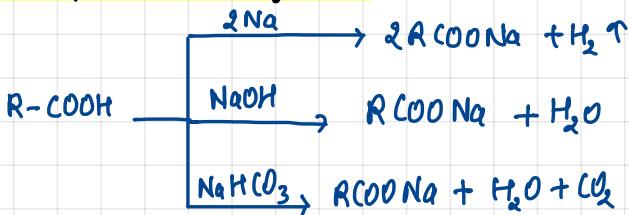


PHYSICAL PROPERTIES

- Aliphatic carboxylic acids upto nine carbon atoms are colourless liquid at room temp with unpleasant odour. The higher acids are wax like solids.
- Due to presence of intermolecular forces the lower carboxyl acids are freely miscible with water. But the solubility in water decreases gradually due to increase in size of alkyl grp.
- Stronger intermolecular forces increased the b.pt of monocarboxylic acids as compared to the alcohols of comparable molecular masses.

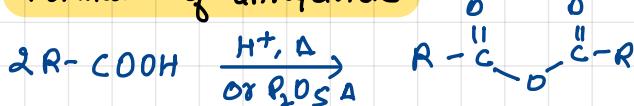


Acidity of Carboxylic Acid



- Carboxylic acids are stronger acids than alcohols and many simple phenols but weaker than the mineral acids.
 - Electron withdrawing group stabilises the carboxylate anion and strengthens the acid, whereas electron donating group destabilises the carboxylate anion and weakens the acid.
- Rxn involving cleavage of C-OH bond**

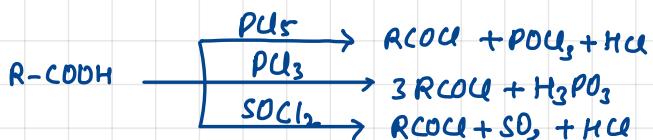
Formation of anhydride



Esterification:



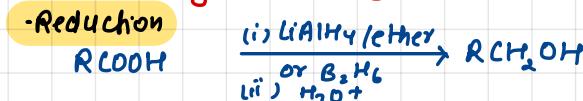
Rxn with PCl₅, PCl₃ and SOCl₂:



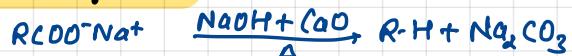
Rxn with ammonia



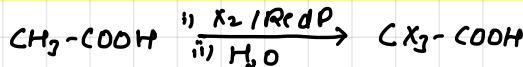
Rxn involving -COOH group



Decarboxylation

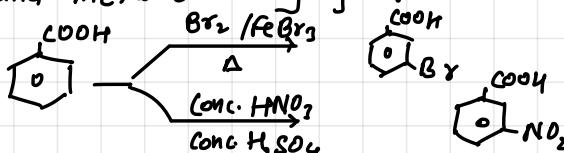


H.V.2 Rxn (Hell Volhard Zelinsky Rxn)



Electrophilic Ring Substitution

Carboxyl group acts as a deactivating and meta directing group



They do not undergo Friedel-Crafts reaction because carboxyl group is deactivating group and catalyst AlCl₃ gets bonded to carboxyl group.

Str. of Proteins:

1) Primary Structure: It simply reveals the sequence of amino acids.

2) Secondary Structure: α -helix str. maintained by H-Bond or β -pleated sheet str. when R is small group.

3) Tertiary Structure: The folding and superimposition of polypeptide chains forms a compact globular shape, termed as tertiary str.

It is stabilised by covalent, ionic, H-Bond and disulphide bonds.

4) Quaternary Structure: The precise arrangement of constituents.

Classification on the Basis of Hydrolysis

Simple Protein: which give only α -amino acid upon hydrolysis e.g. albumin

Conjugated Protein: These proteins give α -amino acid and non protein part, called prosthetic group

Protein	Prosthetic Group
Metalloproteins	Metal ions (Zn^{2+} , Fe^{2+} , Cu^{2+})
Haemoproteins	Haeme group
Glycoproteins	Carbohydrates
Lipoproteins	Lipid
Nucleoproteins	Nucleic acid (DNA, RNA)

Derived Proteins

These are obtained by partial hydrolysis of simple or conjugated proteins.

[Proteins \rightarrow Proteases \rightarrow Peptides \rightarrow Polypeptides]

On the Basis of Molecular Shape



Do not have a tertiary structure.	Have tertiary structure. Quaternary may or may not be present
Long fibres or sheets in shape.	Spherical in shape
Insoluble in water	Dissolve in water to form colloidal solution
The length of polypeptide chain may vary in two samples of the same fibrous protein	The length of polypeptide chain is always identical in two samples of the same globular protein.
e.g. Keratins, collagen, elastin and fibroin.	Egg albumin, serum globulin etc.

Primary str. of Proteins:

Proteins may have one or more polypeptide chains \rightarrow each polypeptide in a protein has amino acids linked with each other in a specific sequence and it is this sequence of amino acids that is said to be the 1^o str. of that protein

for Help
You can donate



Any change in this 1^o str. i.e. the sequence of amino acid creates a different protein

(32)

Primary

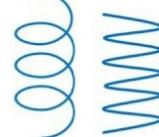


Secondary Structure of Proteins:

The secondary str. of proteins refers to the shape in which a long polypeptide chain can exist.

They are found to exist in two different types of str.

α Helix β sheet



α -helix str.
most common ways
in which a polypeptide chain form
all possible H-Bond
by twisting into
a right handed
screw (helix)
with the -NH₂ group

of each amino acid residue

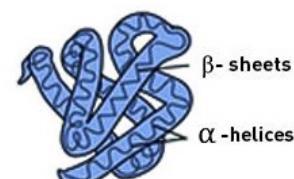
β -pleated sheet str.
In this str. all peptide
chains are stretched
out to nearly
maximum extension
and then laid side
by side are held
together by intermolecular
H-Bond.

Tertiary str. of Proteins:

The tertiary str. of proteins represents overall folding of polypeptide chains i.e. further folding of the secondary structure. It gives rise to 2 major molecular shapes i.e. fibrous and Globular

The main forces which stabilize the 2^o and 3^o str. of proteins are H-Bonds, disulphide linkage, van der waal and electrostatic forces of attraction.

TERTIARY
STRUCTURE



Others is known as quaternary structure

QUATERNARY
STRUCTURE



Nucleic Acids:

These are the polymers which are prepared by Nucleotide also known as polynucleotide

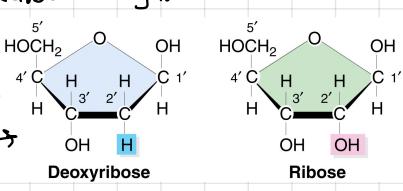
a nucleotide contain...

*) Pentose sugar *) Nitrogenous base *) Phosphate group.

Pentose Sugar:

5 carbon sugar either ribose or deoxy ribose

(not contain oxygen at \rightarrow
2nd position)



- Specific Nature -** Urease catalyse the hydrolysis of urea and not methyl urea, so these are specific in nature.
- Optimum Temperature -** It is active at $20-30^{\circ}\text{C}$.
- pH of medium -** It is about 7, for trypsin 7.5-8.3.
- Concentration -** Dilute solutions are more effective.
- Amount of enzyme -** Very small amount can accelerate the reaction.
- Enzyme Inhibitors -** These compound inhibit the enzyme action, with the help of such compounds, the reaction can be controlled.

HORMONES

These are the chemical substance which are produced by endocrine (ductless) glands in the body. Hormones acts as chemical messengers.

Some examples of ductless (endocrine) glands are thyroid, pituitary, adrenal, pancreas, testes and ovaries.

Hormones are divided into three types:

- Steroids
- Proteins
- Amines

Name of endocrine gland	Hormones secreted
Testis	Testosterone
Ovary	Estrogen
Adrenal	Adrenaline
Thyroid glands	Thyroxin
Pituitary gland	FSH
Pancreas	Insulin

Carbohydrates

These are optically active polyhydroxy aldehydes / ketones or the substance which give these on hydrolysis are called carbohydrates.

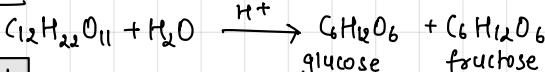
General formula $C_x(H_2O)_y$

Classification on the basis of Hydrolysis

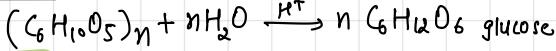
- Monosaccharides** - can not be hydrolysed further e.g. glucose, fructose
- Oligosaccharides** - give 2-10 molecules of monosaccharides e.g. Glucose, fructose
- Polysaccharides** - give large no. of monosaccharides e.g. starch, cellulose.

Preparation of Glucose:

from Sucrose



from Starch

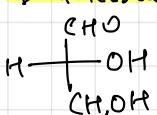


Structure

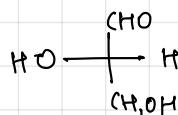
$\begin{array}{c} \text{CHO} \\ | \\ (\text{CH}_2\text{OH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array}$ ← one aldehyde group
 $\begin{array}{c} \text{CHO} \\ | \\ (\text{CH}_2\text{OH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array}$ ← four 2° alcohol
 $\begin{array}{c} \text{CHO} \\ | \\ (\text{CH}_2\text{OH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array}$ ← one 1° alcohol

(str.)

D-Glyceraldehyde



L-Glyceraldehyde

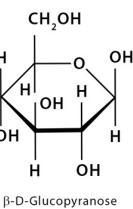
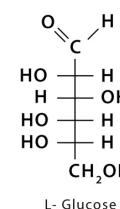
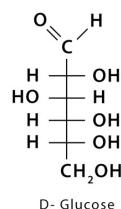


(P) means OH in R.H.S

(L) means OH in L.H.S

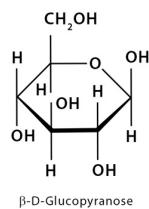
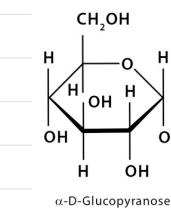
Str. of Glucose

Fischer Projection



β -D-Glucopyranose

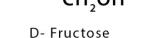
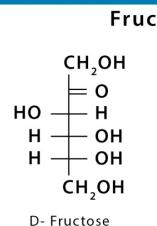
Haworth Projection



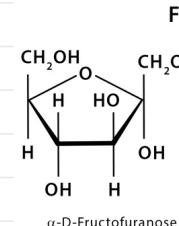
Str. of Fructose:

The C_1 is known as anomeric carbon and these compounds are called anomers.

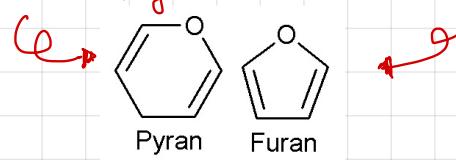
Fischer Projection



Haworth Projection



Six membered cyclic ring



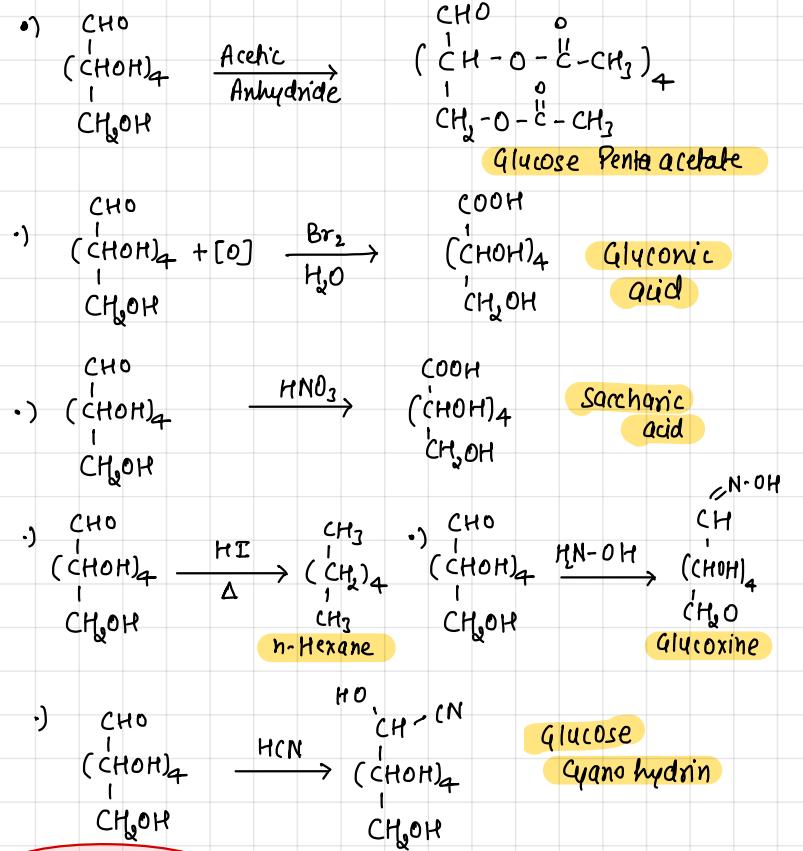
Reducing Sugar

- Free Aldehydic or Ketonic group
- Reduce Fehling Soln or Tollen's Reagent
- e.g. Maltose & Fructose

Non Reducing Sugar

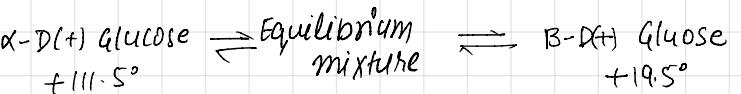
- Do not have any free aldehydic or ketonic group.
- Do not reduce Tollen's Reagent and Fehling Soln
- e.g. Sucrose

Chemical Properties of Glucose



Mutarotation

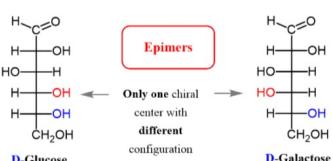
When either of the two forms of glucose is dissolved in water, there is a spontaneous change in specific rotation till the equilibrium value $\theta_b + 52.5^\circ$. This is known as mutarotation.



Importance of Carbohydrate

- Carbohydrates are essential for life in both plants and animals.
- They are major portion of our food.
- Carbohydrates are used as storage molecule as starch in plants and glycogen in animals.
- Cell wall of bacteria and plants is made up of cellulose.
- Honey has been used for a long time as an instant source of energy.
- Epimers** Monosaccharides differing in configuration at a carbon other than anomeric carbon are called epimers. e.g. glucose and galactose differ in configuration at C4, hence called epimers.

D-glucose and D-galactose are epimeric at carbon-4



Sugars and Non-Sugars

- mono saccharides and Oligosaccharides having sweet taste, soluble in water are known as Sugars.
- Polysaccharides which are insoluble in water and not sweet in taste are known as non-sugars.

1 Bharat Panchal Sir

Bharat Panchal - chemistry Gurjii 2.0

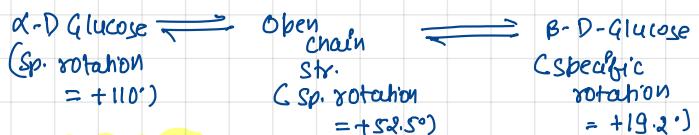
DISACCHARIDES AND POLYSACCHARIDES-

CARBOHYDRATES	Hydrolysis Product	Linkage	Reducing Property
Sucrose (Disaccharide)	$\alpha\text{-D Glucose}$ & $\beta\text{-D Fructose}$	C-1(Glucose) & C-2(Fructose)	Non- Reducing
Maltose (Disaccharide)	$\alpha\text{-D Glucose}$	C-1 Glucose & C-4 Glucose	Reducing
Lactose (Disaccharide)	$\beta\text{-D Galactose}$ & $\beta\text{-D Glucose}$	C-1 (Galactose) & C-4 (Glucose)	Reducing
Cellulose (Polysaccharide)	$\beta\text{-D Glucose}$	C-1 (Glucose) & C-4 (Glucose)	Non- Reducing
Glycogen (Polysaccharide)	$\alpha\text{-D Glucose}$	C-1 (Glucose) & C-4 (Glucose)	Non- Reducing

MUTAROTATION

When glucose is dissolved in water, then its specific rotation changes into an equilibrium value. This spontaneous change in specific rotation of an optically active substance to an equilibrium value is called mutarotation.

The two anomers of glucose i.e. $\alpha\text{-D Glucose}$ & $\beta\text{-D Glucose}$ in solution changes their specific rotation to an equilibrium value which is the rotation of a straight chain str.

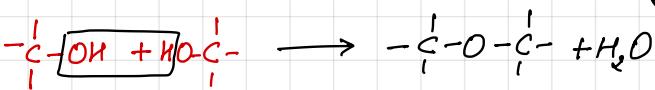


DISACCHARIDES

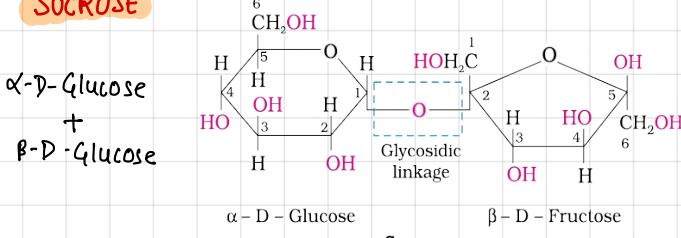
Disaccharides are the carbohydrates which on hydrolysis with dilute acids or with enzyme give two molecules of either same or different monosaccharides.

The two mono saccharides are joined together by an oxide linkage formed by loss of a water molecule. This is actually an ether group and is called glycosidic linkage.

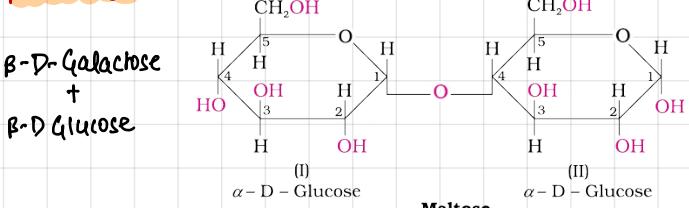
25



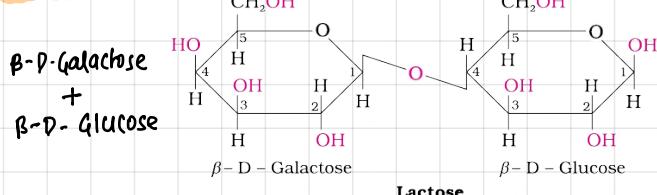
SUCROSE



MALTOSE



LACTOSE

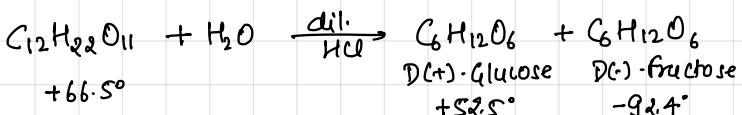


INVERSION OF SUCROSE -

Sucrose on dextro-rotatory but on hydrolysis either with dilute acid or with enzyme invertase, the solution is changed into laevo-rotatory solution.

As dextro-rotatory sucrose is changed to laevo-rotatory solution after hydrolysis.

The sucrose is called "Invert sugar".

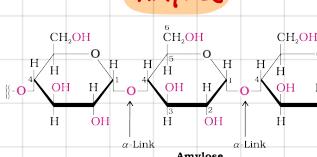


Since the laevo rotation of fructose (-92.4°) is more than dextro rotation of glucose ($+52.5^\circ$), the mixture is laevo-rotatory.

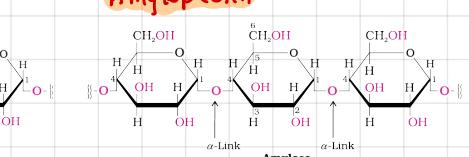
POLYSACCHARIDES

Starch it is a polymer of α -glucose units and it consists of two components - Amylose and Amylopectin

Amylose



Amylopectin



It constitutes about 15-20% starch	It constitutes 80-85% starch
It is soluble in water	It is water insoluble
These are long unbranched chain with C1-C4 glycosidic linkage of glucose	These are branched chain polymer of α -D-glucose units with C1-C4 glycosidic linkage and C1-C6 glycosidic linkage at branching.