SOLUTION

Concentration of Solutions:-
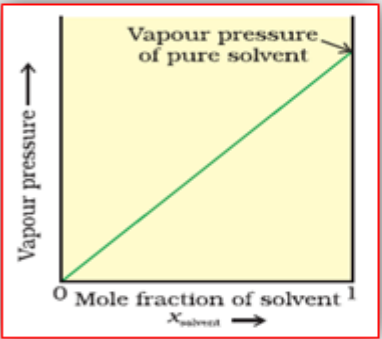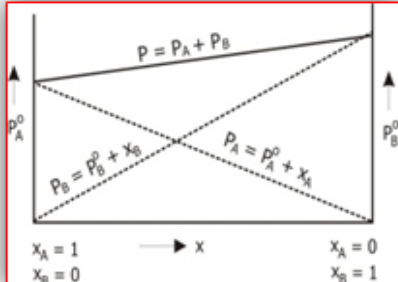
Molarity [M]:	No. of moles of solute present per liter of solution in called 'molarity of solution'. . It is temperature dependent. M= No. of Moles of solute / Volume of solution in litre
Molality [m]:	No. of moles of solute present per kg. of solvent is called molality. It is temperature independent. m= No. of Moles of solute / Mass of Solvent in Kg
Mole Fraction:	Ratio of moles of components to total no. of moles of all the components of solution is called mole fraction (x) of the component.

Henry's law :- "The partial pressure of the gas in vapour phase p is proportional to the mole fraction of the gas x in the solution." **$P = K_H x$**

Applications of Henery Law (1) In Packing of soda/ Soft drinks(2) In Deep see diving(He = 11.7 % , N_2 = 56.2 % and O_2 =32.1%) (3)   Functions of lungs (4)At high altitudes pressure is low there for breathing problems lead to ANOXIA (unable to think and weak)

Vapour Pressure: The pressure exerted by vapours over the liquid surface at equilibrium is called **vapour pressure** of the liquid.

**Raoult's Law:** *"The V.P. of any volatile component in the solution is directly proportional to its mole fraction".*

Raoult's Law for Solutions Containing Non-Volatile Solute	Raoult's Law for Solution Containing Volatile Solute
The vapour pressure of a solution containing non-volatile solute is directly proportional to mole fraction of volatile solvent. P ∝ x_A (volatile solvent) $p = p° x_1$	The partial vapour pressure of any volatile component is directly proportional to mole fraction of that volatile component. $p1 ∝ x1$ $p1 = p1°x1$ $p2 ∝ x2$ $p2 = p2°x2$ $P_T = p1 + p2$

Ideal and Non-Ideal Solutions:

Ideal Solution	Non Ideal Solution
Follows Raoult's law at all temperature and concentrations. $P = P_A + P_B$	Does not follow Raoult's law at all temperature and pressure. $P \neq P_A + P_B$
Intermolecular forces in resulting solution are same as in pure components. A − B = A − A = B − B	Intermolecular forces in resulting solution are different from the inter molecular force of pure components. A − B ≠ A − A, B − B
No change in volume while mixing components. Δ V mix = 0	Change in volume while mixing components. Δ V mix ≠ 0
No heat change take place while mixing the components. Δ H mix = 0	Heat changes take place while mixing the components. Δ H mix ≠ 0
Eg: n–hexane+ n–heptanes & benzene + toluene	Eg: Acetone + Water &Acetone + $CHCl_3$

Non Ideal Solution

Showing Positive elevation from Raoult's Law	Showing Negative Deviation from Raoult's Law
$P_T > P_A + P_B$ Resulting intermolecular force is weaker than pure components.	$P_T < P_A + P_B$ Resulting intermolecular force is stronger than pure components.
Δ V mix = +ve	Δ V mix = −ve
Δ H mix = +ve Endothermic mixing process	Δ H mix = −ve Exothermic process
Acetone + Water , Alcohol + Water Carboxylic Acid + Water	Acetone + $CHCl_3$, $HNO_3 + H_2O$
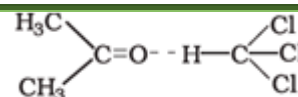
Azeothrpes: (Constant Boiling Mixture) :- Solution in which components are present in a fixed proportion, boils at a constant temperature irrespective of boiling point of pure components

⊙ **Minimum Boiling Azeothrpes:** Boils at a temperature lower than b.ps. of pure components. **[95% Alcohol]**

⊙ **Maximum Boiling Azeothrpes:** Boils at a temperature higher than b.p.s. of pure components. **[68% HNO_3]**

Colligative Properties:- The properties of dilute solutions which depend only on number particles of solute present in the solution and not on their identity are called *colligative properties*

1-Relative Lowering of Vapour Pressure	2- Elevation of Boiling Point : $\Delta T_b = K_b\ m$	3-Depression of Freezing Point	4- Osmotic Pressure
$\dfrac{p_1^0 - p_1}{p_1^0} = \dfrac{w_2 \times M_1}{M_2 \times w_1}$	$\Delta T_b = K_b\ \dfrac{W_{solute}\ X\ 1000}{M_{solute}\ X\ W_{solvent}}$	$\Delta T_f = K_f m$ $\Delta T_f = K_f\ \dfrac{W_{solute}\ X\ 1000}{M_{solute}\ X\ W_{solvent}}$	$\pi\ V = nRT$ π = Osmotic pressure R =Gas constant Π =CRT (C= Molarity)

Osmosis:- The phenomenon of the passage of pure solven from a region of lower concentration (of the solution) to a region of its higher concentration through a semi-permeable membrane.

Osmotic Pressure: Excess pressure which must be applied to a solution in order to prevent flow of solvent into the solution through the semi-permeable membrane.

Reverse Osmosis: If pressure greater than osmotic pressure is applied then, flow of solvent molecules is reversed, i.e. from a higher concentration solution to lower concentrated solution. This phenomenon is called "Reverse Osmosis**". It is used in water purification and desalination of water.**

Van't Hoff Factor: $i = \dfrac{\text{Observed colligative property (actual)}}{\text{Theoretical colligative property (expected)}}$

Q1. 18 g of glucose, $C_6H_{12}O_6$, is dissolved in 1 kg of water in a saucepan. At what temperature will water boil at 1.013 bar? K_b for water is 0.52 K kg mol⁻¹.

Solution:- Number of kilograms of solvent = 1 kg   Moles of glucose = 18 g/ 180 g mol⁻¹ = 0.1 mol
Thus molality of glucose solution = 0.1 mol kg⁻¹ For water, change in boiling point
$$\Delta T_b = K_b \times m = 0.52\ \text{K kg mol}^{-1} \times 0.1\ \text{mol kg}^{-1} = 0.052\ \text{K}$$
Since water boils at 373.15 K at 1.013 bar pressure, therefore, the boiling point of solution will be 373.15 + 0.052 = 373.202 K.

Q2. 45 g of ethylene glycol ($C_2H_6O_2$) is mixed with 600 g of water. Calculate(a) the freezing point depression and(b) the freezing point of the solution.
Solution:- Molality = moles of ethylene glycol / mass of water in kilogram
Moles of ethylene glycol = 45 / 62 g mol⁻¹ = 0.73 mol
Hence molality of ethylene glycol = 0.73/ 0.60 kg = 1.2 mol kg⁻¹
Therefore freezing point depression, $\Delta T_f = 1.86\ \text{K kg mol}^{-1} \times 1.2\ \text{mol kg}^{-1} = 2.2\ \text{K}$
Freezing point of the aqueous solution = 273.15 K – 2.2 K = 270.95 K

Q3. 200 cm³ of an aqueous solution of a protein contains 1.26 g of the protein. The osmotic pressure of such a solution at 300 K is found to be 2.57 × 10⁻³ bar. Calculate the molar mass of the protein.
Sol. = The various quantities known to us are as follows: π = 2.57 × 10⁻³ bar,
V = 200 cm³ = 0.200 litre   T = 300 K   R = 0.083 L bar mol⁻¹ K⁻¹
Substituting these values in equation we get π = CRT

$$M_2 = \frac{1.26\ g \times 0.083\ \text{L bar K}^{-1}\text{mol}^{-1} \times 300\ K}{2.57 \times 10^{-3}\ \text{bar} \times 0.200\ L} = 61{,}022\ \text{g mol}^{-1}$$

Q4. The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 0.5 g when added to 39.0 g of benzene (molar mass 78 g mol⁻¹). Vapour pressure of the solution, then, is 0.845 bar. What is the molar mass of the solid substance?
Given p_i° =0.850 bar   p=0.845 bar: M_1 = 78 g mol⁻¹ w_2 = 0.5 g w_1=39g   Substituting these values in equation .
$$\frac{P_1^0 - P_1}{P_1^0} = \frac{w_2 \times M_1}{M_2 \times w_1} \qquad M_2 = 170\ \text{g mol}^{-1}$$

Q5 If N_2 gas is bubbled through water at 293 K, how many millimoles of N_2 gas would dissolve in 1 litre of water. Assume that N_2 exerts a partial pressure of 0.987 bar. Given that Henry's law constant for N_2 at 293 K is 76.48 *k*bar.
Solution :- According to Henry's law
$$x\ (\text{Nitrogen}) = \frac{p(\text{nitrogen})}{K_H} = \frac{0.987 bar}{76{,}480\ bar} = 1.29 \times 10^{-5}$$
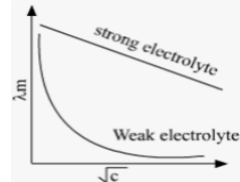As 1 litre of water contains 55.5 mol   if *n* represents number of moles of N_2 in sol,
$$x\ (\text{Nitrogen}) = \frac{n\ \text{mol}}{n\ \text{mol} + 55.5\ \text{mol}} = \frac{n}{55.5} = 1.29 \times 10^{-5}$$
(*n* in denominator is neglected as it is < < 55.5) Thus $n = 1.29 \times 10^{-5} \times 55.5$ mol = 7.16 × 10⁻⁴ mol
= 7.16×10⁻⁴ mol × 1000 mol = 0.716 mmol⁻¹ mol
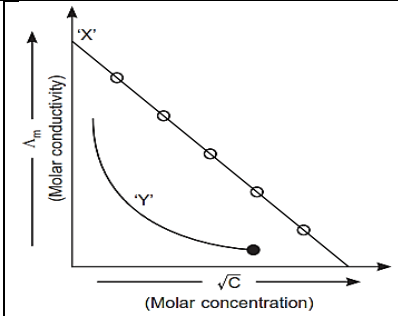
UNIT-3 ELECTROCHEMISTRY

SrNo	Terminology
1.	**Conductance** : Reciprocal of the resistance $G = \dfrac{1}{R}$ Unit is Ω^{-1}
2	**Specific Resistance/Resistivity** : $\rho = R\, A / l$ $l/A = G*(\text{Cell Constant})$ Unit is ohm cm
3	**Specific Conductance or Conductivity** : Conductivity of any conductor is the reciprocal $k = 1/\rho = l/RA$ of specific resistance and is denoted by κ (Kappa) unit Scm^{-1}
4	**Molar Conductivity** : It is defined as the conducting power of all the ions produced by one gram mol of an electrolyte in a solution. It is denoted by $\wedge_m$ unit Scm^2mol^{-1}. $\Lambda_m = \dfrac{\kappa \times 1000}{\text{Molarity}}$
5	**Variation of molar conductivity with concentration** For strong electrolytes λ decreases slightly with increase in concentration due to increase in number of ions per unit volume. e.g KCl For weak electrolytes it increases sharply with decrease in concentration as ionization of weak electrolytes increases on dilution e.g CH_3COOH
6	**Kohlrausch's Law** : According to this law, molar conductivity of an electrolyte, at infinite dilution can be expressed as the sum of contributions from its individual ions e.g. $\wedge^{o} CaCl_2 = \lambda^{o}(Ca^{2+}) + 2\lambda\ ^{o}(Cl^{-})$ **Application of Kohlrausch's Law** 1. For calculation of limiting molar conductivity $\lambda^{o} = \lambda^{c/}\lambda_m$ 2. For calculation of degree of dissociation $\alpha = \dfrac{\Lambda}{\Lambda^{o}}$ 3. For calculation of dissociation constant. $K_a = \dfrac{c\alpha^2}{(1-\alpha)}$
7	**Faraday – First law of electrolysis** : The amount of substance deposited during electrolysis is directly proportional to quantity of electricity passed. $W = zit$ and W=Elt/96500 **Faraday – Second Law** : The amount of different substances librated by the same quantity of electricity passing through the electrolytic solution is proportional to their chemical equivalent weights $\dfrac{w1}{w2} = \dfrac{E1}{E2}$
8	**Nernst equation** $Ecell = E^{o}cell - \dfrac{0.059}{n}\log\dfrac{[product]}{[react.]}$ **Equilibrium constant K_c** At equilibrium Q = K_c and E_{cell} = 0 $E^{o}cell = \dfrac{0.059}{n}\log Kc$
9.	**Electrochemical Cell and Gibbs energy of the reaction** $\Delta_r G^{\circ} = -nFE^{\circ}$ $\Delta_r G^{\circ} = -2.303RT\log K_c$

Products of electrolysis

NaCl (molten)	Cathode : $Na^{+}(l) + e^{-} \rightarrow Na(s)$	Anode : $Cl^{-} \rightarrow \frac{1}{2}Cl_2 + e^{-}$
NaCl (aq)	Cathode : $H_2O\,(l) + e^{-} \rightarrow \frac{1}{2}H_2(g) + OH^{-}$	Anode : $Cl^{-} \rightarrow \frac{1}{2}Cl_2 + e^{-}$
AgNO₃(aq)-Ag electrodes	Cathode : $Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$	Anode: $Ag(s) \rightarrow Ag^{+}(aq) + e^{-}$
AgNO₃(aq)- Pt electrodes	Cathode : $Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$	Anode: $2H_2O(l) \rightarrow O_2(g) + 4H^{+}(aq) + 4e^{-}$
CuCl(aq)- Pt electrodes	Cathode : $Cu^{+}(aq) + e^{-} \rightarrow Cu(s)$	Anode: $2H_2O(l) \rightarrow O_2(g) + 4H^{+}(aq) + 4e^{-}$

Electrochemical Cell	Electrolytic Cell
1. It is device to convert chemical energy to electrical energy 2. It is based upon redox reaction which is spontaneous.	1. It is device to convert electrical energy into chemical energy 2. The redox reaction is non-spontaneous and takes place only when electrical energy is supplied.

SNO	Name of cell	Electrolyte	Chemical Reaction	Remark
1	**Mercury Cell**	Paste of KOH & Zn(OH)₂	**Anode:-** zinc-mercury amalgam $Zn(Hg) + 2OH^{-} \rightarrow ZnO(s) + H_2O + 2e^{-}$ **Cathode:-** HgO and carbon $HgO + H_2O + 2e^{-} \rightarrow Hg(1) + 2OH^{-}$ **Overall reaction:-** Zn(Hg) + HgO → ZnO + H₂	**Provide constant voltage and does not corroded due to absence of ion in overall reaction.** **Voltage 1.35V**
2	**Dry Cell :**	ZnCl₂ and NH₄Cl	**Anode :-** Zinc rod $Zn(s) \rightarrow Zn^{2+} + 2e^{-}$ **Cathode:-** Carbon rod surrounded by MnO₂ $2MnO_2 + 2NH_4^{+} + 2e^{-} \rightarrow Mn_2O_3 + 2NH_3$ **Overall Reaction:-** $Zn + 2MnO_2 + 2NH_4^{+} \rightarrow Zn^{2+} + Mn_2O_3 + 2NH_3$	**Corroded due to the presence of ion in overall reaction.** **ZnCl₂ is used to make a complex [Zn(NH₃)₂Cl₂] it saves the bursting of cell, Voltage 1.5V**
3	**Lead Storage (Secondary Batteries) :**	38% H₂SO₄	**Anode:-** Pb grid $PbSO_4(s) + 2e^{-} \rightarrow Pb(s) + SO_4^{2-}(aq)$ **Cathode:-** Pb grid filled with PbO₂ $PbO_{2(S)} + SO_4^{2-} + 4H^{+}_{(aq)} + 2e^{-} \rightarrow PbSO_{4(s)} + 2H_2O_{(l)}$ **Overall Cell Reaction:-** $Pb(s) + PbO_2(s) + 2H_2SO_4 \rightarrow 2PbSO_4(s) + 2H_2O(1)$	**Can be Recharged by reversing the electrodes Reactant become products and products become reactants**

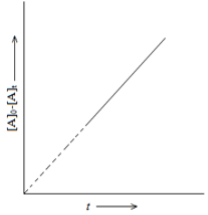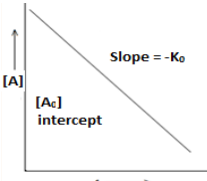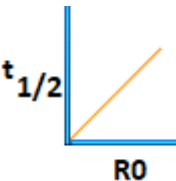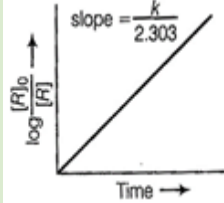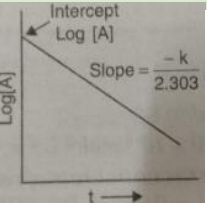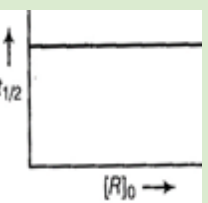| 4	**Fuel Cell** :	KOH solution	Anode :- $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$ Cathode $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$ Overall Reaction:- $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$	Eco friendly, Efficiency 60-70%
5.	**Corrosion**	H$_2$CO$_3$	Anode (oxidation) :- $Fe(s) + Fe^{2+}(aq) + 2e^-$ Cathode (Reduction) :- $O_2(g) + 4H^+(ag) + 4e^- \rightarrow 2H_2O(l)$ **Atmospheric Oxidation:-** 2Fe^{2+}$_{(aq)}$ + 2H$_2$O$_{(l)}$+1/2O$_2$ $\rightarrow$ Fe$_2$O$_{3(s)}$+4H$^+$$_{(aq)}$	Formula of rust Fe$_2$O$_3$. x H$_2$O
Prevention of Corrosion		By covering the surface with paint or by some chemicals (e.g. bisphenol). / Cover the surface by other metals (Sn, Zn, etc.) that are inert or react to save the object. An electrochemical method (sacrificial electrode like Mg, Zn, etc.) which corrodes itself but saves the object.		

Observe the graph shown in figure between Λm(molar conductivity) Vs C (Molar-concentration) and answer the questions based on graph.	 (Molar concentration)	(a)The curve 'Y' is for KCl or CH3COOH? Ans:- It is for CH3COOH. (b)What is intercept on Λm axis for 'X' equal to? Ans:- equal Λ$_m$ (c) Give mathematical equation representing straight line. Ans: $\Lambda_m = \Lambda_m^\circ - A\sqrt{C}$ (d) What is slope equal to? Ans: Slope $= -A$ (e) What happens to molar conductivity on dilution in case of weak electrolyte and why? Ans: Λ$_m$ for weak electrolyte increases sharply on dilution because both number of ions as well as mobility of ions increases.

1. Represent the cell in which the following reaction takes place
Mg(s) +2Ag$^+$(0.0001M) → Mg^{2+}(0.130M) + 2Ag(s) Calculate its E(cell) if E$^\Theta$(cell) = 3.17 V.
Ans: The cell can be written as Mg|Mg^{2+}(0.130M)||Ag$^+$(0.0001M)|Ag
$E^{(cell)} = E^\Theta$(cell) – 0.0591/n log [Mg^{2+}]/[Ag$^+$]^2
=3.17 V – 0.059V/2 log 0.130/(0.0001)^2 = 3.17 V – 0.21 V = 2.96 V.

2. Calculate the equilibrium constant of the reaction:
Cu(s) + 2Ag$^+$(aq) → Cu^{2+}(aq) + 2Ag(s)   E$^\Theta$(cell) = 0.46 V
Ans: E$^\Theta$(cell) = 0.059 V/2 log K$_C$ = 0.46V or log K$_C$ = 0.46 V × 2/0.059V = 15.6

3. The standard electrode potential for Daniell cell is 1.1V. Calculate the standard Gibbs energy for the reaction: Zn(s) + Cu^{2+}(aq) → Zn^{2+}(aq) + Cu(s)
Ans: ▲G$^\Theta$ = – nFE (cell) n in the above equation is 2, F = 96487 C mol^{-1} and
E(cell) = 1.1 V   Therefore, ▲G$^\Theta$ = – 2 × 1.1V × 96487 C mol^{-1}

= –21227 J mol^{-1} = –21.227 kJ mol^{-1}

4. Resistance of a conductivity cell filled with 0.1 mol L^{-1} KCl solution is 100Ω. If the resistance of the same cell when filled with 0.02 mol L^{-1} KCl solution is 520 Ω, calculate the conductivity and molar conductivity of 0.02 mol L^{-1} KCl solution. The conductivity of 0.1 mol L^{-1} KCl solution is 1.29 S/m.
Ans: The cell constant is given by the equation: Cell constant = G* = conductivity × resistance
= 1.29 S/m × 100Ω = 129 m^{-1} = 1.29 cm^{-1}
Conductivity of 0.02 mol L^{-1} KCl solution = cell constant / resistance
κ   = 1.29 cm^{-1}/ 520 Ω = 0.248 × 10^{-2} S cm^{-1} and Λ m= κ × 1000 cm^3 L^{-1} /molarity
= 0.248 × 10^{-2} S cm^{-1} 1000 cm^{3}L^{-1}/ 0.02 mol L^{-1} = 124 S cm^2 mol^{-1}

5. Molar conductivities (Λ) at infinite dilution of NaCl, HCl and CH3COONa are 126.4, 425.9 and
91.0 S Cm mol-1 respectively. Find out the limiting molar conductivity Λ^0 for CH$_3$COOH.
Ans:- 91 + 425.9 = 126.4 + x   x= 516.9 - 126.4 =390.5   S Cm mol^{-1}

6. The conductivity of 0.001028 mol L^{-1} acetic acid is 4.95 × 10^{-5} S cm^{-1}. Calculate its dissociation constant if Ě$^\circ$m for acetic acid is 390.5 S cm^2 mol^{-1}.
Ans: Λm = κ/c =4.95×10^{-5} S cm^{-1}/0.001028 mol L^{-1} × 1000cm^{-1}/ L =48.15 cm^2 mol^{-1}
α = Λm/Λ$^\circ$m =48.15 S cm^2 mol^{-1}/390.5 S cm^2 mol^{-1} = 0.1233
K = cα^2/(1- α) 0.001028 mol L^{-1}× (0.1233)^2/ 1- 0.1233 = 1.78 ×10^{-5} mol L^{-1}

7. How much charge is required for the reduction of 1 mol of MnO$_4^-$ to Mn^{+2}?
Ans: 5× 96500 Colombes

8. A solution of Ni (NO$_3$)$_2$ is electrolyzed between platinum electrode using a current of
5 amperes for 20 minutes. What mass of Ni is deposited at the cathode? [Ni= 58.7]
Ans: Q = it, 5 × 20 × 60 = 6000C
Reaction for the Ni, Ni^{+2} + 2e$^-$→ Ni, (2 mol × 96500C)   58.7 × 6000/2 × 96500 = 1.825g

CHAPTER-4 CHEMICAL KINETICS

RATE OF REACTION	The change in concentration of either reactant or product per unit time. Example : $N_2 + 3H_2 \rightarrow 2NH_3$ Rate of reaction $= +\dfrac{1}{2}\dfrac{d[NH_3]}{dt} = -\dfrac{d[N_2]}{dt} = -\dfrac{1}{3}\dfrac{d[H_2]}{dt}$
Unit of rate	Mol L^{-1}time^{-1} or mol $L^{-1} S^{-1}$
Rate Law	The expression of rate of reaction in term of concentration of reactant aA + bB →Product Rate=K$[A]^x[B]^y$
Rate Constant	Specific Rate of reaction :-Rate of reaction when concentration are taken as unity Rate=K$[A]^x[B]^y$ [A]=1 [B]=1 Rate=K
Unit of rate constatnt	Unit of $k = \left[\dfrac{mol}{L}\right]^{1-n} \times time^{-1}$ For gaseous reaction unit of k may be $= (atm)^{1-n} \times time^{-1}$ N - Order of reaction
Order of reaction	The sum of powerof concentration of reactant in rate law expression aA + bB →Product Rate=K$[A]^x[B]^y$ Order of reaction = x+y It may be Zero,Positive or Negative or fraction.It is experimental quantity.
Mechanism of Reaction	**Elementary reaction:-**Chemical reaction complete in single step and have exponant in rate law expression equal to their stochiometric coefficient .Zero order reaction can not be an elementry reaction. **Complex Reaction:-** For the complex reaction,the overall reaction is controlled by the slowest step.

Difference between Order of Reaction and Molecularity	Order of Reaction	Molecularity
	➢ 1.The sum of the exponents (powers) by which the concentration terms are raised in rate law.	➢ 1.The no. atoms , ions or molecule that must collide with one another simultaneously so that chemical reaction take place
	➢ 2.Determined Experimently by rate law	➢ 2.Theoritical concept ,determined by slowest step
	➢ 3.May be Zero and negetive	➢ 3.Never be Zero and negetive
	➢ 4.May be Fraction	➢ 4.Neverbe Fraction

Pseudo first order reaction	A chemical reaction which seems to be higher order but actually they are of first order ➢ For these reaction,Order of reaction is one but molecularity is more than one Example :-Hydrolysis of ester in acedic medium, Inversion of cane sugar in acidic medium

METHOD OF DETERMINING ORDER OF REACTION	Consider the following data for the reaction A + B = Products and Determine the order of the reaction with respect to A and w.r.t. B and the overall order of the reaction. Also calculate rate constant.

Exp.	Initial conc. (A)	Initial conc. (B)	Initial rate (mol $L^{-1}s^{-1}$)
1	0.10 M	1.00 M	2.1×10^{-3}
2	0.20 M	1.00 M	8.4×10^{-3}
3	0.20 M	2.00 M	8.4×10^{-3}

ANSWER:

Exp.	Rate = K $[A]^x [B]^y$	
1	Rate = K $[0.10\,]^x [1.00\,]^y$ = 2.1×10^{-3} ....(i)	Eq.(i)/(ii) Then$(1/2)^x$ = (1/4) Therefore x = 2
2	Rate = K $[0.20\,]^x [1.00\,]^y$ = 8.4×10^{-3} ....(ii)	Eq.(ii)/(iii) Then$(1/2)^y$ = (1)
3	Rate = K $[0.20\,]^x [2.00\,]^y$ = 8.4×10^{-3} ....(iii)	Therefore y = 0

Rate law=K$[A]^2[B]^0$ K =2.1×10^{-3} / $[0.1]^2[1.00]^0$

Differential and Integrated Rate Laws:

Zero Order Reactions:	First Order Reactions:
$[A] = -K_0t + [A_0]$ that is Y = -mx + C	$\ln[A] = -K_1t + \ln[A_0]$ that is Y = -mx + C
$[A]_0-[A]_t = k_0t$	or $k_1 =(2.303/ t)\log ([A]_0/ [A])$

Slope = -K_0
[A]
[A_c] intercept
$t_{1/2}$
RO

Unit of rate constant = mol litre^{-1}s^{-1}
Examples:
* Enzyme catalyzed reactions

slope = $\dfrac{k}{2.303}$
Slope = $\dfrac{-k}{2.303}$ Intercept Log [A]
$t_{1/2}$
$[R]_0$

.Units of k_1 = s^{-1}**EXAMPLES**
1. $H_2O_2 \longrightarrow H_2O + \frac{1}{2}O_2$
2. $CH_3COOCH_3 + H_2O \xrightarrow{acid} CH_3COOCH + CH_3OH$
3. $C_{12}H_{22}O_{11} + H_2O \xrightarrow{acid} C_6H_{12}O_6 + C_6H_{12}O_6$

| Half Life: Time required to consume the half of initial concentration of reactant is called half life period. At t = $t_{1/2}[A] = [A_0]/2$ $K_0 t_{1/2} = [A]_0-[A_0]/2$ $\quad t_{1/2} = [A]_0/2k$ Half life is directly proportion of the initial concentration of the reactant for a zero order reaction. | Half Life: Time required to consume the half of initial concentration of reactant is called half life period. At t = $t_{1/2}[A] = [A_0]/2$ $k_1=(2.303/ t_{1/2})\log ([A]_0 / [A_0/2])$ $\quad t_{1/2} = 0.693/k_1$ Half-life is independent of the initial concentration of the reactant for a first order reaction |

The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume. $SO_2(g) \rightarrow SO_2(g) + Cl_2(g)$. Calculate the rate constant.

Exp	Time/s^{-1}	Total pressure/atm
1	0	0.5
2	100	0.6

Ans: Given p_0 = 0.5 atm P_t= 0.6 atm t= 100 sec n =2/1 = 2
$k_1=(2.303/ t)\log (n-1)P_0 / nP_0-P_t$
OR $k_1=(2.303/100)\log(0.5) / 2(0.5)-0.6$ Or K_1 =2.231 x 10^{-3} sec^{-1}

Arrhenius Equation
It shows the relationship between
Activation energy and rate constant
and effect of temp on rate constant.

$k = A e^{(-E_a/RT)}$

$$\log(\frac{k_2}{k_1}) = \frac{Ea}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

THRESHOLD ENERGY	The Minimum extra amt of energy which the reactants molecules must have so that reactant molecule reacts and overcome the energy barriers and converts into products.
ACTIVATION ENERGY	The Minimum extra amt of energy absorbed by the reactant molecule so that their energy becomes equal to threshold energy.

1. For a first order reaction, show that time required for 99% completion is twice the time required for the completion of 90% of reaction.

Ans. For a first order reaction, the time required for 99% completion is

$t_1 = \dfrac{2.303}{k}\log\dfrac{100}{100-99}$

$= \dfrac{2.303}{k}\log 100$

$= 2\times\dfrac{2.303}{k}$

For a first order reaction, the time required for 90% completion is

$t_2 = \dfrac{2.303}{k}\log\dfrac{100}{100-90}$ $\qquad = \dfrac{2.303}{k}\log 10$

$= \dfrac{2.303}{k}$ $\qquad$ Therefore, $t_1 = 2t_2$

2. The rate of a reaction quadruples when the temperature changes from 293 K to 313 K. Calculate the energy of activation of the reaction assuming that it does not change with temperature.

$\log\dfrac{k_2}{k_1} = \dfrac{E_a}{2.303R}\left(\dfrac{T_2-T_1}{T_1T_2}\right)$

$T_1 = 293K$
$T_2 = 313K$

It is given that, $k_2 = 4k_1$

$\log\dfrac{4k_1}{k_2} = \dfrac{E_a}{2.303\times8.314}\left(\dfrac{313-293}{293\times313}\right)$

$0.6021 = \dfrac{20\times E_a}{2.303\times8.314\times293\times313}$

$E_a = \dfrac{0.6021\times2.303\times8.314\times293\times313}{20}$

$= 52863.33 J mol^{-1}$

$= 52.86 kJ mol^{-1}$

3. For a reaction, $A+B \rightarrow$ 'Product; the rate law is given by, $r = K[A]^{1/2}[B]^2$. What is the order of the reaction?

Ans. The order of the reaction $= \dfrac{1}{2}+2$ $= 2.5$

4. The conversion of molecules X to Y follows second order kinetics. If concentration of X is increased to three times how will it affect the rate of formation of Y?

Ans:- $Rate_1 = k.(a)_2 = ka_2$

If the concentration of X is increased to three times, then $[X] = 3a mol L^{-1}$

Now, the rate equation will be: Rate $= k(3a)_2$

Hence, the rate of formation will increase by 9 times.

# d and f- BLOCK ELEMENTS   (By Dr M R CHOUDHARY 846913570)

1	d-block elements are called transition elements	incomplete d-orbitals in neutral or most stable oxidation state.
2	Zn, Hg, Cd, are not included as transition elements and why?	as they have filled d-orbitals in neutral and most stable +2 oxidation state.
3	Sc^{3+} has d^0 configuration but it is transition metal	Because of partially filled d^1 configuration of Sc
4	First series transition elements shows irregular trend of atomic radii	Due to shielding effect of inner 3d electrons which overcome ENC.
5	Atomic radii of Zr to Hf are almost same.	due to Lanthenoid Contraction.
6	First series transition elements shows irregular trend of IE	It is because of mutual exchange of energy between d and f orbitals after removal of one electron.
7	Transition metals have high enthalpy of atomization and melting point.	due to presence of unpaired electrons form strong metallic bonding
8	Zn, Cd, Hg are not very hard and have low M.P. and B.P.	Due to presence of all paired electrons they have least enthalpy of atomization, very weak metallic bond & are not very hard with low M.P. and B.P.
9	d-block elements shows a large no. of oxidation state	due to presence of unpaired electrons or partially filled d-orbitals.
10	Which first series transition metal shows highest number of oxidation states and why?	Mn shows highest number of oxidation state due presence of highest number of unpaired electrons.
11	Which first series transition metal do not show variable oxidation states and why?	Sc , due to achieving noble gas configuration in +3 O.S
12	Cr^{3+} is more stable as compared to Cr^{2+}	due to stable half filled t_{2g}^3 configuration.
13	Cu^{2+} is more stable in solution than Cu^+	due to high hydration enthalpy of Cu^{2+} ion in solution.
14	Which first series transition metal shows +1 oxidation states and why?	Cu shows +1 oxidation state in gaseous form due to stable full filled $3d^{10}$ configuration.
15	Higher oxidation states of transition metals found in their oxides and fluorides	because higher oxidation states stabilized by highly electronegative elements such as O and F
16	higher oxidation states are more common in oxides rather than fluorides of transition metals.	due to formation of $d\pi$-$p\pi$ bond between metal and oxygen.
17	+2 O.S becomes more stable in first series transition elements moving from left to right	as number of unpaired electrons decreases.
18	Write oxoanions of first series transition metals in which group number and O.N. of transition metal are same-	MnO_4^-, $Cr_2O_7^{2-}$, VO_3^-, CrO_4^{2-}
19	Moving from left to right E^0 for M^{2+}/M becomes less negative but it shows irregular trend	trends due to irregular variation of $IE_1 + IE_2$.
20	For copper E^0 Cu^{2+}/Cu is +ve (+0.34 V)	it is due to low hydration enthalpy of Cu^{2+} which cannot compensate $\Delta_{sub}H^0 + IE_1 + IE_2$.
21	For Mn , E^0 Mn^{3+}/Mn^{2+} is +ve	because by converting into Mn^{2+} it achieves half filled configuration.
22	For Cr , E^0 Cr^{3+}/Cr^{2+} is –ve	because Cr^{3+} is more stable due to half filled t_{2g} configuration.
23	Most of the compounds of transition metal are coloured in solid state as well as in their solution	It is **due to d-d transition**
24	(Sc^{3+}, Ti^{4+}) does not exhibit any colour	Due to absent of unpaired **e$^-$** as d-d transition is not possible
25	(Zn^{2+}, Cu^+) does not exhibit any colour	full filled d-orbitals (d^{10}) as d-d transition is not possible
26	Transition metals or ions are paramagnetic in nature	Due to presence of unpaired electrons (d^{1-9})
27	Transition metal form large number of coordination complexes	High charge by mass ratio, availability of vacant d-orbital & Variable oxidation state
28	What are Interstitial compounds?	Compounds in which small elements like H, B, C, N trapped in the interstitial space of metal lattice.
29	Transition metals form Interstitial compounds.	due to availability of interstitial space in metal lattice.

30	Why interstitial compounds are found to be more useful than pure metal?	These compounds have high M.P as compared to pure metals. These are very hard and are Chemically inert.
31	Transition metals and their compounds are widely used as catalyst	Due to large surface area, variable oxidation state & Availability of vacant d-orbitals
32	transition metals form alloy.	Due to comparable metallic radii
33	Why oxides of Higher oxidation states of transition metals are acidic in nature whereas lower O.S. are basic in nature?	Higher oxidation states are more polarizing in nature . hence are acidic in nature whereas lower O.S. are less polarizing hence are basic in nature.
34	Actinoids shows greater number of oxidation states then lanthanoids	Due to comparable energy of 5f, 6d, and 7s orbitals.
35	It is difficult to study chemistry of actinoids.	Due to radio active nature and small half life
36	Ce(IV) is a good oxidizing agent in aq. sol^n	because in aq. solution its $E^0_{Ce^{4+}/Ce^{3+}}$ is +1.74 V
37	Actinoid contraction is greater from element to element as compared to lanthanoids .	because of poor shielding by 5f orbitals due to its superficial position.

Potassium Dichromate [$K_2Cr_2O_7$]

Preparation:

It is prepared from chromite ore : $FeCr_2O_4$/ $FeO\ Cr_2O_3$

Step 1:

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

Step 2: $2Na_2CrO_4$ (Yellow)+ $H_2SO_4 \longrightarrow$
$\qquad\qquad Na_2Cr_2O_7$(Orange)+ $Na_2SO_4 + H_2O$

Step 3: $Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$
$\qquad$ Orange $\qquad\qquad\qquad$ Orange

Effect of pH:

$Cr_2O_7^{2-}$ (Orange) + $2OH^- \longrightarrow 2CrO_4^{2-}$ (Yellow) + H_2O

$2CrO_4^{2-}$ (Yellow) + $2H^+ \longrightarrow Cr_2O_7^{2-}$ (Orange) + H_2O

Oxidizing Character: Dichromate ion acts as strong oxidizing agent in acidic medium.

$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$

$Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 7H_2O + 3I_2$

$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \longrightarrow 2Cr^{3+}\ 7H_2O + 6Fe^{3+}$

$Cr_2O_7^{2-} + 14H^+ + 3Sn^{2+} \longrightarrow 2Cr^{3+}\ 7H_2O + 3Sn^{4+}$

$Cr_2O_7^{2-} + 8H^+ + 3H_2S \longrightarrow 2Cr^{3+} + 7H_2O + 3S$

Potassium Permanganate [$KMnO_4$]

Preparation: from **pyrolucite ore [MnO_2]**

Step 1:

$2MnO_2$ (Black)+$4KOH+O_2 \longrightarrow 2K_2MnO_4$ (Green)+ $2H_2O$

Step 2:

$3MnO_4^{2-}$ (Green)+$4H^+ \longrightarrow 2MnO_4^-$(Purple)+$MnO_2+ 2H_2O$

Oxidizing Character: (Oxidation in acidic medium)

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

$\qquad$ Eq. mass of $KMnO_4$ = 158/5 = 31.6

$MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

$2MnO_4^- + 10Cl^- + 16H^+ \longrightarrow 2Mn^{2+} + 8H_2O + 5Cl_2$

$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

$2MnO_4^- + 5SO_3^{2-} + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

$2MnO_4^- + 5NO_2^- + 6H^+ \longrightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$

$2MnO_4^- + 5S^{2-} + 16H^+ \longrightarrow 2Mn^{2+} + 5S + 8H_2O$

$2MnO_4^- + 3H_2O + I^- \longrightarrow 2MnO_2 + IO_3^- + 2OH^-$

$8MnO_4^- + 3S_2O_3^{2-} + H_2O \longrightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$

$2MnO_4^- + 3Mn^{2+} + 2H_2O \longrightarrow 5MnO_2 + 4H^+$

f-Block Elements

General configuration **$(n-2)\ f^{1-14}\ (n-1)d^{0-1}\ ns^2$**

$_{57}$La	[Xe] $5d^1\ 6s^2$	$_{89}$Ac	[Rn] $6d^1\ 7s^2$ -
$_{58}$Ce	[Xe] $4f^1\ 5d^1\ 6s^2$	$_{91}$Pa	[Rn] $5f^2\ 6d^1\ 7s^2$
$_{63}$Eu	[Xe] $4f^7\ 5d^0\ 6s^2$	$_{92}$U	[Rn] $5f^3\ 6d^1\ 7s^2$
$_{64}$Gd	[Xe] $4f^7\ 5d^1\ 6s^2$	$_{94}$Pu	[Rn] $5f^6\ 6d^0\ 7s^2$
$_{70}$Yb	[Xe] $4f^{14}\ 5d^0\ 6s^2$		

Lanthanoid Contraction- Regular decrease in atomic or ionic radii of Lanthenoid with increase in atomic number is called Lanthenoid contraction.

Cause: It is due to imperfect shielding of one 4f orbital by another 4f orbital due to which ENC regularly increases with increase in atomic number.

Consequences: 1. Resemblance in the properties of second and third transition series from Zr & Hf) atomic size of 2nd and 3rd transition series become same.

2. Similarity in the properties of Lanthanoids:- The decrease in atomic radii from Lanthenoid to Lanthenoid is very less hence it is very difficult to separate these elements in pure state.

3. Basic strength of hydroxides of Lanthanoids decreases from Lanthenium (La) to Lutesium (Lu).

Misch Metal – It is alloy of Lanthanoids(95%) with iron (5%)and Trace of S, C, Al ,Ca Lanthenoid – 95% Metal + Trace of S, C, Al ,Ca + Iron – 5%

Uses- making bullet shells and flinter of lighters.

| Lanthanoids	Actinoids
Last electron enters in 4f orbital	Last electron enters in 5f orbital
Are natural elements and non radioactive in nature	Are radioactive in nature and after Np they are synthetic elements
Shows less number of oxidation states [+2,+3,+4]	Shows greater number of oxidation states [+3,+4,+5,+6,+7]
Element to element lanthanoid contraction is less	Element to element actinoid contraction is more

Coordination Compounds

Ligand: Provide pair of electron for formation of coordinate bond to central metal atom is called ligand. (Lewis Base)

Types of ligands:-
  (a) Monodentate :- One donar atom
  (b) Bidentate :- Two donar atom
  (c) Ambidentate:- Two donar atom but at a time form only one bond Eg: SCN^- and NCS^-

F^- -Fluorido, Cl^- - Chlorido, Br^- -Bromido
I^- - Iodido, H^- -Hydrido, OH^- - Hydroxido
CN^- -Cyanido, SCN^- - Thiocyanato
NCS^- - Isothiocyanato, CH_3COO^- -Acetato
SO_4^{2-} - Sulphato, CO_3^{2-} - Carbonato
$(COO^-)_2$ or $C_2O_4^{2-}$ - Oxalato (ox), NO_3^- - Nitrato
NO_2^- - Nitrito(N), PO_4^{3-} - Phosphato

Neutral ligands- H_2O- Aqua , NH_3 - Ammine
$R\,NH_2$ -Alkanamine, CO –Carbonyl,
$H_2NCH_2CH_2NH_2$ - ethane-1,2–diamine
Ethylenediaminetetraacetate ion ($EDTA^{4-}$)
Ligand which has two different donor atoms and either of the two ligetes in the complex is called **ambidentate ligand**. Examples NO_2^- and SCN^-

Coordination Number: Number of coordinate bonds formed by ligands with central metal atom in the complex is called coordination number of complex.

eg. - $[Mg(EDTA)]^{2-}$ $[Fe(CN)_6]^{4-}$ $[Co(en)_3]^{3+}$
                ⇓   ⇓   ⇓
C.N.   6   6   6

5) Homoleptic and Hetroleptic Complexes:
A complex with same type of ligands surrounding central metal atom is called homoleptic complex. E.g.- $[Cu(NH_3)_4]^{2+}$, $[Pt(NH_3)_4]^{2+}$

A complex with different types of ligands surrounding central metal atom is called hetroleptic complex. E.g. $[Pt(NH_3)_2 Cl_2]$

6. Coordination Polyhedron: Spatial arrangement of ligands around central metal atom or ion is called coordination polyhedron.

Writing Formula of Coordination Complex:
1. Cation is written first followed by anion.
2. In coordination sphere central metal atom is written first followed by ligands.
3. If more than one type of ligands are present then alphabet is followed. $Na_2[Fe(H_2O)_4 (NO) Br]$

Nomenclature of Coordination Compounds:
  (1) $Na_2 [Fe (H_2O) Br_4 (NO)]$
Sodium tetrabromidonitrosylferrate (II)
(2) $[Fe (H_2O)_4 Br (NO)] SO_4$
Tetraquabromidonitrosyliron (III) sulphate
(3) $K_4 [Fe (CN)_6]$
       Potassium hexacyanoferrate (II)
(4) $[Cr (NH_3)_3 (H_2O)_3] Cl_3$
Triamminetriaquachromium (III) Chloride

(5) $[Pt (NH_3)_2 Cl (NO_2)]$
       Diamminechloridonitritoplatinum (II)
(6) $[Ni (CO)_4]$ Tetracarbonyl Nickel (O)
(7) $CO (NH_3)_5 CO_3] Cl$
       Pentamminecarbonato cobalt (III) chloride
(8) $K_3 [Cr (C_2O_4)_3]$
       Potassium trioxalate chromate (III)
(9) $Hg [Co (SCN)_4]$
       Mercury tetrathiocyanato cobaltate (III)

Isomerism in Coordination Compounds
(a) Structural isomerism
(i) Linkage isomerism- ambidentate ligand. M–SCN, M–NCS & ($-NO_2$), ($-ONO$)
(ii) Coordination isomerism-Both complex $[Co(NH_3)_6][Cr(CN)_6]$ & $[Cr(NH_3)_6][Co(CN)_6]$
(iii) Ionisation isomerism-
$[Co(NH_3)_5(SO_4)]Br$ & $[Co(NH_3)_5Br]SO_4$.
(iv) Solvate isomerism- exchange of H_2O as ligand and counter anion $[Cr(H_2O)_6]Cl_3$ & $[Cr(H_2O)_5Cl]Cl_2.H_2O$

(b) Stereoisomerism
(i) Geometrical isomerism-
Square planner complexes with formula MA_2B_2- two geometrical isomers, MABCD- Three isomers
Octahedral complexes- MA_4B_2, $M(aa)_2 A_2$ – Cis & trans
MA_3B_3- Fac & mer isomers
(ii) Optical isomerism- Optical isomers are mirror images that cannot be superimposed on one another. These are called as enantiomers.
$[PtCl_2 (en)_2]^{2+}$

Bonding in coordination compounds-
(I) **Werner's Coordination Theory-**
Primary valence is ionizable and refers charge present on complex ion.
Secondary valence is non-ionizable and refers coordination number of complex.
The ions/groups bound by the secondary linkages to the metal have characteristic spatial arrangements corresponding to different coordination numbers.

2) Valence Bond Theory or VBT

Complex	Oxidation state of CMA	Hybridi-zation	Geometry	Magnetic nature	unpaired electrons	Outer sphere / Inner sphere
$[Co(NH_3)_6]^{3+}$	+3	d^2sp^3	Octahedral	Diamagnetic	0	Inner sphere

Complex	Oxidation state	Hybridization	Geometry	Magnetic nature	Unpaired electrons	Sphere
$[CoF_6]^{3-}$	+3	sp^3d^2	Octahedral	Paramagnetic	0	Outer sphere
$[Co(C_2O_4)_3]^{3-}$	+3	d^2sp^3	Octahedral	Diamagnetic	0	Inner sphere
$[Mn(CN)_6]^{4-}$	+2	d^2sp^3	Octahedral	Paramagnetic	1	Inner sphere
$[Fe(CN)_6]^{3-}$	+3	d^2sp^3	Octahedral	Paramagnetic	1	Inner sphere
$[Fe(H_2O)_6]^{3+}$	+3	sp^3d^2	Octahedral	Paramagnetic	5	Outer sphere
$[Ni(NH_3)_6]^{2+}$	+2	sp^3d^2	Octahedral	Paramagnetic	2	Outer sphere
$[NiCl_4]^{2-}$	+2	sp^3	Tetrahedral	Paramagnetic	2	------------------
$[Ni(CO)_4]$	0	sp^3	Tetrahedral	Diamagnetic	0	----------------
$[Ni(CN)_4]^{2-}$	+2	dsp^2	Square planner	Diamagnetic	0	----------------

3) Crystal Field Theory [CFT]

Splitting of d-orbitals in octahedral field:
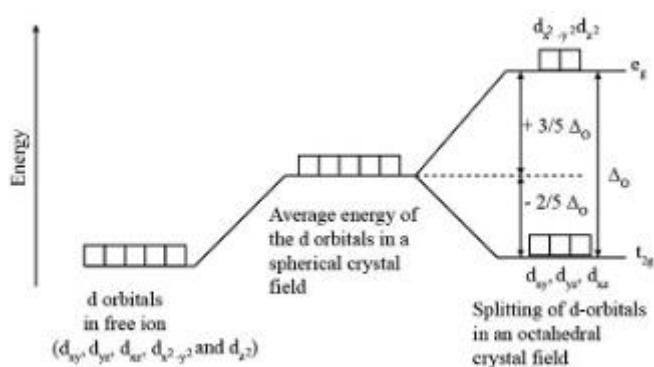
Splitting of d-orbitals in tetrahedral field:
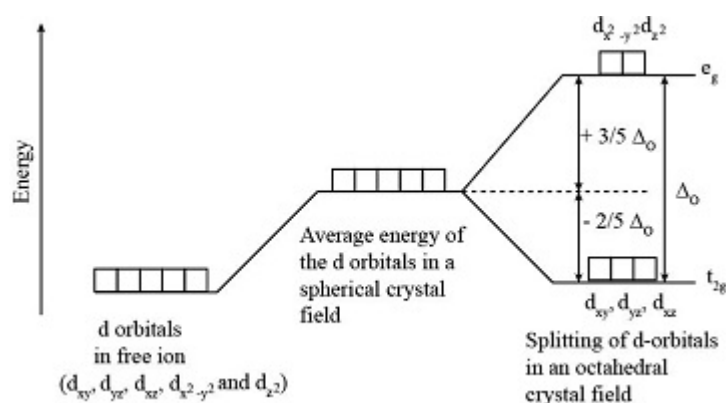
Metal Carbonyls: Homoleptic complex of transition metal with carbonyl ligand are called metal carbonyls. E.g. $[Ni(CO)_4]$, $[Fe(CO)_5]$, $[Cr(CO)_6]$, $[CO_2(CO)_8]$, $[CO_3(CO)_{12}]$, $[Mn_2(CO)_{10}]$

The metal-carbon bond in metal carbonyls possess both σ and π character. The M–C σ bond is formed by the donation of lone pair of electrons on the carbonyl carbon into a vacant orbital of the metal. The M–C π bond is formed by the donation of a pair of electrons from a filled d orbital of metal into the vacant antibonding π^* orbital of carbon monoxide. The metal to ligand bonding creates a synergic effect which strengthens the bond between CO and the metal.

dπ-pπ Back Bond
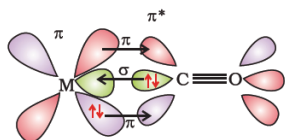
Application of Coordination Complexes:
a) Biological System: Chlorophyll – complex of Mg Haemoglobin – complex of Fe, Vit. B-12 – complex of Co

b) Metallurgy:
Extraction of Au, Ag, by cyanide process.
Refining of Ni by Mond's process
Refining of Zr by Van Arkel process.
c) Quantitative Analysis: Estimation of hardness of water Ca^{2+} and Mg^{2+} are estimated by complexomatric titration using EDTA.
d) Qualitative Analysis: Cu^{2+}, Fe^{2+}, Zn^{2+}, Ni^{2+}, NO_3^-, etc ions are confirmed by reactions involving complex formation.
e) Industrial Catalyst: $[(Ph_3P)_3RhCl]$, a Wilkinson catalyst, is used for the hydrogenation of alkenes
f) Black & White Photography:
In black and white photography, the developed film is fixed by washing with hypo solution which dissolves the undecomposed AgBr to form a complex ion, $[Ag(S_2O_3)_2]^{3-}$.
g) As medicines: Cisplatin [Cancer Treatment],
EDTA [Used to remove heavy metal poison using chelate therapy.

NAME REACTION
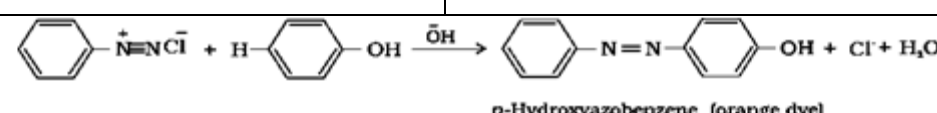## A. HALOALKANES AND HALOARENES
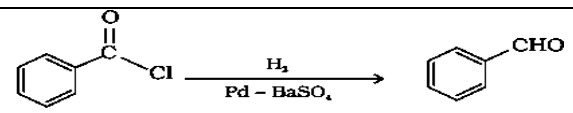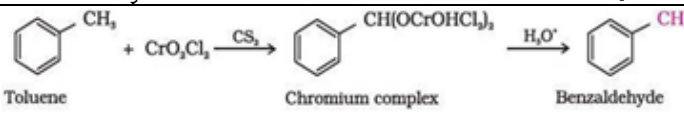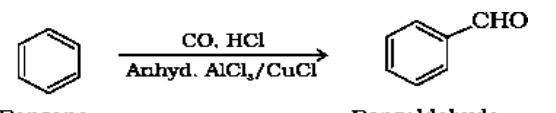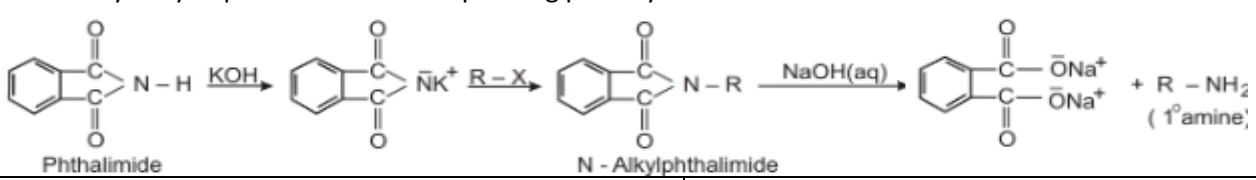
Wurtz reaction : **Alkyl halides** react with **sodium in dry ether** to give **hydrocarbons(Alkanes)** containing double the number of carbon atoms present in the halide.	$2R-X +2Na \xrightarrow{Dry\ ether} R-R + 2NaX$ $2CH_3-Br +2Na \xrightarrow{Dryether} CH_3-CH_3 + 2Na\ Br$
Fittig reaction: **Aryl halides(Haloarenes)** when treated with sodium in dry ether gives in which two aryl groups are joined together.	$2Ar-X +2Na \xrightarrow{Dryether} Ar-Ar + 2NaX$
Wurtz-Fittig reaction : A mixture of an alkyl halide (Haloalkanes) and aryl halide(Haloarenes.) gives alkylarene when treated with sodium in dry ether.	$Ar-X + Na + R-X \xrightarrow{Dryether} Ar-R + 2NaX$
Finkelstein reaction: Alkyl chlorides/ bromides reacts with NaI in dry acetone to give Alkyl iodides.	$R-Cl +NaI \xrightarrow{acetone} R-I + NaCl$ $R-Br +NaI \xrightarrow{acetone} R-I + NaBr$
Swarts reaction Heating of alkyl chloride/bromide in the presence of a metallic fluoride such as AgF, Hg_2F_2, CoF_2 or SbF_3 to give alkyl fluorides	$R-X \quad \underline{AgF, Hg_2F_2, \underline{CoF_2\ or\ SbF_3}} \to R-F$ $CH_3-Br + AgF \longrightarrow CH_3-F + AgBr$

12. ALCOHOLS,PHENOLS AND ETHERS

Hydroboration –oxidation reaction : *The alcohol obtained through anti- Markownikov 's addition of H_2O*	$CH_3-CH=CH_2 \xrightarrow{(i)B_2H_6\ (ii)\ H2O2/O\ H^-} CH_3-CH_2-CH_2-OH$
Reimer-Tiemann reaction- Phenol reacts with chloroform and NaOH to give salicylaldehyde	
Kolbe's reaction:- Phenol reacts with NaOH followed by CO_2 in acidic mediumto give salicylaldehyde	
Williamson's synthesis : In this method an primary alkyl halide reacts with a sodium alkoxide to form symmetrical or unsymmetrical ethers.	$CH_3Cl + CH_3\ ONa \to \quad CH_3OCH_3 + NaCl$

12. ALDEHYDES, KETONES AND CARBOXYLIC ACID

Aldol Condensation : Aldehydes and ketones *having at least one α – hydrogen* undergo a condensation reaction in the presence of **dilute alkali** (NaOH ,KOH etc.)as catalyst to form β- hydroxyaldehyde (aldol)or β – hydroxyketone (ketol) respectively	

Cross Aldol Condensation: When aldol condensation is carried out between two different aldehydesand / or ketones, it is called **cross aldol condensation**. If both of them contain α-hydrogen atoms, it gives a mixture of four products.

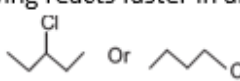|	
Cannizzaro Reaction: Aldehydes, which do not have an α-hydrogen atom, undergo self oxidation and reduction reaction on treatment with concentrated alkali.In this reaction one molecule of the aldehydeis reduced to alcohol and another is oxidized to carboxylic acid salt.	
Clemmensen Reaction: The carbonyl group of aldehydes and Ketones are reduced to CH_2 group on treatment with zinc amalgam(Zn/Hg) and concentrated hydrochloric acid.(Conc.HCl)	$CH_3CHO \quad \underline{Zn-Hg, Conc.HCl} \to \quad CH_3CH_3$ $CH_3CO\ CH_3 \xrightarrow{Zn-Hg, HCl} CH_3CH_2CH_3$

Wolf Kishner Reaction:- reaction used to convert carbonyl group (-CO-) into methylene groups through reaction with hydrazine and KOH- ethylene glycol	$CH_3 - \underset{H}{C} = O + NH_2NH_2 \xrightarrow[\text{Glycol}]{\text{KOH,}} CH_3 - CH_3 + N_2 + H_2O$
Rosenmund Reaction: Acyl chloride (acid chloride) is hydrogenated over catalyst, palladium on $BaSO_4$	Benzoyl chloride $\xrightarrow[Pd - BaSO_4]{H_2}$ Benzaldehyde (CHO)
Etard Reaction- oxidation of toluene with chromyl chloride (CrO_2Cl_2) in CCl_4 to give aromatic aldehyde	Toluene (CH_3) $+ CrO_2Cl_2 \xrightarrow{CS_2}$ Chromium complex $CH(OCrOHCl_2)_2 \xrightarrow{H_2O}$ Benzaldehyde (CHO)
Stephen Reaction: Alkyl nitriles on reduction with $SnCl_2$ and Conc. HCl, give corresponding aldehydes.	$RCN \xrightarrow[H_3O]{SnCl_2 + HCl} RCHO$
Gatterman-Koch reaction: benzene is treated with carbon monoxide in the acidic medium in presence of anhydrous aluminium chloride to give benzaldehyde	Benzene $\xrightarrow[\text{Anhyd. } AlCl_3/CuCl]{CO, HCl}$ Benzaldehyde (CHO)
Ozonolysis of alkenes involves the addition of ozone molecule to alkene to form ozonide, and thencleavage of the ozonide by $Zn-H_2O$ to Aldehyde and/or Ketones.	$CH_3CH=CH_2 \xrightarrow[2. Zn + H_2O]{1. O_3} CH_3 CHO + HCHO$ Propene, Ethanal, Methanal
Decarboxylation : Sodium salts of acids when heated with soda lime, alkanes are formed.	$R-COONa + NaOH \xrightarrow[633 K, \Delta]{CaO} R-H + Na_2CO_3$ (Alkane)
Hell Volhard Zelinsky: (HVZ) Carboxylic acids having an α-hydrogen are halogenated at the α-position on treatment with halogenin the presence of small amount of red phosphorus to give α- halocarboxylic acids	$RCH_2\text{-}COOH \xrightarrow[ii \ H_2O]{i \ X_2/ \ Red \ phosphorus} R\text{-}\underset{X}{CH}\text{-}COOH$ $X= Cl, Br$ α –halocarboxylic acids

13. AMINES

Hoffmann bromamide degradation reaction: primary amides are treated with bromine in thepresence of an alkali, a primary amine containing one carbon less than the amide is formed.	$RCONH_2 + 4NaOH + Br_2 \rightarrow RNH_2 + 2 NaBr + Na_2CO_3 + 2H_2O$ $CH_3-CO-NH_2 + Br_2 + 4 KOH \rightarrow CH_3 NH_2 + K_2CO_3 + 2KBr + 2H_2O$
Gabriel phthalimide synthesis: Phthalimide on treatment with KOH which on heating with alkyl halidefollowed by alkaline hydrolysis produces the corresponding primary amine. Phthalimide N - Alkylphthalimide	
Carbylamine reaction(Isocyanide test): Aliphatic and aromatic primary amines on heating with chloroform and ethanolic potassium hydroxide form isocyanides	$CH_3CH_2NH_2 + CHCl_3 + 3KOH \xrightarrow{\text{alcoholic}} CH_3CH_2NC + 3KCl + 3H_2O$ Ethyl Amine Ethyl isocyanide **Isocyanides or carbylamines which are foul smelling**
Diazotization reaction- Aromatic amine reacts with nitrous acid and Conc HCl to form diazonium salt	$C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{273-278K} C_6H_5N_2Cl + NaCl + 2H_2O$
Sandmeyers reaction: The Cl–, Br– and CN– nucleophiles can easily be introduced in the benzene ring in the presence of Cu(I) ion [CuCl]	$ArN_2^+X^- \begin{cases} \xrightarrow{CuCl/HCl} ArCl + N_2 \\ \xrightarrow{CuBr/HBr} ArBr + N_2 \\ \xrightarrow{CuCN \ /KCN} ArCN + N_2 \end{cases}$
Gatterman reaction: The Cl–, Br– and CN– nucleophiles can easily be introduced in the benzene ring in the presence of copper powder	$ArN_2^+X^- \begin{cases} \xrightarrow{Cu/HCl} ArCl + N_2 + CuX \\ \xrightarrow{Cu/HBr} ArBr + N_2 + CuX \end{cases}$
Coupling reaction: $\xrightarrow{\bar{O}H}$ p-Hydroxyazobenzene (orange dye)	

DISTINGUISH TEST

S.No	Test	Reagent	Inference
1.	**Lucas test** :To distinguishbetween Primary (1^0), Secondary (2^0), & Tertiary (3^0) Alcohols)	$ZnCl_2$/HCl	(3^0) Alcohols gives Turbidity (immediately), 2^0 Turbidity after some time (5-10 min) 1^0 does not give Turbidity at room temp.
2.	**Iodoform test (**Alcohols containing CH_3-CH(OH)-linkage**) and CH_3CO- in Ald/Ketone**	I_2 / NaOH	Yellow Ppt of CHI_3 is formed
3.	**Neutral ferric chloridetest** (Phenol)	Neutral $FeCl_3$	Phenols give Violet colouration
4.	**Tollens test** [Aliphatic Aldehydes(e.g.Ethanal,Pro panal etc) & Aromatic Aldehydes (Benzaldehyde)	Ammonical $AgNO_3$	Bright silver mirror [Ag] is produced due to the formation of silver metal. **(HCOOH is gives this test)**
5.	**Fehling's test** [OnlyAliphatic Aldehydes] ****Aromatic aldehyde do not give this test**	Fehling solution A (aqueous $CuSO_4$ & Fehlingsolution B alkalinesodium potassium tartarate)	Reddish brown precipitate of [Cu2O] is obtained. (alkalinesodium potassium tartarate is also known as Rochelle salt)
6.	**Sodium bicarbonate test** (Aliphatic & AromaticCarboxylic acids)	NaHCO3 Sodium Hydrogencarbonate	Effervescence due to evolution of CO2 gas.
7.	**Isocyanide test Primary Aliphatic & Aromatic amines.**	Chloroform(CHCl$_3$) + Alcoholic KOH	Unpleasent odur (foul smelling) of isocyanides or carbylamines.
8.	**Heinsberg test(To distinguish between (1^0), (2^0), & (3^0) Amines.**	Benzenesulphonyl chloride $C_6H_5SO_2Cl$	Product of 1° Amines soluble in alkali. Product of 2° Amines are insoluble in alkali 3° amines do not react.
9.	**Azo dye test(Aniline)**	($NaNO_2$ + HCl) [Nitrous acid] followed by β -napthol	Reaction with $NaNO_2$ + HCl at 273-278 K gives BDC which forms a brilliant orange Azo dye with β-napthol in sodium hydroxide

REASONING TYPE OF QUESTIONS

10. HALOALKANES AND HALOARENES

	QUESTION-**REASON**ING	ANSWER- **REASON**
1	Benzyl chloride is highly reactive towards the SN1 reaction.	Due to the stability of benzyl carbocation due to resonance
2	2-bromobutane is optically active but 1-bromobutane is optically inactive	Because 2-Bromobutane has a chiral centre so mirror image are nonsuperimposable
3	Electrophilic substitution reactions in haloarenes occur slowly.	Due to **– I effect of halogen predominant over +R effect**
4	Which would undergo SN$_1$ reaction faster $CH_3 - CH_2 - Br$ and $CH_3 - \underset{\underset{Br}{\mid}}{\overset{\overset{CH_3}{\mid}}{C}} - CH_3$	because 3° carbocation is more stable than 1^ocarbocation
5	Why haloarenes are less reactive than haloalkanes towards nucleophilic substitution reactions	In haloarenes C—X bond acquires a partial double bond character due to resonance
6	Which compound in each of the following pairs will react faster in SN_2 reaction? Why? (i) CH_3Br or CH_3I (ii) $(CH_3)_3C$-Cl or CH_3-Cl	(*i*) iodine is a better leaving group because of its larger size. (*ii*) three bulky methyl group hinder the approaching nucleophile
7	Which one of the following reacts faster in an *SN*1 reaction and why?	Compound (I) reacts faster in SN_1 reaction as it is a 2° alkyl halide
8	A solution of KOH hydrolyses $CH_3CH(Cl)CH_2CH_3$ and $CH_3CH_2CH_2CH_2Cl$. Which one of these is more easily hydrolysed and why?	$CH_3CH_2ClCHCH_3$ more easily hydrolysed as it forms 2^0 carbocation which is more stable than 1^0 carbocation
9	State one use each of DDT and iodoform	**DDT:** It is used as insecticide Iodoform: Iodoform is used as an antiseptic.
10	What is known as a racemic mixture? Give an example.	An equi-molar mixture of d- and *l*- isomers(50:50 d+*l*) For example, butan-2-ol. A racemic mixture is optically inactive due to external compensation

11	Although chlorine is an electron withdrawing group, yet it is ortho-, para-directing in electrophilic aromatic substitution reactions. Explain why it is so?	Through resonance effect, chlorine tends to stabilize the carbocation and the effect is onlyapplicable at ortho and para-positions.
12	Grignard's reagents should be prepared under anhydrous conditions, why?	This is because Grignard reagent forms alkanes by reacting with moisture.
13	the dipole moment of Chlorobenzene is lower than that of Cyclohexyl chloride	due to resonance ,Chlorobenzene shorter C—Cl bond(sp^2)than cyclohexyl chloride C—Cl bond(sp^3)
14	Chloroform is stored in closed dark brown bottles	chloroform is slowly oxidised by air in the presence of light to form poisonous gas phosgene.$COCl_2$

11. ALCOHOL, PHENOL AND ETHER

1	p-nitro phenol is more acidic than p-methyl phenol	Due to –I/–R effect of $-NO_2$ group & +I /+R effect of CH3
2	p-nitrophenol is more acidic than o-nitrophenol **OR** O-nitrophenol is steam volatile ,not p-nitrophenol	p-nitro phenol has intermolecular H-bond while o-nitro phenol has intramolecular H-bond.
3	Phenol is more acidic than ethanol.	phenoxide ion stabilised by resonance)
4	Boiling point of ethanol is higher in comparison to methoxymethane.	Because of hydrogen bonding in ethanol
5	The C – O – H bond angle in alcohols is slightly less than the tetrahedral angle (109°28').	Due to lone pair- lone pair repulsion on oxygen
6	Although phenoxide ion has more number of resonating structures than carboxylate ion, carboxylic acid is a stronger acid than phenol.	carboxylate ion stabilized through equivalent resonance whereas phenoxide ion through non equivalent resonance

12. ALDEHYDES KETONES AND CARBOXYLIC ACIDS

| 1	Increasing order reactivity towards nucleophilic addition **OR** (reactivity towards HCN) $C_6H_5CHO < CH_3CHO < HCHO$	$C_6H_5\,CO\,C_6H_5 < CH_3COCH_3< CH_3CHO$, Butanone < Propanone < Propanal < Ethanal Methyl tert-butyl ketone < Acetone < Acetaldehyde
2	Acidic Character $=(1/ pKa)$ $(CH_3)_2CHCOOH < CH_3CH(Br) CH_2COOH < CH_3CH_2CH(Br)COOH$	$Cl-CH_2-COOH < Cl_2CH-COOH < CCl_3-COOH$ CH3COOH < Cl-CH$_2$-COOH < F-CH$_2$-COOH 4-Methoxy benzoic acid <Benzoic acid < 4-Nitrobenzoic acid < 3, 4-Dinitrobenzoic acid.
3	Aldehydes are more reactive than ketones towards nucleophilic addition	due to steric hinderence of 2-alkyl group in ketone and more +I effect of 2-alkyl group in ketone
4	Cyclohexanone forms cyanohydrin in good yield but 2, 4, 6-trimethylcyclohexanone does not.	due to steric hindrance in 2, 4, 6-trimethyl
5	Carboxylic acids are higher BP than alcohols	due to more intermolecular hydrogen bonding

13. AMINES AND DIAZONIUM SALT

| 1	increasing order of basic strength , aqueous solutions	C_6H_5-NH$_2$ < CH$_3$-CH$_2$-NH$_2$ < (C$_2$H$_5$)$_3$N < C$_2$H$_5$-NH- C$_2$H$_5$ NH$_3$ < (CH$_3$)$_3$N < CH$_3$—NH$_2$ < (CH$_{3)2}$NH.
2	increasing order of basic strength , gas phase	C_6H_5-NH$_2$ < CH$_3$-CH$_2$-NH$_2$ < C$_2$H$_5$-NH- C$_2$H$_5$< (C$_2$H$_5$)$_3$N
3	In increasing order of solubility in water	(CH$_3$)$_3$N < CH$_3$ NHCH$_3$< C H$_3$NH$_2$
4	p-methylaniline is more basic than p-nitroaniline	—CH$_3$ group +I – effect ,–NO$_2$ group shows –I Effect (
5	Acetylation of – NH$_2$ group is done in aniline before preparing its ortho and para compounds.	To reduce activating effect of –NH$_2$ group.
6	*pKb* for aniline is more than that for methylamine	In aniline due to resonance
7	Aniline does not undergo Friedel-Crafts reaction	Aniline Lewis base, reacts lewis acid AlCl$_3$ to form salt.
8	Why do amines behave as nucleophiles?	Due to the presence of a lone pair
9	Aniline, p-nitroaniline and p-toluidine	*p*-Toluidine > Aniline > tr-nitroaniline
10	Aromatic primary amines cannot be prepared by Gabriel phthalimide synthesis.	aryl halides do not undergo nuleophilic substitution easily due to presence of partial double character
11	Although amino group is o– and p– directing in electrophilic substitution rea^n, aniline on nitration gives a substantial amount of m-nitroaniline.	In presence of conc HNO$_3$,aniline gets protonated to form the anilinium ion which is *meta* directing

MECHANISM

1. S$_N$1 mechanism

- It is **Two step reactions**.
- **Step I**: In the first step slow dissociation of alkyl halide takes place by reversible reaction forming a carbocation.
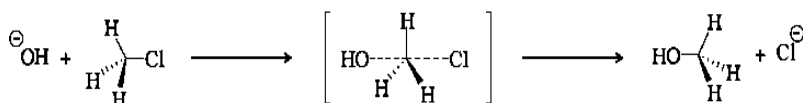
$$(CH_3)_3CBr \xrightleftharpoons{step\ I} \quad \overset{CH_3}{\underset{H_3C \quad CH_3}{\overset{\oplus}{C}}} \quad + \quad \overset{\ominus}{Br}$$
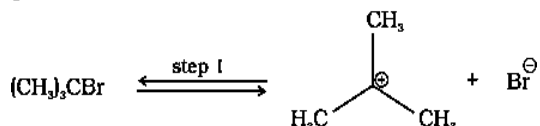
- **Step II**: The carbocation at once combines with the nucleophile to form final product (racemic mixture)

$$\overset{CH_3}{\underset{H_3C \quad CH_3}{\overset{\oplus}{C}}} \quad + \quad {}^-OH \xrightarrow{step\ II} (CH_3)_3COH$$
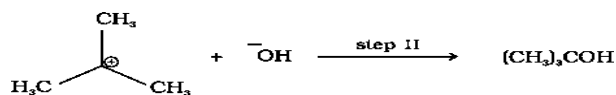
2. S$_N$2 mechanism

- It is **One step reaction**

3. Mechanism for the Hydration of alkenes to alcohol

Mechanism- The mechanism of the reaction involves the following three steps:

	$H_2O + H^+ \rightarrow H_3O^+$
Step 1: Protonation of alkene to form carbocation by electrophilic attack of $H3O^+$.	$>C=C< + H-\overset{H}{\overset{+}{O}}-H \rightleftharpoons -\overset{|}{C}-\overset{|}{C}< + H_2\overset{..}{O}$
Step 2: Nucleophilic attack of water on carbocation	$-\overset{|}{C}-\overset{|}{C}< + H_2\overset{..}{O} \rightleftharpoons -\overset{H}{\underset{|}{C}}-\overset{H}{\underset{|}{C}}-\overset{+}{O}-H$
Step 3: Deprotonation to form an alcohol	$-\overset{H}{\underset{|}{C}}-\overset{H}{\underset{|}{C}}-\overset{+}{O}-H + H_2\overset{..}{O} \rightarrow -\overset{H}{\underset{|}{C}}-\overset{:OH}{\underset{|}{C}}- + H_3\overset{+}{O}$

4. Mechanism for the acidic Dehydration of alcohols to give alkenes (At 443 K)

Step 1: Formation of protonated alcohol.	$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{..}{O}-H + H^+ \overset{Fast}{\rightleftharpoons} H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{+}{O}-H$ Ethanol $\qquad$ Protonated alcohol (Ethyl oxonium ion)
Step 2: Formation of carbocation: It is the slowest step and hence, the rate determining step of the reaction.	$H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\overset{+}{O}}-H \overset{Slow}{\rightleftharpoons} H-\overset{H}{\underset{H}{C}}-\overset{H}{\overset{+}{C}} + H_2O$
Step 3: Formation of ethene by elimination of a proton	$H-\overset{H}{\underset{H}{C}}-\overset{H}{\overset{+}{C}} \rightleftharpoons \overset{H}{\underset{H}{C}}=\overset{H}{\underset{H}{C}} + H^+$ Ethene

5. Mechanism for the acidic Dehydration of alcohols to give ethers (At 413K)

(i) $CH_3-CH_2-\overset{..}{O}-H + H^+ \longrightarrow CH_3-CH_2-\overset{H}{\overset{+}{O}}-H$

(ii) $CH_3CH_2-\overset{..}{\underset{H}{O}}: + CH_3-CH_2-\overset{+}{O}\overset{H}{\underset{H}{}} \rightarrow CH_3CH_2-\overset{+}{\underset{H}{O}}-CH_2CH_3 + H_2O$

(iii) $CH_3CH_2-\overset{+}{\underset{H}{O}}-CH_2CH_3 \longrightarrow CH_3CH_2-O-CH_2CH_3 + \overset{+}{H}$
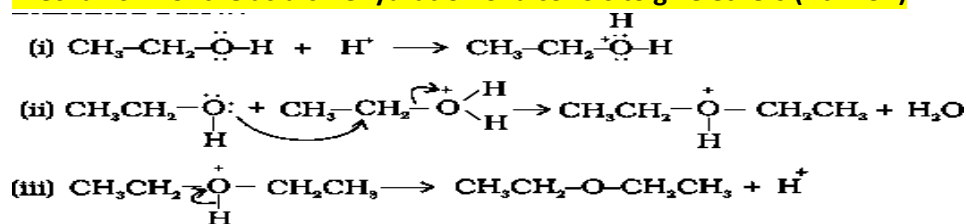
6. Nucleophilic addition reaction in carbonyl compounds.

Planar $\qquad$ Tetrahedral intermediate $\qquad$ Addition product

BIOMOLECULES

Carbohydrates are classified on the basis of their behavior on hydrolysis :	
Monosaccharides:	A carbohydrate that cannot be hydrolyzed further to give simpler unit of examples are glucose, fructose, ribose, etc.
Oligosaccharides:	Carbohydrates that yield two to ten monosaccharide units, on hydrolysis. For example, sucrose , Maltose and Lactose
Polysaccharides:	Carbohydrates which yield more than 10 of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums, etc.
Reducing sugars:	All those carbohydrates which reduce Fehling's solution and Tollens' reagent are referred to as reducing sugars. Examples: All monosaccharides, Maltose and Lactose.
Non-reducing sugars:	In disaccharides, if the reducing groups of monosaccharides i.e., aldehydes or ketone groups are bonded, these are non-reducing sugars e.g. Starch, Sucrose
Anomers:	α & β - Glucose , which differ in the orientation of $-$ OH group at C_1 .
Proteins:	proteins are polymer of α- amino acids ,joined by peptide bonds . They also known as polyamides.
Types of Proteins:	(i) Fibrous proteins:- The polypeptide chains run parallel and are held by H-bond or disulphide linkage , Insoluble in water Eg : Keratin ,Myocin (ii) Globular proteins:- Polypeptides coil around to give a spherical shape, Soluble in water Eg : Insulin ,Albumins
Structure and shape of Proteins:	1) **Primary structure** : It is a specific sequence of amino acids 2) **Secondary structure:** It represent shape ie. α - halix and β- pleated sheet. i) **α - halix :** polypeptide chain twisted in to a right handed screw by forming H-bonds b/w NH group and >C=O grup. ii) **β- pleated sheet :** peptide chains laid side by side and held together by H-bonds 3) **Tertiary structure:** It represent further folding of the secondary structure. It gives rise to two major molecular shapes viz. fibrous and globular. 4) **Quaternary structure of proteins:** composed of two or more polypeptide chains referred to as sub-units. The spatial arrangement of these subunits with respect to each other.
Denaturation of proteins	Disturbing the 2^0 and 3^0 structures of proteins by heating or changing pH. eg: coagulation of egg white on boiling .
Nucleic acids	Polymer of nucleotides linked by phosphodiester linkage -3' 5' linkage
Nucleotide	Each nucleotide contains N-base, Sugar and Phosphate.
Nucleoside	Contains N-base & Sugar.
Double helical structure of DNA	Two strand of DNA coiled around each other and held together by H-bonds b/w pairs of bases. Such as $-$ C≡G$-$, and $-$A =T$-$ Purines : Adinine & Guanine And Pyrimidines : Cytosine, Uracil & Thymine
DNA	N-Bases : A,G ,C &T, Double helix, Contains 2-deoxy ribose sugar, Transfer heredity characters.
RNA	N-Bases: A,G C & U, Single helix, Contains Ribose sugar, Helps in proteins synthesis.
Preparation of Glucose	**(I) From Cane sugar: (Sucrose)** : When sucrose is hydrolysed by boiling with dil HCl or dil H_2SO_4 in alcoholic solution $$C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$$ Sucrose $\qquad\qquad$ Glucose $\qquad$ Fructose **(II) From Starch :** Commercially Glucose is obtained by hydrolysis of starch by boiling it with dil H_2SO_4 at 393 K $$(C_6H_{10}O_5)_n + nH_2O \xrightarrow[\text{393K, 2-3 atm}]{H^+} nC_6H_{12}O_6$$ Starch $\qquad\qquad\qquad\qquad\qquad$ Glucose

Structure of Glucose	**GLUCOSE (OPEN CHAIN /Cyclic STRUCTURE)** CHO ← One aldehyde group CH(OH)₄ ← Four 2° alcoholic group CH₂OH ← One 1° Alcoholic group α–D–(+)–Glucose β – D – (+) – Glucose
Reactions of Glucose	**Proove 6 carbon in straight chain** H₂ + Red P, Δ Reduction → CH₃(–CH₂)₄ – CH₃ (n-hexane) **Proove one –C=O Gp** HCN → CN, CH–OH, (CHOH)₄, CH₂OH **Proove one –C=O Gp** NH₂OH → CH=NOH, CH(OH)₄, CH₂OH **Proove one –CHO Gp** Bromine-water Mild oxidation → COOH, (CHOH)₄, CH₂OH **Proove one primary Alcohal Gp** HNO₃ Reaction → COOH, (CHOH)₄, COOH **Proove 5 –OH Gp** CH₃CO/CH₃CO›O → CHO, (CH–O–C–CH₃)₄ + CH₃COOH, CH₂–O–C–CH₃
Reactions that prove cyclic structure of Glucose	i. Aldehyde group present but glucose does not react with NaHSO3 & NH3. ii. Glucose does not give the Schiff's Test & 2,4-DNP test for aldehyde. iii. Glucose penta-acetate does not react hydroxyl amine, which shows that aldehyde group is absent in glucose. iv. Glucose exist in two stereo-isomeric forms (α&β). ➤ All observations indicate that free aldehydic group is not present in glucose.
Cyclic Structure of Glucose	**Structure of Glucose** **Structure of Fructose** Pyran α–D–(+)–Glucopyranose β–D–(+)–Glucoyranose Furan α–D–(–)–Fructofuranose β–D–(–)–Fructofuranose
Structure of Nucleotide	deoxynucleotides. deoxyadenosine 5'-phosphate oxynucleotides. uridine 5-phosphate

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