PLUS 2

NOTES

Chapter Wise



1.SOLUTIONS

Solutions are homogeneous mixture of two or more substances.
➔ Solute:Substance in lesser quantity
➔ Solvent :Substance in higher quantity
➔ Solubility :Solubility of a substance is its maximum amount that can be dissolved in specific amount of solvent at a temperature.

1.Solubility of gas in liquid

➢ Henry's law:

"As the pressure of gas increases solubility of gas in liquid also increases"
OR
Partial pressure (p) of the gas in vapour phase is proportional to the mole fraction (X) of the gas in the solution.

ie $P=K_H X$ (K_H is Henry's constant)

Applications of Henry's law:

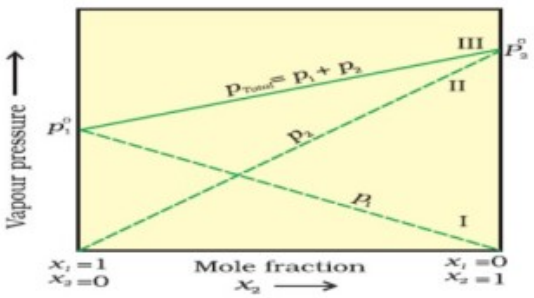
(i) To increase the solubility of CO_2 in soft drinks or soda.
(i) Bends experienced by Scuba divers.
(iii) Anoxia experienced by peoples at high altitude

➢ Effect of temperature

The solubility of a gas in a liquid decreases with increase in temperature
Therefore aquatic life is more comfortable in cold water than hot water.

Raoult's Law:

For a solution of volatile liquids, the partial vapour pressure of each component in the solution is directly proportional to its molefraction.
For component A
$P_A=P^0_A X_A$
and for component B
$P_B=P^0_B X_B$



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Ideal solution:

The solution which obeys Raoult's law are called ideal solutions.

$\Delta H_{mix} = 0$

$\Delta V_{mix} = 0$

A-A (solvent-solvent) and B-B(solute-solute) interactions are equal to the A-B (solvent-solute) interactions.

Examples of ideal solution:

(1) solution of n-hexane and n-heptane

(2) solution of bromo ethane and chloro methane

(3) benzene and toluene

Non ideal solution

The solution which does not obey's Raoult's law are called Non ideal solutions.

$\Delta H_{mix} \neq 0$

$\Delta V_{mix} \neq 0$

Non ideal solution divided into two

➢ Non ideal solution showing Positive deviation from Roults law:

A-B interaction less than A-A and B-B interaction.

$\Delta H_{mix} > 0$

$\Delta V_{mix} > 0$

Eg:- Ethanol and acetone

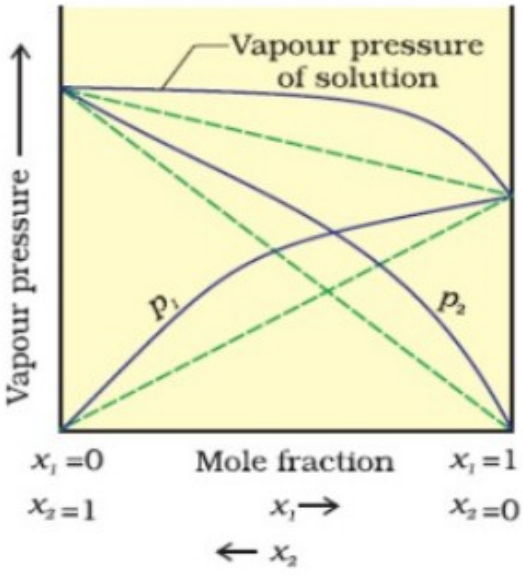
➢ Non ideal solution showing Negative deviation from Roults law:

A-B interaction greater than A-A and B-B interaction.

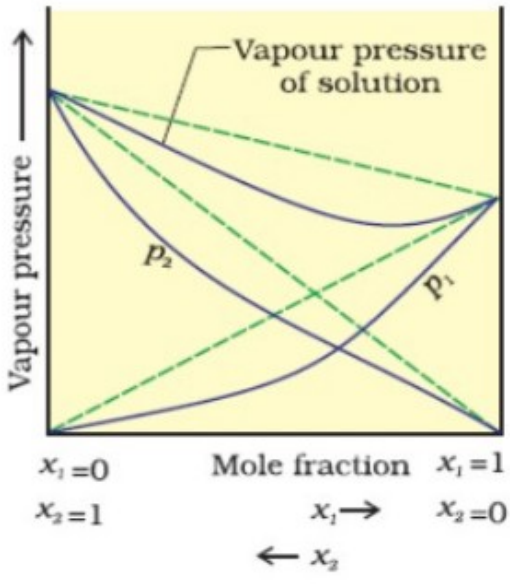
$\Delta H_{mix} < 0$

$\Delta V_{mix} < 0$

Eg: Chloroform and acetone



Non ideal solution showing Positive deviation



Non ideal solution showing Negative deviation

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Azeotropic mixtures (Azeotropes) or Constant boiling mixture:

They are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature.

They are two types-

- ➢ minimum boiling azeotrope

The solutions which show a large positive deviation from Raoult's law

- ➢ maximum boiling azeotrope

The solutions which show large negative deviation from Raoult's law.

Colligative Properties

Colligative property is the property which depend upon the number of solute particles and does not depend upon their nature.

They are

(1) Relative lowering of vapour pressure
(2) Elevation of boiling point
(3) Depression of freezing point
(4) Osmotic pressure

Applications of Colligative Properties

Used to determine molar mass of non volatile solute using the following equations

Colligative Properties	Equation	Equation to calculate M_2
Relative lowering of VP	$\frac{P^o_S - P_S}{P^o_S} = X_{solute}$	$M_2 = \frac{P^o_1 . W_2 . M_1}{W_1 (P^o_1 - P_1)}$
Elevation of BP	$\Delta T_b = K_b . m$	$M_2 = \frac{K_f . W_2 . 1000}{\Delta T_b . W_1}$
Depression of FP	$\Delta T_f = K_f . m$	$M_2 = \frac{K_f . W_2 . 1000}{\Delta T_f . W_1}$
Osmotic pressure	$\pi = CRT$	$M_2 = \frac{W_2 . R . T}{\pi V}$

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Osmosis , Osmotic Pressure and Reverse osmosis

➢ **Osmosis :** It is the flow of solvent molecules from lower concentration side to a higher concentration side through a semi-permeable membrane

Eg, for semi-permeable membrane are egg membrane, all animal and plant membrane, Cellulose acetate.

➢ **Osmotic pressure :-** It is defined as the excess pressure that must be applied on solution side to stop osmosis

➢ **Reverse osmosis :-** The direction of osmosis can be reversed if a pressure larger than osmotic pressure is applied to the solution side. This process
is called reverse osmosis. Reverse osmosis is used in desalination of sea water and in water purifiers.

Isotonic, Hypotonic & Hypertonic Solutions

The solutions having same osmotic pressure is called Isotonic solution
Eg : blood and 0.9% (m/v)NaCl solution

The solution having high osmotic pressure than other is called Hypertonic solution

The solution having lower osmotic pressure than other is called Hypotonic solution

Importance of colligative properties

(i) Osmotic pressure is used to measure molecular mass of proteins, polymers and other macromolecules because of two reasons:
(a) osmotic pressure is measured at room temperature
(b) molarity is used instead of molality.
(ii) Anti freeze solutions (eg. Glycol) are used in automobile radiators to prevent the freezing of water (depression of freezing point).
(iii) NaCl and $CaCl_2$, is used to remove ice from road because it depress the freezing point of water.
(iv) The osmotic pressure of fluid inside the blood cell and that of 0.9% (mass/volume) NaCI solution are equal , they are isotonic (solutions having same osmotic pressure). Therefore, 0.9%(mass/volume) NaCI solution is used in intravenous injections.

Abnormal molecular mass

Molecular mass calculated on the basis of colligative properties may be lower or higher than the normal value. Such molecular mass is called abnormal molar mass. Abnormal molecular mass is due to the following reasons.

(i) Dissociation of particles

Due to dissociation of particles, the number of particles increases. Therefore colligative property increases, Hence molecular mass decreases
Eg: KCI solution (Here KCI dissociated in to K and Cl-. Therefore number of particles increases.)
(ii) Association of particles.
Due to association of particles, the number particles

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decreases. Therefore colligative property decreases and hence molecular mass increases.
Eg: Acetic acid (ethanoic acid) in benzene, (In benzene, acetic acid dimerises due to hydrogen
bonding. Therefore number of particles decreases).

➔ **Van't Hoff factor i=** $\frac{\text{Normal molecular mass}}{\text{Abnormal molecular mass}}$

For association i < 1 **For dissociation i >1**

UNIT.2
ELECTRO CHEMISTRY

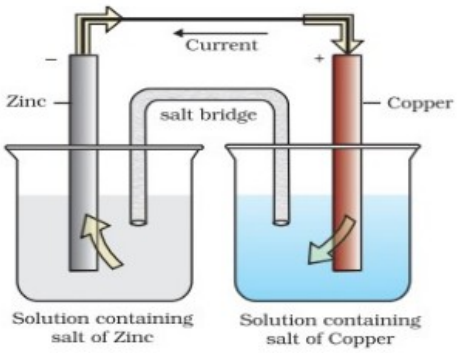
It is a branch of chemistry that deals with the relationship between chemical energy and electrical energy and their inter conversions.

1.Daniel cell.

It is constructed by dipping a Zn rod in $ZnSO_4$ solution and a Cu rod in $CuSO_4$ solution. The two solutions are connected externally by a metallic wire through a voltmeter and a switch and internally by a salt bridge.

(i)$Cu^{2+} + 2e^- \rightarrow Cu(s)$ (Reduction /In right half cell)
(ii) $Zn(s) \rightarrow Zn^{2+} + 2e^-$ (Oxidation /In left half cell)

Left half cell-Oxidation-Anode-Negative(LOAN) Right half cell-Reduction-Cathode-Positive. Here electron flow occurs from Zinc rod to Copper rod,and the conventional current flows from Copper rod to Zinc rod



Electrode Potential(Ecell)

The tendency of a metal to lose or gain electron when it is in contact with its own solution is called electrode potential,(E el). Electrode potential measured at standard conditions is known as Standard electrode potential(E^0cell).
The cell potential is the difference between the electrode potentials (Reduction

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potentials) of the cathode and anode.
E cell = E cathode - E anode
E cell = E right - E left

the symbolic cell representation of Daniel cell is
Zn (s)/ Zn^{2+}(aq) //Cu^{2+}(aq) /Cu (s)

Nernst equation –Various forms

For a general electrode reaction $M^{n+}(aq) + ne^- \rightarrow M(s)$

- Electrode potential $E_{(M^{n+}/M)} = E^{\ominus}_{(M^{n+}/M)} - \frac{RT}{nF} \ln \frac{[M]}{[M^{n+}]}$
- Cell potential for Daniel cell $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$

$$E_{Cell} = E^{\ominus}_{Cell} - \frac{0.059}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

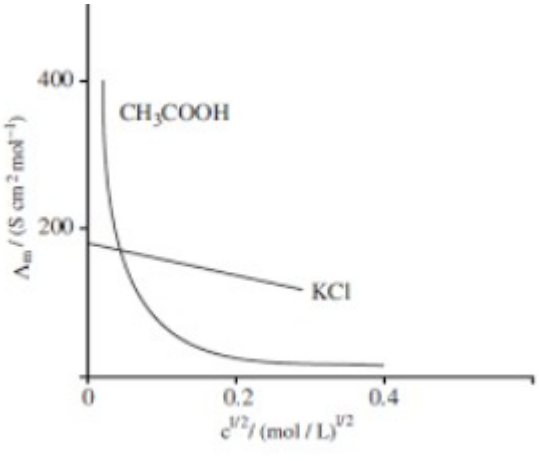
- Free energy and EMF of cell $\Delta_r G^{\ominus} = -nF E^{\ominus}_{(cell)}$
- EMF of cell and Equilibrium constant $E^{\ominus}_{(cell)} = \frac{2.303RT}{nF} \log K_C$

Variation of Molar conductivity (Λm) with dilution

For both strong and weak electrolyte, the molar conductivity increases with dilution When dilution reaches maximum or concentration approaches zero, the molar conductivity becomes maximum and it is called the limiting molar conductivity (Λm^0).
For strong electrolytes, the relation between Λm and concentration can be given as:

$\Lambda m = \Lambda m^0 - A\sqrt{C}$ (Debye Huckel Equation)

Where 'C' is the concentration and A is a constant .The variation of Λ m for strong and weak electrolytes is shown in the graphs For strong electrolytes, the value of Λm^0 can be determined by the extrapolation of the graph.



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Kohlrausch's law

The law states that the limiting molar conductivity of an electrolyte can be represented as the sum of the individual Molar ionic conductances of the anions and the cations of the electrolyte.

Let the molar ionic conductances of anion and cation at infinite dilutions are $\lambda +$ and $\lambda -$
respectively,Then

$$\Lambda m^0 = \upsilon_+ \lambda^+ + \upsilon_- \lambda^-$$

Where υ_+ and υ_- represents the total number of cations and anions produced by one unit formula of an electrolyte.

Applications

1.Determination of Λm^0 of weak electrolytes.

2.Determination of degree of dissociation of weak electrolytes

$$\alpha = \frac{\Lambda m}{\Lambda m^0}$$

Faraday's laws of electrolysis

Faraday's first law

It states that the amount of substance deposited or liberated at the electrodes (m) is directly proportional to the quantity of electricity (Q) flowing through the electrolyte.

Faraday's second law

It states that when same quantity of electricity is passed through solutions of different substances, the amount of substance deposited or liberated is directly proportional to their own equivalent masses.

Batteries/ Commercial cells

Non- rechargeable cells – Primary cell Drycell, Mercury cell
Rechargeable cells – Secondary cells Lead storage cell,Ni-Cd cells.

Cells	Anode	Cathode	Electrolyte	Overall cell reaction
Dry Cell (Leclanche cell)	Zn container	Graphite $+MnO_2$	Ammonium chloride (NH_4Cl).	$2Zn(s) + MnO_2 + NH_4^+ \rightarrow 2Zn^{2+} + MnO(OH) + NH_3$
Mercury cell (Button cell)	Zinc – mercury amalgam	Paste of HgO and carbon	Paste of KOH and ZnO	$Zn(Hg) + HgO(s) \rightarrow ZnO(s) + Hg(l)$
Lead storage cell	Lead	Grid of lead packed with lead dioxide (PbO_2)	38% H_2SO_4	$Pb(s)+PbO_2(s)+2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

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Mercury cell has a constant potential of 1.35 V since the overall reaction does not involve any ion in solution. Mercury cell is suitable for hearing aids, watches, etc.

In Lead storage battery cell reaction can be reversed by passing current through it in the opposite direction. The most important secondary cell is, which is used in automobiles and inverters.

Fuel cells

These are galvanic cells which convert the energy of combustion of fuels like hydrogen,methane, methanol,etc. directly into electrical energy.

One example for fuel cell is Hydrogen – Oxygen fuel cell, which is used in the Apollo space programme.Here hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous Sodium hydroxide solution.

The electrode reactions are:

Cathode: $O_2(g) + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-(aq)$

Anode: $2H_2(g) + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^-$

Overall reaction is: $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$

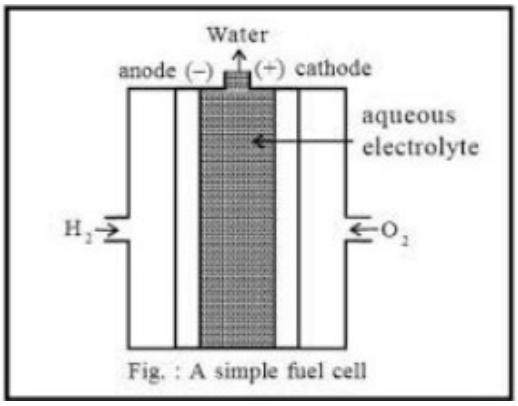


Fig. : A simple fuel cell

Advantages

1.The cell works continuously as long as the reactants are supplied.
2. It has higher efficiency
3. It is eco-friendly (i.e. pollution free)
4. Water obtained from H_2 – O_2 fuel cell can be used for drinking.

Corrosion

It is the slow destruction of the metal due to the attack of various atmospheric gases with the metallic surface .

Some common examples are:

The rusting of iron, tarnishing of silver, formation of green coating on copper and bronze (verdigris) etc.Rusting of iron is an electrochemical phenomenon.

Chemically rust is hydrated ferric oxide ($Fe_2O_3 . x H_2O$)

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Methods to prevent corrosion

• Barrier protection By coating the metal surface with paint, varnish etc.
• Sacrificial protection By coating the metal surface with another electropositive metal like Zinc, Magnesium etc. The coating of metal with zinc is called Galvanisation and the resulting iron is called Galvanized iron.
• Anti-rust solutions.
• Cathodic protection.

UNIT.3
CHEMICAL KINETICS

Rate of a chemical reaction

The rate of a chemical reaction is the change in concentration of any one of the reactant or product in unit time

Average rate and instantaneous rate

$$r_{av} = \frac{-\Delta[R]}{\Delta t} = \frac{\Delta[P]}{\Delta t} \qquad r_{inst} = \frac{-d[R]}{dt} = \frac{d[P]}{dt}$$

a) **Average rate**

The rate of a reaction at a particular interval of time is called Instantaneous Rate of a reaction.

$2HI(g) \rightarrow H_2(g) + I_2(g)$

$$r_{av} = \text{Rate of reaction} = -\frac{1}{2}\frac{\Delta[HI]}{\Delta t} = \frac{\Delta[H_2]}{\Delta t} = \frac{\Delta[I_2]}{\Delta t}$$

Instantaneous Rate of a reaction

The rate of a reaction at a particular instant of time is called Instantaneous Rate of a reaction.

For a general reaction, $aA + bB \rightarrow cC + dD$,
instantaneous rate is given by

$$r_{inst} = \frac{-1}{a}\frac{d[A]}{dt} = \frac{-1}{b}\frac{d[B]}{dt} = \frac{1}{c}\frac{d[C]}{dt} = \frac{1}{d}\frac{d[D]}{dt}$$

Factors affecting rate of a reaction

1. Concentration of the reactants
2. Temperature
3. Presence of catalyst

Dependence of rate of reaction on concentration:

For a general reaction, $aA + bB \rightarrow cC + dD$,

Rate $\alpha [A]^X [B]^Y$

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or

$r = k [A]^X [B]^Y$

(where x and y may or may not be equal to a and b)

In the above equation 'k' is a constant called rate constant of the reaction

Rate law expression:

The representation of rate of reaction in terms of molar concentration of reactants as experimentally determined is called rate law or rate equation or rate law expression.

$r = k[A]^X [B]^Y$

Unit of Rate constant $mol^{1-n} L^{n-1} sec^{-1}$

Where n is Order of reaction

Reaction	Order	Units of rate constant
Zero order reaction	0	$mol\,L^{-1}\,s^{-1}$
First order reaction	1	s^{-1}
Second order reaction	2	$mol^{-1}\,L\,s^{-1}$

Elementary and complex reactions

A reaction that takes place in a single step is called elementary reaction. While a reaction that occurs in more than one step is called a complex reaction.

Order of reaction:

It is the sum of powers of the concentration of the reactants in the rate law expression

For a general reaction, $aA + bB \rightarrow cC + dD$;

$r = k [A]^X [B]^Y$, Order of the reaction = x + y

Order of a reaction can be 0, 1, 2, 3 and even a fraction.

Examples for zero order reactions :

A zero order reaction means that the rate of reaction is independent of the concentration of reactants.

- Some enzyme catalysed reactions
- Thermal decomposition of HI on gold surface
- Reactions which occur on metal surfaces . (The decomposition of gaseous ammonia on a hot platinum surface is a zero order reaction at high pressure.)

$$2NH_3(g) \xrightarrow[\text{Pt catalyst}]{1130K} N_2(g) + 3H_2(g) \qquad \text{Rate} = k\,[NH_3]^0 = k$$

Examples for 1 st order reactions :

- Hydrogenation of ethene:
  $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$; $r = k[C_2H_4]$
- All natural and artificial radioactive decay

Pseudo First order reaction:

Reactions which are not truly first order ,but become first order under special conditions are called pseudo unimolecular or pseudo first order reaction

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- ✓ Inversion of cane sugar
- ✓ Ester hydrolysis

Molecularity of a reaction:

It is the number of reacting species (molecules, atoms or ions) which must collide simultaneously in order to bring about a chemical reaction

No	Order	Molecularity
1	It is the sum of the powers of the concentration terms in the rate law expression	It is the total number of reactant species collide simultaneously in a chemical reaction
2	It is an experimental quantity	It is a theoretical quantity
3	It can be **zero or fractional**	It **cannot be zero or fractional**
4	It is applicable to both **elementary and complex reactions**	It is applicable **only to elementary reactions**

Integrated rate equation of first order reaction

Integrated rate equation	$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$
Half life period	$t_{1/2} = \frac{0.693}{k}$
Unit of K	S^{-1}

Integrated rate equations

$$[R] = -kt + [R]_0$$

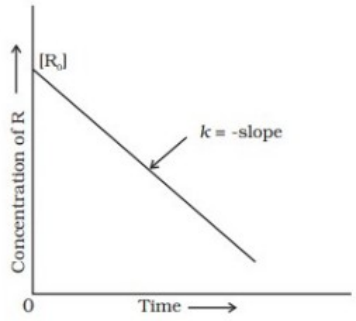


Fig. 4.3: Variation in the concentration vs time plot for a zero order reaction

$$\ln[R] = -kt + \ln[R]_0$$

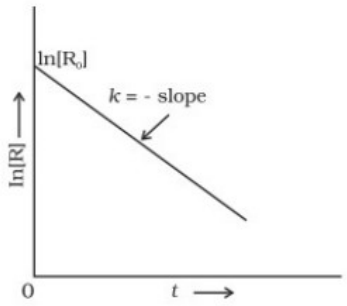


Fig. 4.4: A plot between ln[R] and t for a first order reaction

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Half life of a reaction ($t_{1/2}$)

It is the time required for half of the reactant converted in to product

Half life of a zero order reaction:

$$k = \frac{[R]_0 - [R]}{t}$$

At $t = t_{1/2}$, $[R] = \frac{1}{2}[R]_0$

The rate constant at $t_{1/2}$ becomes

$$k = \frac{[R]_0 - 1/2[R]_0}{t_{1/2}}$$

$$t_{1/2} = \frac{[R]_0}{2k}$$

Half life of a first order reaction:

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

at $t_{1/2}$ $[R] = \frac{[R]_0}{2}$

So, the above equation becomes

$$k = \frac{2.303}{t_{1/2}} \log \frac{[R]_0}{[R]/2}$$

or $$t_{1/2} = \frac{2.303}{k} \log 2$$

$$t_{1/2} = \frac{2.303}{k} \times 0.301$$

$$t_{1/2} = \frac{0.693}{k}$$

It is clear that $t_{1/2}$ for a zero order reaction is directly proportional to the initial concentration of the reactants and inversely proportional to the rate constant.
For first order reaction $t_{1/2}$ is independent of initial concentration of reactant

Temperature Dependence of the Rate of a Reaction Reaction Arrhenius equation

This is an equation which relates rate constant with temperature

$k = A\, e^{-Ea/RT}$ A :Arrhenius Factor, E_a:Activation energy

As temperature increases k increases thus rate of reaction also increases. For every 10°C rise in temperature, the rate of reaction becomes almost double.

Expression for activation energy if different temperature and different rate constant are given below

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

Ea = activation energy, k_1 and k_2 are the values of rate constants at temperatures T_1 and T_2 respectively.

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Activation energy (Ea):
The energy requierd to form an activated complex
Activation energy (E) = Threshold energy - Actual energy possessed by reacting molecules

Effect of Catalyst
Catalyst provides an alternate path of lower activation energy to the reactant molecules.

Threshold energy:
The minimum energy that the reacting molecules must posses in order to undergo effective collisions to form product is called threshold energy.

UNIT 4.
d and f BLOCK ELEMENTS

General properties of transition elements

Magnetic properties

The magnetic moment of transition element is only determined by spin angular momentum, depending upon the number of unpaired electrons and is calculated by using the 'spin-only' formula, i.e.,

$$\mu = \sqrt{n(n+2)}$$

where n is the number of unpaired electrons ,
μ is the magnetic moment and unit is Bohr magneton (BM).

For example ,
Calculate the magnetic moment of a divalent ion in aqueous solution if its atomic number is 25.
For atomic number 25, electronic configuration is [Ar] $4s^2\,3d^5$ the divalent ion in aqueous solution will have configuration
[Ar]$4s^0\,3d^5$
d^5 configuration (five unpaired electrons).
The magnetic moment, μ is

$$\mu = \sqrt{5(5+2)} = 5.92\,BM$$

Formation of Coloured Ions

Colour of transition metal is due to d-d transitionIon with d^0 and d^{10} are colourless or white because no unpaired electrons are available for excitation all other ions with d electrons 1 to 9 are having characteristic colour due to d-d transition

Complex Formation

A few examples $K_4[Fe(CN)_6]$, $K_3[Fe(CN)_6]$
Transition metals forms number of complex compounds. This is due to
a)smaller sizes of the metal ions,
b)their high ionic charges

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c)availability of d orbitals for bond formation.

Catalytic properties

Catalytic property of transition metals is due to their ability to adopt multiple oxidation states and to form complexes.

Examples for Catalysis:- Vanadium(V) oxide in Contact Process, Finely divided iron in Haber's Process, and Nickel in Catalytic Hydrogenation

Oxidation state

Transition elements show variable oxidation states because energies of ns sub level and (n-1)d sub level are almost equal.

Hardness and Melting points

Except Zn, Cd and Hg transition metals are hard and they have high melting point. The high melting points of these metals are attributed to involvement of greater number of unpaired electrons. Greater the number of unpaired electrons stronger will be metallic bonding and higher will be melting points.

Among all transition elements W has highest melting point Zn, Cd and Hg do not contain unpaired electrons. Therefore, they are soft metals.

Alloy formation

Transition elements form alloys due to similar size e.g. Manganese steel

Formation of interstitial compounds

Transition metals forms interstitial compounds because small atoms like H, C or N are trapped inside the crystal lattices of transition metals . As a result they have high melting points than those of pure metals. They are very hard.

Some important compounds of Transition elements

POTASSIUM DICHROMATE

Preparation

Dichromates are generally prepared from chromate, which in turn are obtained by the fusion of chromite ore ($FeCr_2O_4$) with sodium or potassium carbonate in free access of air. The reaction with sodium carbonate occurs as follows:

$$4\ FeCr_2O_4 + 8\ Na_2CO_3 + 7O_2 \rightarrow 8\ Na_2CrO_4 + 2\ Fe_2O_3 + 8\ CO_2$$

The yellow solution of sodium chromate is filtered and acidified with sulphuric acid to give a solution from which orange sodium dichromate, $Na_2Cr_2O_7.2H_2O$ can be crystallised after cooling.

$$2Na_2CrO_4 + 2\ H_2SO_4 \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$

The solution of sodium dichromate Is treated with potassium chloride.

$$Na_2Cr_2O_7 + 2\ KCl \rightarrow K_2Cr_2O_7 + 2\ NaCl$$

Orange crystals of potassium dichromate crystallise out.

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Properties of Potassium dichromate

i) The chromates and dichromates are interconvertible in aqueous solution depending upon pH of the solution.

$$2\,CrO_4^{2-}\ (yellow) + 2H^+ \rightarrow Cr_2O_7^{2-}\ (orange) + H_2O$$

$$Cr_2O_7^{2-}\ (orange) + 2\,OH^- \rightarrow 2\,CrO_4^{2-}\ (yellow) + H_2O$$

ii) Oxidising action

It acts as strong oxidizing agent in acidic medium

$$K_2Cr_2O_7 + H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O + 3[O]$$

Therefore acidified $K_2Cr_2O_7$ oxidises

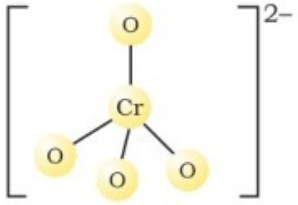
i)Potassium Iodide to Iodine

$$K_2CrO_7 + H_2SO_4 + KI \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O + I_2$$

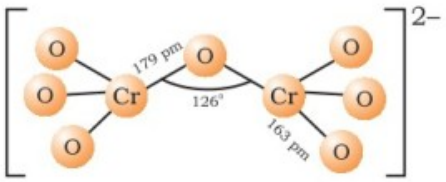
ii)Hydrogen Sulphide to sulphur

$$K_2Cr_2O_7 + H_2SO_4 + H_2S \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O + S$$

CrO_4^{2-} $Cr_2O_7^{2-}$



Chromate ion



Dichromate ion

POTASSIUM PERMANGANATE

Preparation

Commercial method of preparation of Potassium permanganate

Step 1 Pyrolusite is fused with KOH in presence of air and an oxidizing Agent

$$MnO_2 + KOH + O_2 \rightarrow K_2MnO_4 + H_2O$$

Step 2 Electrolytic oxidation of Potassium manganate gives potassium permanganate

At anode, $MnO_4^{2-} \rightarrow MnO_4^- + e^-$

At Cathode, $2H^+ + e^- \rightarrow H_2$

Formed MnO_4^- reacts with K^+ to form $KMnO_4$

The purple solution obtained on evaporation gives crystal of potassium permanganate

Generally prepared From Pyrolusite ore (MnO_2)

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Structure of Manganate and permanganate ion





Lanthanoids

Lanthanoids are 14 elements coming after Lanthanum starting from Lutetium and ends in Lawrencium .

The common oxidation state of lanthanoid is +3. Example La^{3+} ,Ce^{3+} .....

Lanthanoid contraction

Steady and slow decreasing of atomic and ionic radii of lanthanoids from La^{3+} to Lu^{3+} is called as Lanthanoid contraction.

Reason for lanthanoid contraction

ineffective shielding effect of 4f orbital

Consequence of lanthanoid contraction

1. The radii of some elements of second transition series is similar to third transition series

Eg:- Zr and Hf , Nb and Ta

2. Lanthanoids occur together in nature and separation become difficult

Use of lanthanoids

1. Misch metal is alloy of lanthanoids (about 95% lanthanoids, about 5% iron and traces of S,C, Ca and Al). Misch Metal is used in Mg based alloy to produce bullets, shell etc.
2. Mixed oxides of lanthanoids are employed as catalysts in petroleum cracking.

UNIT 5
CO-ORDINATION COMPOUNDS

Ligands

The ions or molecules bound to the central atom/ion in the coordination entity are called ligands.

Unidentate:-When a ligand is bound to a metal ion through a single donor atom, the ligand is said to be unidentate. Example Cl^- , H_2O , NH_3 etc..,

Didentate :- When a ligand can bind through two donor atoms as in the ligand is said to be didentate

Example $H_2NCH_2CH_2NH_2$ (ethane-1,2-diamine) or $C_2O_4^{2-}$ (oxalate),

Polydentate:-when several donor atoms are present in a single ligand the ligand is said to be polydentate.

Example $N(CH_2CH_2NH_2)_3$,

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Note:- Ethylenediaminetetraacetate ion (EDTA $^{4-}$) is an important hexadentate ligand. It can bind through two nitrogen and four oxygen atoms to a central metal ion

Nomenclature of Mono nuclear co-ordination compounds (IUPAC)

Write the formulas for the following coordination compounds:

(a) tetraammineaquachloridocobalt(III)chloride	$[Co(NH_3)_4(H_2O)Cl]Cl_2$
(b) potassiumtetrahydroxidozincate(II)	$K_2[Zn(OH)_4]$
(c) potassiumtrioxalatoaluminate(III)	$K_3[Al(C_2O_4)_3]$
(d) dichloridobis(ethane-1,2-diamine)cobalt(III)ion	$[CoCl_2(en)_2]^+$
(e) tetracarbonylnickel(0)	$[Ni(CO)_4]$

Write the IUPAC names of the following coordination compounds:

(a) $[Co(NH_3)_5Cl]Cl_2$	pentaamminechloridoocobalt(III)chloride
(b) $[Cr(H_2O)_6]Cl_3$	hexaaquachromium(III)chloride
(c) $K_3[Fe(CN)_6]$	potassiumhexacyanidoferrate(III)
(d) $[NiCO_4]$	tetracarbonylnickel(0)
(e) $[Cr(en)_3]^{3+}$	tris(ethylene diamine)chromium(III) ion
(f) $[Pt(NH_3)_2Cl(NO_2)]$	diamminechloridonitrito-N-platinum(II)
(g) $K_3[Cr(C_2O_4)_3]$	potassiumtrioxalatochromate(III)
(h) $[CoCl_2(en)_2]Cl$	dichloridobis(ethane-1,2-diamine)cobalt(III)chloride
(i) $[Co(NH_3)_5(CO_3)]Cl$	pentaamminecarbonatocobalt(III)chloride
(j) $Hg[Co(SCN)_4]$	mercurytetrathiocyanato-S-cobaltate(III)

Homoleptic complexes:

Those complexes in which metal or ion is coordinate bonded to only one kind of donor atoms. For example: $[Co(NH_3)_6]^{3+}$

Heteroleptic complexes:

Those complexes in which metal or ion is coordinate bonded to more than one kind of donor atoms. For example: $[CoCl_2(NH_3)_4]^+$, $[Co(NH_3)_5Br]^{2+}$

Isomerism in coordination compounds:-

Compounds which have same molecular formula,but different structures and therefore different physical and chemical properties are called isomers. Depending upon the position and arrangement of ligands around the central metal atom several types of isomerism are possible.Isomerism are broadly classified into two.

A. Structural isomerism

These are isomers which have different structural arrangement around the central metal atom. The various structural isomers are.

Ionisation isomerism

These type of isomerism arises because of the capability of coordination compounds to produce different ions in solution.

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Eg:- $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$

Hydrate isomerism or solvate isomerism

This type of isomerism arises because of the capability of water molecule to appear in a variety of ways inside and outside the coordination sphere.

Eg:- Three hydrate isomerism are possible for the molecular formulae $CrCl_3\ 6H_2O$

Eg:- $[Cr(H_2O)_6]Cl_3$ $[Cr(H_2O)_5Cl]\ Cl_2.H_2O$ $[Cr(H_2O)_4Cl_2]Cl\ 2H_2O$

Linkage isomerism : It is shown by the complex containing ambidentate ligand with more than one donor atom. Eg:- when NO^{2-} is bonded to the metal through nitrogen the ligand is named as nitrito-N and if it is bonded to the metal through oxygen (ONO^-) the ligand is named as nitrito-O.

Eg:- $[Co(NH_3)_5\ NO_2]Cl_2$ and $[Co(NH_3)_5\ ONO]Cl_2$ -

Coordination isomerism

This type of isomerism arises from the interchange of ligands between cationic and anionic entities in the complex..

Eg:- $[Cu(NH_3)_4]\ [PtCl_4]$ and $[Pt(NH_3)_4]\ [CuCl_4]$

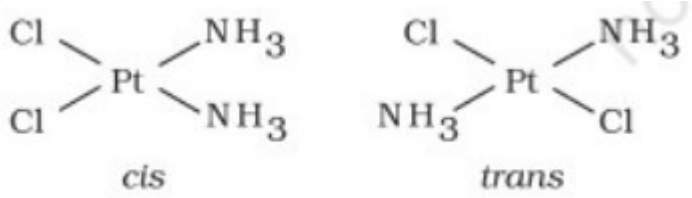
$[Co(NH_3)_6]\ [Cr(CN)_6]$ and $[Cr(NH_3)_6]\ [Co(CN)_6]$

Stereo isomerism

Isomers are those which contain same atom or group but they differ in the spatial arrangement around the central atom. They are of two types.

a.Geometrical isomerism

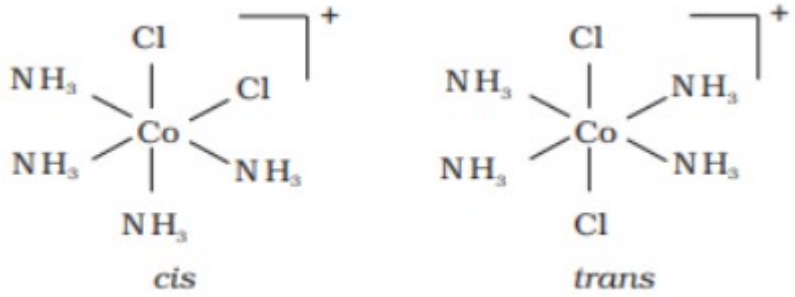
Also known as cis-trans isomerism. These types of isomerism arises due to different spatial arrangements of ligands..)



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Octahedral complexes

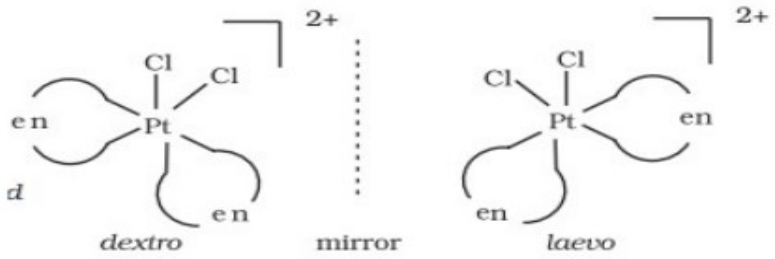


Optical Isomerism

Optical isomers which are mirror images to each other and cannot be superimposed on one another are called as enantiomers. Such molecules or ions that cannot be superimposed are called chiral.

The enantiomer are called dextro (d) and laevo (l) depending upon the direction they rotate the plane of polarised light in a polarimeter (d rotates plane polarised light to the right direction , where as l to the left).

Optical isomerism is common in octahedral complexes involving didentate ligands . In a coordination entity of the type $[PtCl_2(en)_2]^{2+}$, only the cis-isomer shows optical activity



Valence bond theory:

a) According to this theory, the metal atom or ion under the influence of ligands can use its (n-1)d, ns, np or ns, np, nd orbitals for hybridisation to yield a set of equivalent orbitals of definite geometry such as octahedral, tetrahedral, and square planar.

b) These hybridised orbitals are allowed to overlap with ligand orbitals that can donate electron pairs for bonding.

Crystal Field Theory:

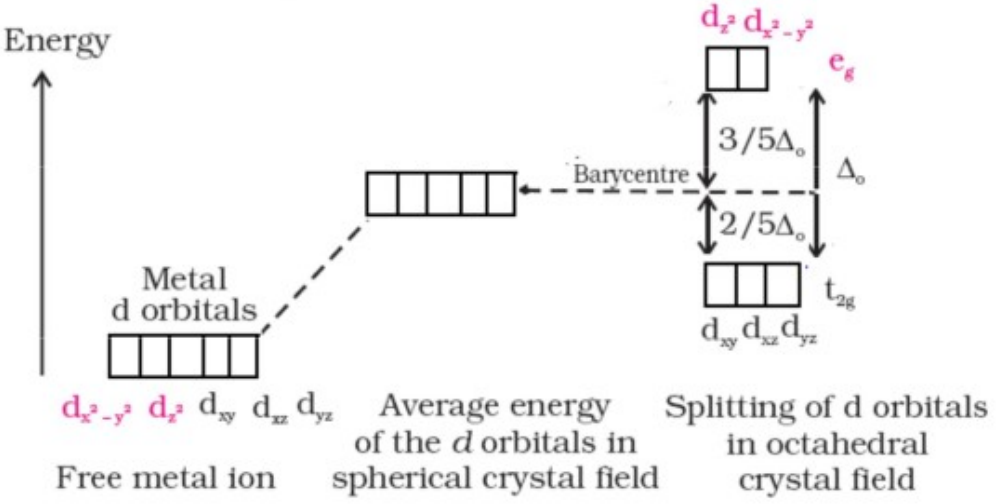
a) It assumes the ligands to be point charges and there is electrostatic force of attraction between ligands and metal atom or ion.

b) It is theoretical assumption.

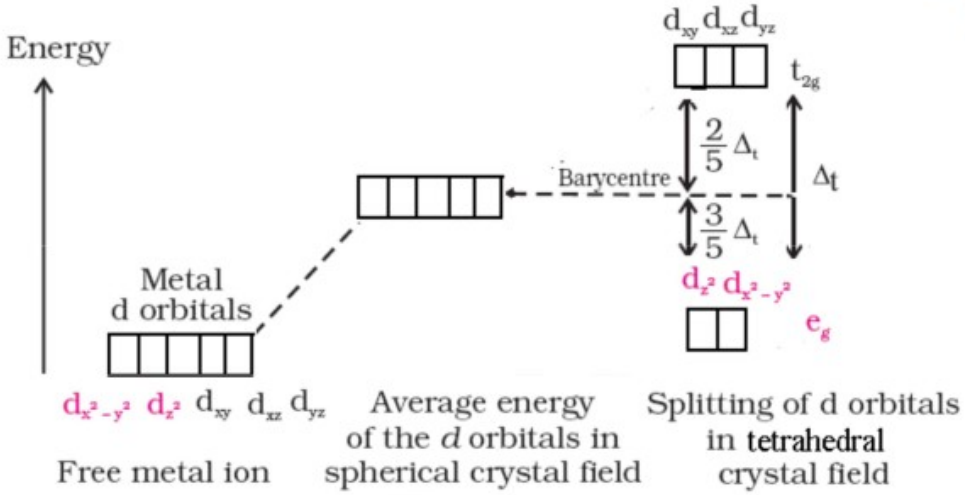
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- **Crystal field splitting in octahedral coordination complexes:**



- **Crystal field splitting in tetrahedral coordination complexes:**



UNIT 6
HALO ALKANES AND HALO ARENES

Halo alkanes or Alkyl halides are having general formulae R-X Example CH_3Cl , C_2H_5Cl Halo arenes or aryl halides having general formulae Ar X Example C_6H_5Cl

HALO ALKANES

1. Methods of Preparation of Halo alkanes

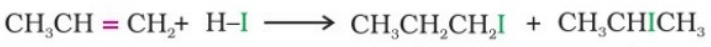
(i)From Alkenes

Addition of hydrogen halides: By reaction with HCl.HBr,HI Propene yields two products, however only one predominates as per Markovnikov's rule.

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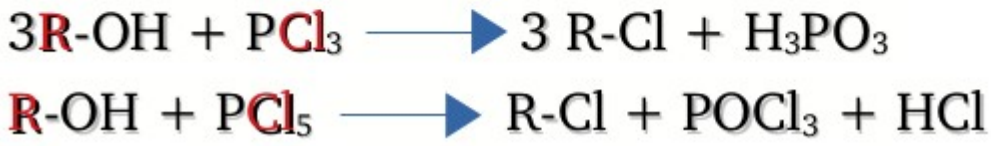
(ii) From Alcohols (R-OH)

Here the hydroxyl group of an alcohol is replaced by halogen

(iii) By Halogen Exchange Reactions

R-X + NaI → R-I + NaX (where X = Cl, Br) (Finkelstein reaction)

R-X + AgF → R-F + AgX (where X = Cl or Br) (Swarts reaction)



Reactions of Halo alkanes

(1) Nucleophilic substitution reactions

The reaction in which a nucleophile replaces already existing nucleophile in a molecule
is called nucleophilic substitution reaction.



(a) Substitution nucleophilic bimolecular (SN_2)

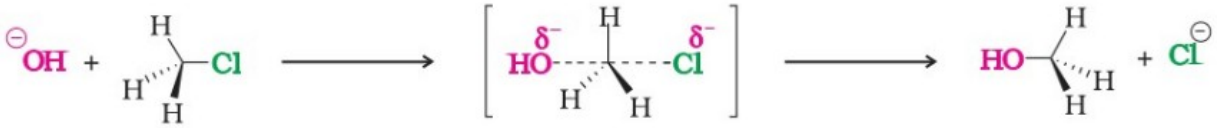
SN_2 reaction occurs in one step.

This mechanism proceeds through inversion of configuration , in the same way as anumbrella is turned inside out when caught in a strong wind.

The reaction between methyl chloride CH_3Cl and hydroxide ion OH- to yield methanol CH_3OH and chloride ion Cl^- is example



Rate
depends upon the concentration of both the reactants. So it follows second order kinetics.



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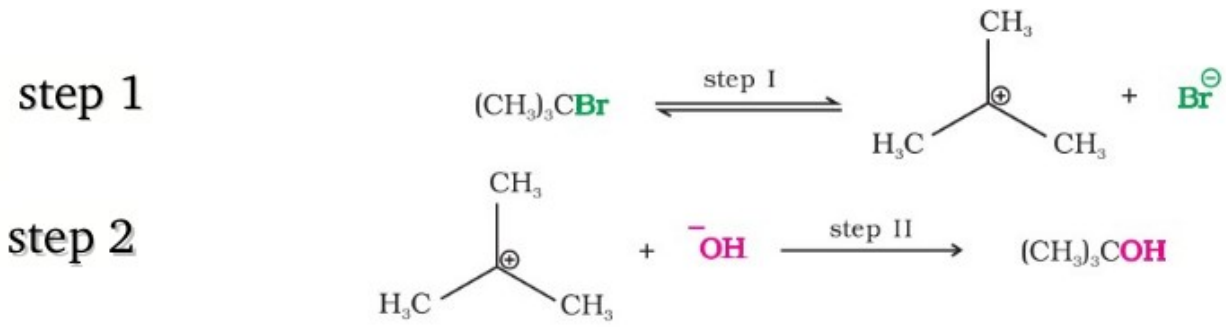
The order of reactivity of alkyl halides towards SN_2 reaction
Primary halide > Secondary halide > Tertiary halide

Substitution nucleophilic unimolecular (SN_1)

➢ S N 1 reaction occurs in two steps.
➢ In the first step, the C—X bond undergoes slow cleavage to produce a carbo cation and a halide ion. In the second step, the carbo cation is attacked by the nucleophile to form the product.
➢ Here first step is the slowest and reversible. So it is the rate determining step. Since this step contains only one reactant, it follows first order kinetics.
➢ The reaction between tert- butyl bromide and hydroxide ion yields tert-butyl alcohol is example



Rate of reaction depends upon the concentration of only one reactant, which is tert- butyl bromide (2-bromo-2-methyl propane) so it follows first order kinetics



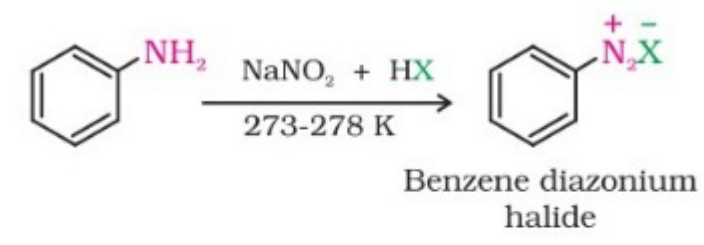
The order of reactivity of alkyl halides towards S N 1 reaction
Tertiary halide > Secondary halide > Primary halide

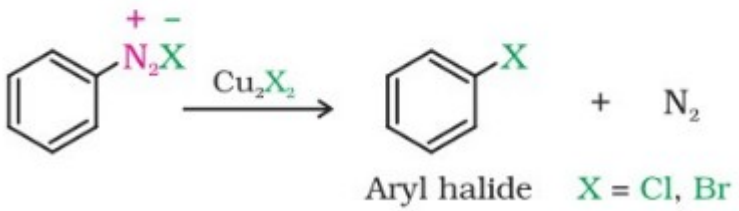
HALO ARENES

Methods of Preparation of Halo arenes

1) From amines by **Sandmeyer's reaction:**

When an aromatic primary amine (like aniline) is treated with HCl and sodium nitrite ($NaNO_2$) at cold condition an aromatic diazonium salt is formed. This reaction is called Diazotisation. When this diazonium salt is treated with HX in presence of cuprous halide we get a halo benzene. This reaction is called Sandmeyer's reaction .



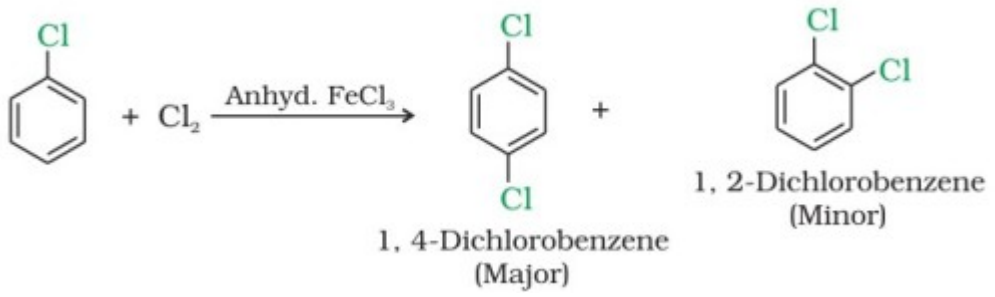


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Important Electrophilic substitution reactions of Halo arenes are

(i)Halogenation :

Halo alkanes react with chlorine in presence of anhydrous ferric chloride to form o-dichlorobenzene and p-dichlorobenzene.



(ii) Nitration: On nitration using Conc. HNO_3 and Conc. H_2SO_4 (nitrating mixture), chlorobenzene gives o-nitro chloro benzene and p-nitro chlorobenzene in which later is major product



Sulphonation :-

On sulphonation using Conc. H_2SO_4 , chloro benzene gives ortho chloro benzene sulphonic acid and para chloro benene sulphonic acid (major product).

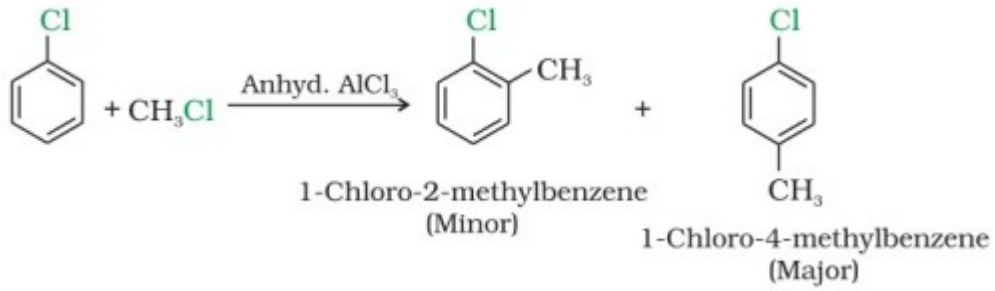


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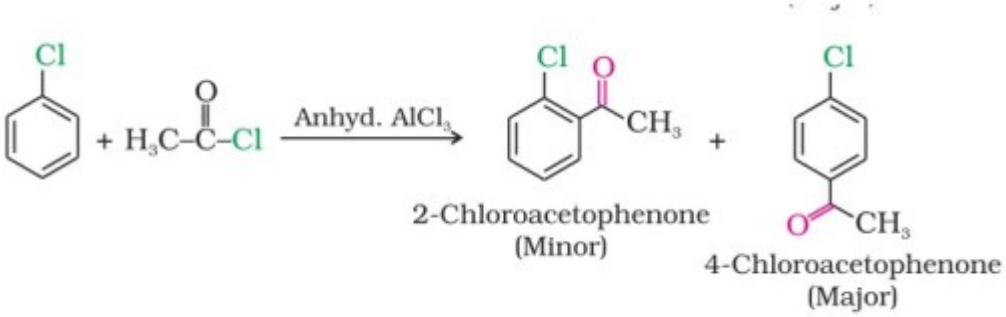
(iv) Friedel-Crafts alkylation

Chloro benzene when treated with methyl chloride (CH_3-Cl) in presence of anhydrous $AlCl_3$, we get p-chloro toluene as the major product and o-chloro toluene as minor product



Friedel-Crafts acylation :

Chloro benzene when treated with acetyl chloride in presence of anhydrous $AlCl_3$ we get p-chloro acetophenone as the major product an o-chloro acetophenone as minor product

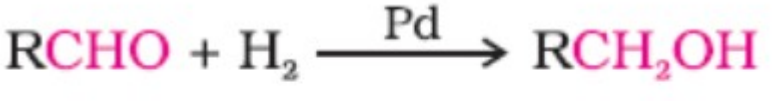


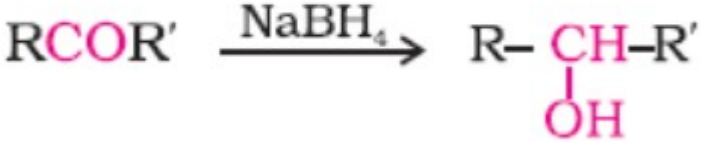
UNIT 7.
Alcohols, Phenols and ethers

1.Preperation of alcohols

a) From carbonyl compounds

Aldehydes on reduction give primary alcohol and ketones give secondary alcohol



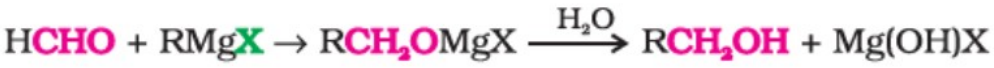


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b) From Grignard reagent RMgX

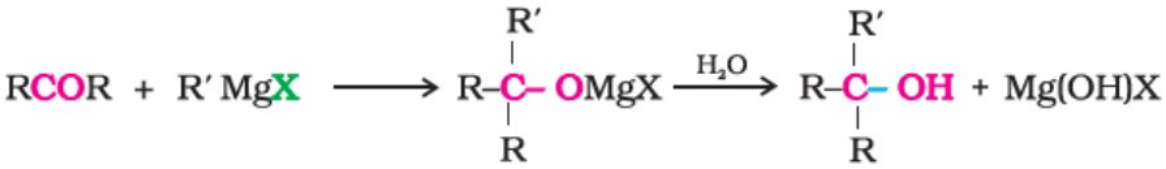
Formaldehyde reacts with Grignard reagent to give primary alcohol.



Other aldehydes give secondary alcohol.

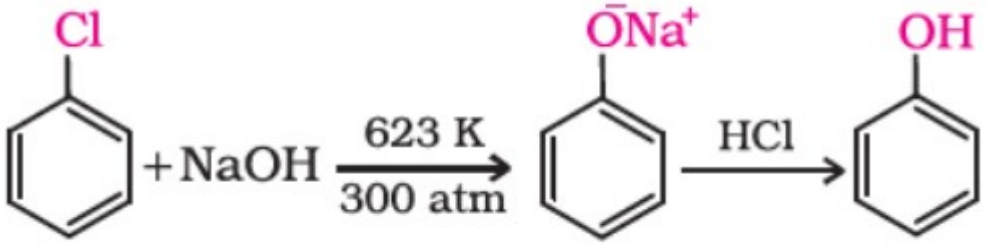


Ketones give tertiary alcohol.



2.Preparation of Phenols

Chlorobenzene is fused with NaOH

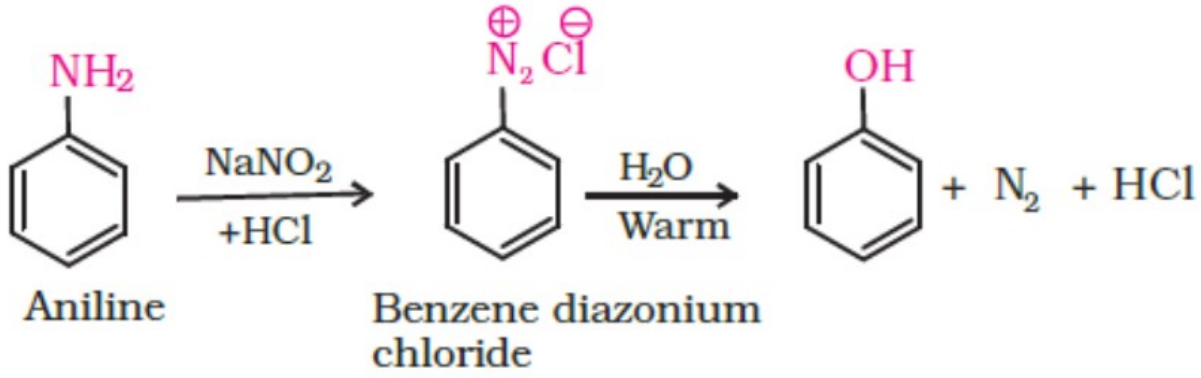


b) From diazonium salts

Aniline is treated with nitrous acid ($NaNO_2$ +HCl) at 273-278k to form benzene diazonium chloride. It is then warmed with water to form phenols.

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Chemical properties of Alcohols

a) Luca's test (Reaction with Hydrogen halides)

Alcohols react with Hydrogen halides to form alkyl halides.

$$ROH + HX \rightarrow R{-}X + H_2O$$

1°alcohol, 2°alcohol, 3°alcohol can be distinguished by using Luca's reagent (ConcHCl+$ZnCl_2$)
3°alcohol produce turbidity immediately. 2°alcohol produce turbidity within 5 minutes.
1°alcohol do not produce turbidity at room temperature.

b) Dehydration

Alcohols undergo dehydration to form alkenes

$$C_2H_5OH \xrightarrow[443\ K]{H_2SO_4} CH_2 = CH_2 + H_2O$$

Ethanol on dehydration gives ethane.

Secondary and tertiary alcohols are dehydrated under milder conditions. For example

$$CH_3CH(OH)CH_3 \xrightarrow[440\ K]{85\%\ H_3PO_4} CH_3{-}CH = CH_2 + H_2O$$

$$CH_3{-}C(CH_3)(CH_3){-}OH \xrightarrow[358\ K]{20\%\ H_3PO_4} CH_3{-}C(=CH_2){-}CH_3 + H_2O$$

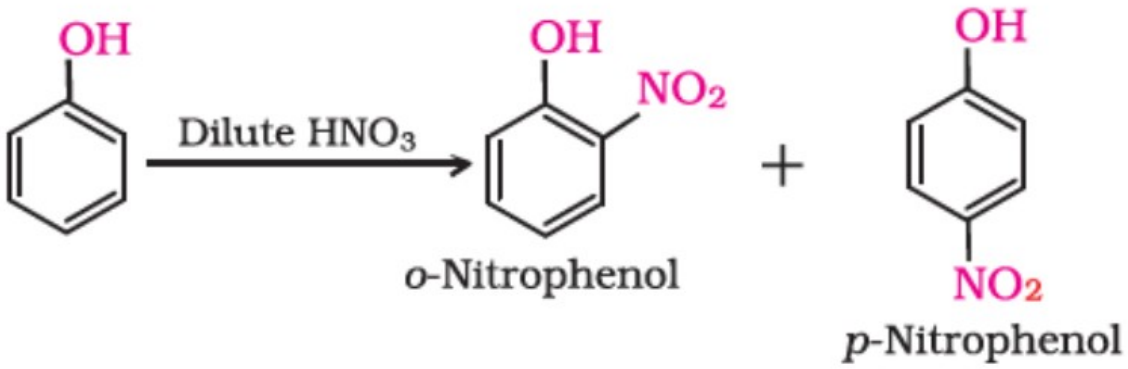
Thus, the relative ease of dehydration of alcohols follows the following order:

Tertiary > Secondary > Primary

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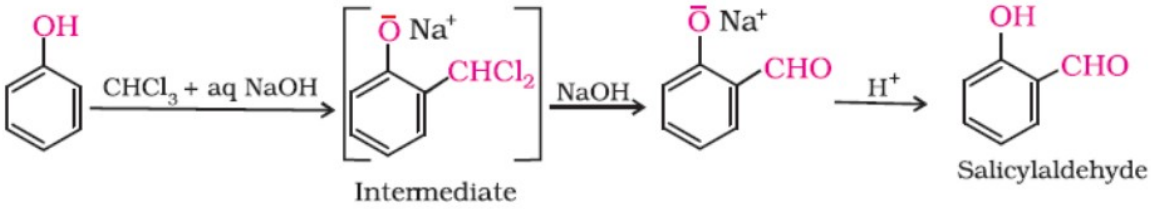
Chemical properties of Phenols

a) Nitration of phenol (Electrophilic substitution)



b) Reimer-Tiemannn Reaction

When phenol is treated with chloroform in presence of NaOH to form salicylaldehyde



Some important commercial alcohols-Ethanol

Ethanol is obtained by the fermentation of sugar.

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{Invertase}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

$$C_6H_{12}O_6 \xrightarrow{\text{Zymase}} 2C_2H_5OH + 2CO_2$$

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Ethers

Preparation of Ethers-

Williamsons Synthesis

An alkyl Halide is treated sodium alkoxide.



Properties of Ethers

- **Cleavage of unsymmetrical ether**

  During the cleavage of unsymmetrical ether. Smaller alkyl group produce alkyl halides.

  Eg:- $CH_3 - O - CH_3\,CH_3 + HBr \rightarrow CH_3\,Br + CH_3CH_2OH$

  ethy / methy / ether methyl promide ethanol

- If ether consists of one methyl group and one 1^0 or 2^0 alkyl group, then S_N2 mechanism takes place. In such a case methyl halide is obtained with alcohol of bulky alkyl group.

  $$CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - O - CH_3 - HI \rightarrow CH_3I + CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - OH$$

  Mehylso-propyl ether methyl iodide Iso propyl alcohol

  If ether consists of one methyl group and one 3^0 alkyl group, then reaction is completed by S_N1 mechanism.

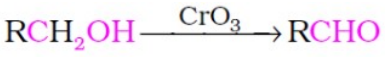
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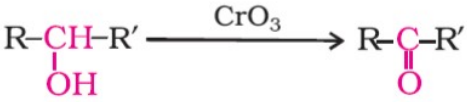
UNIT 8
Aldehydes, ketones and carboxylic acids

I)Preparation of aldehydes and ketones

1) By the oxidation of alcoholsAldehydes and ketones are prepared by oxidation of primary alcohols and secondary alcohols.



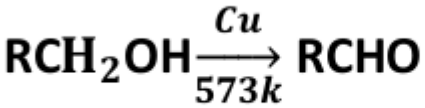
Secondary alcohols are oxidised to ketones by chromic anhyride (CrO_3).



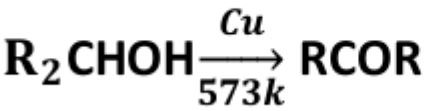
Sec- alcohol Ketone

2)By dehydrogenation of alcohols

Dehydrogenation of 1° alcohol gives aldehyde.

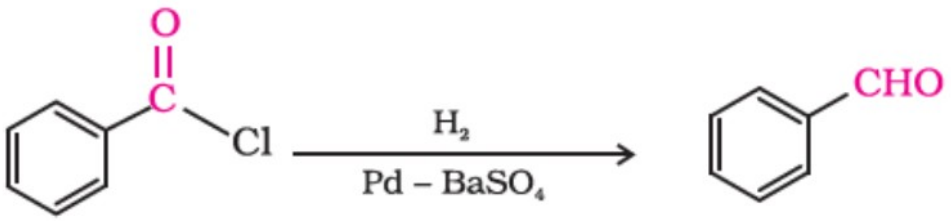


Dehydrogenation of 2° alcohol gives ketones



3)Rosenmunds reduction

Acid chloride is reduced in presence of palladium and Barium sulphate.



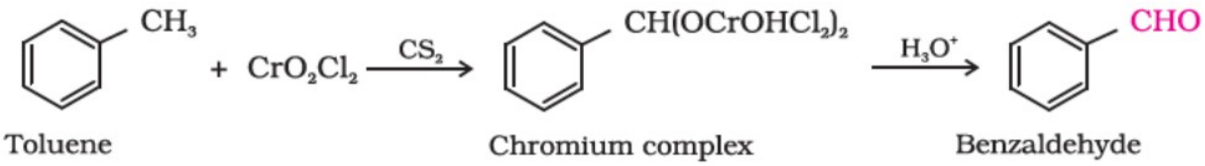
Benzoyl chloride Benzaldehyde

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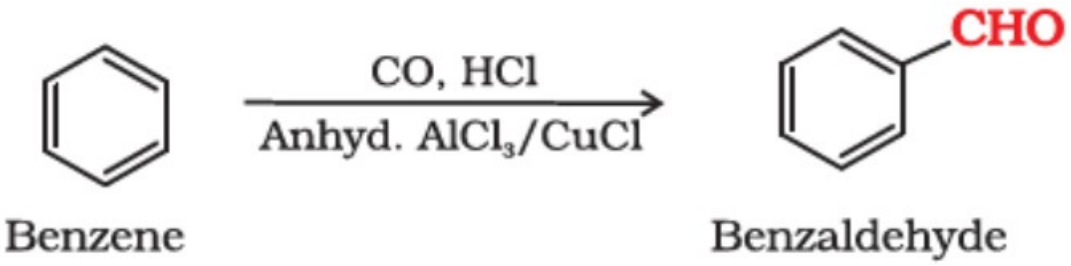
4)Etard reaction

Use of chromyl chloride (CrO_2Cl_2): Chromyl chloride oxidises methyl group to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.



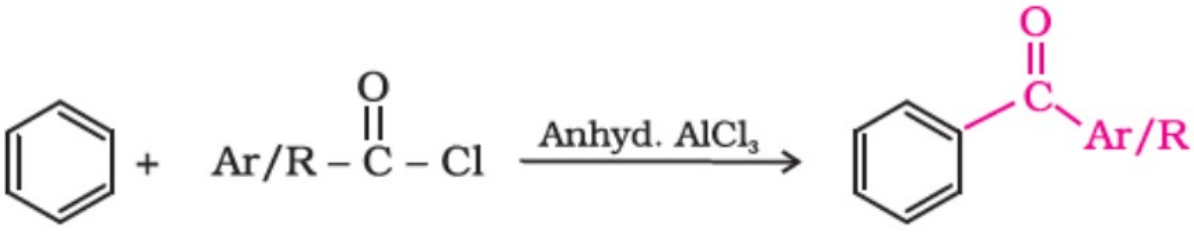
5) Gattermann-Koch Reaction

When benzene is treated with CO, HCl in presence of anhydrous aluminum chloride, it gives benzaldehyde.



6.Friedel Crafts reaction

When benzene is treated with acid chloride in presence of anhydrous aluminium chloride, corresponding ketone is formed.



Chemical reactions of Aldehydes and ketones

1.Reduction

a) Reduction to alcohols

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Aldehydes on reduction with Lithium aluminium hydride or H_2 in presence of Ni, Pd gives 1° alcohols.

$$RCHO + H_2 \xrightarrow{Pd} RCH_2OH$$

Ketones gives 2° alcohols. $RCOR \xrightarrow{NaBH_4} R_2CHOH$

b) Reduction to hydrocarbons. Here -CO- group is reduced to -CH_2 with Zinc amalgam and conc. HCl (Clemmensen reduction)

$$>C{=}O \xrightarrow[HCl]{Zn\text{-}Hg} >CH_2 + H_2O \qquad \text{(Clemmensen reduction)}$$

Wolff-kishner Reduction

$$>C{=}O \xrightarrow[-H_2O]{NH_2NH_2} >C{=}NNH_2 \xrightarrow[heat]{KOH/ethylene\ glycol} >CH_2 + N_2$$

(Wolff-Kishner rduction)

Tollen's test

Tollens' test: On warming an aldehyde with freshly prepared ammoniacal silver nitrate solution (Tollens' reagent), a bright silver mirror is produced due to the formation of silver metal.

$$RCHO + 2[Ag(NH_3)_2]^+ + 3\,\bar{O}H \longrightarrow RCO\bar{O} + 2Ag + 2H_2O + 4NH_3$$

Fehling's test

On heating an aldehyde with Fehling's reagent, a reddish-brown precipitate is formed.

$$R\text{-}CHO + 2Cu^{2+} + 5\bar{O}H \longrightarrow RCO\bar{O} + Cu_2O + 3H_2O$$

Red-brown ppt

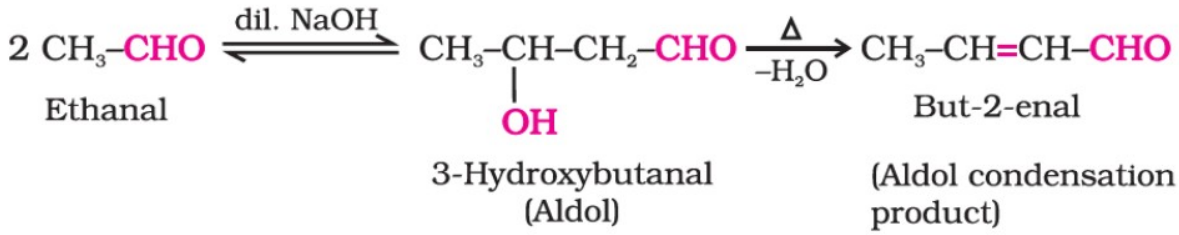
Ketones do not give Tollens test and Fehling's test. So, these tests are used to distinguish aldehydes and ketones.

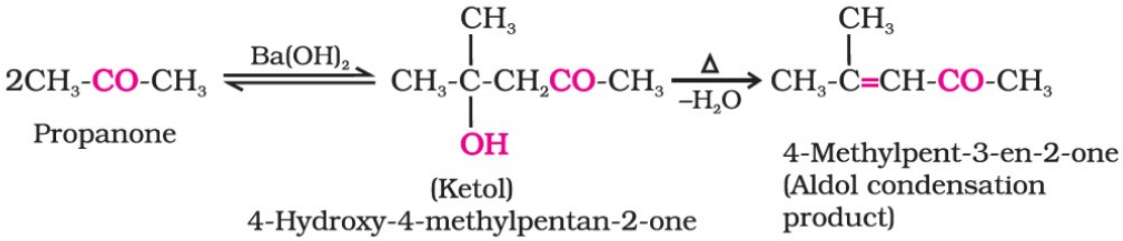
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3)Aldol condensation

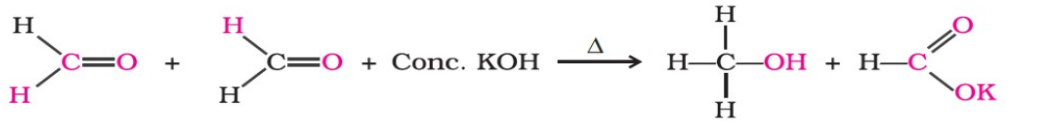
(i) *Aldol condensation:* Aldehydes and ketones having at least one α-hydrogen undergo a reaction in the presence of dilute alkali as catalyst to form β-hydroxy aldehydes (aldol) or β-hydroxy ketones (ketol), respectively. This is known as **Aldol reaction.**

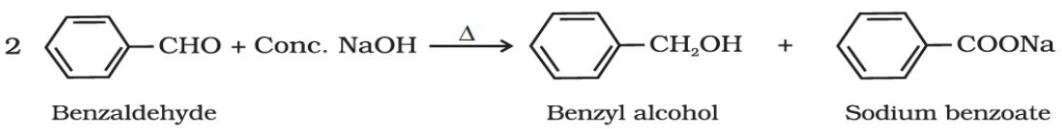




4)Cannizzaro reaction

Cannizzaro reaction: Aldehydes which do not have an α-hydrogen atom, undergo self oxidation and reduction (disproportionation) reaction on heating with concentrated alkali. In this reaction, one molecule of the aldehyde is reduced to alcohol while another is oxidised to carboxylic acid salt.





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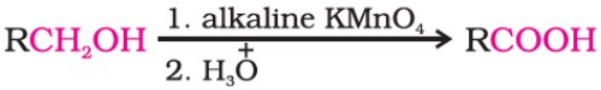
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II) Carboxylic acids

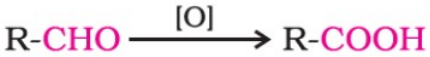
Methods of preparation of carboxylic acids

1.From primary alcohols and aldehydes

Primary alcohols are readily oxidized to carboxylic acid.

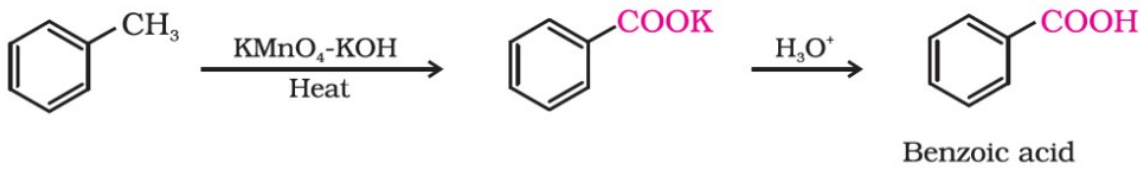


Aldehydes are oxidized by common oxidizing agents like nitric acid, $KMnO_4$,Tollens reagent etc. to carboxylic acids.

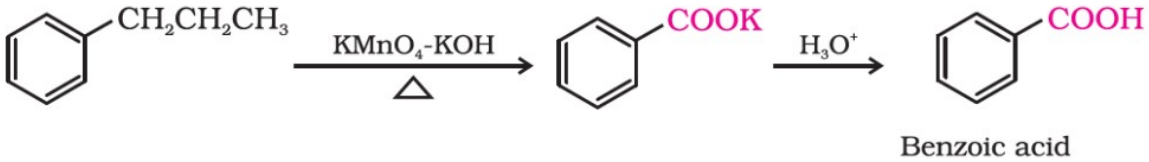


2.From alkyl benzene

Aromatic carboxylic acid can be prepared by the oxidation of alkyl benzene with acidic or alkaline $KMnO_4$



Benzoic acid

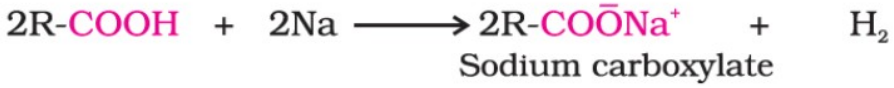


Benzoic acid

Chemical reactions of carboxylic acids

1.Acidity

Carboxylic acids are more acidic than alcohols and phenols. It reacts with electropositive metals and liberate H-gas.



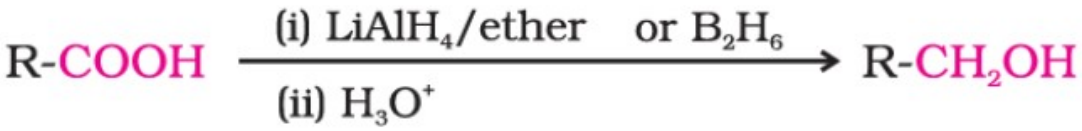
Sodium carboxylate

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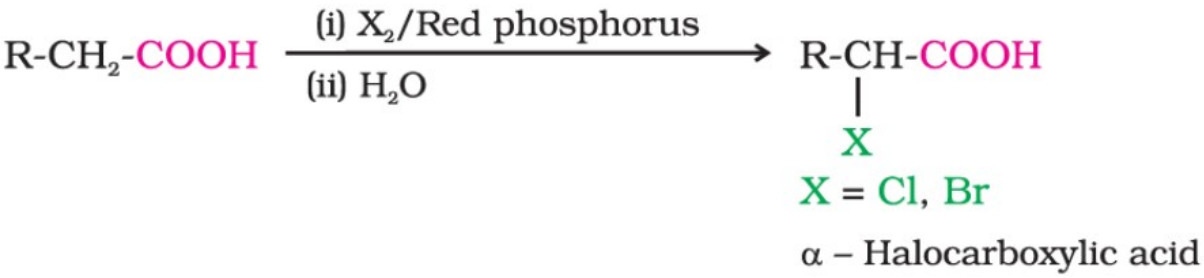
2.Reduction

Carboxylic acids are reduced to primary alcohols with Lithium aluminium Hydride or Diborane.



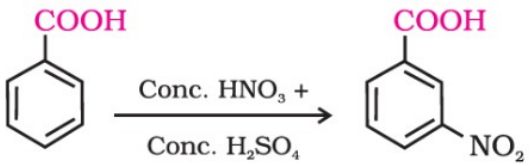
3.Hell-Volhard-Zelinsky reaction

Carboxylic acids undergo α-halogenation with Cl_2 , Br_2 in presence of red phosphorus gives α-halo carboxylic acids.

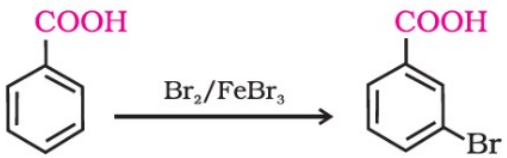


4.Ring Substitution

The -COOH group is a deactivating group and meta-directing. So, on electrophilic substitution reactions, they give meta derivative product.



m-Nitrobenzoic acid



m-Bromobenzoic acid

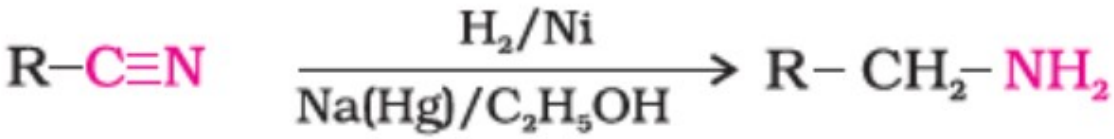
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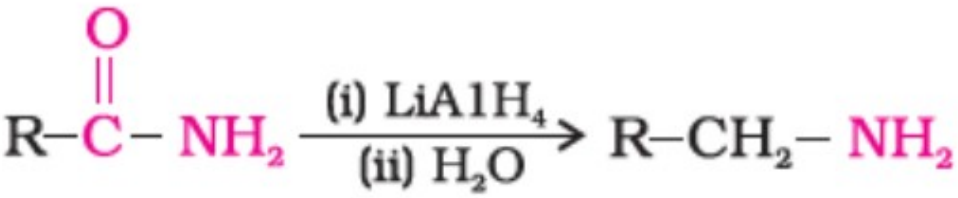
UNIT 9
Amines

I)Preparation of Amines

1.Reduction of Nitriles

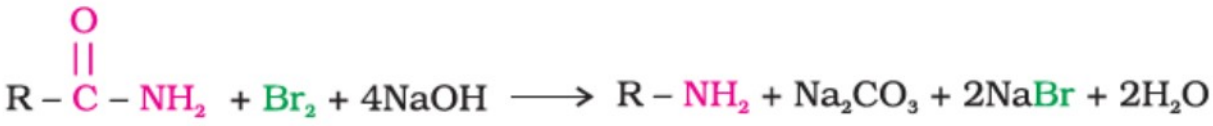


2.Reduction of Amides



Hoffmann Bromamide degradation reaction

A primary amine is treated with Bromine and aqueous NaOH. The amine so formed contains one carbon atom less than the parent amide.



Chemical reactions of Amines

1. Carbylamine reaction

Aliphatic and aromatic primary amine is heated with chloroform and alcoholic KOH to form isocyanides (Carbylamines) with foul smell.



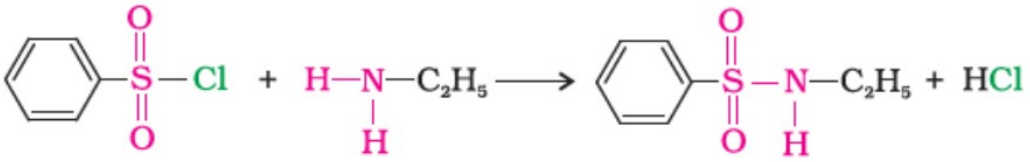
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2. Hinsberg test

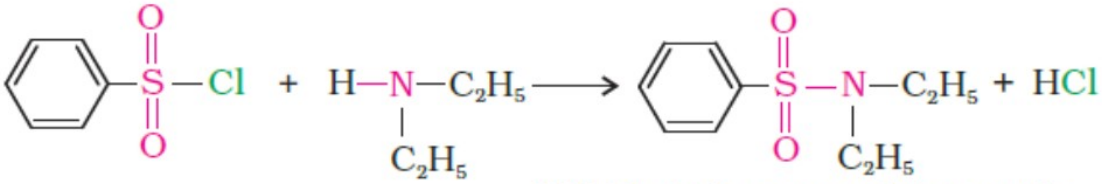
Benzenesulphonyl chloride ($C_6H_5SO_2Cl$), which is also known as **Hinsberg's reagent,** reacts with primary and secondary amines to form sulphonamides.

a) Heinsberg reagent reacts with primary amine. **The product is soluble in alkali.**



N-Ethylbenzenesulphonamide
(soluble in alkali)

b) b) Hinsberg reagent reacts with secondary amine. **The product is insoluble in alkali.**



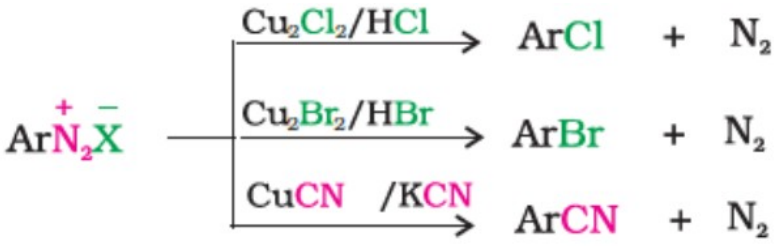
N,N-Diethylbenzenesulphonamide

Tertiary amines do not react with Hinsberg reagent.

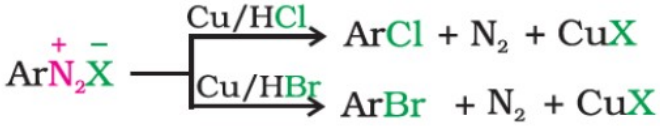
III) Chemical reactions of Diazonium salts

a.Sandmeyer's Reaction

Benzene diazonium chloride is treated with cuprous halide and halogen acids to form Halo benzenes.



When Benzene diazonium chloride is treated with Halogen acids in presence of Cu powder, the reaction is known as **Gattermann reaction.**

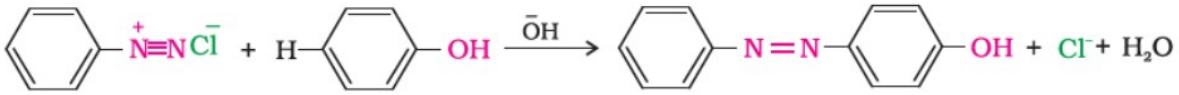


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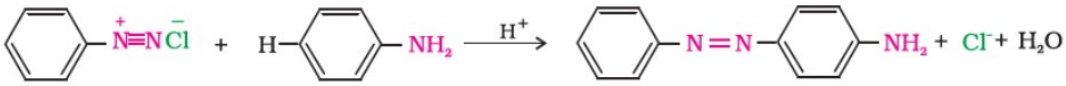
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b. Coupling reaction

Benzene diazonium chloride is treated with phenol to form p-hydroxy azobenzene.



p-Hydroxyazobenzene (orange dye)



p-Aminoazobenzene
(yellow dye)

UNIT 10
BIO MOLECULES

The molecules present in living system like carbohydrates, proteins, nucleic acids, lipids, vitamins etc. which are essential for the growth and maintenance of our body are called **Biomolecules**.

1.Carbohydrates (Saccharides)

They can be defined as polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.

Sugars:- Carbohydrates which are crystalline, water soluble and sweet in taste are called as sugars. Eg: Glucose, Fructose

Non-sugars :- Carbohydrates which are not crystalline, water insoluble and have no sweet taste are called non-sugars. Eg: Cellulose

2.Classification of carbohydrates

Based on their behaviour on hydrolysis:

Based on this, carbohydrates are classified into three types:

- **Monosaccharides:** These are carbohydrates which cannot be hydrolysed in to simpler units of polyhydroxy aldehydes or ketones. E.g. glucose, fructose, ribose, galactose etc.

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- **Oligosaccharides:** These are carbohydrates which give two to ten monosaccharide units on hydrolysis. They are further classified as disaccharides, trisaccharides, tetrasaccharides etc. E.g.Sucrose, maltose, lactose.
- **Polysaccharides:** These are carbohydrates which give a large number of monosaccharide units on hydrolysis. E. . starch, cellulose, glycogen etc.

Carbohydrates	Monomers
Sucrose	Glucose, Fructose
Maltose	Two units of Glucose
Lactose	Glucose,Galactose
Starch,Cellulose,	Glycogen A large number of Glucose units

Based on their reducing character:

Based on this, carbohydrates are of two types - reducing sugar and non-reducing sugar.

- **reducing sugars :-** Carbohydrates which contain free aldehydic or ketonic groups. All monosaccharides are reducing sugars. Disaccharides like maltose and lactose are also reducing
- **non-reducing sugars.:** Those which do not contain free aldehydic or ketonic group.sucrose is non-reducing
- **Preparation of glucose**

From sucrose (Cane sugar): If sucrose is boiled with dilute HCl or H_2SO_2 in alcoholic solution. glucose and fructose are obtained in equal amounts.

$C_{12}H_{22}O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

4.Glycosidic Linkage

During the formation of a disaccharide or polysaccharide, the monosaccharide units are joined together through C-0-C linkage. Such a linkage is called glycosidic linkage.

5. Invert Sugar

Cane sugar (sucrose) on hydrolysis gives an equimolar mixture of (+) glucose and (-) fructose.

$C_{12}H2_2O_{11} + H_2O \longrightarrow C_6H_{12}O_6 + C_6H_{12}O_6$

(+)Sucrose dextro (+) Glucose (+52.50) laevo (-)Fructose (-92.40)

Sucrose is dextro rotatory (+) but the net optical rotation of the product formed after hydrolysis is laevo (-). So the process is called inversion of cane sugar and the product formed is called invert sugar.

6.Starch:

Starch is the main storage polysaccharide of plants. It is a polymer of glucose and consists of two components— Amylose and Amylopectin.

Amylose is water soluble component which constitutes about 15-20% of starch. It is a linear polymer of glucose units.

Amylopectin is insoluble in water and constitutes about 80- 85% of starai. It is a branched chain polymer of glucose units.

7.Glycogen:

The carbohydrates are stored in animal body as glycogen. It is also known as animal starch because its structure is similar to amylopectin, a branched chain polymer of glucose units.

8.Denaturation of Protein:

When a protein is subjected to physical change (like change in temperature) or chemical change (like change in pH), it loses the biological

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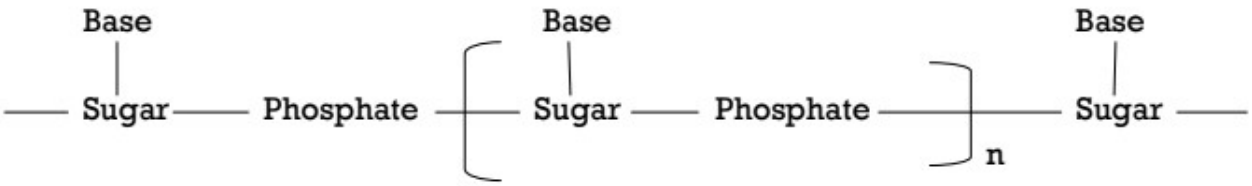
activities. This process is called denaturation of protein. E.g. coagulation egg white on boiling, curding of milk etc.

9.Nucleic acids:

They are long chain polymers of nucleotides and are responsible for transmission of heredity. These are of two types - deoxy ribonucleic acid (DNA) and ribonucleic acid (RNA).

The nucleotide units combine to form nucleic acid through **Phospho diester linkage**.

A simplified version of nucleic acid chain is as shown below,



Differences between DNA and RNA

DNA	RNA
1. DNA is double stranded	1. RNA is single stranded
2. The pentose sugar is deoxyribose	2. The pentose sugar is ribose
3. The nitrogen bases are Adenine, Guanine, Cytosine and Uracil.	3. The nitrogen bases are Adenine, Guanine, Cytosine and Thymine.
4. Undergo replication	4. Not undergoing replication
5. Found in the Nucleus	5. Found in Cytoplasm
6. DNA is the chemical basis of herebity and may be regarded as the reserve of genetic information.	6. Protein synthesis

VITAMINS

Vitamins are organic compounds required in the diet in small amounts to perform specific biological functions for maintenance of normal growth and health. Vitamin –D synthesized in the body

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Vitamins and deficiency deseases

Vitamins	Defeciency deseases
Vitamin A (Retinol)	Night blindness, Xerophthalmia
Vitamin B_1 (Thaimine)	Beri-beri
Vitamin B_2 (Riboflavin)	Chellosis
Vitamin B_6 (Pyridoxione)	Convulsions
Vitamin B_{12} (Cyano cobalamine)	Pernicious anaemia
Vitamin C (Ascorbic vitamin)	Scuvy
Vitamin D (Sunshine vitamin)	Rickets
Vitamin E (Antiserility vitamin)	Sterility, muscular weakness
Vitamin K	Increased blood clotting time

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