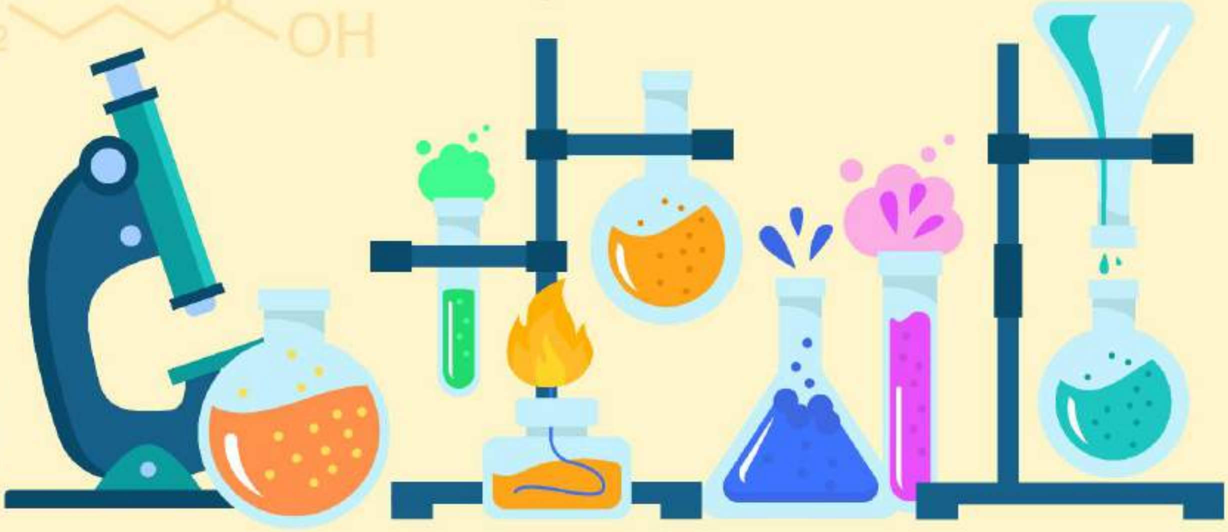
केंद्रीय विद्यालय संगठन
रायपुर संभाग



STUDY CAPSULE
VOLUME I
कक्षा - XII
सत्र - 2025-26

रसायन विज्ञान
CHEMISTRY

SESSION-2025-26

KENDRIYA VIDYALAYA SANGATHAN, RAIPUR REGION

OUR MENTORS

Mrs. P.B.S.USHA
Deputy Commissioner
Kendriya Vidyalaya Sangathan,
Regional Office, Raipur

Shri. Vivek Kumar Chauhan
Assistant Commissioner
Kendriya Vidyalaya Sangathan,
Regional Office, Raipur

Shri. Ravindra Kumar,
Assistant Commissioner
Kendriya Vidyalaya Sangathan,
Regional Office, Raipur

COURSE COORDINATOR

Mr. Shersingh Rajpoot
Principal,K.V.Bacheli
Dist. Dantewada(C.G.)

RESOURCE PERSON

1. Mr. Wasim Khan, PGT(Chemistry), K.V. Dongargarh
2. Mrs. Sweta Bajpai, PGT(Chemistry), K.V.Raipur No. 02

VETTED BY:

1. Santosh Kumar Chaini , PGT(Chemistry), K.V. Raigarh
2. Yashwanti Sahu, PGT(Chemistry), K.V.Raipur No. 01
3. Rohita Bansod, PGT(Chemistry), K.V. Mahasamund
4. Farhana Khan, PGT(Chemistry), K.V. BMY Bhilai
5. Sheela Chacko, PGT(Chemistry), K.V. Durg

CONTENT DEVELOPER TEAM FOR VOL-II (2025-26)

S.NO.	CHAPTER'S NAME	NAME OF TEACHER	NAME OF KENDRIYA VIDYALAYA
1.	SOLUTIONS	SANTOSH KUMAR CHAINI	K.V. RAIGARH
		VIJAY KUMAR SAHU	K.V. AMBUKAPUR
2.	ELECTROCHEMISTRY	DIMPLE PAREEK	K.V. BILASPUR
		SUNEETA GAWANDE	K.V. CISF BHILAI
3.	CHEMICAL KINETICS	YASHWANTI SAHU	K.V. RAIPUR NO 1 S-II
		NEELAM SINGH	K.V. CRPF BILASPUR
		DASHRATH	K.V. BIJAPUR
4.	d- & f- BLOCK ELEMENTS	ROHITA BANSOD	K.V. MAHASAMUND
		ASHVAJEET DIVE	K.V. BACHELI
5.	CO-ORDINATION COMPOUNDS	RICHA YADAV	K.V. DANTEWADA
		SANGEET SONI	K.V. RAJNANDGAON
6.	HALOALKANES & HALOARENES	VIMMI THOMAS	K.V. RAIPUR NO 1 S-I
		DESHRAJ	K.V. BAIKUNTHPUR
7.	ALCOHOLS, PHENOLS & ETHERS	SHEELA CHACKO	K.V. DURG
		ANITA	K.V. KIRANDUL
		JYOTI RANI	K.V. KORBA NO II (NTPC)
8.	ALDEHYDES, KETONES & CARBOXYLIC ACIDS	FARHANA KHAN	K.V. BMY BHILAI
		SHIVANI YADAV	K.V. NARAYANPUR
		EKTA SHEORAN	K.V. JHAGRAKHAND
9.	AMINES	NEM SINGH	K.V. KURUD
		MEENAKSHI	K.V. RAIPUR NO 2
10.	BIOMOLECULES	VISHNUPRIYA MEENA	K.V. JASHPUR
		S K GIRI	K.V. NAYA RAIPUR

INDEX

COURSE STRUCTURE

CLASS XII

CHEMISTRY THEORY

Time: 3 Hours **Total Marks: 70**

S. No.	Title	Marks
1	Solutions	7
2	Electrochemistry	9
3	Chemical Kinetics	7
4	d -and f -Block Elements	7
5	Coordination Compounds	7
6	Haloalkanes and Haloarenes	6
7	Alcohols, Phenols and Ethers	6
8	Aldehydes, Ketones and Carboxylic Acids	8
9	Amines	6
10	Biomolecules	7
	Total	**70**

Unit 1: Solutions

Types of solutions, expression of concentration of solutions of solids in liquids, solubility of gases in liquids, solid solutions, Raoult's law, colligative properties - relative lowering of vapor pressure, elevation of boiling point, depression of freezing point, osmotic pressure, determination of molecular masses using colligative properties, abnormal molecular mass, Van't Hoff factor.

Unit 2: Electrochemistry

Redox reactions, EMF of a cell, standard electrode potential, Nernst equation and its application to chemical cells, Relation between Gibbs energy change and EMF of a cell, conductance in electrolytic solutions, specific and molar conductivity, variations of conductivity with concentration, Kohlrausch's Law, electrolysis and law of electrolysis (elementary idea), dry cell-electrolytic cells and Galvanic cells, lead accumulator, fuel cells, corrosion.

Unit 3: Chemical Kinetics

Rate of a reaction (Average and instantaneous), factors affecting rate of reaction: concentration, temperature, catalyst; order and molecularity of a reaction, rate law and specific rate constant, integrated rate equations and half-life (only for zero and first orderreactions), concept of collision theory (elementary idea, no mathematical treatment), activation energy, Arrhenius equation.

Unit 4: d and f Block Elements

General introduction, electronic configuration, occurrence and characteristics of transition metals, general trends in properties of the first row transition metals — metallic character, ionization enthalpy, oxidation states, ionic radii, colour, catalytic property, magnetic properties, interstitial compounds, alloy formation, preparation and properties of K2Cr2O7 and KMnO4.

Lanthanides - Electronic configuration, oxidation states, chemical reactivity and lanthanide contraction and its consequences.

Actinides - Electronic configuration, oxidation states and comparison with lanthanides

Unit 5: Coordination Compounds

Coordination compounds - Introduction, ligands, coordination number, colour, magnetic properties and shapes, IUPAC nomenclature of mononuclear coordination compounds. Bonding, Werner's theory, VBT, and CFT; structure and stereoisomerism, importance of coordination compounds (in qualitative analysis, extraction of metals and biological system).

Unit 6: Haloalkanes and Haloarenes

Haloalkanes: Nomenclature, nature of C–X bond, physical and chemical properties, optical rotation mechanism of substitution reactions.

Haloarenes: Nature of C–X bond, substitution reactions (Directive influence of halogen in monosubstituted compounds only).

Uses and environmental effects of - dichloromethane, trichloromethane, tetrachloromethane, iodoform, freons, DDT.

Unit 7: Alcohols, Phenols and Ethers

Alcohols: Nomenclature, methods of preparation, physical and chemical properties (of primary alcohols only), identification of primary, secondary and tertiary alcohols, mechanism of dehydration, uses with special reference to methanol and ethanol.

Phenols: Nomenclature, methods of preparation, physical and chemical properties, acidic nature of phenol, electrophilic substitution reactions, uses of phenols.

Ethers: Nomenclature, methods of preparation, physical and chemical properties, uses

Unit 8: Aldehydes, Ketones and Carboxylic Acids

Aldehydes and Ketones: Nomenclature, nature of carbonyl group, methods of preparation, physical and chemical properties, mechanism of nucleophilic addition, reactivity of alpha hydrogen in aldehydes, uses.

Carboxylic Acids: Nomenclature, acidic nature, methods of preparation, physical and chemical properties; uses.

Unit 9: Amines

Amines: Nomenclature, classification, structure, methods of preparation, physical and chemical properties, uses, identification of primary, secondary and tertiary amines.

Diazonium salts: Preparation, chemical reactions and importance in synthetic organic chemistry.

Unit 10: Biomolecules

Carbohydrates - Classification (aldoses and ketoses), monosaccahrides (glucose and fructose), D-L configuration oligosaccharides (sucrose, lactose, maltose), polysaccharides (starch, cellulose, glycogen); Importance of carbohydrates.

Proteins -Elementary idea of - amino acids, peptide bond, polypeptides, proteins, structure of proteins - primary, secondary, tertiary structure and quaternary structures (qualitative idea only), denaturation of proteins; enzymes. Hormones - Elementary idea excluding structure.

Vitamins - Classification and functions.

Nucleic Acids: DNA and RNA.

PRACTICAL

Evaluation Scheme for Examination	Marks
Volumetric Analysis	08
Salt Analysis	08
Content Based Experiment	06
Project Work	04
Class record and viva	04
Total	**30**

BOARD QUESTION PAPER PATTERN AS PER CBSE NORMS (2024-25)

The CBSE Class 12 Chemistry Board Exam (for the 2024-25 academic session) will have a total of 70 marks for the theory paper and 30 marks for the practical exam, totaling 100 marks.

Here's a breakdown of the question paper pattern for the 70-mark theory paper:

- Total Questions: 33.
- Sections: 5 (Section A, B, C, D, and E).
- Types of Questions and Marking Scheme:
    - Section A: 16 Multiple Choice Questions (MCQs) carrying 1 mark each (Total 16 marks).
    - Section B: 5 Very Short Answer Type Questions carrying 2 marks each (Total 10 marks).
    - Section C: 7 Short Answer Type Questions carrying 3 marks each (Total 21 marks).
    - Section D: 2 Case-Based Questions carrying 4 marks each (Total 8 marks).
    - Section E: 3 Long Answer Type Questions carrying 5 marks each (Total 15 marks).

- **Important points to remember:**

- No overall choice: All questions are compulsory.
- Internal choices: There will be internal choices in some questions within each section.
- Log tables and calculators are not allowed during the exam.
- Passing Marks: Candidates must obtain at least 33% marks in both theory and practical exams separately to be declared as 'Pass'.
- the National Education Policy (NEP) 2020 to promote critical thinking and application-based learning.

1. SOLUTIONS

GIST OF THE LESSON

Concentration of Solutions:-

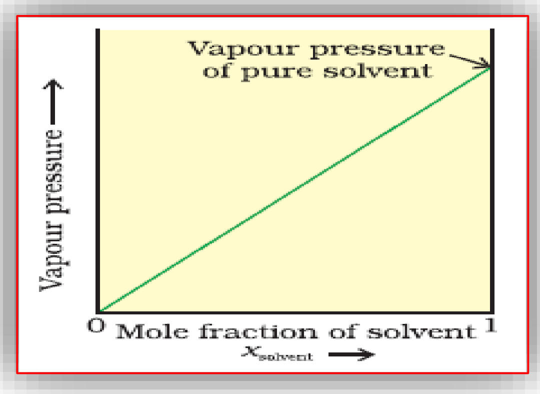
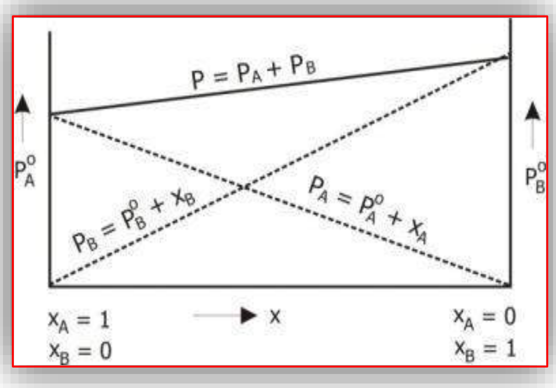
w/w% Composition:	**Mass of solute present per 100 g. of solution** $w/w\%\ \text{Composition} = \frac{\text{w Solute}}{\text{w Solution}} \times 100$
Molarity [M]:	**No. of moles of solute present per liter of solution in called 'molarity of solution'. . It is temperature dependent. M= No. of Moles 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**
Normality[N]:	**No. of gram equivalent of solute present per liter of solution is called normality of solution.** **N = No. of gm equivalent of solute / Volume of solution in litre**
Parts Per Million [ppm]:	**It is used for very dilute solutions, Parts of solute in per million parts of solution are called ppm. Ppm = Part of solute x10^6 / Part of solution**
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.

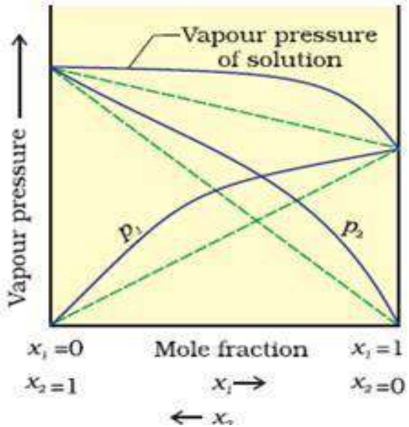
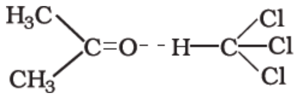
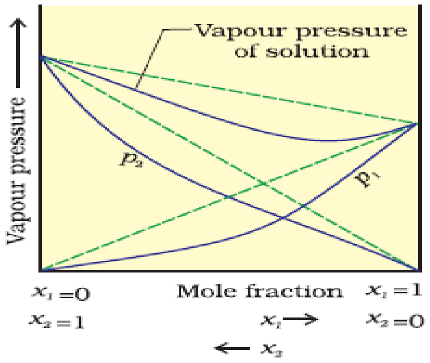
Raoult's Law*:*"The V.P. of any volatile component in the solution is directly proportional to its mole fraction***".***

Raoult's Law for Solutions Containing Non-Volatile Solute	Raoult's Law for Solution Containing Volatile Solute
	

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. $A - B \neq A - A, B - B$
No change in volume while mixing components. $\Delta V_{mix} = 0$	Change in volume while mixing components. $\Delta V_{mix} \neq 0$
No heat change take place while mixing the components. $\Delta H_{mix} = 0$	Heat changes take place while mixing the components. $\Delta H_{mix} \neq 0$
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**
Vapour pressure of resulting solution is greater than sum of partial pressure of components. $P > P_A + P_B$	Vapour pressure of resulting solution is less than sum of the partial pressure of pure components. $P < P_A + P_B$
Resulting intermolecular force is weaker than pure components.	Resulting intermolecular force is stronger than pure components.
ΔV_{mix} = +ve	ΔV_{mix} = –ve
Volume of solution > Sum of volume of pure components	Volume of solution < Sum of volume of pure components
ΔH_{mix} = +ve Endothermic mixing process	ΔH_{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

$$\frac{p_1^0 - p_1}{p_1^0} = \frac{w_2 \times M_1}{M_2 \times w_1}$$

The relative lowering of vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute present in the solution.

2-Osmosis and Osmotic Pressure

Diffusion:-**Movement of solute particles from higher cone to lower cone.**

E.g. Incense stick

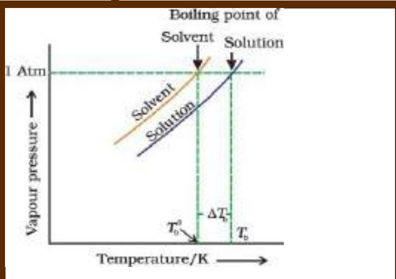
Osmotic Pressure: **Excess pressure which must be applied to a solution in order to prevent flow of solvent into the solution through the semi-permeable membrane.**
$\pi V = nRT$ π = Osmotic pressure R =Gas constant

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.

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.**

3- Elevation of Boiling Point :
Difference between boiling of solution containing non volatile solute and B.P. of pure solvent is called elevation of B.P.

$\Delta T_b = T_b - T^0_b$



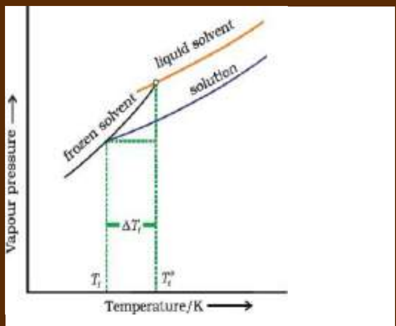
ΔTb□ m
[molality] ΔTb =
Kb m
Kb=Molal ElevationConstant

$$\Delta T_b = K_b \frac{W_{solute} \times 1000}{M_{solute} \times W_{solvent}}$$

4-Depression of Freezing Point

Difference in freezing point of pure solvent and freezing point of solution is called 'Depression in Freezing Point'.

ΔTf = T^0 – Tf
f



ΔTf□ m [molality]

ΔTf = Kf m

Kf =Molal Depression Constant

$$\Delta T_f = K_f \frac{W_{solute} \times 1000}{M_{solute} \times W_{solvent}}$$

Van't Hoff Factor:

$$i = \frac{\text{Observed colligative property (actual)}}{\text{Theoretical colligative property (expected)}} = \frac{\text{No. of molecules actually present}}{\text{No. of molecules expected to be present}}$$

$$i = \frac{\text{No. of mole } \textbf{After dissociation/Association}}{\text{No. of mole } \textbf{Before dissociation/Association}}$$

$$i = \frac{\left[\frac{P^o - P^s}{P^o}, \Delta T_f, \Delta T_b, \pi\right]_{\text{Observed}}}{\left[\frac{P^o - P^s}{P^o}, \Delta T_f, \Delta T_b, \pi\right]_{\text{Theoretical}}}$$

Association	**Dimerisation**	**Trimerisation**	**Tetramerisation**	**pentamerisation**
i =	1/2	1/3	1/4	1/5
dissociation	NaCl	$MgCl_2$	$AlCl_3$	$K_4[Fe(CN)_6]$
i =	2	3	4	5

1.	**Isotonic solutions have the same**: A) boiling point B) osmotic pressure C) vapor pressure D) freezing point Answer: B
2	**The van’t Hoff factor (i) for completely dissociated K_2SO_4 is:** A) 2 B) 3 C) 4 D) 1 Answer: B
3.	**Vapor pressure of a solvent decreases when a non-volatile solute is added. This follows:** A) Raoult’s law B) Henry’s law C) Dalton’s law D) Boyle’s law Answer: A
4.	**The solubility of a gas in a liquid is directly proportional to its:** A) molality B) mole fraction C) partial pressure D) molarity Answer: C
5	**Which colligative property is expressed by $\Delta T_e = i \cdot Kb \cdot m$?** A) Freezing point lowering B) Vapor pressure lowering C) Boiling point elevation D) Osmotic pressure Answer: C
6	A solution contains 1 mole of glucose (non-electrolyte) and 1 mole of NaCl (electrolyte). Which will have a higher boiling point elevation (ΔT_b)? A) glucose solution B) NaCl solution C) Same for both D) Cannot say Answer: B
7	What is the mole fraction of solute when 90% of vapor pressure remains compared to pure solvent? A) 0.10 B) 0.90 C) 0.50 D) 0.25 Answer: A
8	Which of the following shows ideal behavior (Δ_mix H = 0, Δ_mix V = 0)? A) water–ethanol B) benzene–toluene C) acetone–chloroform D) ethanol–acetone Answer: B
9	If the molality of a dilute solution is doubled, the value of K_b: A) doubles B) halves C) remains same D) becomes zero Answer: C
10	Henry’s law is mostly applied for: A) solid solutions B) liquid solutions C) gases dissolved in liquids D) immiscible liquids Answer: C
	Assertion-Reason questions **A. Both A and R are true, and R is the correct explanation of A.** **B. Both A and R are true, but R is not the correct explanation of A.** **C. A is true, but R is false.** **D. A is false, but R is true.**
11	**Assertion (A):** When a non-volatile solute is added to a solvent, its vapor pressure decreases. **Reason (R):** Non-volatile solute particles do not escape into the vapor phase. **Answer: (A)** Explanation: Solute particles take up space at the surface, reducing the number of solvent particles that can escape as vapor. So, vapor pressure decreases
12	**Assertion (A):** Addition of salt to water raises the boiling point of water. **Reason (R):** Boiling point elevation is a colligative property

Answer: A
Explanation: Adding a solute like salt increases the boiling point because it lowers vapor pressure, a concept explained by colligative properties.

13 **Assertion (A):** Osmotic pressure increases with increase in solute concentration.
Reason (R): More solute particles cause higher movement of solvent through the semipermeable membrane.

Answer: A
Explanation: Osmotic pressure depends directly on the number of solute particles. More solute means more pressure needed to stop osmosis

14 **Assertion (A):** Molality changes with temperature.
Reason (R): Mass of solvent changes with temperature

Answer: D Explanation: Molality does not change with temperature because it depends on the mass (not volume) of the solvent, which does not change with temperature. The reason is also false.

15 **Assertion (A):** A 0.1 M NaCl solution shows more colligative effect than 0.1 M glucose solution.
Reason (R): NaCl dissociates into more particles in solution than glucose.

Answer: A
Explanation: NaCl breaks into Na^+ and Cl^-, giving 2 particles, while glucose remains 1 particle. Colligative properties depend on the number of solute particles

SHORT ANSWER TYPE QUESTIONS (2 MARKS)

16 **Define molality. How is it different from molarity?**

Answer: Molality (m) is the number of moles of solute present in 1 kg of solvent.
Difference: Molality depends on mass of solvent, while molarity depends on volume of solution and varies with temperature.

17 **State Henry's Law**.

Answer: Henry's Law states that the solubility of a gas in a liquid is directly proportional to the pressure of the gas above the liquid at constant temperature.
Mathematically:
$C = kP$, where C = solubility, k = Henry's constant, P = pressure.

18 **What is meant by an ideal solution? Give one example**.

Answer: An ideal solution is one that follows Raoult's Law over the entire range of concentration and shows no enthalpy or volume change on mixing.
Example: Benzene + Toluene

19 **What happens to the boiling point of a solution when a non-volatile solute is added?**

	Answer: The boiling point increases. This is called boiling point elevation, a colligative property.
20	**What is an azeotrope? Give an example.** **Answer:**Anazeotrope is a mixture of two or more liquids that boils at a constant temperature and has constant composition. Example: Ethanol (95%) + Water (5%). Form an azeotropic solution
21	**Define van't Hoff factor (i). What is its value for glucose?** **Answer:** The van't Hoff factor (i) is the ratio of observed colligative property to calculated colligative property. For glucose, which does not ionize: $i = 1$.
22	**What is the effect of temperature on the solubility of gases in liquids?** **Answer:** As temperature increases, the solubility of gases in liquids decreases
23	**Define Raoult's Law for a solution of volatile liquids.** **Answer:** Raoult's Law: The partial vapor pressure of each component in a solution is directly proportional to its mole fraction. $pA = p^{\circ}A \times xA$
24	**Why is the freezing point of water lowered when salt is added to it?** **Answer:** Salt is a non-volatile solute. It causes freezing point depression, a colligative property, because the vapor pressure of the solution is lowered.
25	**What is meant by colligative properties? Name any two.** **Answer**: Colligative properties are properties that depend on the number of solute particles and not on their nature. Examples: 1. Relative lowering of vapor pressure **2.** Elevation of boiling point
	SHORT ANSWER TYPE QUESTIONS (3 MAKS)
26	**Define the following terms: a) Mole fraction b) Molarity c) Molality** **Answer:**

- Mole fraction: Ratio of moles of one component to the total moles of all components in the solution.

  $xA = nA / (nA + nB)$
- Molarity (M): Moles of solute per litre of solution.

  M = moles of solute / volume of solution (L)
- Molality (m): Moles of solute per kg of solvent.

  m = moles of solute / mass of solvent (kg)

27 **State Raoult's Law for a binary solution. How does it help in determining the total vapor pressure?**

Answer: Raoult's Law:

- $P_A = p^\circ A \times xA$
- $P_B = p^\circ B \times xB$
- Total vapor pressure, $P_{Total} = P_A + P_B$

It shows that total vapor pressure depends on the vapor pressures and mole fractions of both components.

28 **What is the effect of adding a non-volatile solute to a solvent on the following:**

(a) Vapor pressure (b) Boiling point (c) Freezing point

Answer:

- Vapor pressure: decreases
- Boiling point: Increases
- Freezing point: Decreases

These changes are due to decrease in no of molecules of solvent at the surface..

29 **Define the term "abnormal molar mass". How is it related to the van't Hoff factor?**

Answer: Abnormal molar mass: When the observed molar mass differs from the theoretical one due to asso ciation or dissociation of solute.

- van't Hoff factor (i) is used to correct it:

i = normal molar mass / observed molar mass

i= 1 no association and dissociation i>1 dissociation. I<1 association

30 **Write two differences between ideal and non-ideal solutions. Give one example each.**

Answer:

Ideal Solution	Non-Ideal Solution
No enthalpy or volume change on mixing	Shows enthalpy/volume change
Obeys Raoult's Law	Deviates from Raoult's Law

Examples: Ideal: Benzene + Toluene Non-Ideal: Acetone + Chloroform

31 A solution is prepared by mixing 50 g of urea (M = 60 g/mol) with 850 g of water. Calculate the molality.

Answer:
Moles of urea = 50 / 60 = 0.833 mol
Mass of water = 850 g = 0.850 kg
Molality = 0.833 / 0.850 = 0.98 m

32 What is a positive deviation from Raoult's Law? Give one example.

Answer:

- Positive deviation: Total vapor pressure is more than expected.
- Due to weak intermolecular forces between solute and solvent.
- Example: Ethanol + Acetone

33 Define Henry's Law. Explain why aquatic species are more comfortable in cold water.

Answer:

(i) Henry's Law: Solubility of gas ∝ pressure of gas
(ii) Cold water holds more oxygen, as solubility of gases increases with decreasing temperature, making it better for aquatic life.

34 Why do colligative properties depend only on the number of solute particles and not on their nature?

Answer: Because colligative properties arise from the effect of solute particles on solvent properties like vapor pressure, regardless of the type of particles (only their count matters).

35 Calculate the mole fraction of glucose in a solution containing 36 g of glucose ($C_6H_{12}O_6$) dissolved in 144 g of water. (Molar mass of glucose = 180 g/mol, H_2O = 18 g/mol)

Answer:
Moles of glucose = 36 / 180 = 0.2 mol
Moles of water = 144 / 18 = 8 mol
Total moles = 0.2 + 8 = 8.2
Mole fraction of glucose = 0.2 / 8.2 = 0.024

Case-Based Questions

36 Henry was the first to give a quantitative relation between pressure and solubility of a gas in a solvent which is known as Henry's law. The law states that at a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution. Dalton, a contemporary of Henry, also concluded independently that the solubility of a gas in a liquid solution is a function of partial pressure of the gas. If we use the mole fraction of a gas in the solution as a measure of its solubility, then it can be said that the mole fraction of gas in the solution is proportional to the partial pressure of the gas over the solution. The most commonly used form of Henry's law states that "the partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x) in the solution" and is expressed as: p

= K_H x Here K_H is the Henry's law constant. If we draw a graph between partial pressure of the gas versus

Different gases have different K_H values at the same temperature. This suggests that K_H is a function of the nature of the gas. It is obvious from equation that higher the value of K_H at a given pressure, the lower is the solubility of the gas in the liquid. It can be seen that K_H values for both N_2 and O_2 increase with increase of temperature indicating that the solubility of gases increases with decrease of temperature. It is due to this reason that aquatic species are more comfortable in cold waters rather than in warm waters.

Answer the following questions - (1+1+2 mark each):

a) **Aquatic animals are more comfortable in cold water as compared to hot water. why?**

Answer: Because the solubility of oxygen gas increases at lower temperatures, making more oxygen available in cold water for aquatic life.

OR

What will happen to the solubility of a gas if the pressure of the gas above the liquid is increased?

Answer: The solubility of the gas will increase as it is directly proportional to the partial pressure of the gas.

b) How is the solubility of a gas affected if the gas has a low value of K_H?

Answer- If K_H is low, the solubility of the gas is high.

c) State the relationship between partial pressure of a gas and its mole fraction in solution as per Henry's Law.

Answer: According to Henry's Law, partial pressure (p) of the gas is directly proportional to its mole fraction (x) in the solution:

$$P_A = K_H \cdot x_A$$

37 **In order to overcome the scarcity of drinking water in a remote village in Gujarat, Arnav and Aariv two young entrepreneurs still in their high school, have developed a unique water purifier that is capable of converting sea water into drinking water. It works on the principle of concentration difference between two solutions. Based on your understanding of solutions answer the following questions about the product made by Arnav & Aariv:**

(a)Name the phenomenon/ process based on which this product is made?

(b)How difference in concentration of solutions help in converting sea water into drinking water?

(c)What arrangement they must have created in their product to covert sea water into drinking water?

OR

Equimolar solutions of NaCl and glucose are not isotonic. Why?

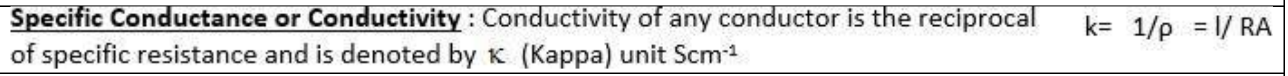
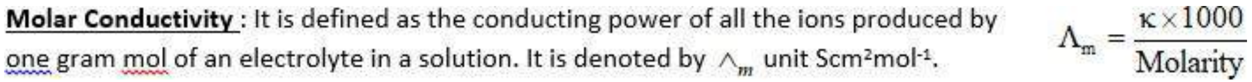
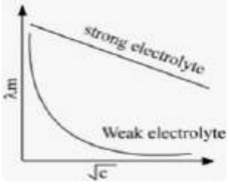
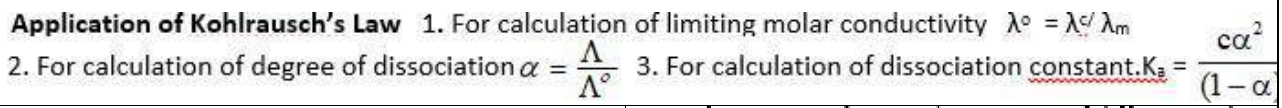
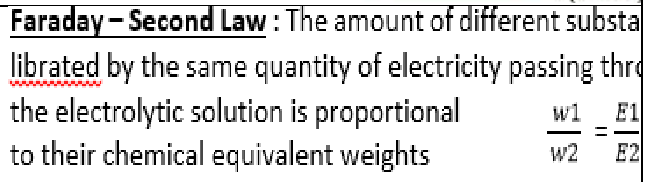
Answer : a) The product is based on the phenomenon of Reverse Osmosis between solutions of two different concentration.

(b) When solutions of two different concentration are separated by a semipermeable membrane and excess pressure is applied on the solution of higher concentration, solvent flow from higher concentration to lower concentration. This is called Reverse Osmosis and same can be used to treat seawater and convert into drinking water.

c) Following arrangement must have been made:

	i) Use of a semipermeable membrane. ii) Separate Compartment having seawater and Drinking Water separated by semipermeable membrane. iii) Excess pressure applied in compartment having sea water. OR (c) NaCl is an electrolyte and gets dissociated to two ions (Na+ and Cl-) and exerts almost double osmotic pressure than glucose which is a non-electrolyte and does not dissociate.
	Long Answer Question (5 Marks Each)
38	**What is the difference between ideal and non-ideal solutions? Give one example of each**. **Answer:** • Ideal solution: Obeys Raoult's Law at all concentrations. No heat is absorbed or evolved. Example: Benzene + Toluene • Non-ideal solution: Deviates from Raoult's Law. Heat is absorbed or evolved. Example: Acetone + Chloroform ii) **a. What is Raoult's Law?** **b. Define vapour pressure.** **c. What happens to the vapour pressure when a non-volatile solute is added to a solvent?** **Answer:** a. Raoult's Law states that the partial vapour pressure of each component in a solution is directly proportional to its mole fraction. b. Vapour pressure is the pressure exerted by vapour in equilibrium with its liquid at a given temperature. c. Vapour pressure decreases when a non-volatile solute is added
39	i) **Define molarity and molality. Mention their units.** **Answer:** Molarity (M): Moles of solute per litre of solution. Unit: mol/L Molality (m): Moles of solute per kg of solvent. Unit: mol/kg **ii) a. Why is molality preferred over molarity in expressing concentration?** **b. What is the effect of temperature on molarity and molality?** **c. A solution contains 10 g of urea (M = 60 g/mol) in 250 g of water. Calculate molality.** **Answer:** a. Molality is independent of temperature as it depends on mass, not volume. b. Molarity changes with temperature due to volume change; molality remains unchanged. c. Moles of urea = 10 / 60 = 0.167 mol Mass of water = 250 g = 0.25 kg Molality = 0.167 / 0.25 = 0.668 mol/kg
40	**State Henry's Law. How is solubility of gas in liquid related to pressure?** **Answer:** Henry's Law: Solubility of a gas in a liquid is directly proportional to the pressure of the gas. More pressure = more gas dissolved. **ii)a. Why soft drinks are bottled under high pressure?** **b. How does Henry's Law explain bends in scuba divers?** **c. Write the relation between pressure and solubility of gas.** **Answer:** a. To increase CO_2 solubility. b. At high pressure, N_2 dissolves more in blood. Sudden pressure drop causes bubbles = bends. c. S = kP, where S = solubility, P = pressure, k = Henry's constant

ELECTROCHEMISTRY

Sr No	Terminology
1.	 **Conductance :** Reciprocal of the resistance $G = \frac{1}{R}$ Unit is Ω^{-1}
2	 **Specific Resistance/Resistivity :** ρ= R A / l l/A = G*(Cell Constant) Unit is ohm cm
3	 **Specific Conductance or Conductivity :** Conductivity of any conductor is the reciprocal of specific resistance and is denoted by κ (Kappa) unit Scm^{-1} k= 1/ρ = l/ RA
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}. $\Lambda_m = \frac{\kappa \times 1000}{Molarity}$
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 CH3COOH 
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. $\Lambda^{\circ}_{CaCl_2} = \lambda^{\circ}(Ca^{2+}) + 2\lambda^{\circ}(Cl^{-})$  **Application of Kohlrausch's Law** 1. For calculation of limiting molar conductivity $\lambda^{\circ} = \lambda^{c} / \lambda_m$ 2. For calculation of degree of dissociation $\alpha = \frac{\Lambda}{\Lambda^{\circ}}$ 3. For calculation of dissociation constant. $K_a = \frac{c\alpha^2}{(1-\alpha}$
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=EIt/96500  **Faraday – Second Law** : The amount of different substa librated by the same quantity of electricity passing thr the electrolytic solution is proportional to their chemical equivalent weights $\frac{w1}{w2} = \frac{E1}{E2}$
8	**Nernst equation** $Ecell = E^{o}cell - \frac{0.059}{n} \log \frac{[product]}{[react.]}$ **Equilibrium constant Kc** At equilibrium Q = Kc and Ecell = 0 $E^{o}cell = \frac{0.059}{n} \log Kc$
9.	**Electrochemical Cell and Gibbs energy of the reaction** $\Delta_r G^{\circ} = -nFE^{\circ}$ $\Delta_r G^{\circ} = -2.303RT \log K_c$
	Mnemonics to memorise key concept Oxidation vs. reduction: electrochemical cell and electron gain/loss **LOAN** - **L**eft **A**node **O**xidation **N**egative **LEO** the lion says **GER** [grr]:"**L**oss of **E**lectrons, **O**xidation; **G**ain of **E**lectrons, **R**eduction". **ANT OIL**: **CAT RIG** At the **AN**ode, **O**xidation **I**nvolves **L**oss of electrons. At the **CAT**hode ,**R**eduction **I**nvolves **G**aining electrons

PRODUCTS OF ELECTROLYSIS

NaCl (molten)	Cathode : $Na^+(l) + e^- \rightarrow Na(s)$ Anode : $Cl^- \rightarrow ½Cl2 + e^-$
NaCl (aq)	Cathode : $H2O\ (l) + e^- \rightarrow ½H2(g) + OH^-$ Anode : $Cl^- \rightarrow ½Cl2 + e^-$
AgNO3(aq)-Ag electrodes	Cathode : $Ag^+(aq) + e^- + Ag(s)$ Anode: $Ag(s) +\ Ag^+(aq) + e^-$
AgNO3(aq)- Pt electrodes	Cathode : $Ag^+(aq) + e^- + Ag(s)$ Anode: $2H2O(l) \rightarrow O2(g) + 4H^+(aq) + 4e^-$
CuCl(aq)- Pt electrodes	Cathode : $Cu^+(aq) + e^- + Cu(s)$ Anode: $2H2O(l) \rightarrow O2(g) + 4H^+(aq) + 4e^-$

COMPARISION OF CELLS

Electrochemical Cell/Galvanic 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.

S NO	**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 MnO_2 $2MnO_2 + 2NH_4 + 2e \rightarrow Mn_2O_3 + 2NH_3$ **Overall Reaction:-** **$Zn(s) + 2MnO_2(s) + 2NH_4Cl(aq) \rightarrow ZnCl_2(aq) + Mn_2O_3(s) + 2NH_3(g) + H_2O(l)$**	**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 $PbO2(S) + SO_4^{2-} + 4H^+(aq) + 2e^- \rightarrow PbSO4(s) + 2H2O(l)$ **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**	H2CO3	**Anode (oxidation)** :- $Fe(s) \rightarrow Fe^{2+}(aq) + 2e^-$ **Cathode (Reduction) :-** $O_2\ (g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$ **Atmospheric Oxidation:-** $2Fe^{2+}(aq) + 2H_2O(l) + 1/2O_2 \rightarrow$ $Fe2O3(s) + 4H^+(aq)$	Forml a of rust Fe_2O_3. x H_2O
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.	

1	The standard electrode potential of Zn^{2+}/Zn is –0.76 V and that of Cu^{2+}/Cu is +0.34 V. The cell potential of the galvanic cell Zn | Zn^{2+} || Cu^{2+} | Cu is: a) +1.10 V b) –1.10 V c) +0.42 V d) –0.42 V ANS-(a)
2	The conductivity of a solution increases with: a) Decrease in temperature b) Increase in viscosity c) Increase in number of ions d) Decrease in number of ions ANS-(c)
3	Which of the following is not a primary cell? a) Leclanché cell b) Daniell cell c) Dry cell d) Lead storage battery ANS-(d)
4	The unit of molar conductivity is: a) ohm^{-1} cm b) ohm cm^2 mol^{-1} c) S cm^2 mol^{-1} d) ohm^{-1} mol^{-1} ANS-(c)
5	Nernst equation is used to calculate: a) Cell potential under standard conditions b) Free energy change c) Cell potential under non-standard conditions d) Equilibrium constant ANS-(c)
6	Faraday's second law of electrolysis relates: a) Mass and volume of gas b) Equivalent masses of elements c) Number of electrons d) Mass and charge ANS-(b)
7	The amount of electricity required to deposit 1 mol of aluminium from a solution of $AlCl_3$ will be ANS-(c) (a)0.33 Faraday (b)1 Faraday (c) 3 Faraday **(d)**1.33 Faraday
8	Electrolytic conductance depends on: a) Temperature b) Nature of electrolyte

c) Concentration d) All of the above ANS-(d)

9 Which battery is used in mobile phones and laptops?

a) Lead-acid battery b) Mercury cell

c) Nickel-cadmium cell d) Lithium-ion battery ANS-(d)

10 Electrolysis of aqueous NaCl produces at cathode:

a) Na metal b) H_2 gas c) Cl_2 gas d) NaOH ANS-(b)

II. Assertion and Reason Questions (1 Mark Each) – [5 Questions]

Instructions: For each question, select the correct option:

a) Both A and R are true, and R is the correct explanation of A.

b) Both A and R are true, but R is not the correct explanation of A.

c) A is true, but R is false.

d) A is false, but R is true.

11 **Assertion (A):** Conductivity of a solution decreases with dilution.

Reason (R): Number of ions per unit volume decreases with dilution. ANS-(a)

12 **Assertion (A):** Corrosion of iron occurs in presence of air and moisture.

Reason (R): Water and oxygen together form a galvanic cell on the iron surface. ANS-(a)

13 **Assertion (A):** Standard hydrogen electrode is assigned zero potential.

Reason (R): It acts as a reference for measuring electrode potential of other electrodes. ANS-(a)

14 **Assertion (A):** Lead storage battery is rechargeable.

Reason (R): In lead battery, redox reaction is reversible. ANS-(a)

15 **Assertion (A):** Molar conductivity of weak electrolytes increases sharply at infinite dilution.

Reason (R): Ionization of weak electrolytes increases on dilution. ANS-(a)

III. Short Answer Type – 2 Marks Each [10 Questions]

16 **In a galvanic cell, the following cell reactions occurs:**

$Zn(s) + 2Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$ E^0cell = +1.56 V

(i) Is the direction of flow of electrons from zinc to silver or silver to zinc?

(ii) How will concentration of Zn^{2+} ions and Ag^+ ions be affected when the cell function?

ANS. (i) Zinc to silver

(ii) Concentration of Zn^{2+} ions will increase and Ag^+ ions will decrease.

17 **Following reactions may occur at cathode during the electrolysis of aqueous $CuCl_2$ solution using Pt electrodes.**

$$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)} : E^0 = +0.34 \text{ V}$$

$$H^+_{(aq)} + e^- \longrightarrow \frac{1}{2}H_{2(g)} : E^0 = 0.00 \text{ V}$$

On the basis of their standard electrode potential values, which reaction is feasible at cathode and why?

Ans $Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ Because it has higher reduction potential.

18	**Solutions of two electrolytes ‘A’ and ‘B’ are diluted. The ΛM of ‘B’ increases 1.5 times while that of A increases 25 times. Which of the two is a strong electrolyte? Justify your answer**. **Ans** Electrolyte ‘B’ is strong. As on dilution the number of ions remains the same, only interionic attraction decreases therefore increase in Λm is small.
19	**Using the *E*° values of *A* and *B* predict which is better for coating the surface of iron to prevent corrosion and why?** $\left[E^{\circ}_{(\mathrm{Fe}^{2+}/\mathrm{Fe})} = -0.44\right]$ $E^{\circ}_{(A^{2+}/A)} = -2.37\ \mathrm{V}; E^{\circ}_{(B^{2+}/B)} = 0.14\ \mathrm{V}$ **Ans** Metals of lower electrode potential value when connected with iron protect it from oxidation and prevent corrosion. Hence, coating of metal A having lower electrode potential will be better than B which has higher electrode potential
20	**State Faraday’s first law of electrolysis. How much charge in terms of Faraday is required for the reduction of 1 mol of Cu^{2+} to Cu.** **Ans** Faraday’s first law of electrolysis : During electrolysis the amount of any substance deposited or liberated at an electrode is directly proportional to the quantity of electricity passed through the electrolyte i.e.,$w = Z \times I \times t$ where, Z is a constant of proportionality known as electrochemical equivalent of the substance deposited. The electrode reaction is $Cu^{2+} + 2e^{-} \rightarrow Cu$ Quantity of charge required for reduction of 1 mole of Cu^{2+} $= 2F = 2 \times 96500 = 193000$ C
21	**From the given cells :Lead storage cell, Mercury cell, Fuel cell and Dry cell** **Answer the following :** (i) **Which cell is used in hearing aids?** **(ii) Which cell was used in Apollo Space Programme?** **(iii) Which cell is used in automobiles and invertors?** **(iv) Which cell does not have long life?** **Ans** (i) Mercury cell is used for low current devices like watches and hearing aids. (ii) The hydrogen oxygen fuel cell was used in Apollo space programme. (iii) Lead storage battery is used in automobiles and invertors. (iv) Dry cell
22	**Why does conductivity of a solution decrease with dilution while molar conductivity increases?** **Ans** When a solution is diluted, the number of ions per unit volume decreases hence conductivity decreases because it measures the conductance of a specific volume of solution. Molar conductivity, on the other hand, increases with dilution because it measures the conductance of one mole of ions, and dilution reduces ion-ion interactions, allowing ions to move more freely.
23	**Given the standard electrode potentials, $K^{+}/K = -2.93V$, $Ag^{+}/Ag = 0.80V$, $Hg^{2+}/Hg = 0.79V$ $Mg^{2+}/Mg = -2.37$ V, $Cr^{3+}/Cr = -0.74V$ Arrange these metals in their increasing order of reducing power** **Ans** Ag<Hg<Cr<Mg
24	**Why on dilution the $_{m}\Lambda$ of CH_3COOH increases drastically, while that of CH_3COONa increases gradually?** **Ans** On dilution the $m\Lambda$ of CH_3COOH increases drastically because dissociation increases rapidly with dilution. While that of CH_3COONa increases gradually because further dissociation does not occur but mobility of ions increases to some extent.
25	**Explain with examples the terms weak and strong electrolytes.** **Ans .** Weak electrolytes : The electrolytes which are not completely dissociated into ions in solution are called weak electrolytes e.g., CH_3COOH, NH_4OH, HCN, etc. Strong electrolytes : The electrolytes which are completely dissociated into ions in solution are called strong electrolytes. e.g., HCl, KCl, NaOH, NaCl, etc..
	IV. Short Answer Type – 3 Marks Each

26 **The conductivity of 0.20 mol L^{-1} solution of KCl is 2.48×10^{-2} S cm^{-1}. Calculate its molar conductivity and degree of dissociation .**

Given $\lambda°$ (K+) = 73.5 S cm^2 mol^{-1} and $\lambda°$ (Cl^-) = 76.5 S cm^2 mol^{-1}.

Ans Using formula, $\Lambda_m = \frac{1000 \times \kappa}{C}$

$$\Lambda_m^c = \frac{(1000\,\text{cm}^3\,\text{L}^{-1}) \times (0.0248\ \text{S cm}^{-1})}{(0.20\ \text{mol L}^{-1})}$$

$$= 124\ \text{S cm}^2\ \text{mol}^{-1}$$

$$\alpha = \frac{\Lambda_m^c}{\Lambda_m^\circ} = \frac{124}{73.5 + 76.5} = 0.82$$

27 **Mention the reactions occurring at (i) anode,(ii) cathode, during working of a mercury cell. Why does the voltage of a mercury cell remain constant during its operation?**

Ans The cell potential of mercury cell remains constant during its life as the overall reaction does not involve any ion in solution whose concentration can change during its life time.

The cell reactions are as follows :

Anode :

$$\underset{\text{(Amalgam)}}{\text{Zn(Hg)}} + 2\text{OH}^- \longrightarrow \text{ZnO}_{(s)} + \text{H}_2\text{O}_{(l)} + 2e^-$$

Cathode :

$$\text{HgO}_{(s)} + \text{H}_2\text{O}_{(l)} + 2e^- \longrightarrow \text{Hg}_{(l)} + 2\text{OH}^-$$

Net reaction :

$$\text{Zn(Hg)} + \text{HgO}_{(s)} \longrightarrow \text{ZnO}_{(s)} + \text{Hg}_{(l)}$$

28 **Calculate the standard electrode potential of Ni^{2+}/Ni electrode if emf of the cell is 0.059 V.**

$\text{Ni}_{(s)}|\text{Ni}^{2+}(0.01\text{M})||\text{Cu}^{2+}(0.1\text{M})|\text{Cu}_{(s)}$ **[Given : $E_{Cu2+/Cu}$= 0.34 V] °**

$$E_{\text{cell}} = E°_{\text{cell}} - \frac{0.059}{n} \log \frac{[\text{Ni}^{2+}_{(aq)}]}{[\text{Cu}^{2+}_{(aq)}]}$$

$$0.059 = E°_{\text{cell}} - \frac{0.059}{2} \log\left(\frac{0.01}{0.1}\right) \qquad [\text{Here } n = 2]$$

$$0.059 = E°_{\text{cell}} - \frac{0.059}{2} \log\left(\frac{1}{10}\right)$$

$$0.059 = E°_{\text{cell}} - \frac{0.059}{2} (-\log 10)$$

$$0.059 = E°_{\text{cell}} + \frac{0.059}{2}$$

$$\Rightarrow E°_{\text{cell}} = 0.059 - \frac{0.059}{2}$$

$$\therefore \quad E°_{\text{cell}} = \frac{0.059}{2} = 0.0295 - 0.03$$

Now $E°_{\text{cell}} = E°_{\text{cathode}} - E°_{\text{anode}}$

$0.03 = 0.34 - E°_{\text{anode}}$

$E°_{\text{anode}} = 0.34 - 0.03 = 0.31$ V

Hence, $E°_{\text{Ni}^{2+}/\text{Ni}} = +\ 0.31$ V

29 **A solution of Ni $(NO_3)_2$ is electrolyzed between platinum electrodes using a current of 5 amperes for 20 minutes. What mass of Ni is deposited at the cathode? (Given At. Mass Ni=58.5g)**

Ans Quantity of electricity passed (Q) = Current in amperes × time in second

= 5 × 20 × 60 = 6000 C

$Ni^{+2} + 2e \longrightarrow Ni$ i.e. 2 × 96487 C of electricity deposited Ni = 58·5 g

∴ 6000 C of electricity deposit Ni =(58.5/2 × 96487) × 6000 = 1·82 g.

30 **(a) State Kohlrausch's law of independent migration of ions.**

(b) Suggest a way to determine the limiting molar conductivity value of water.

Ans (a) Kohlrausch's law of independent migration of ions states that the limiting molar conductivity of an electrolyte can be represented as the sum individual contributions of its cations & anions.

(b) $\Lambda°_m$ value of water.

Consider the following chemical equations,

(i) $H_2O(l) \rightarrow H^+(aq) + OH^-(aq)$
(ii) $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$
(iii) $NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$
(iv) $NaCl(aq) \rightarrow Na^+(aq) + Cl^-(aq)$

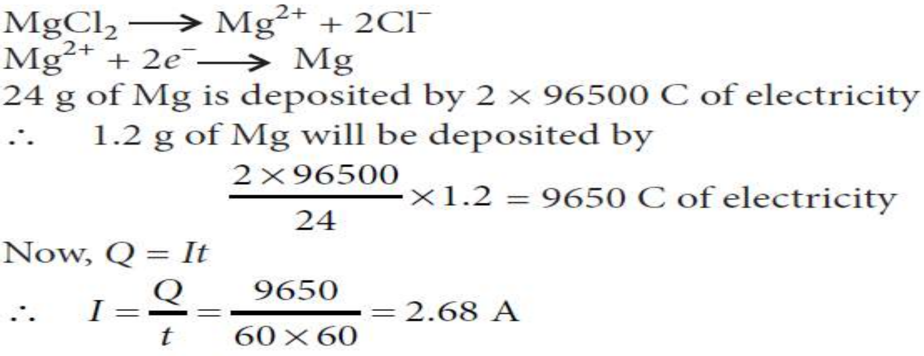
Combining the four equations and using Kohlrausch's law, we get,

$\Lambda^\circ_m (H_2O) = \Lambda^\circ_m (HCl) + \Lambda^\circ_m (NaOH) - \Lambda^\circ_m (NaCl)$

Hence, if we know the values of Λ°_m for HCl, NaOH and NaCl, we can calculate the value of Λ°_m for water.

31 **Calculate the strength of the current required to deposit 1.2 g of magnesium from molten $MgCl_2$ in 1 hour. [1 F = 96,500 C mol^{-1} ;Atomic mass : Mg = 24.0 u]**

Ans



$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$
$Mg^{2+} + 2e^- \longrightarrow Mg$
24 g of Mg is deposited by 2 × 96500 C of electricity
$\therefore$ 1.2 g of Mg will be deposited by

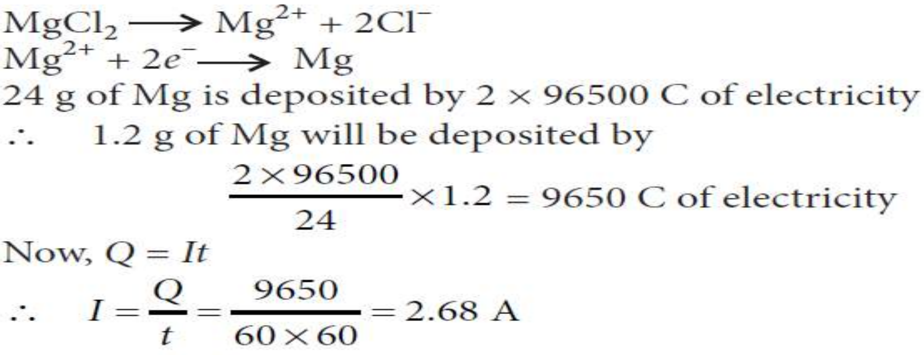
$$\frac{2\times 96500}{24}\times 1.2 = 9650 \text{ C of electricity}$$

Now, $Q = It$

$$\therefore \quad I = \frac{Q}{t} = \frac{9650}{60\times 60} = 2.68 \text{ A}$$

32 **Calculate the strength of the current required to deposit 1.2 g of magnesium from molten $MgCl_2$ in 1 hour. [1 F = 96,500 C mol^{-1} ;Atomic mass : Mg = 24.0 u]**

Ans.



$MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$
$Mg^{2+} + 2e^- \longrightarrow Mg$
24 g of Mg is deposited by 2 × 96500 C of electricity
$\therefore$ 1.2 g of Mg will be deposited by

$$\frac{2\times 96500}{24}\times 1.2 = 9650 \text{ C of electricity}$$

Now, $Q = It$

$$\therefore \quad I = \frac{Q}{t} = \frac{9650}{60\times 60} = 2.68 \text{ A}$$

33 **The electrical resistance of a column of 0.05 mol L^{-1} NaOH solution of diameter 1 cm and length 50 cm are 5.55 × 10^3 ohm. Calculate its resistivity , conductivity, and molar conductivity.**

Ans $A = \pi r^2 = 3.14\times(0.5)^2 = 0.785 cm^2$,l=50cm,
$R = \rho l/A$
$\rho = RA/l = 5.55\times10^3 \times 0.785/50$
$\rho = 87.135\ \Omega cm$
Conductivity, $K = 1/\rho = 1/87.135 = 0.01148\ S\ cm^{-1}$
mol −1
Molar conductivity, Λ_m =k x 1000/M = 229.6 S cm^2 mol^{-1}

34 **Resistance of a conductivity cell filled with 0.1 mol L^{-1} KCl solution is 100 ohms. If the resistanceof the same cell when filled with 0.02 mol L^{-1} KCl solution is 520 ohms, 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 Cell constant = Conductivity × resistance

For 0.1 mol L^{-1} KCl solution

Conductivity k =1.29 S/m =$1.29\times10^{-2}\ \Omega^{-1}\ cm^{-1}$

Cell constant = k × R = 0.0129 × 100 = 1.29 cm^{-1}

For 0.02 mol L^{-1} KCl solution

k= Cell constant/ Resistance = 1.29/520

k =2.48 X 10^{-3}S cm^{-1}

Molar conductivity =10^{-3}

Conductivity , k= Cell constant /Resistance

=1.29/520

= 0.00248 $\Omega^{-1}\ cm^{-1}$ or 2.48 X 10^{-3} S cm^{-1}

Molar conductivity , Λ_m = Conductivity(k)×1000 $cm^3\ L^{-1}$/Molarity

= 0.00248 Ω^{-1} ×1000 $cm^3\ L^{-1}$/0.02 mol L^{-1}

= 124 $\Omega^{-1}\ cm^2\ mol^{-1}$

35 **What is a nickel-cadmium cell? State its one merit and one demerit over lead storage cell.Write the overall reaction that occurs during discharging of this cell.**

Ans Nickel cadmium cell is a secondary battery which consists of a cadmium anode, nickel hydroxide as cathode and sodium or potassium hydroxide acts as electrolyte.

Merit : It has longer life than lead storage battery.

Demerit : It is more expensive than lead storage battery.

The following reaction takes place during discharging

$$Cd_{(s)} + 2Ni(OH)_{3(s)} \rightarrow CdO_{(s)} + 2Ni(OH)_{2(s)} + H_2O_{(l)}$$

V. Case-Based Questions – 4 Marks.

36 Electrochemistry concerns chemical phenomena associated with charge separation, usually in liquid media, such as solutions. The separation of charge is often associated with charge transfer, which can occur homogeneously in solution between different chemical species, or heterogeneously on electrode surfaces. On electrode surfaces, the oxidation and reduction half-reactions are separated in space, usually occurring at different electrodes immersed in solution in a single cell or in separate cell compartments. The electrodes are linked by conducting paths both in solution (via ionic transport) and externally (via electric wires etc.) so that charge can be transported and the electrical circuit completed. (1+1+2)

Answer the following questions

(a**) What is the use of a salt bridge in an electrochemical process ?.**

OR

When can a galvanic cell behave as an electrolytic cell?

(b) Which reference electrode is used to measure the electrode potential of other electrodes?

(c)What is the relationship between Gibbs energy and cell potential?

What will be the sign ΔG and E⁰ cell for a spontaneous reaction?

Ans (a) To complete the circuit so that current can flow.

It helps to maintain the electrical neutrality of the solutions in the two half cells.

OR

A galvanic cell can behave as an electrolytic cell when Eext > Ecell.

(b) Standard hydrogen electrode is the reference electrode whose electrode potential is taken to be zero. The electrode potential of other electrodes is measured with respect to it.

(c) $\Delta rG = – nFE(cell)$, sign ΔG and E^o negative and positive respectively

37 Galvanic cells that are designed to convert the energy of combustion of fuels like hydrogen, methane, methanol, etc. directly into electrical energy are called fuel cells. One of the most successful fuel cells uses the reaction of hydrogen with oxygen to form water. The cell was used for providing electrical power in the Apollo space programme. The water vapours produced during the reaction were condensed and added to the drinking water supply for the astronauts. In the cell, hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous sodium hydroxide solution. Catalysts like finely divided platinum or palladium metal are incorporated into the electrodes for increasing the rate of electrode reactions. (2+1+1)

a) How do primary batteries differ from secondary batteries ?

b) Write two advantages of fuel cells over other cells.

(c) Write the cathodic & anodic reactions taking place in mercury cell.

OR

(c) Write the cathodic & anodic reactions taking place in H_2-O_2 fuel cell

Ans. (a) Primary batteries are designed for one-time use and cannot be recharged, whereas secondary batteries are designed to be recharged and used repeatedly.

(b) (i) It is pollution free.

(ii) It has high efficiency of 70 - 75% and its rate can be controlled.

(c) $Zn(Hg) + 2OH^- \rightarrow ZnO(s) + H_2O + 2e^-$

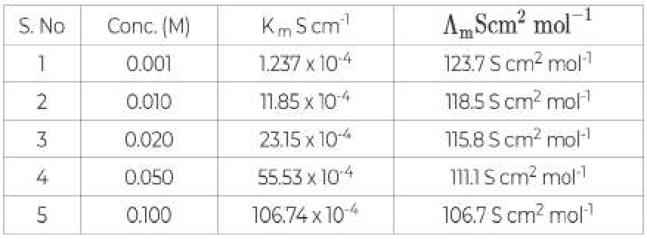
$HgO + H_2O + 2e \rightarrow Hg(1) + 2OH^-$

Overall reaction:- Zn(Hg) + HgO $\rightarrow$ ZnO + H2

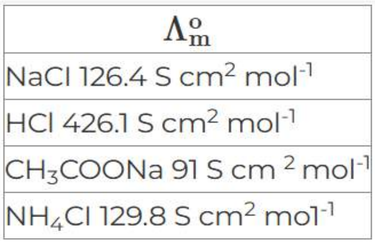
OR

$$\begin{array}{l} \text{At cathode : } O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)} \\ \text{At anode : } 2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^- \\ \hline \text{Net reaction : } 2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)} \end{array}$$

38 **Observe the following table in which conductivity and molar conductivity of NaCI at 298 K at different concentration for different electrolytes is given. Answer the questions based in the table that follows: Conductivities and molar conductivities of NaCI at 298 K at different concentrations.**



S. No	Conc. (M)	K_m S cm^{-1}	Λ_m Scm^2 mol^{-1}
1	0.001	1.237×10^{-4}	123.7 S cm^2 mol^{-1}
2	0.010	11.85×10^{-4}	118.5 S cm^2 mol^{-1}
3	0.020	23.15×10^{-4}	115.8 S cm^2 mol^{-1}
4	0.050	55.53×10^{-4}	111.1 S cm^2 mol^{-1}
5	0.100	106.74×10^{-4}	106.7 S cm^2 mol^{-1}



Λ^o_m
NaCl 126.4 S cm^2 mol^{-1}
HCl 426.1 S cm^2 mol^{-1}
CH_3COONa 91 S cm ^{2} mol^{-1}
NH_4Cl 129.8 S cm^2 mol^{-1}

(a) What happens to conductivity on decreasing concentration and why?

OR

Why is Λ^om(limiting molar conductivity) for HCI more than NaCl?

(b) Calculate degree of dissociation (α) of NaCl of 0.001 M concentration using the table.

(c) Calculate Λ^o_m of CH_3COOH using the given table.

Ans (a) Decreases.no of ion per unit volume decreases,no of ion per unit volume decreases.

Or

The limiting molar conductivity (Λom) of HCl is higher than that of NaCl because H+ ions have a much higher ionic mobility compared to Na+ ions. This is due to the smaller size and higher charge density of H+ ions

(b) $\alpha = \Lambda m / \Lambda^o m = 110 / 126.45 \approx 0.87$ or 87%

(c) Kohlrausch's Law: Λom(CH3COOH) = Λom(CH3COONa) + Λom(HCl) - Λom(NaCl)

Therefore, Λom(CH3COOH) = 91.0 + 426.16 - 126.45 = 390.71 S cm²/mol

VI. Long Answer Type Questions – 5 Marks Each

39 **a) What is the role of zinc chloride in dry cell?**

b) Λm° for NaCl, HCl and NaAc are 126.4, 425.9 and 91.0 S cm^2/mol respectively. Calculate Λo for HAc.

c) Write the chemical reactions taking place at the electrodes during discharging of lead storage battery.

Ans a) Zinc chloride increased conductivity of electrolyte and captures produced ammonia gas

b) Calculation of Λ° for HAc: (acetic acid)

Λ°(HAc) = Λ°(HCl) + Λ°(NaAc) - Λ°(NaCl)

Λ°(HAc) = 425.9 S cm²/mol + 91.0 S cm²/mol - 126.4 S cm²/mol

Λ°(HAc) = 390.5 S cm²/mol

c) Reactions in a Lead-Acid Battery During Discharge:

At the Anode (negative electrode): (Lead is oxidized to lead sulphate)

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

At the Cathode (positive electrode): (Lead dioxide is reduced to lead sulphate)

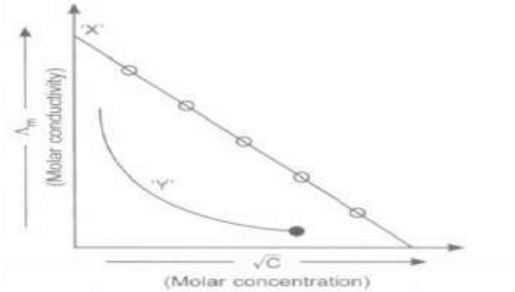
$PbO_2(s) + SO4^{2-}(aq) + 4H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

Overall Reaction:

(Lead and lead dioxide react with sulfuric acid to form lead sulfate and water)

$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

40 **Observe the graph shown in figure between Am (molar conductivity) Vs C√C (Molar concentration) and answer the questions based on graph.**



(a) The curve 'Y' is for KCI or CH_3 COOH?

(b) What is intercept on Λ_m axis for 'X' equal to?

(c) Give mathematical equation representing straight line.

(d) What is slope equal to?

(e) What happens to molar conductivity on dilution in case of weak electrolyte and why?

Ans

(a) Y represents the behavior of a weak electrolyte like CH3COOH

(b) It represents the molar conductivity at infinite dilution, denoted as Λ_m° or Λ_0

(c) $\Lambda m = \Lambda m^0 - A\sqrt{c}$.

(d) Slope is equal to -A,

(e) For weak electrolytes, molar conductivity increases with dilution due to increased dissociation greater number of ions and thus higher molar conductivity.

41 **For a galvanic cell, the following half reactions are given. Decide, which will remain as reduction reaction and which will be reversed to become an oxidation reaction. Give reason for your answer.**

(I) $Cr^{3+} + 3e^- \rightarrow Cr(s);\ E^\circ = -0{\cdot}74\ V$

(II) $Fe^{2+} + 2e^- \rightarrow Fe(s);\ E^\circ = -0{\cdot}44\ V$

(b)State Faraday's second law of electrolysis.

(c) Define –(i) cell potential (ii) cell constant

Ans

(a) Fe^{2+} reduction will remain as a reduction half-reaction, while the Cr^{3+} reduction will be reversed to become an oxidation half-reaction ($Cr \rightarrow Cr^{3+} + 3e^-$). This is because Fe^{2+} has a higher reduction potential than Cr^{3+}, meaning it is more easily reduced

(b) Faraday's second law of electrolysis states that when the same quantity of electricity is passed through different electrolytic solutions, the amounts of substances deposited or liberated at the electrodes are directly proportional to their equivalent weights

(c) (i) It is the potential difference between the two electrodes of an electrochemical cell when no current is flowing.(ii) It is defined as the ratio of the distance between the electrodes to the cross-sectional area of the electrodes.

3 CHEMICAL KINETICS

<table>
<tr>
<td>Rate Constant</td>
<td>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</td>
</tr>
<tr>
<td>Unit of rate constatnt</td>
<td>Unit of k $=\left[\frac{mol}{L}\right]^{1-n} \times time^{-1}$ For gaseous reaction unit of k may be = $(atm)^{1-n} \times time^{-1}$
N - Order of reaction</td>
</tr>
<tr>
<td>Order of reaction</td>
<td>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.</td>
</tr>
<tr>
<td>Mechanism of Reaction</td>
<td><u>Elementary reaction:-</u>Chemical reaction complete in single step and have exponant in rate law expression equal to their stochiometric cofficient.Zero order reaction can not be an elementry reaction.
<u>Complex Reaction:-</u> For the complex reaction,The overall reaction is controlled by the slowest step.
In the rate law expression,rate of reaction depends on concentration of reactant of slowest step which must be free from intermediate.
<table>
<tr>
<td>(i)Thermal decomposition of N_2O_5
$2N_2O_5 \rightarrow 4NO_2 + O_2$</td>
<td>(ii) Reaction of NO_2 and F_2
$2NO_2 + F_2 \rightarrow 2NO_2F$</td>
</tr>
<tr>
<td>Step(i) $N_2O_5 \xrightarrow{slow} NO_2 + NO_3$
Step(ii) $N_2O_5 + NO_3 \xrightarrow{fast} 3NO_2 + O_2$</td>
<td>Step(i) $NO_2 + F_2 \xrightarrow{slow} NO_2F + F$
Step(ii) $NO_2 + F \xrightarrow{fast} NO_2F$</td>
</tr>
</table>
</td>
</tr>
<tr>
<td>Difference between Order of Reaction and Molecularity</td>
<td>
<table>
<tr><th>Order of Reaction</th><th>Molecularity</th></tr>
<tr><td>➢ 1.The sum of the exponents (powers) by which the concentration terms are raised in rate law.</td><td>➢ 1.The no. atoms , ions or molecule that must collide with one another simultaneously so that chemical reaction take place</td></tr>
<tr><td>➢ 2.Determined Experimently by rate law</td><td>➢ 2.Theoritical concept ,determined by slowest step</td></tr>
<tr><td>➢ 3.May be Zero and negetive</td><td>➢ 3.Never be Zero and negetive</td></tr>
<tr><td>➢ 4.May be Fraction</td><td>➢ 4.Neverbe Fraction</td></tr>
</table>
</td>
</tr>
<tr>
<td><u>Pseudo first order reaction</u></td>
<td>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 :-<u>Hydrolysis of ester in acedic medium,</u>
$CH_3COOC_2H_5 + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$
Rate =K$[CH_3COOC_2H_5][H_2O]$
When water is in excess then K'$[CH_3COOC_2H_5]$
<u>Inversion of cane sugar in acidic medium</u> $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$
Rate =K$[C_{12}H_{22}O_{11}][H_2O]$ When water is in excess then K'$[C_{12}H_{22}O_{11}]$</td>
</tr>
</table>

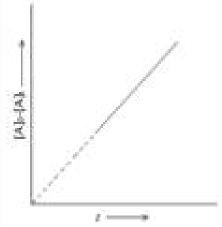
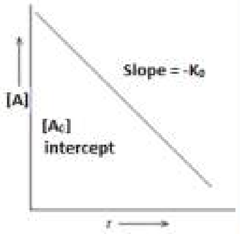
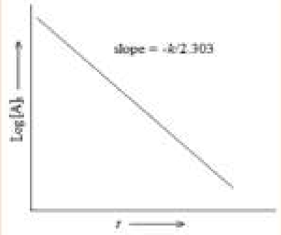
<table>
<tr>
<td>METHOD OF DETERMINING ORDER OF REACTION</td>
<td>Initial Rate Method:
The data's are given in term of different rates at different concentrations, thus we calculate the rate expression and then find the order of reaction. Example: Reaction A + B → Product
<table>
<tr><th>S.No.</th><th>Conc.of A</th><th>Conc.of B</th><th>Rate</th></tr>
<tr><td>1.</td><td>x_1</td><td>y_1</td><td>r_1</td></tr>
<tr><td>2.</td><td>x_2</td><td>y_2</td><td>r_2</td></tr>
<tr><td>3.</td><td>x_3</td><td>y_3</td><td>r_3</td></tr>
</table>
According to rate law
$Rate_1 = k(x_1)^m(y_1)^n$ ....(i)
$Rate_2 = k(x_2)^m(y_2)^n$ ....(ii)
$Rate_3 = k(x_3)^m(y_3)^n$ ....(iii)
Here we have three unknown quantities k, m, n and we have three equations thus the solution is possible and k, m, n have unique value, Thus order of reaction = m + n
Example: 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.
<table>
<tr><th>Exp.</th><th>Initial conc. (A)</th><th>Initial conc. (B)</th><th>Initial rate (mol $L^{-1}s^{-1}$)</th></tr>
<tr><td>1</td><td>0.10 M</td><td>1.00 M</td><td>2.1×10^{-3}</td></tr>
<tr><td>2</td><td>0.20 M</td><td>1.00 M</td><td>8.4×10^{-3}</td></tr>
<tr><td>3</td><td>0.20 M</td><td>2.00 M</td><td>8.4×10^{-3}</td></tr>
</table>
ANSWER:
<table>
<tr><td>Exp.</td><td>Rate = K $[A]^x [B]^y$</td><td rowspan="2">Eq.(i)/(ii) Then$(1/2)^x$ = (1/4)</td></tr>
<tr><td>1</td><td>Rate = K $[0.10]^x [1.00]^y$ = 2.1×10^{-3} ....(i)</td></tr>
</table>
</td>
</tr>
</table>

2	Rate = K $[0.20]^x [1.00]^y = 8.4 \times 10^{-3}$ ……………………..(ii)	Eq.(ii)/(iii) Then$(1/2)^y = (1)$ Therefore y = 0
3	Rate = K $[0.20]^x [2.00]^y = 8.4 \times 10^{-3}$ ……………………..(iii)	

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

Differential and Integrated Rate Laws:

Reaction in which the rate of reaction is directly proportional to one power of concentration of reactant

Zero Order Reactions:	First Order Reactions:
Rate of reaction = K[reactant]^0 **A → Products** $-d[A]/dt = K_0 [A]^0$ $-d[A] = K_0 dt$ **On integrating both side** $\int -d[A] = \int K.dt$ $-[A] = K_0t + C$ --(i) **(Where C= integrating constant)** **At t= 0 $[A] = [A_0]$ then C =- $[A_0]$** **Putting the value of C in equation (i)** $[A] = K_0t - [A_0]$ Or $K_0t = [A_0] - [A]$ $[A] = -K_0t + [A_0]$ that is $Y = -mx + C$ $[A]_0 - [A]_t = k_0t$	Rate of reaction = K[reactant]^1 A → Products $-d[A]/dt = K_1 [A]^1$ $-d[A]/[A] = K_1dt$ On integrating both side $\int -d[A]/[A] = \int K1dt$ $-ln[A] = K_1t + C$ --(i) **(Where C= integrating constant)** **At t= 0 $[A] = [A_0]$ then C =- ln$[A_0]$** **Putting the value of C in equation (i)** $ln[A] = K_1t - ln[A_0]$ Or $K_1t = ln[A_0] - ln[A]$ $ln[A] = -K_1t + ln[A_0]$ that is $Y = -mx + C$ or $k_1 = (2.303/t)\log([A]_0/[A])$
Where, $[A]_0$ = Initial concentration of A **[A]=Concentration of A at time t.** **k_0 = Rate constant for zero order reaction.**	Where, $[A]_0$ = Initial concentration of A [A]= Concentration of A at time t. K_1 = Rate constant for First order reaction.
 	
Unit of rate constant = mol litre^{-1}s^{-1} **Examples:** • Enzyme catalyzed reactions Decomposition of gases on the surface of metallic catalysts like decomposition of HI on gold surface.	.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. $C_{12}H_{22}O_{11} + H_2O \xrightarrow{acid} C_6H_{12}O_6 + C_6H_{12}O_6$ 4. $NH_4NO_2 \longrightarrow N_2 + 2H_2O$ 5. $C_6H_5N=NCl + H_2O \longrightarrow C_6H_5OH + N_2 + HCl$ 6. $CH_3COOC_2H_5 + H_2O \xrightarrow{H^+} CH_3COOH + C_2H_5OH$ 7. $2PH_3(g) \longrightarrow 2P(s) + 3H_2(g)$ 8. $N_2O_5 \longrightarrow 2NO_2 + 1/2O_2$

Half Life

Half Life: Time required to consume the half of initial concentration of reactant is called half life period. At t = $t_{1/2}$ $[A] = [A_0]/2$ $K_0t_{1/2} = [A]_0 - [A_0]/2$ $t_{1/2} = [A]_0/2k$ 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 $t = t_{1/2}$ $[A] = [A_0]/2$ $k_1 = (2.303/t_{1/2})\log([A]_0/[A_0/2])$ $t_{1/2} = 0.693/k_1$ Half-life is independent of the initial concentration of the reactant for a first order reaction

Factor Affacting rate of reaction

- 1.**Nature of reactant:-**

Chemical Nature of Reactant:-Reaction having less value of activation energy will takes place faster

- 2.**Concentration of Reactant**:- Rate of reaction α Conc. of Reactant
- 3. **Temperature:-**On increasing temperature, rate of reaction increases

weather the reaction is exothermic or endothermic because KE of molecule increase on increases temperature which led to increasing activated molecule.

- Relation between rate constant and temperature

(a)Generally it isfound that for every 10 ^0C rise in temperature rate of reaction become 2 to 3 times

Temperature Cofficient:-It is defined as ratio of rate of a reaction at two different temperature which will bediffer by 10 ^0C

$$\boxed{\mu = \frac{K_{T+10}}{K_T} = 2 \text{ to } 3} \; ; \; \boxed{\frac{r_2}{r_1} = \frac{K_2}{K_1} = \mu^{\Delta T/10}}$$

- 5.Presence of catalyst:-In the presence of catalyst, Ea(Activation energy) decreases therefore rate of reaction increases
- 6.Exposure of radiation:-Rate of some reaction increases on exposure of radiation. These reaction are called photochemical reaction For Example:-
- $H_2 + Cl_2 \longrightarrow 2HCl$ (very slow reaction) $H_2 + Cl_2 \xrightarrow{h\nu} 2HCl$ (explosive)

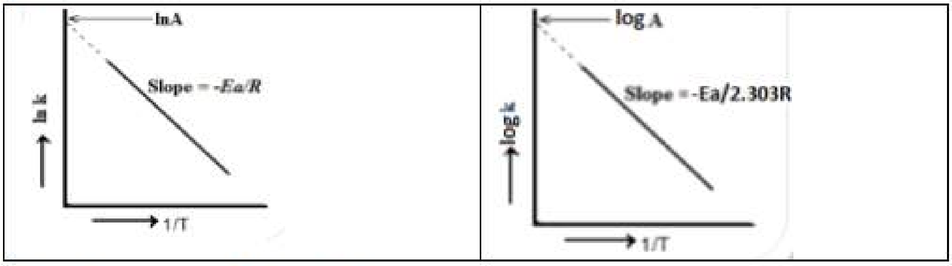
The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume. $SO_2Cl_2(g) \rightarrow SO_2(g) + Cl_2(g)$. Calculate the rate constant.

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. $k = A\, e^{(-E_a/RT)}$  $\log K_2/K_1 = E_a/2.303R\,[1/T_1 - 1/T_2]$
THRESHOLD ENERGY	The Minimum extra amt of energy which the reactants molecules must have sothat 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.
Applications of Activation Energy:-	**(i) Rate of reaction ∞ 1/ Activation Energy** **(ii) To find the nature of reaction (Exothermic/Endothermic reaction)** **(A) Activation Energy of Products - Activation Energy of Reactants = +ive Exothermic** **(B) Activation Energy of Products - Activation Energy of Reactants = =-ive Endothermic.**

Collision Theory of Reaction Rate	• **Collision frequency (Z):**-The number of collisions taking place per second per unit volume of the reaction mixture is known as collision frequency (Z). • **Rate = $Z_{AB}\, e^{-Ea/RT}$ Where Z=**collision frequency and **$-E_a/RT$ =Fraction of molecule having equal or more then activation energy.** • For a collision to be effective, the following two barriers are to be cleared. Energy Barrier 2.Orientation Barrier • To account for the orientation factor for the collision to be effective , Probability or Orientation or Steric factor(P) has been introduced • **Rate = $PZ_{AB}\, e^{-Ea/RT}$**

1 In the reaction A + B → product, if B is taken in excess, then it is an example of -

a) Second order reaction   b) Zero order reaction
c) Pseudo first order reaction   d) First order reaction

Ans: c

2 When initial concentration of reactant is double in a reaction, the half-life period is not affected. The order of reaction is-

a) Second   b) Zero
c) First   d) More than zero but less than first.

Ans: c

3 If the graph plotted between *ln* k and $\frac{1}{T}$ for the first order reaction, the slope of the straight line so obtained is given by

a) $-\frac{E_a}{R}$ b) $-\frac{E_a}{2.303R}$
c) $-\frac{2.303}{E_aR}$ d) $-\frac{E_a}{2.303}$

Ans: a

4 The role of a catalyst is to change

(a) gibbs energy of reaction.   (b) enthalpy of reaction.
(c) activation energy of reaction.   (d) equilibrium constant

Ans: c

5 Which of the following expression is correct for the rate of reaction given below?

$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(aq) + 3H_2O(l)$

a) $-\frac{\Delta[Br^-]}{\Delta t} = -5\frac{\Delta[H^+]}{\Delta t}$ b) $-\frac{\Delta[Br^-]}{\Delta t} = -\frac{5}{6}\frac{\Delta[H^+]}{\Delta t}$
c) $-\frac{\Delta[Br^-]}{\Delta t} = -\frac{6}{5}\frac{\Delta[H^+]}{\Delta t}$ d) $-\frac{\Delta[Br^-]}{\Delta t} = -6\frac{\Delta[H^+]}{\Delta t}$

Ans: b

6 Consider the Arrhenius equation given below and mark the correct option.

$k = A\,e^{-Ea/RT}$

(a) Rate constant increases exponentially with increasing activation energy and decreasing temperature.
(b) Rate constant decreases exponentially with increasing activation energy and decreasing temperature.
(c) Rate constant increases exponentially with decreasing activation energy and decreasing temperature.
(d) Rate constant increases exponentially with decreasing activation energy and increasing temperature.

Ans: d

7 A hypothetical reaction 2p + q → s + r, has rate constant as 2.0×10^{-3} mol lit^{-1} sec^{-1}. The order of the reaction is-

a) Unpredictable   b) Zero
c) One   d) Two

Ans: b

8 Which of the following statements is not correct about order of a reaction.

(a) The order of a reaction can be a fractional number.
(b) Order of a reaction is experimentally determined quantity.
(c) The order of a reaction is always equal to the sum of the stoichiometric coefficients of reactants in the balanced chemical equation for a reaction.
(d) The order of a reaction is the sum of the powers of molar concentration of the reactants in the rate law expression.

Ans: c

9 In a reaction, the threshold energy is equal to

(a) activation energy + normal energy of reactants
(b) activation energy - normal energy of reactants
(c) normal energy of reactants - activation energy
(d) average kinetic energy of molecules of reactants

Ans: a

10 A first order reaction takes 40 min for 30% decomposition. t1/2 will be-

(a) 77.7 min (b) 52.5 min (c) 46.2 min (d) 22.7 min

Ans: a

ASSERTION AND REASON TYPE

In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Both assertion and reason are correct and the reason is correct explanation of assertion.
(b) Both assertion and reason are correct but reason does not explain assertion.
(c) Assertion is correct but reason is incorrect.
(d) Assertion is incorrect but reason is correct.

11 **Assertion :** Order of the reaction can be zero or fractional.
Reason : We cannot determine order from balanced chemical equation **Ans b**

12 **Assertion :** Order and molecularity are same.
Reason : Order is determined experimentally and molecularity is the sum of the stoichiometric coefficient of rate determining elementary step **Ans d**

13 **Assertion :** The enthalpy of reaction remains constant in the presence of a catalyst.
Reason : A catalyst participating in the reaction, forms different activated complex and lowers down the activation energy but the difference in energy of reactant and product remains the same. **Ans a**

14 **Assertion :** All collisions of reactant molecules lead to product formation.
Reason : Only those collisions in which molecules have correct orientation and sufficient kinetic energy lead to compound formation. **Ans d**

15 **Assertion :** Rate constants determined from Arrhenius equation are fairly accurate for simple as well as complex molecules.
Reason : Reactant molecules undergo chemical change irrespective of their orientation during collision **Ans c**

TWO MARKS QUESTIONS

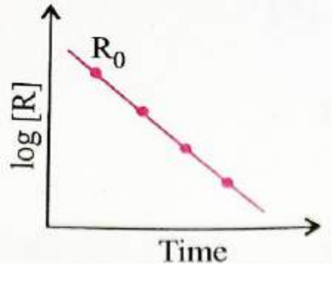
16 **a) Define the half life period of a reaction.**

b) For a reaction R → P half Life ($t_{1/2}$) is observed to be independent of the initial concentration of reactants. What is the order of reaction?

Ans:-) a)The half Life period of a reaction is the time in which the concentration of a reactant is reduced to one-half of its initial concentration.

b) Since half life ($t_{1/2}$) is independent of the initial concentration of the reactant, the reaction is of first order

17 **Observe the following graph in diagram and answers of following questions.**



i) If slope is equal to -2.0×10^{-6}, what will be the value of rate constant.

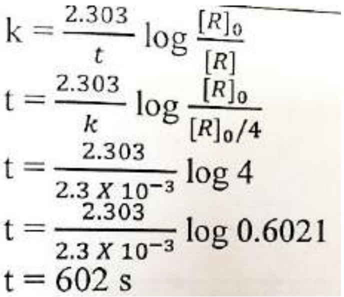
ii) How does the half-life of zero order reaction relate to its rate constant.

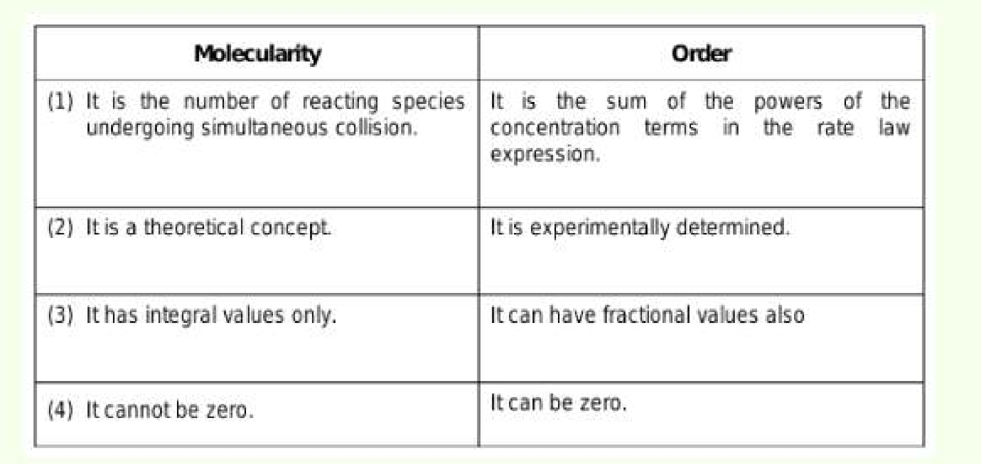
Ans. i) the given graph is of first order reaction there for

Slope = - k / 2.304

$k = -2.303 \times \text{slope}$

$k = -2.303 \times (-2.0 \times 10^{-6})\, s^{-1}$

	$k= 4.606 \times 10^{-6}\ s^{-1}$ ii) $t_{1/2} = [R]_0 /2k$
18	**a) For a given reaction A+B → P: the rate law is given by,** $r = k[A]^{1/2}[B]^2$ **. What is the order of the reaction?** **b) What is the rate of reaction? Write two factors that affect the rate of reaction.** **Ans** 3 a) The order of reaction= sum of powers of concentration terms = ½ + 2= 5/2 = 2.5 b) The rate of a reaction or the speed of a reaction is defined as the change in concentration of a reactant or product in unit time. $R \rightarrow P$ Rate = $-\Delta[R] / \Delta t$ Rate = $\Delta[P] / \Delta t$ Two factors affecting rate of reaction are: i) Concentration of reactants ii) Temperature
19	**A first order reaction takes 40 minutes for 30% decomposition. Calculate half Life** $t_{1/2}$ **.** **Given: log10= 1, log7 = 0.8451** **Ans.** k= 2.303/t. log$[R]_0$/[R] ,t= 40 min. =2.303/40. log100/100-30; k=2.303/40.log10/70; =2.303/40(log10-Log7) k=2.303/40.log10/7; 2.303/40×.1549= 0.00891 $k = 8.91 \times 10^{-3}$ **min**$^{-3}$ **$t_{1/2}$= .693/k**; $.693/8.91\times10^{-3}$;$=.693\times10^{+3} / 8.91 = 77.78$ minutes
20	**The thermal decomposition of an acid is a first order reaction with a rate constant of** $2.3\times10^{-3}\ s^{-1}$ **at a certain temperature. Calculate how long it will take for three-fourth of the initial quantity of acid to decompose.** **(log 4 = 0.6021, log 2 = 0.301)** **Ans:**  $k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$ $t = \frac{2.303}{k} \log \frac{[R]_0}{[R]_0/4}$ $t = \frac{2.303}{2.3\ X\ 10^{-3}} \log 4$ $t = \frac{2.303}{2.3\ X\ 10^{-3}} \log 0.6021$ $t = 602\ s$
21	**For a reaction A + B→P, the rate is given by rate=** $k[A]\,[B]^2$ **i) How is the rate of a reaction affected if the concentration of B is double?** **ii) what is the overall order of the reaction if a is present in large excess?** **Ans.** i) A + B→P Rate= $k[A]\,[B]^2$; Rate r'= $k[A]\,[2B]^2$ Rate=$4\times k[A]\,[2B]^2$ = 4r' If concentration of B is double the rate of reaction becomes 4 times. ii) If A is present in large excess, the rate law becomes $r = k'\,[B]^2$ where k' = k [A] Thus the overall order of reaction is two
22	**Write two difference between order of reaction and molecularity of reaction** **Ans. (any two)**



Molecularity	Order
(1) It is the number of reacting species undergoing simultaneous collision.	It is the sum of the powers of the concentration terms in the rate law expression.
(2) It is a theoretical concept.	It is experimentally determined.
(3) It has integral values only.	It can have fractional values also
(4) It cannot be zero.	It can be zero.

23 **The rate constant for a first order reaction is 60 s^{-1}. How much time will it take to reduce the initial concentration of the reactant to 1 /10 th of its initial value?**

Ans. t= 2.303/k log$[R]_o$ / [R]

as [R] = $[R]_o$/ 10

t= 2.303/k log$[R]_o$ / $[R]_o$/10

t= 2.303/60. log10

t = 2.303 /60×1 =3.838 × 10^{-2} s

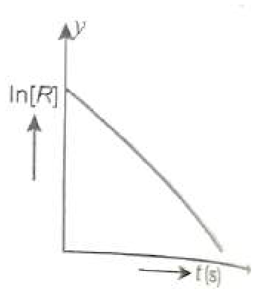
24 **i) Explain why H_2 and O_2 do not react at room temperature.**

ii) write the rate equation for the reaction $A_2 + 3B_3 \rightarrow 2C$, if the overall order of the reaction is zero.

Ans. i) Due to high activation energy for the reaction.

ii) Rate = $k[A_2]^0 [B]^0$ or Rate= k

26 **For a certain chemical reaction variation in the concentration ln[R] vs time plot is given below:**



i) What is the order of the reaction?

ii) What are the units of rate constant k?

iii) Give the relationship between K and $t_{1/2}$ (half life period)

iv) What is the slope of the curve?

Ans: i) First order

ii) $time^{-1}$ or s^{-1}

iii) k= 0.693 / $t_{1/2}$

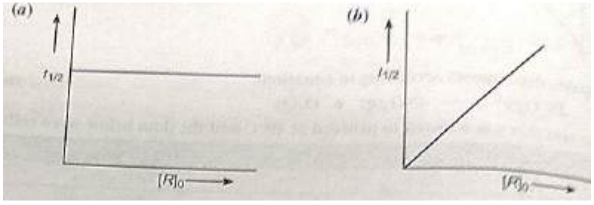
iv) slope = -k (rate constant)

THREE MARKS QUESTIONS

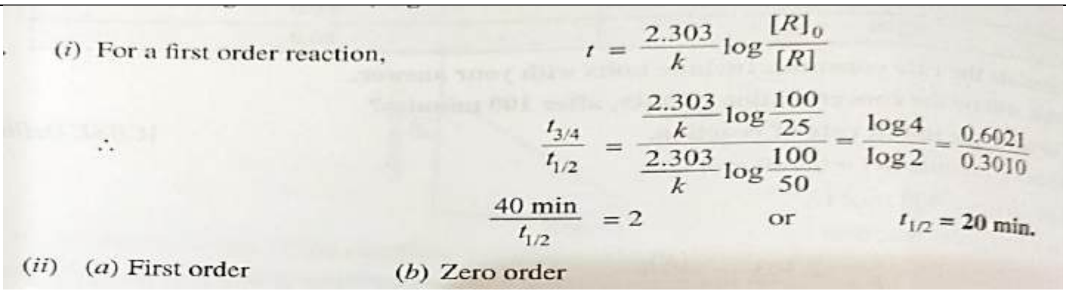
27 **A first order reaction is 75% completed in 40 minutes. Calculates its half life $t_{1/2}$.**

ii)Predict the order of the reaction in the given plots:

Where $[R]_o$ is the concentration of reactant (Given log2= 0.3010,log 4= 0.6021)



Ans



(*i*) For a first order reaction, $t = \frac{2.303}{k}\log\frac{[R]_0}{[R]}$

∴ $\frac{t_{3/4}}{t_{1/2}} = \frac{\frac{2.303}{k}\log\frac{100}{25}}{\frac{2.303}{k}\log\frac{100}{50}} = \frac{\log 4}{\log 2} = \frac{0.6021}{0.3010}$

$\frac{40\text{ min}}{t_{1/2}} = 2$ or $t_{1/2} = 20$ min.

(*ii*) (*a*) First order (*b*) Zero order

28 **The decomposition of A into product has value of k as 4.5×10^3 s^{-1} at 10° C and energy of activation is 60 kJ $mol^{-1.}$ At what temperature would KB 1.5×10^4 s^{-1}? (Given log 3.333 =0.5228**

Ans: $\log k_2 / k_1 = E_a/2.303R\ [T_2 - T_1/T_2\ T_1)$

$\log 1.5 \times 10^4 / 4.5 \times 10^3$

$=60000\ J\ mol^{-1}/2.303 \times 8.314(T_2 - 283/283\ T_2$

$\log 3.333 = 3.13363\ (T_2 - 283/283T_2\ )$

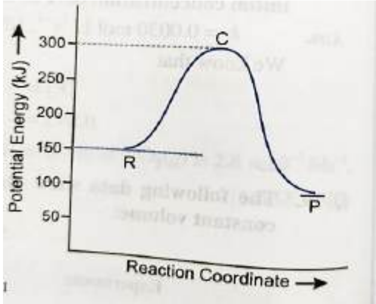
$=0.5228/313363 = T_2 - 283/283\ T_2$

$0.0472\ T_2 = T_2 - 283$

$T_2 = 283/0.9528 = 297k = 297 - 273°C = 24°C$.

29 a) **Explain pseudo first order reaction with example.**

b) Answer the following questions on the basis of the given plot of potential energy vs reaction coordinate



i) What is the threshold energy for the reaction?

ii) What is the activation energy for the forward reaction?

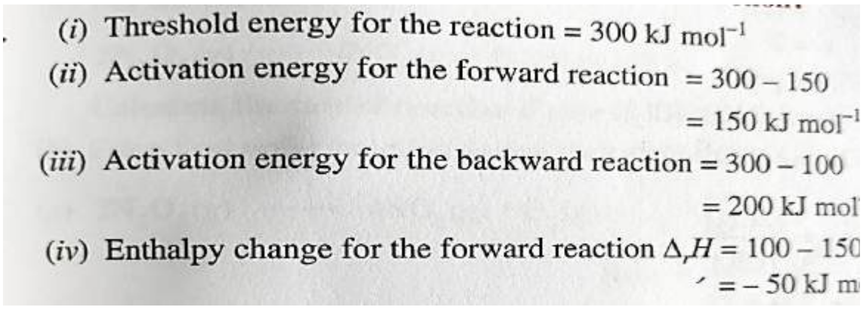
iii) What is the activation energy for the backward reaction?

iv) what is the enthalpy change for the forward reaction?

Ans. a) Chemical reaction which are Biomolecular but due to negligible change in the concentration of one of the reactant, the reaction behaves as first order reaction.Such reactions are called pseudo first order reactions.example:

Inversion of cane sugar: $C_{12}H_{22}O_{11.} + H_2O \rightarrow C_6H_{12}O_{6.} + C_6H_{12}O_6$

b)



(*i*) Threshold energy for the reaction = 300 kJ mol^{-1}

(*ii*) Activation energy for the forward reaction = 300 – 150 = 150 kJ mol^{-1}

(*iii*) Activation energy for the backward reaction = 300 – 100 = 200 kJ mol

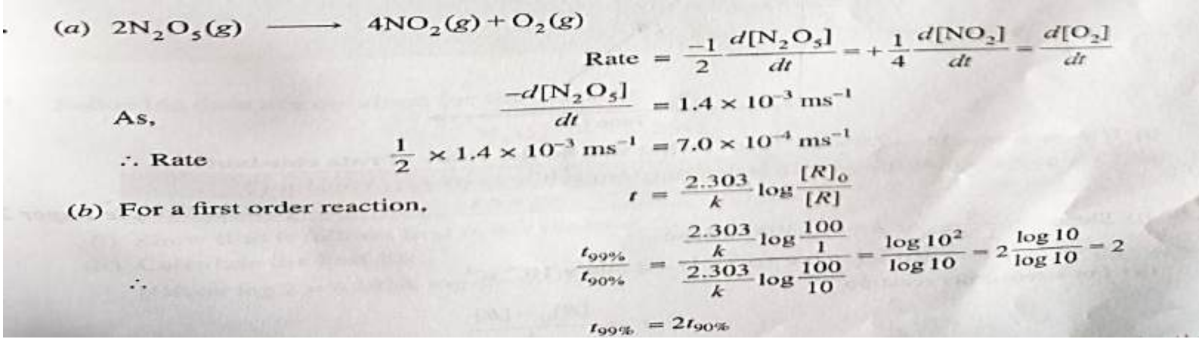
(*iv*) Enthalpy change for the forward reaction $\Delta_r H$ = 100 – 150 = – 50 kJ m

30 **a) for the reaction**

$2N_2O_5$ (g) → $4NO_2$(g) + O_2(g) at 318 K calculate the rate of reaction if rate of disappearance of N_2O_5(g) is 1.4×10^{-3} ms^{-1}

b) for a first order reaction derive the relationship $t_{99}\% = 2t_{90}\%$

Ans.



(a) $2N_2O_5(g) \longrightarrow 4NO_2(g) + O_2(g)$

$$\text{Rate} = \frac{-1}{2}\frac{d[N_2O_5]}{dt} = +\frac{1}{4}\frac{d[NO_2]}{dt} = \frac{d[O_2]}{dt}$$

As, $\frac{-d[N_2O_5]}{dt} = 1.4 \times 10^{-3}\ \text{ms}^{-1}$

∴ Rate $\frac{1}{2} \times 1.4 \times 10^{-3}\ \text{ms}^{-1} = 7.0 \times 10^{-4}\ \text{ms}^{-1}$

(b) For a first order reaction, $t = \frac{2.303}{k}\log\frac{[R]_0}{[R]}$

$$\therefore \frac{t_{99\%}}{t_{90\%}} = \frac{\frac{2.303}{k}\log\frac{100}{1}}{\frac{2.303}{k}\log\frac{100}{10}} = \frac{\log 10^2}{\log 10} = 2\frac{\log 10}{\log 10} = 2$$

$$t_{99\%} = 2t_{90\%}$$

31 **Define half life of a reaction. Write the expression for**

i) half life for zero order reaction and

ii) first order reaction.

Ans: The half Life ($t_{1/2}$) of reaction is that time in which the concentration of a reactant is reduced to one half of its initial concentration.

i) $t_{1/2}$ for zero order reaction = $[R]_o$ / 2k. [R]=initial concentration, k = rate constant

ii) $t_{1/2}$ for first order reaction = 0.693/k

32 **Following data are obtained for the reaction:**

$N_2O_5 + \rightarrow 2NO_2 + ½\ O_2$

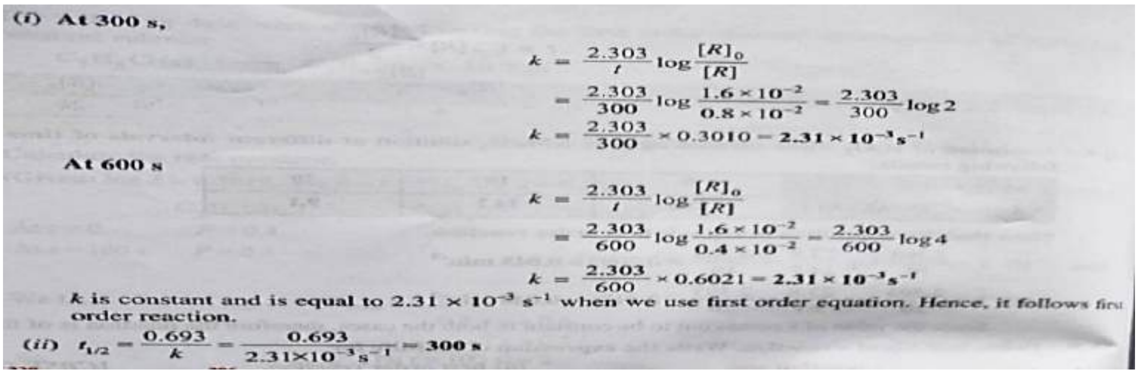
t/s	**0**	**300**	**600**
$[N_2O_5]$ / molL^{-1}	1.6×10^{-2}	0.8×10^{-2}	0.4×10^{-2}

i) Show that it follows a first order reaction.

ii) Calculate the half life.

(Given log 2= 0.3010; log4 =0.6021)

Ans:



(i) At 300 s,

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

$$= \frac{2.303}{300}\log\frac{1.6\times10^{-2}}{0.8\times10^{-2}} = \frac{2.303}{300}\log 2$$

$$k = \frac{2.303}{300}\times 0.3010 = 2.31\times10^{-3}\text{s}^{-1}$$

At 600 s

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

$$= \frac{2.303}{600}\log\frac{1.6\times10^{-2}}{0.4\times10^{-2}} = \frac{2.303}{600}\log 4$$

$$k = \frac{2.303}{600}\times 0.6021 = 2.31\times10^{-3}\text{s}^{-1}$$

k is constant and is equal to $2.31 \times 10^{-3}\ \text{s}^{-1}$ when we use first order equation. Hence, it follows first order reaction.

(ii) $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{2.31\times10^{-3}\text{s}^{-1}} = 300\ \text{s}$

33 **A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction.**

(Given log2 =0.3010, log 4 = 0.6021, R = 8.314 J K^{-1} mol^{-1})

Ans. For a first order reaction

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

$k_1 = 0.693 / 40\ \text{min}^{-1}$

$k_2 = 0.693 / 20\ \text{min}^{-1}$

$k_2 / k_1 = 0.693/ 20 / 0.693/40 = 2$

$\log k_2 / k_1 = E_a / 2.303\times8.314(T_2 - T_1/T_1T_2)$

$\log2 = E_a / 2.303\times8.314\ (320-300/300\times320)$

$0.3010 = E_a\times20/19.147\times300\times320$

$E_a = 0.3010\times19.147\times300\times320/20$

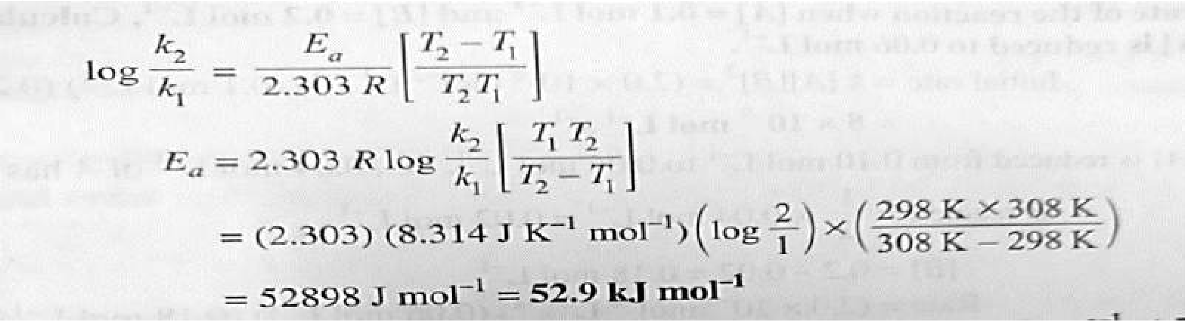
$E_a = 27663.58\ \text{J mol}^{-1} = 27.66\ \text{kJ mol}^{-1}$

34 **i) What will be the effect of temperature on rate constant?**

ii) The rate of a chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K. Calculate activation energy.

Ans. i) The rate constant of a reaction is nearly doubled with rise in temperature by 10° degree Celsius. The exact dependence of the rate constant on temperature is given by Arrhenius equation, k =Ae$^{-\mathbf{Ea/RT}}$ where A is called called frequency factor and E$_a$ is the activation energy of the reaction.

ii)



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

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

$$= (2.303)\,(8.314\text{ J K}^{-1}\text{ mol}^{-1})\left(\log\frac{2}{1}\right)\times\left(\frac{298\text{ K}\times 308\text{ K}}{308\text{ K} - 298\text{ K}}\right)$$

$$= 52898\text{ J mol}^{-1} = \mathbf{52.9\ kJ\ mol^{-1}}$$

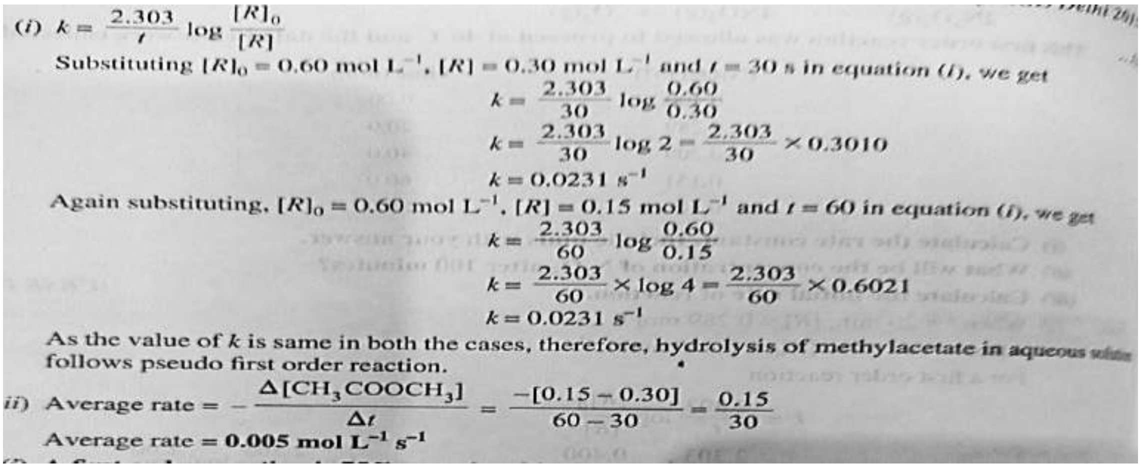
35 **For the hydrolysis of methyl acetate solution the following result were obtained:**

t/s	0	30	60
[CH_3COOCH_3]/mol^{-1}	**0.60**	**0.30**	**0.15**

i) Show that it follows pseudo first order reaction, as the concentration of water remains constant.

ii) Calculate the average rate of reaction between the time interval 30 to 60 seconds. (Given log 2=0.3010, log 4= 0.6021)

Ans.



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

Substituting $[R]_0 = 0.60\text{ mol L}^{-1}$, $[R] = 0.30\text{ mol L}^{-1}$ and $t = 30$ s in equation (i), we get

$$k = \frac{2.303}{30}\log\frac{0.60}{0.30}$$

$$k = \frac{2.303}{30}\log 2 = \frac{2.303}{30}\times 0.3010$$

$$k = 0.0231\text{ s}^{-1}$$

Again substituting, $[R]_0 = 0.60\text{ mol L}^{-1}$, $[R] = 0.15\text{ mol L}^{-1}$ and $t = 60$ in equation (i), we get

$$k = \frac{2.303}{60}\log\frac{0.60}{0.15}$$

$$k = \frac{2.303}{60}\times\log 4 = \frac{2.303}{60}\times 0.6021$$

$$k = 0.0231\text{ s}^{-1}$$

As the value of k is same in both the cases, therefore, **hydrolysis of methylacetate in aqueous** follows pseudo first order reaction.

(ii) Average rate $= -\frac{\Delta[CH_3COOCH_3]}{\Delta t} = \frac{-[0.15 - 0.30]}{60 - 30} = \frac{0.15}{30}$

Average rate = $\mathbf{0.005\ mol\ L^{-1}\ s^{-1}}$

36 **A reaction is first order in A and second order in B**

i) Write the differential rate equation?

ii) How is the rate affected by increasing the concentration of B three times?

iii) How is the rate affected when concentration of both A and B are doubled?

Ans. i) Rate = -d[R] /dt Rate = k [A] [B]$^{\mathbf{2}}$

ii) if the concentration of B is tripled then rate = k[A] [3B]$^{\mathbf{2}}$

= 9k[A][B]^2

The rate of reaction becomes 9 times.

iii) If the concentration of both A and B are doubled,then

rate = k[2A] [2B]$^{\mathbf{2}}$ =8k [A][B]^2

The rate of reaction becomes 8 times.

CASE BASED QUESTIONS:

37 The rate of reaction is concerned with decrease in concentration of reactant or increase in the concentration of products per unit time. It can be expressed as an instantaneous rate at a particular instant of time the average rate over a large interval of time. Mathematical representation of rate of reaction is given by rate law.Rate constant and order of a reaction can be determined from rate law or its integrated rate equation.

a) What is the average rate of reaction?

b) Write two factors that affect the rate of reaction.

c) i) What happens to the rate of reaction for zero order reaction?

ii) What is the unit of k for zero order reaction?

OR

c) i) for a reaction P + 2Q →Product

Rate = $k[P]^{1/2}[Q]^{1}$; What is the order of the reaction?

ii) Define pseudo first order reaction with an example.

Ans. a) The rate of reaction measured over a long interval of time is called average rate of reaction

Average rate of reaction =

$$-\Delta[R] / \Delta t = \Delta[P]/\Delta t$$

b) Two factors that affect the rate of reaction are the concentration of reactants and temperature.

c) i) the rate of reaction for a zero order reaction is always constant.

ii) unit of k for a zero order reaction is **mol $L^{-1}s^{-1}$**

OR

c) i) order of the reaction= ½ +1 =3/2 = 1.5

ii) A reaction that appears to be higher order but follows first order kinetics under certain conditions is called pseudo first reaction. For example hydrolysis of ester is a pseudo first order reaction.When water is taken in large excess.

$CH_3COOC_2H_5 + H_2O(excess) \rightarrow CH_3COOC_2H_5 + C_2H_5OH$

Rate= k $[H_2O]$ $[CH_3COOC_2H_5$

The term $[H_2O]$ can be taken as constant. The equation becomes

Rate= k $[CH_3COOC_2H_5]$

Where k = k’$[H_2O]$

38 The biological processes taking place in our body are nothing but simply chemical reactions which impact our day to day activities directly therefore understanding how chemical reactions work and what affect the rates of reaction is really important. An example is the decomposition of hydrogen peroxide. Due to high solubility of hydrogen peroxide the reaction is quite slow but it gets catalyzed in presence of an enzyme catalase found in liver cells. By enzyme action, hydrogen peroxide gets decomposed to form hydrogen and water, which unlike hydrogen peroxide are completely harmless.

Answer the following questions are multiple choice questions choose the appropriate answer :

i) the change in concentration of any reactant or product for unit time is called :

a) Rate of reaction b) Order of reaction
c) Molecularity of reaction d) Activation energy

Ans i) a) Rate of reaction

ii) the reaction of decomposition of hydrogen peroxide is a:

a) Pseudo first order reaction b) First order reaction
c) Second order reaction d) Zero order reaction

Ans ii) b) Order of reaction

iii) The rate of decomposition of hydrogen peroxide is increased in presence of catalyst because:

a) catalyst provides an alternative pathway by reducing activation energy of the reacting molecules.

b) Catalyst provide an alternative pathway by increasing activating activation energy of the reacting molecules.

c) Catalyst is not consumed in the reaction.

d) Catalysts take part in the reaction.

Ans iii) a) Catalyst provides and alternative pathway by reducing activation energy of the reacting molecules

39 The rate of reaction is concerned with decrease in concentration of reactants or increase in the concentration of products per unit time. It can be expressed as instantaneous rate at a particular instant of time and average rate over a large interval of time. Mathematical representation of rate of reaction is given by rate law. Rate constant and order of a reaction can be determined from rate law or its integrated rate equation.

Answer the following questions:

(i) What is average rate of reaction?

Ans. Change in conc. Of reactant or product per unit time.

(ii) Write two factors that affect the rate of reaction.

Ans. (a)Concentration (b) Temperature.

(iii) (a) What happens to rate of reaction for zero order reaction?

(b) What is the unit of k for zero order reaction?

Ans (a) Rate is independent of conc. of reactants

(b) mol L-1 s-1

OR

(iii) (a) For a reaction P + 2Q --⟶ Products Rate = k[P]1/2 [Q]1. What is the order of the reaction?

(b) Define pseudo first order reaction with example.

Ans. (a) 3/2 or 1.5

(b) A reaction appears to be of higher order but follows first order.

Example – hydrolysis of ester.

LONG ANSWER QUESTIONS (5 MARKS)

40 **Temperature is an important factor affecting the rate of reaction.**

(i) What is the effect of temperature on the rate constant of a reaction?

(ii) How can this effect of temperature on rate constant be represented quantitatively?

(iii) The activation energy for the reaction 2HI(g) --> H_2(g)+I_2 (g) is 209.5 KJ/mol at 518 K. Calculate the fraction of molecules of reactants having energy equal to or greater than activation energy?

Answer:

(i) With increase in temperature, the rate of the reaction and the rate constant increases. As a generalization, the rate of the reaction (and the rate constant) becomes almost double for every 10^o rise in temperature. This is also called temperature coefficient. It is the ratio of rate constants of the reaction at two temperatures differing by10o.

Thus, Temperature coefficient = Rate constant at T ^{o}C

Rate constant at (T+10^o C)

(ii) The temperature effect on the rate constant can be represented quantitatively by Arrherius equation k=Ae −Ea/RT

(iii) We have

Activation energy = 209.5 KJ/mol

Temperature= 581 K

R = 8.314 J/mol/K

Now, the fraction of molecules of reactants having energy equal to or greater than activation energy is given as 64

x= e-Ea/RT

taking log both sides we get

log x = -Ea/(2.303RT)

log x = -209500/ (2.303 x 8.314 x 581)

log x = -18.832

x = antilog (-18.832) = antilog (-18.832 +19 -19) = antilog (0.1678-19)

x = 1.471 x 10^{-19}

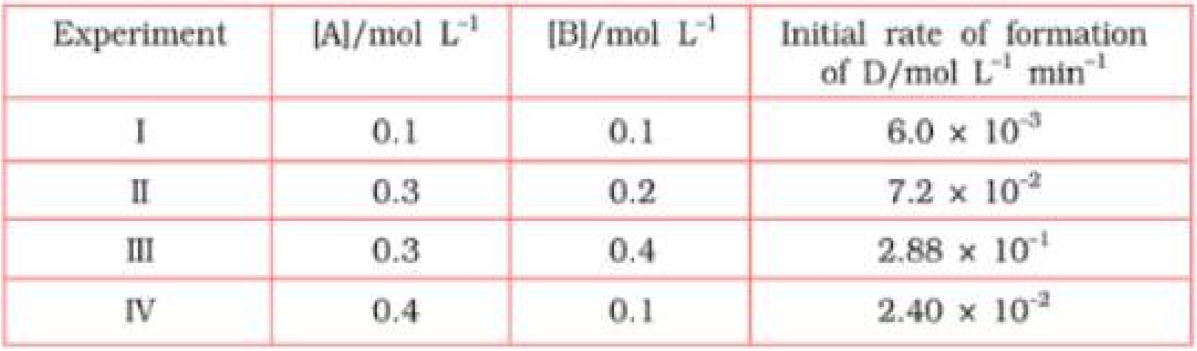
41 **Concentration of reactants play an important role in deciding the rate of reaction.**

(i) Give an expression for the dependence of rate of reaction on conc. of reactants.

(ii) How is the order of a reaction different from molecularity?

(iii) The following results have been obtained during the kinetic studies of the reaction:

2A + B -----> C + D. Determine the rate law and the rate constant for the reaction.



Experiment	[A]/mol L^{-1}	[B]/mol L^{-1}	Initial rate of formation of D/mol L^{-1} min^{-1}
I	0.1	0.1	6.0×10^{-3}
II	0.3	0.2	7.2×10^{-2}
III	0.3	0.4	2.88×10^{-1}
IV	0.4	0.1	2.40×10^{-2}

(i) The equation that describes mathematically the dependence of the rate of reaction on the concentration terms of reactants is the Rate equation. Rate = $k[A]^x[B]^y$

(ii) Order of a reaction is the sum of the coefficients of the reacting species involved in the rate equation. Molecularity is the number of reacting species involved in simultaneous collisions in an elementary or simplest reaction.

(iii) Let assume the rate of reaction wrt A is x and wrt B is y . So, the rate of reaction is expressed as-

Rate = $k[A]^x[B]^y$

$r_1 = 6 \times 10^{-3} = k[0.1]^x[0.1]^y$ ---------1

$r_2 = 7.2 \times 10^{-2} = k[0.3]^x[0.2]^y$ --------2

$r_3 = 2.88 \times 10^{-2} = k[0.3]^x[0.4]^y$ --------3

$r_4 = 2.4 \times 10^{-2} = k[0.4]^x[0.1]^y$ --------4

Divide Eqn 4 by 1 $4 = (0.4/0.1)^x$

On Calculation we get $x = 1$

Divide Eqn 3 by 2 $4 = (0.4/0.2)^y$

On Calculation we get $y = 1$

Rate = $k[A]^x[B]^y$

Substituting values from Eqn 1

$r_1 = 6 \times 10^{-3} = k[0.1]^x[0.1]^y$

$r_1 = 6 \times 10^{-3} = k[0.1]^1[0.1]^2$

$k = 6 \times 10^{-3} / ([0.1]^1[0.1]^2) = 6 \text{ mol}^{-2} \text{ L}^2 \text{ s}^{-1}$

$k = (2.303/t_{1/2}) \log 2$

$k = (2.303/t_{1/2})\ 0.3010$

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

For zero order reaction $t_{1/2}$ dependent of $[R]_0$.

For first order reaction $t1/2$ is independent of [R].

42	Express the rate of the following reaction in terms of the formation of ammonia: (5) N2(g) + 3H2(g) → 2NH3(g) (ii) If the rate constant of a reaction is $k = 3 \times 10^{-4}\ s^{-1}$, then identify the order of the reaction. (iii) For a reaction R → P, half-life ($t_{1/2}$) is observed to be independent of the initial concentration of reactants. What is the order of reaction? (iv) Define the following: (a) Elementary step in a reaction (b) Rate constant Ans (i) $\frac{-d[N_2]}{dt} = \frac{-1}{3}\frac{d[H_2]}{dt} = +\frac{1}{2}\frac{d[NH_3]}{dt}$ (ii) S^{-1} is the unit for rate constant of first order reaction. (iii) The $t_{1/2}$ of a first order reaction is independent of initial concentration of reactants. (iv) (a) Elementary step in a reaction: Each step of a complex reaction is called the elementary step of the reaction. (b) Rate constant is equal to the rate of reaction when molar concentration of reactant is unity.

CHAPTER-4 d-& f-Block elements

1	d-block elements are called transition elements	as they have 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 strong metallic bond, have high enthalpy of atomization and melting point.	due to presence of unpaired electrons.
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 form.	It is **due to d-d transition**
24	(Sc^{3+}, Ti^{4+}) does not exhibit any colour	Ions with vacant d-orbitals (d^0) as d-d transition is not possible in this type of ions.
25	(Zn^{2+}, Cu^{+}) does not exhibit any colour	full filled d-orbitals (d^{10}) as d-d transition is not possible in this type of ions.
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. Retain metallic conductivity 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)+ $H_2SO_4 \longrightarrow Na_2Cr_2O_7$(Orange)+ Na_2SO_4 + H_2O

Step 3: $\underset{\text{Orange}}{Na_2Cr_2O_7} + 2KCl \longrightarrow \underset{\text{Orange}}{K_2Cr_2O_7} + 2NaCl$

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)

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

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

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

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

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

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

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

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

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

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

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

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

MCQs (1 Mark)

1. How many electrons does manganese in MnO_4^- gain in alkaline medium?

(a) 3
(b) 2
(c) 5
(d) 7

Answer: *(a)* 3

2. Which 3*d* series element has a positive standard reduction potential value?

(a) Scandium
(b) Copper
(c) Nickel
(d) Zinc

Answer: *(b)* Copper

3. Galvanization involves applying a coating of which metal to prevent the rusting of iron?

(a) Sn
(b) Cu
(c) Ti
(d) Zn

Answer: *(d)* Zn

4. Name the heaviest naturally occurring element.

(a) Mercury
(b) Gold
(c) Uranium
(d) Thorium

Answer: *(c)* Uranium

5. Which transition element is used to make bulb filaments?

(a) Tungsten
(b) Caesium
(c) Gallium
(d) Cobalt

Answer: *(a)* Tungsten

6. Lanthanoid contraction is caused due to:

(a) The appreciable shielding on outer electrons by 4*f* electrons from the nuclear charge.
(b) The appreciable shielding on outer electrons by 5*d* electrons from the nuclear charge.
(c) The same effective nuclear charge from Ce to Lu.
(d) The imperfect shielding on outer electrons by 4*f* electrons from the nuclear charge.

Answer: *(d)* The imperfect shielding on outer electrons by 4*f* electrons from the nuclear charge.

7. Which is the densest metal?

(a) Molybdenum
(b) Osmium
(c) Ruthenium
(d) Technetium

Answer: *(b)* Osmium

8. Cerium ($Z = 58$) is an important member of the lanthanoids. Which of the following statement about caesium is incorrect?

(a) The common oxidation states of caesium are + 3 and + 4.
(b) The + 3 oxidation state of cerium is more stable than + 4 oxidation state.
(c) The + 4 oxidation state of cerium is not known in solutions.
(d) Cerium (IV) acts as an oxidizing agent.

Answer: *(c)* The + 4 oxidation state of cerium is not known in solutions.

9. Four successive members of the first-row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionisation enthalpy?

(a) Vanadium ($Z = 21$)
(b) Manganese ($Z = 25$)
(c) Chromium ($Z = 24$)
(d) Iron ($Z = 26$)

Answer: *(b)* Manganese ($Z = 25$)

10. Vanadium (III) oxide is a strong:

(a) Oxidizing agent
(b) Reducing agent
(c) Witting agent
(d) Precipitating agent

Answer: *(b)* Reducing agent

11. Identify the incorrect statement among the following.

(a) Lanthanoid contraction is a term applicable to the shrinking of both atomic and ionic sizes of lanthanoids.
(b) A consequence of the lanthanoid contraction is the huge difference in the radii of Zr and Hf.
(c) Shielding power of 4*f* electrons is quite weak.
(d) There is a decrease in the radii of the atoms or ions proceeds from La to Lu.

Answer: (b) A consequence of the lanthanoid contraction is the huge difference in the radii of Zr and Hf.

Assertion–Reason Questions (1 Mark)

(a) *Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).*

(b) *Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).*

(c) *Assertion (A) is true, and the Reason (R) is false.*

(d) *Assertion (A) is false, but the Reason (R) is true.*

1. **Assertion (A) :** Transition metals form coloured complexes.
   Reason (R) : The colour of the complexes is due to *d*–*d* electron transitions.
   Answer: (a)
2. **Assertion (A) :** Zn^{2+} ion is colourless.
   Reason (R) : Zn^{2+} has completely filled *d*-orbitals.
   Answer: (a)
3. **Assertion (A) :** Transition elements usually have high melting points.
   Reason (R) : Chromium is the hardest among all metals.
   Answer: (b)
4. **Assertion (A) :** $CuSO_4.5H_2O$ loses its blue colour when heated.
   Reason (R) : Copper sulphate is a double salt.
   Answer: (c)
5. **Assertion (A) :** Copper releases hydrogen gas on reaction with hydrochloric acid.
   Reason (R) : Copper has a positive reduction potential value (0.34 V).
   Answer: (d)

SAQs–I (2 Marks)

1. The actual electronic configuration of chromium and copper is $3d^5\ 4s^1$ and $3d^{10}\ 4s^1$ respectively instead of $3d^4\ 4s^2$ and $3d^9\ 4s^2$ respectively. Explain.

   Answer: In these elements one electron from the outer 4s orbital jumps to the inner 3d orbital to achieve extra stable electronic configuration.

   $_{24}$Cr: [Ar] $3d^4\ 4s^2$ …Expected configuration
   $_{24}$Cr: [Ar] $\mathbf{3d^5}\ 4s^1$ …Extra stable half-filled configuration
   $_{29}$Cu: [Ar] $3d^9\ 4s^2$ …Expected configuration
   $_{29}$Cu: [Ar] $\mathbf{3d^{10}}\ 4s^1$ …Extra stable fully-filled configuration

2. What happens when:

   (a) Potassium chromate or chromate ion is treated with an acid.
   (b) Potassium dichromate or dichromate ion is treated with an alkali or a base.

   Answer:

   (a) Chromate changes its colour from yellow to orange due to the formation of dichromate ion:

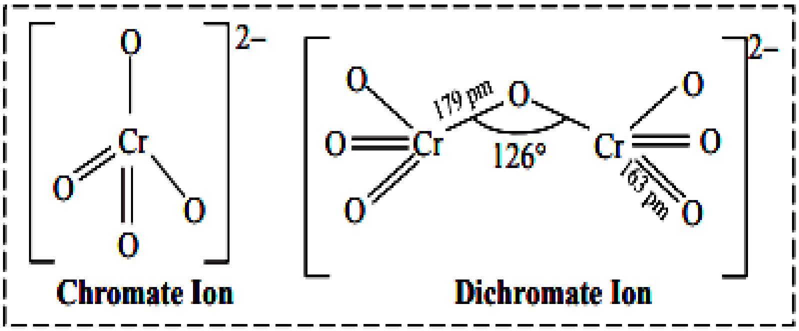
   In the presence of an acid: $CrO_4^{-} \rightarrow Cr_2O_7^{2-}$
   Yellow Orange

   (b) Dichromate changes its colour from orange to yellow due to the formation of chromate ion:

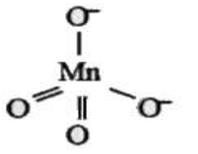
   In the presence of a base: $Cr_2O_7^{2-} \rightarrow CrO_4^{-}$
   Orange Yellow

3. Draw the structures of chromate and dichromate ion and mention their colours.

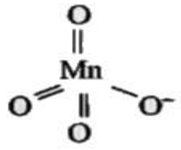
   Answer: Chromate ion is yellow, while dichromate ion is orange in colour.



4. Draw the structures of manganate and permanganate ions and mention their colours.
Answer: Manganate ion is green, while dichromate ion is violet in colour.



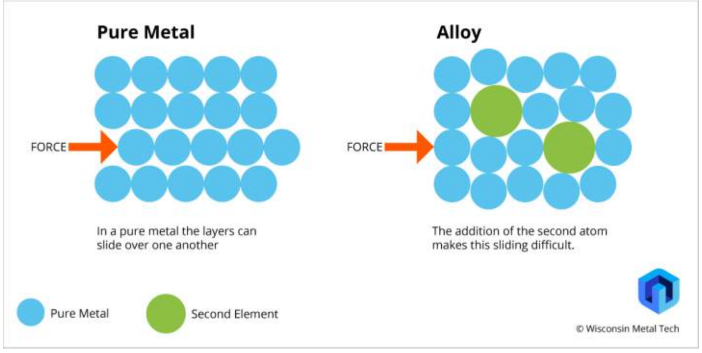
Manganate ion



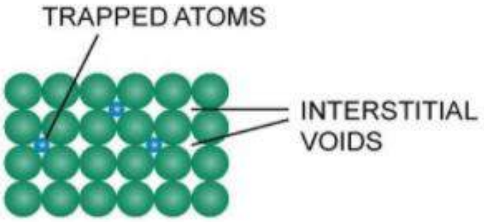
Permanganate ion

5. What makes the *d*-Block elements capable of forming alloys and interstitial compounds?
Answer:

Alloy formation: The *d*-Block elements have similar atomic radii. As a result, atoms of one element fit well into the crystal of another *(see figure for reference)*.



Formation of interstitial compounds: The interstitial sites of the metals of the *d*-Block are big enough to trap the atoms of small-sized elements like H, B, C and N *(see figure for reference).*



Formation of interstitial compounds

6. Explain the magnetic behaviour of the *d*-Block elements?Explain with example?.
Answer:

(i) ***Paramagnetism:*** Most of the *d*-Block elementsl like Mn2+ are weakly attracted by the magnetic field and are paramagnetic in nature. It is because of the unpaired electrons in their $(n-1)$ *d* orbital.

(ii) ***Diamagnetism:*** Some *d*-Block elements like Zn and ions like Sc^{3+} and Cu^{+} are weakly repelled by the magnetic field and are diamagnetic in nature. It is because of the absence of unpaired electrons in them.

(iii) ***Ferromagnetism:*** Elements like Fe, Co, Ni and Gd are ferromagnetic. They are attracted strongly by the magnetic field.

7. The *d*-Block elements form a large number of complexes and their complexes are brightly coloured. Why?
Answer:

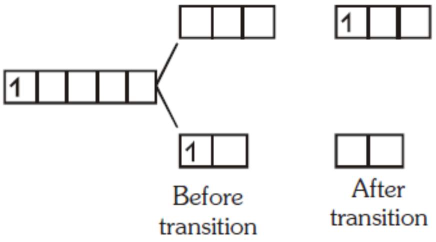
(i) ***Complex formation:*** The complex-formation tendency of the *d*-Block elements is attributed to their:

- reasonably small size (smaller than the *s*-Block elements),
- high nuclear charge, and
- the presence of vacant *d* orbitals made available to the ligands for the lone pair of electrons.

(ii) ***Reason for colour:*** Ligands cause splitting of the *d* orbitals into two sets. When light falls on the complex, the electron absorbs energy and is excited from the lower energy *d*

orbital to the higher energy *d* orbital (as shown below), a phenomenon called '*d*–*d* transition'.

The electron releases the absorbed energy to return to the ground state. This released energy falls in the visible region of the spectrum.



8. Explain the catalytic behaviour of the transition elements.

Answer:

(i) The transition elements show variable oxidation states of different stabilities.

(ii) They provide good surface to the reactant molecules for their adsorption.

9. What is the most common oxidation state of transition and inner-transition elements?

Answer:

(i) The +2 oxidation state is the most common for transition elements.

(ii) For the inner-transition elements, it's +3.

10. Give reasons:

(a) The extent of actinide contraction is greater than lanthanide contraction.

Answer: The 5*f* electrons provide poorer shielding in the series as compared to 4*f* electrons. The 5*f* orbitals are comparatively larger and more diffused. Imperfect screening is greater in case of 5*f* electrons than in case of 4*f* electrons.

(b) Actinides show a greater range of oxidation state than lanthanides.

Answer: This is due to the fact that 5*f*, 6*d* and 7*s* levels are of comparable energies, so electron can participate in bonding from all three sub-shells.

SAQs–II (3 Marks)

1. How would you explain the following:

(a) The relatively low melting points of Mn and Tc as compared to other transition elements?

Answer: It is due to their half-filled *d* orbital that leads to weaker metallic bonding.

(b) The capability of the transition elements to show variable oxidation states?

Answer: In the transition elements, the electrons of the (n–1) *d* orbital can also participate in bonding along with the electrons of *ns* orbital as they have a very less energy difference.

(c) The ability of iron (III) to catalyse the reaction, $2I^- + S_2O_8^{2-} \rightarrow I_2 + 2SO_4^{2-}$

Answer: Fe^{3+} first converts to lesser stable Fe^{2+} and then reverts back, fastening the reaction in the second step:

Step 1 : $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$ (slow)

Step 2 : $2Fe^{2+} + S_2O_8^{2-} \rightarrow 2Fe^{3+} + 2SO_4^{2-}$ (fast)

2. What is lanthanide contraction? Explain its cause and consequences.

Answer:

(i) ***Definition:*** The steady decrease in the atomic and ionic radii from La to Lu in the lanthanide series is referred to as lanthanide contraction.

(ii) ***Cause:*** Lanthanide contraction is caused due to the poor shielding of the 6*s* electrons by the 4*f* electrons.

(iii) ***Consequences:***

(a) The basic strength of the hydroxides of lanthanides decreases from $La(OH)_3$ to $Lu(OH)_3$.

(b) It becomes difficult to separate the lanthanide elements from their ore due to the similarity in their properties.

(c) The atomic sizes of the elements of the 4*d* and 5*d* series become comparable.

3. Give the preparation of potassium dichromate from chromite ore.

Answer: Potassium dichromate is prepared from the chromite ore in three steps:

(i) Conversion of chromite ore to sodium chromate:

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

(ii) Conversion of sodium chromate to sodium dichromate:

$2Na_2CrO_4 + 2HCl \rightarrow Na_2Cr_2O_7 + 2NaCl + H_2O$

(iii) Conversion of sodium dichromate to potassium dichromate:

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

4. Explain why:

(a) Zinc, cadmium, and mercury are not considered as transition elements.
Answer: Their (n−1) d orbital is completely filled in elemental as well as their common oxidation state.

(b) The *d*-Block elements are usually hard and have high enthalpies of atomization and high melting points.
Answer: They have many unpaired electrons that enable them to form strong metallic as well as covalent bonding. They require more energy for getting atomized and more temperature for melting.

(c) Zinc, Gold, silver and mercury are soft metals.
Answer: They have very weak metallic bonding as they have less or no unpaired electrons in their (n−1) *d*- or *ns* orbitals.

5. Name the catalysts used in the following processes.

(a) Manufacture of ammonia by Haber's Process.
Answer: Iron.

(b) Oxidation of ethyne to ethanol.
Answer: Palladium (II) chloride.

(c) Photographic industry.
Answer: Silver.

6. Answer the following questions:

(a) Name the hardest metal of the first transition series and mention the reason of its hardness.
Answer: It's chromium with six unpaired electrons that allows it to form stronger metallic and covalent bonds.

(b) What is the general electronic configuration of the *d*-Block elements?
Answer: $(n{-}1)\,d^{1\text{-}10}\,ns^{1\text{-}2}$ (except $_{46}$Pd: [Kr] $4d^{10}\,5s^{\mathbf{0}}$).

(c) List is few transition elements that do not show variable oxidation states.
Answer: Scandium (+3 only) and zinc (+2 only).

7. Account for the following:

(a) Transition metal fluorides are ionic in nature while chlorides and bromides are covalent.
Answer: According to Fajan's rule, the bigger the anion, the more polarizable it is, and thus the more covalent it is. The size of an atom increases on moving down the group from fluorine to iodine. Fluorine being the smallest forms ionic compounds. The compounds of chlorine and bromine with transition metals develop covalent character.

(b) Hydrochloric acid attacks all the actinoids.
Answer: It's because all actinoids are highly reactive, especially in the finely divided state. The effect of nitric acid is very small due to the formation of a protective oxide layer on their surface..

(c) AgCl dissolves in ammonia solution.
Answer: It's because AgCl forms a soluble $[Ag(NH_3)_2]Cl$ complex with NH_3.

8. Give reason:

(a) $La(OH)_3$ is more basic than $Lu(OH)_3$.
Answer: The size of lanthanide ions decreases from La to Lu as a result of lanthanide contractions. This increases the covalent character of their hydroxides, and their basic strength decreases from $La(OH)_3$ to $Lu(OH)_3$.

(b) Zn^{2+} salts are white or colourless.
Answer: Zn or Zn^{2+} don't have any unpaired electrons in their *d* orbitals, which is why the '*d–d* transition' is not possible in their compounds, and they are white or colourless.

(c) Cu (I) compounds are unstable in an aqueous solution and undergo disproportionation.
Answer: Cu^+ is more unstable in aqueous solution than Cu^{2+} because, while copper's 2nd I.E. is considerable, the hydration enthalpy of Cu^{2+} is significantly lower than Cu^+, and so it more than compensates for copper's 2nd I.E. As a result, many Cu^+ complexes in aqueous solution are unstable and disproportionate.

9. Compare the chemistry of the actinoids with that of lanthanoids with reference to:

(a) Electronic configuration.

Answer: The electrical configuration of lanthanoids is [Xe]$4f^{1\text{-}14}\ 5d^{0\text{-}1}\ 6s^2$, while that of actinoids is [Rn]$5f^{1\text{-}14}\ 6d^{0\text{-}1}\ 7s^2$.

(b) Oxidation states.

Answer: Due to the wide energy difference between the 4*f* and 5*d* subshells, lanthanoids have +2 and +4 oxidation states in addition to the +3 oxidation state. Due of the narrow energy difference between the 5*f* and 6*d* subshells, actinoids have a high variety of oxidation states.

(c) Chemical reactivity.

Answer: Lanthanoids with high electropositivity exhibit chemical reactivity that is almost identical. Actinoids are more reactive than lanthanides, especially in their finely divided form.

10. Answer the following questions:

(c) What elements are good at stabilizing the higher oxidation states like +6 and +7 of the transition elements? Give reason.

Answer: Oxygen and fluorine as they are two of the most electronegative elements.

(c) Why is the first ionization enthalpy of zinc very high as compared to the elements that precede zinc in the modern periodic table?

Answer: It is because zinc has stable $3d^{10}$ and $4s^2$ electronic configuration. It takes a significant amount of energy to remove an electron from zinc's orbital.

(c) Calculate the magnetic moment of a divalent ion of iron in aqueous medium.

Answer: Fe^{2+}: [Ar] $3d^6$

$$\mu = \sqrt{n(n+2)}\ \text{B.M.} \qquad \text{(where, } n = \text{number of unpaired } e^-\text{)}$$
$$= \sqrt{4(4+2)}$$
$$= 4.9\ \text{B.M.}$$

CBQs (4 Marks)

1. Read the passage given below and answer the following questions:

The transition elements have incompletely filled *d* subshells in their ground state or in any of their oxidation states. The transition elements occupy position in between *s*- and *p*-Blocks in Groups 3 to 12 of the periodic table. Starting from fourth period, the transition elements consist of four complete series: Sc to Zn, Y to Cd and La, Hf to Hg and Ac, Rf to Cn. In general, the electronic configuration of outer orbitals of these elements is $(n-1)d^{1\text{-}10}\ ns^{1\text{-}2}$. The electronic configurations of outer orbitals of Zn, Cd, Hg and Cn are represented by the general formula $(n-1)d^{10}\ n^2$.

All the transition elements have typical metallic properties such as high tensile strength, ductility, malleability. Except mercury, which is liquid at room temperature, other transition elements have typical metallic structures. The transition metals and their compounds also exhibit catalytic property and paramagnetic behaviour. Transition metal also forms alloys. An alloy is a blend of metals prepared by mixing the components. Alloys may be homogeneous solid solutions in which the atoms of one metal are distributed randomly among the atoms of the other.

Answer the following questions:

(i) What characteristics of transition metals is associated with higher catalytic activity?

Answer: Their ability to show variable oxidation states and provide good surfaces.

(ii) Transition elements form alloys. Why?

Answer: Because of their comparable atomic sizes.

(iii) Which element of the first transition series exhibit the largest number of oxidation states? State the reason.

Answer: Chromium, because it has the greatest number of unpaired electrons ($3d^5\ 4s^1$).

OR

The reduction potential values for transition metals show irregular variation. Why?

Answer: It is due to the irregular variation in their ionization enthalpies and sublimation enthalpies.

2. **Read the passage given below and answer the following questions:**

The *f*-Block elements are those in which the differentiating electrons enters the $(n{-}2)f$ orbital. There are two series of the *f*-Block elements corresponding to filling of 4*f* and 5*f* orbitals. The series of 4*f* orbitals is called lanthanoids. Lanthanoids show different oxidation states depending upon stability of f^0, f^7 and f^{14} configurations, though the most common oxidation state is +3. There is a regular decrease in the size of lanthanoids ions with increase in atomic number which is known as lanthanoid contraction.

The 5*f* series is referred to as actinoids. The actinoid elements are radioactive. They are more reactive than lanthanoids and show a greater variety of oxidation states. The extent of actinoid contraction is also greater than the lanthanoid contraction.

Answer the following questions:

(i) If the atomic number of two lanthanoid elements X and Y are 65 and 68 respectively, what will be their outer electronic configuration?

Answer: $4f^8$ and $4f^{11}$

(ii) Give the reaction of lanthanoids (Ln) with water.

Answer: $Ln + 3H_2O \rightarrow Ln(OH)_3 + 3/2\ H_2$

(iii) What is the common oxidation state of lanthanoids? Name a member of the lanthanoid series which is well known to exhibit the +4 oxidation state.

Answer: The most common O.S. of lanthanoids is +3. Cerium is know to exhibit the +4 oxidation state.

OR

Name an important allow which contains some of the lanthanoid metals. Mention its uses.

Answer: Mischmetall. The allow which contains 95% of lanthanoid metals and 5% iron is used to make bullets, shells and lighter flints.

3. **Read the passage given below and answer the following questions:**

The elements of the *d*-Block that lie between the reactive metals of the *s*-Block and the elements of *p*-Block are known as transition metals. The transition elements were regarded as those elements which possess partially filled penultimate *d* subshell in their ground state or common oxidation states. Transition metals show variable oxidation states except a few. The most common oxidation state is +2. In showing variable oxidation states, there are involvement of *ns* and unpaired electrons of $(n{-}1)d$ subshell. Lower states are ionic while higher states are covalent. Most of transition metal and their compounds exhibit paramagnetism. Most of the compounds of transition metals are coloured. The colour and paramagnetism are due to presence of incomplete *d* orbital and unpaired electrons. They also form their oxides on the surface.

Answer the following questions:

(i) How many unpaired electrons are there in ferrous ion?

Answer: Fe^{2+} has 4 unpaired electrons ($3d^6$ configuration).

(ii) Calculate the spin-only magnetic moment of Ni^{2+} in aqueous solution is?

Answer: $\mu = \sqrt{n\,(n+2)}$ B.M. Here, $n = 2$ (unpaired electrons of Ni^{2+})

$= \sqrt{2\,(2+2)}$

$= 2.84$ B.M.

(iii) Which elements do not satisfy the definition of transition elements? Mention the reason

Answer: Zinc, cadmium and mercury. These elements do not have any unpaired electrons in the elemental or common oxidation states.

OR

Why scandium and show only one oxidation state?

Answer: Scandium achieves noble gas configuration in it +3 oxidation state, while zinc in its +2 oxidation state has a stable d^{10} configuration.

LAQs (5 Marks)

1. **(a)** A blackish brown coloured solid 'A' when fused with an alkali metal hydroxide in the presence of air, produces a dark green coloured compound 'B' which upon electrolytic oxidation in alkaline medium gives a dark purple coloured compound 'C'. Identify 'A', 'B' and 'C' and write the reactions involved.

Answer:

$$\underset{\text{‘A’}}{2MnO_2} + 4KOH + O_2 \rightarrow \underset{\text{‘B’}}{2K_2MnO_4} + 2H_2O$$

Electrolytic oxidation of B:

$$\begin{array}{lcl} \text{At anode} & : & MnO_4^{2-} \rightarrow \underset{\text{‘C’}}{MnO_4^-} + e^- \\ \text{At cathode} & : & 2H_2O + 2e^- \rightarrow H_2 + 2OH^- \end{array}$$

(b) What happens when acidic solution of green compound ‘B’ is allowed to stand for some time? Give the equation involved. What is this type of reaction called?

Answer: K_2MnO_4 or ‘B’ reacts with atmospheric carbon dioxide:

$$3K_2MnO_4 + 2CO_2 \rightarrow 2KMnO_4 + MnO_2 + 2K_2CO_3$$

This type of reaction where same species is both oxidized and reduced is called disproportionation reaction.

2. Write balanced chemical equations for the oxidation of:

(a) Ferrous to ferric by potassium dichromate in acidic medium.

Answer:

$$\begin{array}{rcl} Cr_2O_7^{2-} + 14H^+ + 6e^- & \rightarrow & 2Cr^{3+} + 7H_2O \\ 6Fe^{2+} & \rightarrow & 6Fe^{3+} + 6e^- \\ \hline Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ & \rightarrow & 2Cr^{3+} + 6Fe^{3+} + 7H_2O \\ \hline \end{array}$$

(b) Iodide to iodine by potassium dichromate in acidic medium.

Answer:

$$\begin{array}{rcl} Cr_2O_7^{2-} + 14H^+ + 6e^- & \rightarrow & 2Cr^{3+} + 7H_2O \\ 6I^- & \rightarrow & 6I_2 + 6e^- \\ \hline Cr_2O_7^{2-} + 6I^- + 14H^+ & \rightarrow & 2Cr^{3+} + 6I_2 + 7H_2O \\ \hline \end{array}$$

(c) Ferrous to ferric by potassium permanganate in acidic medium.

Answer:

$$\begin{array}{rcl} MnO_4^- + 8H^+ + 5e^- & \rightarrow & Mn^{2+} + 4H_2O \\ Fe^{2+} & \rightarrow & Fe^{3+} + e^- \,] \times 5 \\ \hline MnO_4^- + 8H^+ + 5Fe^{2+} & \rightarrow & Mn^{2+} + 5Fe^{3+} + 4H_2O \\ \hline \end{array}$$

(d) Oxalate to carbon dioxide by potassium permanganate in acidic medium.

Answer:

$$\begin{array}{rcl} MnO_4^- + 8H^+ + 5e^- & \rightarrow & Mn^{2+} + 4H_2O \,] \times 2 \\ C_2O_4^{2-} & \rightarrow & 2CO_2 + 2e^- \,] \times 5 \\ \hline 2MnO_4^- + 5C_2O_4^{2-} + 16H^+ & \rightarrow & 2Mn^{2+} + 10CO_2 + 8H_2O \\ \hline \end{array}$$

(e) Iodide to iodate by potassium permanganate in alkaline medium.

Answer:

$$\begin{array}{rcl} MnO_4^- + 2H_2O + 3e^- & \rightarrow & MnO_2 + 4OH^- \,] \times 2 \\ I^- + 6OH^- & \rightarrow & \mathbf{IO_3}^- + 3H_2O + 6e^- \\ \hline 2MnO_4^- + I^- + H_2O & \rightarrow & 2MnO_2 + \mathbf{IO_3}^- + 2OH^- \\ \hline \end{array}$$

3. Answer the following questions:

(a) Calculate the spin-only magnetic moment of iron in the compound, $[Fe(H_2O)_5NO]^{2+}$.

Answer: NO ligand here is carrying a charge of **+1**. The oxidation state of iron is, therefore, +1 with electronic configuration $3d^6\,4s^1$. NO+ being a strong ligand pairs the solitary electron of $4s$ into $3d$, reducing the unpaired electrons (n) of iron from 4 to 3.

Now, $\mu = \sqrt{n(n+2)}$ B.M.

$= \sqrt{3(3+2)}$

$= 3.87$ B.M.

(b) $K_2[PtCl_6]$ is a well-known compound, whereas the corresponding Ni compound is not known. Why?

Answer: The +4 oxidation state of Pt is quite stable. Ni (IV), on the other hand, is unstable, and its smaller size doesn't allow it to form hexa-coordinated complexes.

(c) Among the ionic species, Sc^{3+}, Ce^{4+} and Eu^{2+}, which one is a good oxidizing agent and why?

Answer: Ce^{4+} as it has a strong tendency to convert to more stable Ce^{3+} by accepting an electron.

(d) CrO_3 is an acid anhydride. Explain.

Answer: CrO_3 reacts with water to form H_2CrO_4, chromic acid.

(e) A serious accident took place in a laboratory when a student tried to dissolve $KMnO_4$ in conc. H_2SO_4 instead of dil. H_2SO_4. What went wrong?

Answer: With conc. H_2SO_4, $KMnO_4$ reacts vigorously to form an explosive substance called manganese heptoxide, Mn_2O_7.

*****

CHAPTER-5 COORDINATION COMPOUNDS

Simple Salt	Double Salt	Complex Salt
Contain one type of cation and one type of anion. E.g. NaCl.	Contain two types of cations. E.g. Mohr's salt $(NH_4)_2SO_4.\ FeSO_4.6H_2O$, Potash Alum- $Al_2(SO_4)_3.\ K_2SO_4.24H_2O$	Contain complex ion. Eg. $K_4Fe(CN)_6 \rightarrow 4K^+ + [Fe(CN)_6]^{4-}$

Transition metal have great tendency to form coordination compounds because: Small size and high charge Availability of vacant d-orbitals & Tendency to show variable oxidation states.

Basic Terms

1. Coordination Sphere: Central metal atom and ligands bonded to CMA called coordination sphere → represented in a square bracket.

2. Central Metal Atom: Accept electrons for the formation of coordinate bond is called central metal atom. (Lewis acid)

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

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^-

4.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) Cation is written first followed by anion.
2) While writing name of coordination sphere ligands are named first followed by central metal atom.
3) To indicate number of ligands prefix di, tri, tetra, penta, hexa, hepta etc are used. If ligands itself involve such prefixes in its name then prefix bis, tris, tetrakis, and so on are used to indicate number of ligands.
4) While writing name of central metal atom: -
   a. If coordination sphere is cation name of metal atoms written as such: Fe – Iron, Au – Gold, Cu – Copper, Cr – Chromium, Ag – Silver.
   b. If, coordination sphere is anion suffix 'ate' is used to write name of central metal atom. Such as: Fe – Ferrate, Hg – Mercurate, Cu – Cuperate, Ag –

oxidation number is indicated in perantheses'()'.

(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

Argentate, Au – Aurate, Pd – Peladate, Cr - Chromate

5) After writing name of central metal atom its

(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- Arises in a coordination compound containing ambidentate ligand. M–SCN, M–NCS & ($-NO_2$), (–ONO)

(ii) Coordination isomerism- Arises from the interchange of ligands between cationic and anionic entities of different metal ions present in a complex. $[Co(NH_3)_6][Cr(CN)_6]$ & $[Cr(NH_3)_6][Co(CN)_6]$

(iii) Ionisation isomerism- Arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand which can then become the counter ion.

$[Co(NH_3)_5(SO_4)]Br$ & $[Co(NH_3)_5Br]SO_4$.

(iv) Solvate isomerism- Arises due to exchange of H_2O as ligand and counter anion in the complex.

$[Cr(H_2O)_6]Cl_3$ & $[Cr(H_2O)_5Cl]Cl_2.H_2O$

(b) Stereoisomerism

(i) Geometrical isomerism- Arises in heteroleptic complexes due to different possible geometric arrangements of the ligands.

If same ligands are on same side – Cis isomer.

If same ligands are on opposite side – trans isomer.

Tetrahedral complexes does not exhibit geometrical isomerism due to some relative position of ligands around central metal atom.

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.

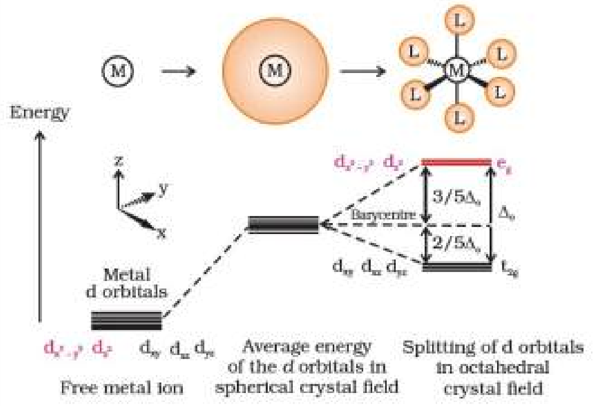
The ions/groups bound by the secondary linkages to the metal have characteristic spatial arrangements corresponding to different coordination numbers.

2) Valence Bond Theory or VBT

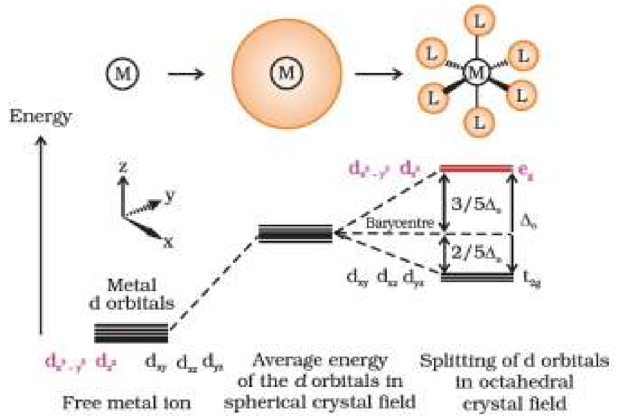
Complex	Oxidation state of CMA	Hybridi-zation	Geometry	Magnetic nature	Number of unpaired electrons	Outer sphere / Inner sphere
$[Co(NH_3)_6]^{3+}$	+3	d^2sp^3	Octahedral	Diamagnetic	0	Inner sphere
$[CoF_6]^{3-}$	+3	$sp^3 d^2$	Octahedral	Paramagnetic	0	Outer sphere
$[Co(C_2O_4)_3]^{3-}$	+3	d^2sp^3	Octahedral	Diamagnetic	0	Inner sphere
$[Mn(CN)_6]^{2-}$	+2	d^2sp^3	Octahedral	Paramagnetic	1	Inner sphere
$[Fe(CN)_6]^{3-}$	+2	d^2sp^3	Octahedral	Paramagnetic	1	Inner sphere
$[Fe(H_2O)_6]^{3+}$	+2	$sp^3 d^2$	Octahedral	Paramagnetic	5	Outer sphere
$[Ni(NH_3)_6]^{2+}$	+2	$sp^3 d^2$	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:



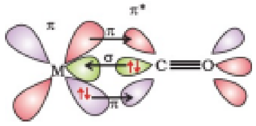
Splitting of d-orbitals in tetrahedral field:



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.

1	A coordination compound contains: A. Only ionic bonds B. Only covalent bonds C. Both ionic and covalent bonds D. Metallic bonds **Answer: C**
2	Which of the following is a coordination compound? A. NaCl B. KNO_3 C. $[Cu(NH_3)_4]^{2+}$ D. H_2SO_4 **Answer: C**
3	The central metal atom in a coordination complex is usually: A. Non-metal B. Noble gas C. Transition metal D. Alkali metal **Answer: C**

4	In $[Fe(CN)_6]^{3-}$, the oxidation state of Fe is: A. +2 B. +3 C. +6 D. 0 **Answer: B**
5	Which of the following is a monodentate ligand? A. Ethylenediamine B. Cl^- C. $C_2O_4^{2-}$ D. EDTA **Answer: B**
6	Ligands are: A. Neutral atoms only B. Charged ions only C. Donors of electron pairs D. Acceptors of electron pairs **Answer: C**
7	Which of the following is a bidentate ligand? A. NH_3 B. CN^- C. H_2O D. $C_2O_4^{2-}$ **Answer: D**
8	The coordination number of Ni in $[Ni(CO)_4]$ is: A. 2 B. 3 C. 4 D. 6 Answer: C
9	What is the charge on the complex ion $[Co(NH_3)_6]^{3+}$? A. +3 B. 0 C. -3 D. +6 **Answer: A**
10	The IUPAC name of $[Pt(NH_3)_2Cl_2]$ is: A. Platinum diamine chloride B. Diamminedichloroplatinum(II) C. Dichlorodiamineplatinum(IV) D. Dichloroplatinum(II)amine **Answer: B**
	ASSERTION AND REASON QUESTIONS (1 MARK EACH)
	In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices. (a) Both assertion and reason are correct and the reason is correct explanation of assertion. (b) Both assertion and reason are correct but reason does not explain assertion. (c) Assertion is correct but reason is incorrect. (d) Assertion is incorrect but reason is correct.
11	Assertion (A): $[Ni(CN)_4]^{2-}$ is square planar and diamagnetic. Reason (R): CN^- is a strong field ligand and causes pairing of electrons. **Answer:** Both A and R are true, and R is the correct explanation of A. Explanation: CN^- causes pairing of electrons in Ni^{2+} ($3d^8$), leading to dsp^2 hybridization and square planar geometry. No unpaired electrons → diamagnetic
12	Assertion (A): $[Fe(H_2O)_6]^{2+}$ is paramagnetic. Reason (R): Water is a strong field ligand and pairs up the electrons in Fe^{2+}. **Answer**: A is true, but R is false. Explanation: $[Fe(H_2O)_6]^{2+}$ is paramagnetic due to four unpaired electrons in Fe^{2+}. But H_2O is a weak field ligand, does not cause pairing
13	Assertion (A): EDTA is a hexadentate ligand. Reason (R): It can form six coordinate bonds with a metal ion. **Answer**: Both A and R are true, and R is the correct explanation of A. Explanation**:** EDTA has 4 oxygen atoms and 2 nitrogen atoms that can donate electrons → 6 donor sites → hexadentate
14	Assertion (A): The complex $[Co(NH_3)_6]^{3+}$ does not give a precipitate with $AgNO_3$. Reason (R): The Cl^- ions are not present outside the coordination sphere. **Answer:** A is false, but R is true. Explanation**:** $[Co(NH_3)_6]^{3+}$ has no chloride ions at all, so it won't give a white ppt with $AgNO_3$. R is true, but A is incorrect because it refers to a wrong complex
15	Assertion (A): In $[Cu(NH_3)_4]^{2+}$, the oxidation state of Cu is +2. Reason (R): Each NH_3 ligand donates one pair of electrons and is neutral.

Answer: Both A and R are true, and R is the correct explanation of A.
Explanation**:** NH_3 is a neutral ligand. So, oxidation state of Cu in $[Cu(NH_3)_4]^{2+}$ is +2. R correctly supports A.

SAQ TYPE I (2 MARKS EACH)

16 **Find out the coordination number of Fe in $[Fe(CN)_6]^{4-}$? Explain.**
Answer:The coordination number is 6 because six cyanide (CN^-) ligands are directly bonded to Fe. Each CN^- ligand donates one lone pair to Fe.

17 **Write the IUPAC name of $[Cr(NH_3)_4Cl_2]Cl$.**
Answer:The IUPAC name is Tetraammine dichlorido chromium(III) chloride.

18 **Find out the oxidation state of cobalt in $[Co(NH_3)_6]Cl_3$?**

Answer:Let oxidation state of Co be x:
$x + 6(0) + 3(-1) = 0$
$x - 3 = 0 \rightarrow x = +3$
So, oxidation state of Co is +3.

19 **In Coordination compound which donates electron pair? Give one example which is bidentate.**
Answer : Ligand is an ion or molecule that donates a pair of electrons to the central metal atom.
Example of bidentate ligand: Ethylenediamine (en) – it has two donor atoms (–NH_2 groups).

20 **Explain the difference between a double salt and a coordination compound**.

Answer:

Double salt	Coordination Compound
Double salts dissociate completely into ions in solution (e.g., Mohr's salt).	Coordination compounds do not dissociate completely; the complex ion remains intact in solution (e.g., $[Fe(CN)_6]^{4-}$).

21 **What is the geometrical shape of $[Ni(CO)_4]$? Is it diamagnetic or paramagnetic?**
Answer:

- Shape: Tetrahedral
- It is diamagnetic because all electrons are paired due to strong field CO ligands.

22 **Give one example each of homoleptic and heteroleptic complexes.**
Answer:

I. Homoleptic: $[Co(NH_3)_6]^{3+}$ (only one type of ligand – NH_3)
II. Heteroleptic: $[Co(NH_3)_4Cl_2]^+$ (two types – NH_3 and Cl^-)

23 **State and explain the postulate of Werner's theory of coordination compounds.**
Answer: Werner postulated that metals show two types of valency:

I. Primary valency: ionisable (oxidation state)
II. Secondary valency: non-ionisable, corresponds to coordination number (number of ligands bonded to the metal).

24 **Draw the structure of the complex ion $[Cr(C_2O_4)_3]^{3-}$ and state its denticity.**
Answer: $C_2O_4^{2-}$ (oxalate) is a bidentate ligand. There are 3 oxalate ligands → coordination number = 6.Each ligand forms 2 bonds → Total = 6 bonds.Structure is octahedral, and the denticity is 2 per ligand.

25 **Why is $[Ni(CN)_4]^{2-}$ square planar while $[NiCl_4]^{2-}$ is tetrahedral?**
Answer:

	• In $[Ni(CN)_4]^{2-}$, CN^- is a strong field ligand → causes pairing of electrons → dsp^2 hybridization → square planar • In $[NiCl_4]^{2-}$, Cl^- is a weak field ligand → no pairing → sp^3 hybridization → tetrahedral
	SAQ TYPE III (3 MARKS EACH)
26	**Ravi added excess $AgNO_3$ to an aqueous solution of a coordination compound and observed a white precipitate. The formula of the complex was found to be $[Co(NH_3)_5Cl]Cl_2$.Explain the observation. How many ions are produced in solution?** **Answer:** • The white precipitate is AgCl, formed when Cl^- ions (outside coordination sphere) react with $AgNO_3$. • The complex dissociates as: $[Co(NH_3)_5Cl]Cl_2 \rightarrow [Co(NH_3)_5Cl]^{2+} + 2Cl^-$ • Number of ions = 3
27	**Priya was studying $[Ni(CO)_4]$ and found it to be diamagnetic. She wondered why it did not show any unpaired electrons despite Ni having a $3d^8$ configuration.** **Explain how this is possible using the concept of hybridisation and ligand strength.** **Answer:** • Ni in $[Ni(CO)_4]$ is in 0 oxidation state: $3d^8\ 4s^2$ • CO is a strong field ligand, causes pairing of 3d electrons • Forms sp^3 hybrid orbitals (tetrahedral) • All electrons paired → Diamagnetic
28	**A compound has the formula $[Cr(H_2O)_6]Cl_3$. When silver nitrate is added, all three chlorides precipitate.** **What does this tell you about the position of Cl^- ions in the compound? Justify your answer.** **Answer:** All 3 Cl^- ions are outside the coordination sphere.They are free to react with Ag^+ to form AgCl ppt. Hence, $[Cr(H_2O)_6]Cl_3$ releases 3 Cl^- ions → Cr^{3+} is coordinated only to H_2O ligands
29	**An unknown complex $[M(en)_2Cl_2]$ shows optical isomerism but not geometrical isomerism.Identify the geometry of the complex and explain your reasoning.** **Answer:** • en (ethylenediamine) is a bidentate ligand • $[M(en)_2Cl_2]$ shows optical isomerism → Must be cis form • Geometry: Octahedral • In trans form, it becomes superimposable → no optical activity • Conclusion: Octahedral geometry with cis-isomer showing chirality
30	**A student wrote the formula $[Cu(NH_3)_4]Cl_2$ but observed that it gave a different number of ions in solution than expected.** **Identify the correct formula if 3 ions are obtained on dissociation and justify your answer.** **Answer:**

	• $[Cu(NH_3)_4]Cl_2$ → gives 3 ions: $[Cu(NH_3)_4]^{2+} + 2Cl^-$ • Student's formula is correct, the confusion is probably about how many ions come from the complex. • Final dissociation gives: 1 complex ion + 2 Cl^- = 3 ions
31	**An iron complex has the formula $[Fe(CN)_6]^{4-}$ and is found to be diamagnetic, whereas $[FeF_6]^{3-}$ is paramagnetic.** **Explain the difference using crystal field theory.** **Answer:** • CN^- is a strong field ligand → causes pairing of electrons Fe^{2+} ($3d^6$) → all paired → diamagnetic • F^- is a weak field ligand → no pairing Fe^{3+} ($3d^5$) → unpaired electrons remain → paramagnetic
32	**During a salt analysis experiment, a student found that one chloride ion reacts with $AgNO_3$ but two do not. The compound used was $[CoCl_2(NH_3)_4]Cl$.** **Write the ionisation reaction and explain the observation.** **Answer:** • Ionisation: $[CoCl_2(NH_3)_4]Cl \rightarrow [CoCl_2(NH_3)_4]^+ + Cl^-$ • Only 1 Cl^- is outside the coordination sphere → reacts with Ag^+ • Other 2 Cl^- are inside the coordination sphere → don't react Observation explained
33	**A compound $[Zn(NH_3)_4]^{2+}$ is found to be colorless, but $[Cu(NH_3)_4]^{2+}$ is deep blue.Explain why this difference in color arises.** **Answer:** • Zn^{2+}: $3d^{10}$ → no d–d transition → colorless • Cu^{2+}: $3d^9$ → one unpaired electron, d–d transition allowed • Ligands (NH_3) cause crystal field splitting → color observed due to d–d transitions
34	**The complex $[Fe(C_2O_4)_3]^{3-}$ is found to be more stable than $[Fe(H_2O)_6]^{3+}$.Give reason based on the nature of ligands.** **Answer:** • $C_2O_4^{2-}$ is a bidentate ligand, forms chelates • H_2O is a monodentate ligand → no chelation • Chelation effect makes $[Fe(C_2O_4)_3]^{3-}$ more stable
35	**A coordination compound has the formula $[Co(en)_3]^{3+}$.It shows optical activity.Explain why this happens and whether geometrical isomerism is possible.** **Answer:** • en = bidentate ligand • $[Co(en)_3]^{3+}$ forms an octahedral complex • All ligands are the same → no geometrical isomerism • Non-superimposable mirror images → optical isomerism exists
	CASE BASED QUESTIONS
36	**Case Study 1: Werner's Theory and Structure**

Read the passage carefully:
Werner’s theory was the first to explain the bonding in coordination compounds. According to this theory, metal ions exhibit two types of valencies – primary (ionisable) and secondary (non-ionisable). In the complex $[CoCl_3\cdot 6NH_3]$, three chloride ions are ionisable while six ammonia molecules are directly bonded to cobalt.

Questions:

(a) . According to Werner's theory, which type of valency is non-ionisable?
Answer: Secondary valency.
(b). In the complex $[CoCl_3\cdot 6NH_3]$, how many chloride ions are ionisable?

Answer: Three chloride ions.
(c) Explain the two types of valencies given by Werner’s theory with reference to $[CoCl_3.6NH_3][CoCl_3\cdot 6NH_3]$ $[CoCl_3.6NH_3]$.
Answer:

- Primary valency corresponds to the oxidation state of the metal and is ionisable. In $[CoCl3\cdot 6NH3][CoCl_3\cdot 6NH_3][CoCl3\cdot 6NH_3]$, cobalt shows a primary valency of 3, satisfied by 3 ionisable Cl^- ions.
- Secondary valency refers to the coordination number and is non-ionisable. It is fulfilled by six NH_3 molecules bonded directly to Co^{3+}, forming coordinate bonds.

OR

(c) Write the ionisation reaction of $[CoCl_3\cdot 6NH_3]$ in water and state what it indicates about the structure.

Answer: Ionisation reaction:

$$[CoCl_3\cdot 6NH_3] \rightarrow [Co(NH_3)_6]^{+3} + 3Cl^-$$

This indicates that all three Cl^- ions are outside the coordination sphere and are ionisable, while the 6 NH_3 ligands are inside the coordination sphere, bonded directly to cobalt.

37

Case Study 2: Isomerism in Coordination Compounds

Read the passage carefully:
Coordination compounds can exhibit isomerism just like organic compounds. Geometrical and optical isomerism are the most common types. Geometrical isomerism occurs in square planar or octahedral complexes, while optical isomerism occurs when the complex is chiral.
Questions:

(a) **What type of isomerism is shown by square planar coordination compounds?**
Answer: Geometrical isomerism.
(b) **What is required for a coordination compound to exhibit optical isomerism?**
Answer: The compound must be chiral (i.e., non-superimposable on its mirror image).
(c) **Explain the difference between geometrical and optical isomerism in coordination compounds with an example of each.**
Answer:

- **Geometrical isomerism** arises due to different spatial arrangements of ligands around the central metal ion. Example: $Pt(NH_3)_2Cl_2Pt(NH_3)_2Cl_2Pt(NH_3)_2Cl_2$ shows **cis** and **trans** forms.
- **Optical isomerism** occurs when a compound is chiral and has non-superimposable mirror images (enantiomers). Example: $Co(en)_3Co(en)_3Co(en)_3^{3+}$ shows optical isomerism.

OR

(c)Why does $Pt(NH_3)_2Cl_2$ exhibits geometrical isomerism, but not optical isomerism?
Answer: $Pt(NH_3)_2Cl2Pt(NH_3)_2Cl_2Pt(NH_3)_2Cl_2$ is a square planar complex where ligands can occupy adjacent (**cis**) or opposite (**trans**) positions, leading to geometrical isomerism.

	However, it does not exhibit optical isomerism because the molecule is **not chiral**—its mirror images are superimposable.
38	**Case Study 3: Coordination Number and Ligands** **Read the passage carefully:** The coordination number of a complex is the number of ligand donor atoms bonded to the central metal ion. Ligands can be monodentate, bidentate, or polydentate. Complexes with chelating ligands are generally more stable. Questions: **(a). What is meant by the coordination number of a complex?** **Answer:** The coordination number of a complex is the number of ligand donor atoms bonded to the central metal ion. **(b). Name the type of ligands based on the number of donor atoms they have.** **Answer:** Ligands can be monodentate, bidentate, or polydentate. **(c) Why are complexes with chelating ligands generally more stable?** **Answer:** Complexes with chelating ligands are more stable because chelating ligands form ring structures with the metal ion, reducing the possibility of ligand displacement. This increases the thermodynamic stability of the complex due to the chelate effect. OR **(c). Differentiate between monodentate and bidentate ligands with one example each.** **Answer:** • Monodentate ligands have one donor atom and form one bond with the central metal ion. Example: **Cl^-** (chloride ion). • Bidentate ligands have two donor atoms and form two bonds with the central metal ion. Example: Ethane-1,2-diamine (en).
	LONG ANSWER TYPE QUESTIONS (1 X 5 = 5 MARKS)
39	A student was asked to write the IUPAC names of coordination compounds. He got confused between oxidation state, ligand naming, and coordination number. Help him by answering the following: **(a)** Write the IUPAC name of $[Cr(NH_3)_4Cl_2]Cl$. **Answer :** Tetraamminedichloridochromium(III) chloride **(b)** Write the oxidation state of Cr in this compound. **Answer :** Oxidation state of Cr = +3 **(c)** Identify the type of isomerism this compound can show. **Answer :** Geometrical isomerism (cis-trans) **(d)** Explain how the geometry of this complex influences isomerism. **Answer :** It is an octahedral complex. The two Cl^- ligands can be adjacent (cis) or opposite (trans), causing geometrical isomerism. **(e)** How will you test the presence of Cl^- ions outside the coordination sphere? **Answer :** Add $AgNO_3$. A white precipitate confirms free Cl^- ions (i.e., those outside the coordination sphere).
40	Analyze the following two complexes: $[Fe(CN)_6]^{3-}$ and $[FeF_6]^{3-}$, and answer the following questions: **Answer : (a)** Which one is more stable and why? $[Fe(CN)_6]^{3-}$ is more stable because CN^- is a strong field ligand (forms stronger metal-ligand bonds). **(b)** Which complex is colored and why? **Answer :** Both are colored due to d–d transitions. **(c)** State the type of hybridization involved in both.

	Answer : $[Fe(CN)_6]^{3-}$: d^2sp^3 (inner orbital), $[FeF_6]^{3-}$: sp^3d^2 (outer orbital) **(d)** Which complex is high spin and which is low spin? **Answer :** $[Fe(CN)_6]^{3-}$: Low spin, $[FeF_6]^{3-}$: High spin **(e)** Compare their magnetic moments. **Answer :** $[Fe(CN)_6]^{3-}$ has 1 unpaired electron (low μ), $[FeF_6]^{3-}$ has 5 unpaired electrons (high μ)
41	Study the given coordination compound $[Ni(CO)_4]$ and answer the following: **(a)** Write the oxidation state of Ni. **Answer :** Oxidation state of Ni = 0 **(b)** What type of hybridization is involved? **Answer :** sp^3 hybridization **(c)** Is the compound paramagnetic or diamagnetic? Justify. **Answer :** Diamagnetic – No unpaired electrons (all paired due to strong field CO) **(d)** What is the geometry of this complex? **Answer :** Tetrahedral geometry **(e)** Explain the bonding of CO as a ligand in terms of σ-donation and π-backbonding. **Answer :** CO donates lone pair via σ-bond from carbon to Ni, Ni back-donates electron density into empty antibonding molecular orbital of CO.

6. HALOALKANES AND HALOARENES

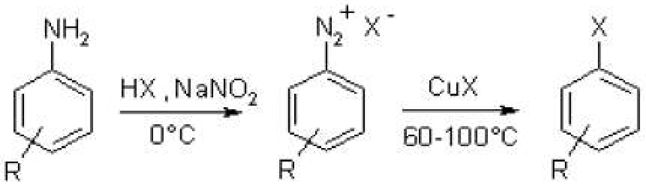
Gist of the lesson

KEY NOTES

- Haloalkanes are classified as fluoro, chloro, bromo or iodo compounds according to the type of halogen present and as mono-, di-, tri-, tetra- haloalkanes, etc., according to the one, two, three, four, etc., halogen atoms respectively present in their molecule.
- Alkyl halides are further classified as primary (1°), secondary (2°) and tertiary (3°) according to the halogen atom attached to primary, secondary and tertiary carbon atoms, respectively. Due to electronegativity difference between the carbon and the halogen, the shared pair of electron lies closer to the halogen atom. As a result, the halogen carries a small negative charge, while the carbon carries a small positive charge.
- **Methods of Preparation of Haloalkanes:** Haloalkanes can be prepared from displacement of alcoholic group in alkyl alcohol by halogen acid, PCl_5 or PCl_3. Haloalkanes can also be prepared by addition of halogen acids or halogens on alkene and alkyne.
- **Methods of preparation of Haloarenes**

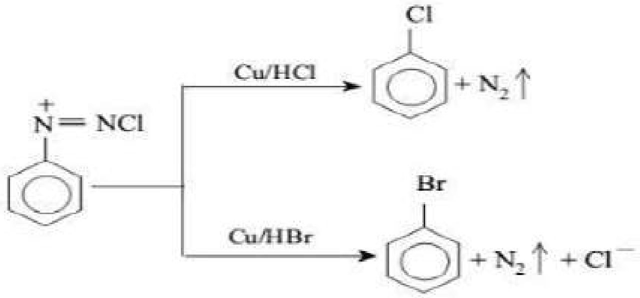
  From diazonium salts:

  (i) By Sandmeyer reaction:



X= CN, Br, Cl, SO_3H

(ii) By Gattermann reaction:



- **Chemical reactions of haloalkanes**

  (a) Nucleophilic Substitution Reactions:

  (i) C-X bond in alkyl halide is more polar due to electron repelling nature of alkyl group and thus readily undergo nucleophilic substitution reaction. These are of two types:

(1) S_N1 (Substitution Nucleophilic Unimolecuiar): In such type of reactions, rate = k [RX], i.e., rate, is independent of concentration of nucleophile and occurs in two steps. Such reactions are favoured by polar solvents.

(2) S_N2 (Substitution Nucleophilic Bimolecular): In such type of reactions, rate = k [RX] [Nu^-], i.e., rate of reaction depends on concentration of nucleophile and take place in one step.

☐ 7. Polyhalogen Compounds

Chloroform ($CHCl_3$) – solvent, anesthetic

Iodoform (CHI_3) – antiseptic

CCl_4 – fire extinguisher solvent

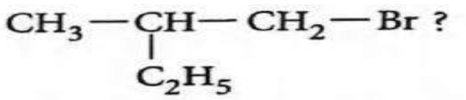
Freons – refrigerants, ozone depleting

DDT – pesticide (environmentally harmful)

☐ 8. Environmental Effects

CFCs (Freons) deplete ozone layer

DDT is non-biodegradable and bioaccumulative

1	Which of the following is an example of vic-dihalide? a) Dichloromethane b) 1,2 dichloroethane c) Ethylidene Chloride d) Allyl Chloride **Ans (b)**
2	What is the correct IUPAC name for  $CH_3-\underset{\displaystyle C_2H_5}{\underset{\vert}{CH}}-CH_2-Br$? (a) 1-bromo -2 - ethylpropane (b) 1-bromo-2 - ethyl- 2- methylethane (c) 1-bromo -2 - methylbutane (d) 2-methyl -1-bromobutane **Ans (c)**
3	Molecules whose mirror images are non-superimposable over them are known as chiral. Which of the following molecules is chiral in nature? a) 2-bromobutane b) 1-bromobutane c) 2-bromopropane d) 2-bromopropane **Ans. (a)**
4	Which of the following reagents will not convert ethyl alcohol into ethyl chloride? a) PCl_5 b) NaCl c) $SOCl_2$ d) $HCl/ZnCl_2$ **Ans. (b**
5	Alkyl halides are prepared from alcohols by treating with (a) $HCl + ZnCl_2$ (b) Red P + Br_2 (c) H_2SO_4 + KI (d) Both(a)and(b) Ans (d)
6	How many chiral compounds are possible on mono-chlorination of 2-methyl butane? a)2 b) 4 c) 6 d) 8 Ans (a
7	Which of the following halide is 2°? (a) Isopropyl chloride (b) Isobutyl chloride (c) n -propyl chloride (d) n-butyl chloride Ans (a)
8	The reaction of alkyl halides with alcoholic KOH is an example of: (a) Addition reaction (b) Substitution reaction (c) Elimination reaction (d) Rearrangement reaction **Ans – (c)**
9	Which of the following is NOT a method for preparing haloarenes? (a) Direct halogenation of benzene (b) Sandmeyer reaction (c) Diazotization and subsequent halogenation (d) Wurtz reaction **Ans – (d)**

10 Which of the following is an example of a Grignard reagent?

(a) CH_3MgCl (b) CH_3CH_2OH (c) CH_3OCH_3 (d) CH_3CHO

Ans – (b)

ASSERTION AND REASONING TYPE QUESTIONS:

For each question below, choose the correct option:

A) Both Assertion (A) and Reason (R) are true, and R is the correct explanation of A.

B) Both A and R are true, but R is not the correct explanation of A.

C) A is true, but R is false.

D) A is false, but R is true

11 **Assertion(A)**:The boiling points of alkyl halides decrease in the order RI>RBr>RCl>RF

Reason (R): The boiling points of alkyl chlorides, bromides and iodides are considerably higher than that of the hydrocarbon of comparable molecular mass.

Ans: (B) Both assertion and reason are correct statements but reason is not correct explanation for assertion

12 **Assertion:** KCN reacts with methyl chloride to give methyl isocyanide

Reason: CN^- is an ambident nucleophile.

Ans (D) Assertion is wrong but Reason is correct

13 **Assertion:** Presence of a nitro group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution.

Reason: Nitro group, being an electron withdrawing group decreases the electron density over the benzene ring.

Ans: (A) Both assertion and reason are correct statements but reason is correct explanation for assertion

14 **Assertion:** In monohaloarenes, further electrophilic substitution occurs at ortho and para position

Reason: Halogen atom is a ring deactivator

Ans: (B) Both assertion and reason are correct statements but reason is not correct explanation for assertion.

15 **Assertion:** Hydrolysis of (-)-2- bromooctane proceeds with inversion of configuration.

Reason: This reaction proceeds through the formation of a carbocation.

Ans: (C)Assertion is correct but Reason is wrong

SA I 2 MARK QUESTIONS

16 **What are ambident nucleophiles? Explain with an example.**

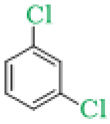
Ans1: Groups like cyanides and nitrites possess two nucleophilic centres and are called ambident nucleophiles

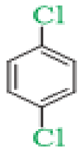
17 **a) n- butyl bromide has higher boiling point than tert.- butyl bromide. Why?**

(b). p- dichlorobenzene has higher melting point than meta – dichlorobenzene?

Ans(a): n- butyl bromide being a straight chain alkyl halide has larger surface area than tert. butyl bromide. Larger the surface area ,larger the magnitude of the Vanderwaal's forces and higher is the boiling point.

Ans(b):





p - dichlorobenzene

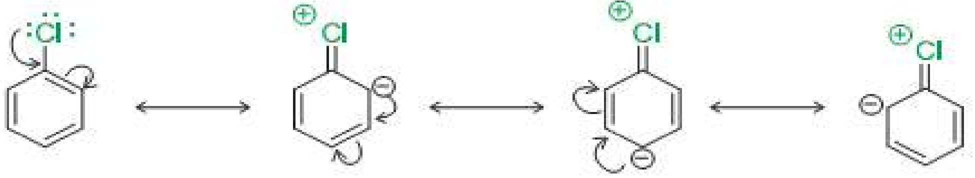
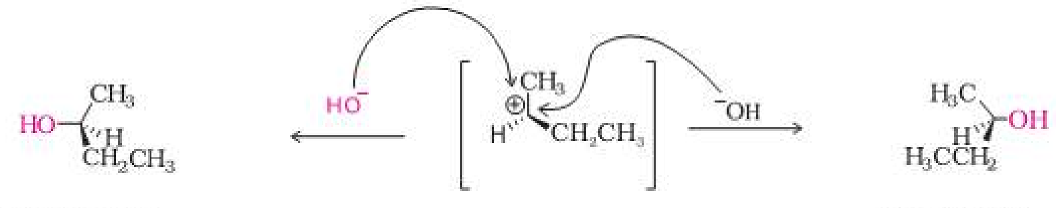
m – dichlorobenzene

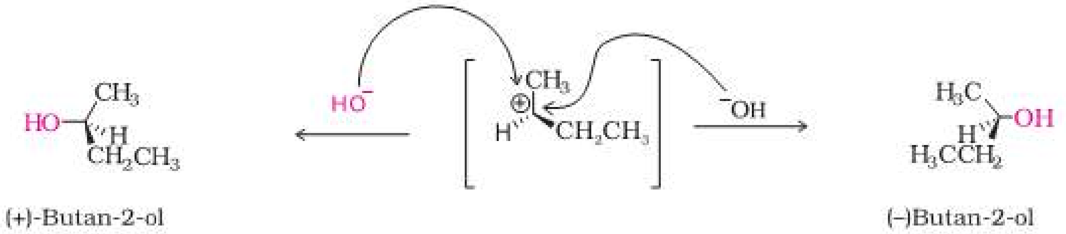
p- dichlorebenzene is having symmetrical structure therefore it can fit better into the crystal lattice which increases its melting point

18 **(a) Why is Butan-1-ol optically inactive but Butan-2-ol is optically active.**

(b) Benzyl chloride undergoes S_N1 reaction faster than cyclohexyl methyl chloride. Give reasons

Ans(a): Butan-2-ol has four different groups attached to the tetrahedral carbon and has chiral carbon, therefore it is optically active.

	Ans(b): because in case of benzyl chloride the carbocation formed is stablised by resonance.
19	**a) Why iodoform has appreciable antiseptic properties?** **(b) A small amount of ethyl alcohol is usually added to chloroform bottles. Why?** **Ans(a):** As it liberates free iodine having antiseptic properties. **Ans(b):** To destroy traces of phosgene if formed.
20	**Chlorobenzene is less reactive towards nucleophilic substitution reaction. Explain.** **Ans:** Chlorobenzene is less reactive towards nucleophillic substitution due to – a)resonance , C- Cl bond acquires a double bond character  and becomes stronger than a single bond. b). SP_2 hybridisation in C of C-X bond, the carbon becomes more electronegative and holds the electron pair of C-X bond more tightly decreasing the bond length . c). Instability of phenyl cation. d). Repulsion for incoming nucleophile from electron rich ring.
21	**a). Why is Vinyl chloride less reactive than ethyl chloride. ?** **(b). Allyl chloride is hydrolysed more readily than n-propyl chloride. Why ?** **Ans(a):** Cl is attached to sp2 hybridised carbon **Ans(b):** The carbocation formed by allyl chloride is more stabledue to resonance
22	**(a). Thionyl chloride is preferred for converting alcohol to haloalkane.** **(b). Grignard reagents should be prepared under anhydrous conditions.** **Ans(a)** : Thionyl chloride is preferred for converting alcohol to haloalkane because the biproducts formed are all gases which escape into the atmosphere. $R\text{-}OH + SOCl_2 \rightarrow RCl + SO_2 + HCl$ **Ans(b)** : Grignard reagents should be prepared under anhydrous conditions.because Grignard reagent reacts with water and get decomposed and form alkanes $RMgX + H_2O \rightarrow R\text{-}H + Mg(OH)X$.
23	**Hydrolysis of optically active 2- bromobutane forms optically inactive butan - 2 - ol. Explain .** Ans: $CH_3CH(Br)CH_2CH_3$ 2 - Bromo butane The compound undergoes hydrolysis by S_N1 mechanism via the formation of carbocation which is planar.The attack of nucleophile can result in product which is a mixture of compounds both with same configuration and inverted configuration. Therefore it results in the formation of racemic mixture which is optically inactive.  (+)-Butan-2-ol (–)Butan-2-ol
24	**Hydrolysis of optically active 2- bromobutane forms optically inactive butan - 2 - ol. Explain .** Ans: $CH_3CH(Br)CH_2CH_3$ 2 - Bromo butane The compound undergoes hydrolysis by S_N1 mechanism via the formation of carbocation which is planar.The attack of nucleophile can result in product which is a mixture of compounds both with same configuration and inverted configuration. Therefore it results in the formation of racemic mixture which is optically inactive.



25 **Sulphuric acid is not used during the reaction of alcohols with KI.**

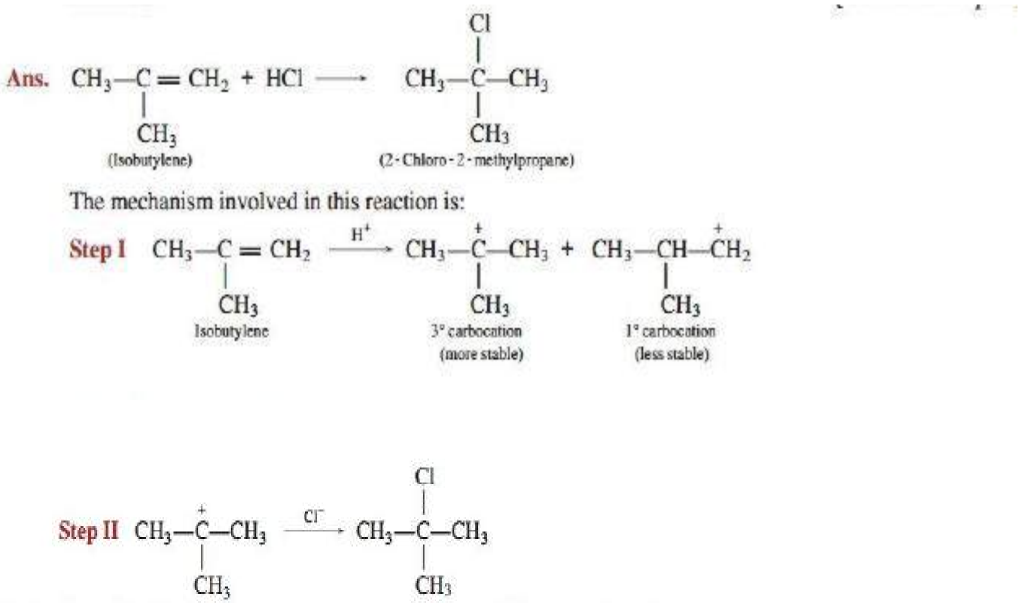
Ans:.H_2SO_4 cannot be used along with KI in the conversion of an alcohol to an alkyl iodide as it converts KI to corresponding HI and then oxidizes it to I_2.

26 **Alkyl halides are generally not prepared in laboratory by free radical halogenations of alkanes.**

Ans: Alkyl halides are generally not prepared in laboratory by free radical halogenations of alkanes.since Free radical chlorination or bromination of alkanes gives a complex mixture of isomeric mono- and polyhaloalkanes, which is difficult to separate as pure compounds. Consequently, the yield of any one compound is low.

SA II 3 MARK QUESTIONS

27 **Predict the major product formed when HCl is added to isobutylene. Explain the mechanism involved.**



28 **Give reasons for the following observations:**

(i) Chloroethane is insoluble in water.
(ii) Haloarenes are less reactive than haloalkanes towards nucleophilic substitution reaction.
(iii) The treatment of alkyl chloride with aqueous KOH leads to the formation of alcohol but in the presence of alcoholic KOH, alkene is the major product.

Ans (i) It is unable to form hydrogen bonds with water.

(ii) As C–X bond in aryl halide acquires a partial double bond character due to resonance while the C–X bond in alkyl halide is a pure single bond.

(iii) Alkoxide ion present in alcoholic KOH, is not only a strong nucleophile but also a strong base so preferentially eliminate a molecule of HCl from alkyl halide to form alkenes.

29 **Give reasons:**
(i) *n*-Butyl bromide has higher boiling point than *t*-butyl bromide.
(ii) Racemic mixture is optically inactive.

(iii) The presence of nitro group (—NO_2) at *o/p* positions increases the reactivity of haloarenes towards nucleophilic substitution reactions.

Ans **(i)** *n*-Butyl bromide being a straight chain alkyl halide has larger surface area than *tert*-butyl bromide. Larger the surface area, larger the magnitude of the van der Waal's forces and hence higher is the boiling point.

(ii) A racemic mixture contains the two enantiomers *d* and *l* in equal proportions. As the rotation due to one enantiomer is cancelled by equal and opposite rotation of another enantiomer, therefore, it is optically inactive.

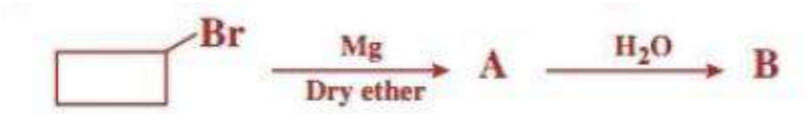
(iii) The presence of NO_2 group at *o/p* position in haloarenes helps in the stabilisation of resulting carbanion by –R and –I effects and hence increases the reactivity of haloarenes towards nucleophilic substitution reactions

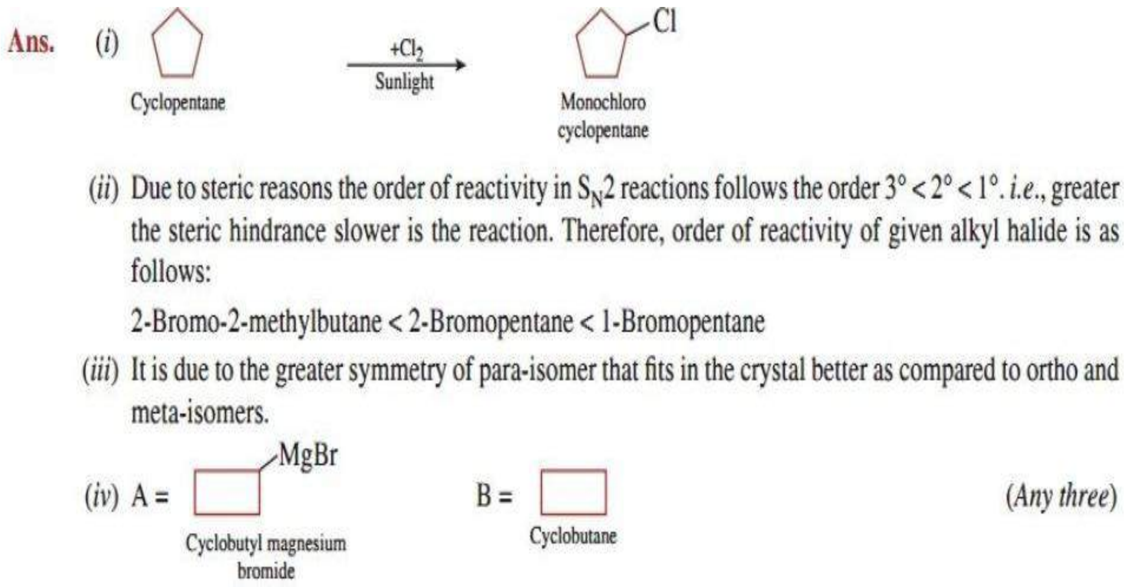
30 **Answer the following:**

(i) Which isomer of C_5H_{10} gives a single monochloro compound C_5H_9Cl in bright sunlight?

(ii) Arrange the following compounds in increasing order of reactivity towards SN^2 reaction: 2-Bromopentane, 1-Bromopentane, 2-Bromo-2-methylbutane

(iii) *p*-dichlorobenzene has higher melting point than those of *o*– and *m*– isomers.
(iv) Identify A and B in the following:





Ans. (*i*) Cyclopentane $\xrightarrow[\text{Sunlight}]{+Cl_2}$ Monochloro cyclopentane

(*ii*) Due to steric reasons the order of reactivity in S_N2 reactions follows the order 3° < 2° < 1°. *i.e.*, greater the steric hindrance slower is the reaction. Therefore, order of reactivity of given alkyl halide is as follows:

2-Bromo-2-methylbutane < 2-Bromopentane < 1-Bromopentane

(*iii*) It is due to the greater symmetry of para-isomer that fits in the crystal better as compared to ortho and meta-isomers.

(*iv*) A = Cyclobutyl magnesium bromide B = Cyclobutane (*Any three*)

31 **5. Write main product formed when:**

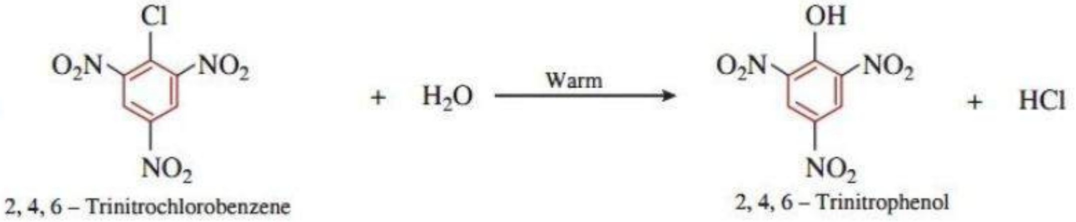
(i) Methyl chloride is treated with NaI/Acetone.
(ii) 2,4,6-Trinitrochlorobenzene is subjected to hydrolysis.
(iii) *n*-Butyl chloride is treated with alcoholic KOH.

Ans:

(*i*) $CH_3Cl + NaI \xrightarrow{Acetone} CH_3—I + NaCl$

Methyl chloride → Methyl iodide

(*ii*)



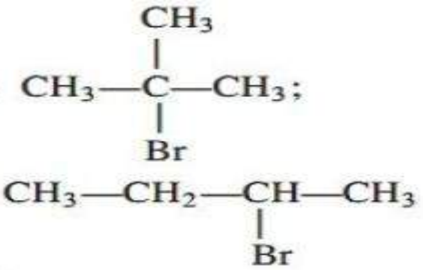
(*iii*) $CH_3—CH_2—CH_2—CH_2—Cl + alc\ KOH \longrightarrow CH_3—CH_2—CH = CH_2 + KCl + H_2O$

32 **Compound ‘A’ with molecular formula C_4H_9Br is treated with aq. KOH solution. The rate of this reaction depends upon the concentration of the compound ‘A’ only. When another optically active isomer ‘B’ of this compound was treated with aq. KOH solution, the rate of reaction was found to be dependent on concentration of compound and KOH both.**

(i) Write down the structural formula of both compounds ‘A’ and ‘B’.

(ii) Out of these two compounds, which one will be converted to the product with inverted configuration?

Ans. (*i*) Compound A:

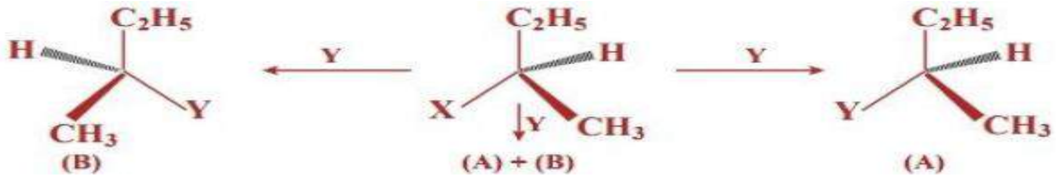


$CH_3—C(CH_3)(Br)—CH_3$;

Compound B: $CH_3—CH_2—CH(Br)—CH_3$

(*ii*) Compound ‘B’

33 **Consider the three types of replacement of group X by group Y as shown here.**

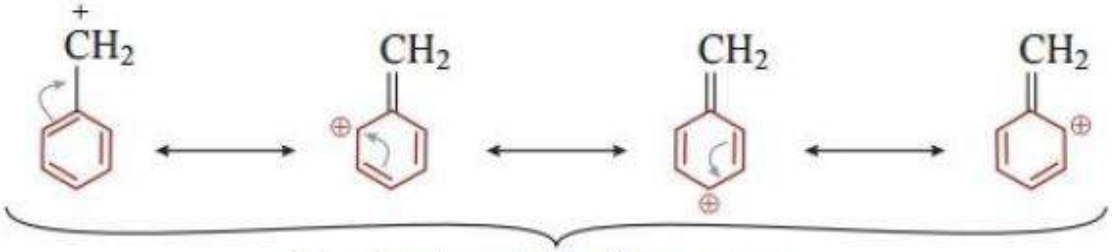


This can result in giving compound (A) or (B) or both. What is the process called if:
(i) (A) is the only compound obtained?
(ii) (B) is the only compound obtained?
(iii) (A) and (B) are formed in equal proportions?

Ans: (i) Retention
(ii) Inversion
(iii) Racemisation

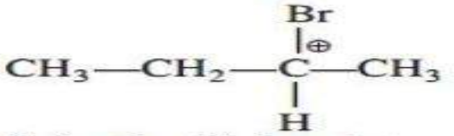
34 **Give reasons for the following:**
(i) Benzyl chloride is highly reactive towards the SN^1 reaction.
(ii) 2-Bromobutane is optically active but 1-bromobutane is optically inactive.
(iii) Electrophilic reactions in haloarenes occur slowly.

Ans: (i) Benzyl chloride is highly reactive towards the S_N1 reaction because the intermediate benzyl carbocation formed in the slowest step is stabilized through resonance.



Benzyl cation stabilised by resonance

(ii) 2-Bromobutane is a chiral molecule as it contains an asymmetric carbon atom, therefore, it is optically active; whereas 1-bromobutane is an achiral molecule as it does not contain an asymmetric carbon atom, therefore it is optically inactive.



$CH_3—CH_2—\overset{Br}{\underset{H}{C^{\oplus}}}—CH_3$

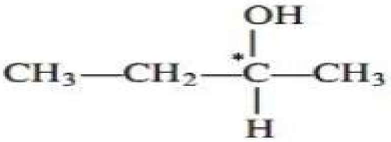
Carbocation of 2 - Bromobutane

(iii) Halogen in haloarenes withdraws electrons through –I effect and releases electrons through +R effect. The inductive effect is stronger than the resonance effect and causes net electron withdrawal. As a result, the electrophilic substitution reactions in haloarenes occur slowly.

35 **(i) Why are alkyl halides insoluble in water?**
(ii) Why is butan-1-ol optically inactive but butan-2-ol is optically active?
(iii) Although chlorine is an electron withdrawing group, yet it is *ortho, para* directing in electrophilic aromatic substitution reactions. Why?

Ans: **(i)** This is due to the inability of alkyl halide molecules to form intermolecular hydrogen bonds with water molecules.

(ii)



$CH_3—CH_2—\overset{OH}{\underset{H}{\overset{*}{C}}}—CH_3$

Due to presence of a chiral carbon, butan-2-ol is an optically active compound.

(iii) As the weaker resonance (+R) effect of Cl, which stabilizes the carbocation formed, tends to oppose the stronger inductive (–I) effect of Cl, which destabilizes the carbocation at *ortho* and *para* positions. This makes deactivation less for *ortho* and *para* positions.

36 **a) Give the full name of DDT.**
(b)What are freons? Give one example.
(c)Why the use of chloroform as anesthetic is decreasing?

Ans10. (a) *p,p'*-Dichlorodiphenyltrichloroethane

(b) The chlorofluorocarbon compounds of methane and ethane are collectively known as freons. Example: Freon-12 (CCl_2F_2)

(c)Inhaling chloroform vapors depresses the central nervous system and its chronic exposure may cause damage to the liver and kidneys due to metabolism of chloroform to phosgene gas. Hence the use of chloroform as anesthetic is decreasing.

CASE BASED QUESTIONS

37 **Read the passage given below and answer the following questions:**
Nucleophilic substitution reactions are of two types; substitution nucleophilic bimolecular (SN2) and substitution nucleophilic unimolecular (SN1) depending on molecules taking part in determining the rate of reaction. The reactivity of alkyl halide towards SN1 and SN2 reactions depends on various factors such as steric hindrance, stability of intermediate or transition state, and polarity of the solvent. SN2 reaction mechanism is favoured mostly by primary alkyl halide or transition state and polarity of the solvent,

SN2 reaction mechanism is favoured mostly by primary alkyl halide then secondary and then tertiary. This order is reversed in the case of SN1 reactions.

(a) Which of the following is most reactive towards nucleophilic substitution reaction and why ?

(i)C_6H_5Cl (ii) CH_2 =CHCl iii) $ClCH_2CH=CH_2$ (iv) CH_3CH = CHCl

(b) Out of SN1 and SN2 by which mechanism Isopropyl chloride undergoes hydrolysis and why ?

(c) Why does tertiary alkyl halides are practically inert to substitution by SN2 mechanism ?

or

(c) Arrange the following is the correct order of decreasing SN2 reactivity?

RCH_2X , R_3CX , R_2CHX

Ans (a). iii) $ClCH_2$ -CH = CH_2

Explanation: More the stability of the carbocation higher will be the reactivity of the parent chloride. Allyl chloride > Vinyl chloride > Chlorobenzene.

(b) Isopropyl chloride undergoes hydrolysis via both SN-1 and SN-2 mechanisms. Both of them yield the same result/ products. Since, isopropyl chloride is a secondary alkyl halide.

(c) The repulsion between the alkyl or any other groups present on an carbon atom, if the distance between the two is less than vander waals radius, than it is said to be the steric hindrance. That is the reason why tertiary alkyl halides are practically inert to substitution by SN2 mechanism as there is steric hindrance.

OR

(c) $RCH_2X > R_2CHX > R_3CX$

38 **Haloalkanes are colourless (when pure), sweet smelling liquids. CH_3Cl, CH_3Br and C_2H_5Cl and freons are gases. Boiling point increases with increase in molecular weight and increase in carbon chain and decreases with branching. They are insoluble in water due to inability to form H-bonds with water. Dipole moment increases with polarity, density increases with increase in molar mass. They are non-inflammable, therefore, CCl_4 is used as fire extinguisher under the name pyrene. *p*-dichlorobenzene has zero dipole moment, higher melting point than *o*-dichloro benzene due to symmetry, fits into crystal lattice readily. Haloalkanes undergo nucleophilic substitution reaction by S_N2 mechanism, 1° > 2° > 3°, S_N1 if carbocation formed is stable.**

They also undergo nucleophilic elimination reactions with alcoholic KOH. Haloarenes are less reactive than haloalkanes towards nucleophilic substitution due to resonance. Haloarenes undergo electrophilic substitution reaction like nitration, sulphonation, Friedel Crafts alkylation, acylation. Chloroform is used as solvent, Freon is used as refrigerant, dichloromethane is used as paint remover. Iodoform is used as antiseptic. DDT is insecticide but non- biodegradable.

(a) Arrange R—F, R—Br, R—I, R—Cl in increasing order of boiling point.

(b) A hydrocarbon 'A' (C_5H_{10}) gives only one monochloro product on photo chlorination. Identity 'A'.

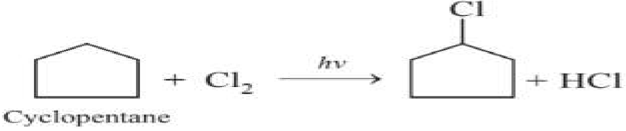
(c) Out of CH_2==CH—CH_2Cl and $CH_3CH_2CH_2Cl$ which one undergoes S_N1 mechanism faster?

or

(c) Why is chloroform stored in dark coloured bottles?

Ans (a). R—F < R—Cl < R—Br < R—I

(b) Identity 'A'.



(c) Ans. CH_2==CH—CH_2Cl because CH_2—CH—CH_2+ is more stable due to resonance.

or

(**c) Ans.** It is done so as to prevent formation of $COCl_2$ which is poisonous

$$CHCl_3 + \frac{1}{2}O_2 \xrightarrow{Sunlight} COCl_2 + HCl$$

39 **The substitution reaction of alkyl halides occurs in S_N1 or S_N2 mechanism whatever mechanism alkyl halide follow for substitution reaction to occur, the polarity of the carbon-halogen bond is responsible for the substitution reaction. The rate of S_N1 reactions are governed by the stability of carbocation where as for S_N2 reactions steric factor is the deciding factor. If the starting material is a chiral compound, we may end up with an inverted product or racemic mixture depending upon the type of mechanism followed by alkyl halide. Cleavage of ethers with HI is also governed by steric factor and stability of carbocation which indicates that in organic chemistry, these two major factors help us in deciding the kind of product formed.**

(a) Predict the stereochemistry of the product formed if optically active alkyl halide undergoes substitution reaction by S_N1 mechanism.

(b) Name the instrument used for measuring the angle by which the plane polarised light is rotated.

(c) Predict the major product formed when 2-bromopentane reacts with alcoholic KOH.

OR

(c) Write the structure of the products formed when anisole is treated with HI.

Ans (a). Racemic mixture will be formed.

(b). Polarimeter

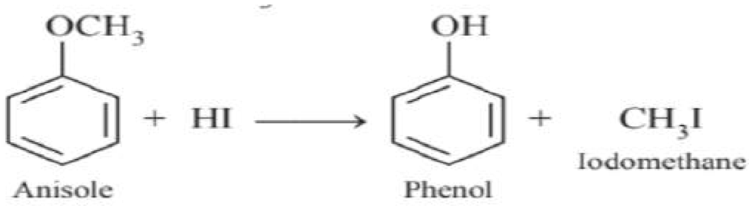
(c) Pent-2-ene will be major product.

$CH_3CH(Br)CH_2CH_2CH_3 + KOH(alc) \rightarrow CH_3CH{=}{=}CHCH_2CH_3 + KBr + H_2O$

2-Bromopentane Pent-2-ene

OR

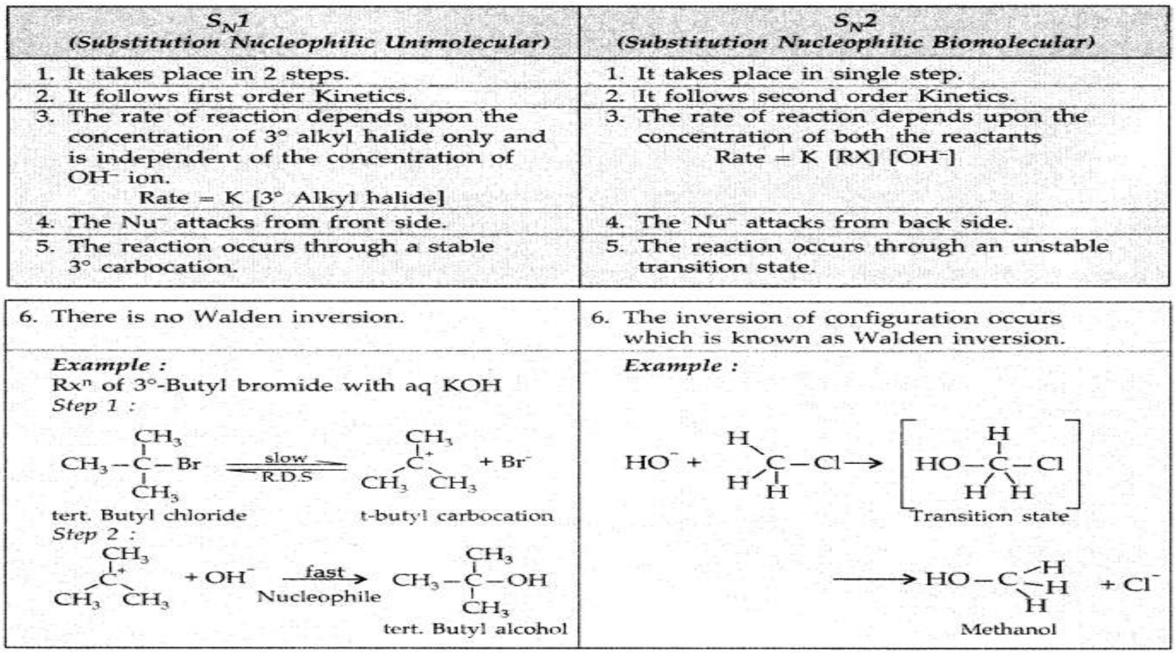
(c)



LONG ANSWER 5 MARK QUESTIONS

40 **How would you differentiate between S_N1 and S_N2 mechanisms of substitution reactions? Give one example of each.**

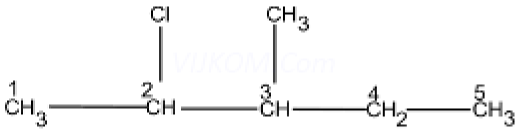
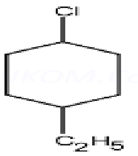
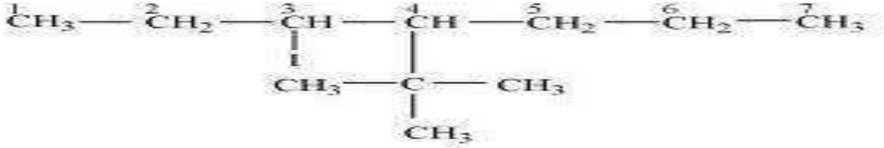
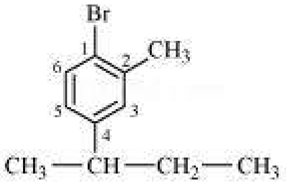
Ans1:

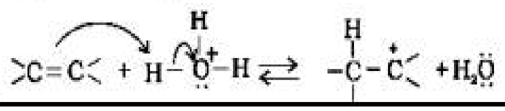


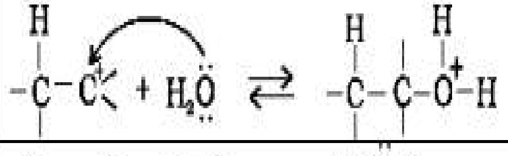
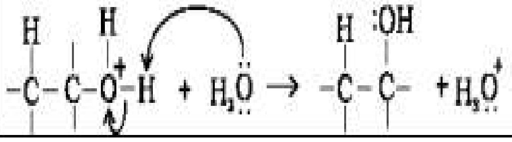
S_N1 (***Substitution Nucleophilic Unimolecular***)	***S_N2*** (***Substitution Nucleophilic Biomolecular***)
1. It takes place in 2 steps.	1. It takes place in single step.
2. It follows first order Kinetics.	2. It follows second order Kinetics.
3. The rate of reaction depends upon the concentration of 3° alkyl halide only and is independent of the concentration of OH^- ion. Rate = K [3° Alkyl halide]	3. The rate of reaction depends upon the concentration of both the reactants Rate = K [RX] [OH^-]
4. The Nu^- attacks from front side.	4. The Nu^- attacks from back side.
5. The reaction occurs through a stable 3° carbocation.	5. The reaction occurs through an unstable transition state.
6. There is no Walden inversion.	6. The inversion of configuration occurs which is known as Walden inversion.
Example : Rxⁿ of 3°-Butyl bromide with aq KOH *Step 1 :* tert. Butyl chloride → t-butyl carbocation + Br^- (slow, R.D.S) *Step 2 :* t-butyl carbocation + OH^- (Nucleophile) → tert. Butyl alcohol (fast)	***Example :*** HO^- + H_3C-Cl → [Transition state] → Methanol + Cl^-

41 **Write structures of the following compounds:**

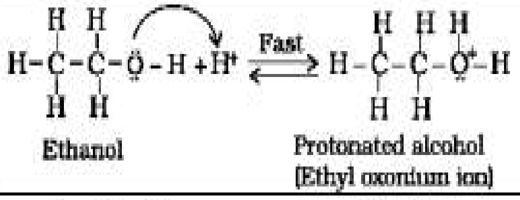
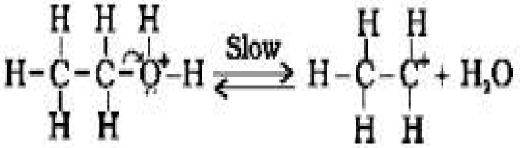
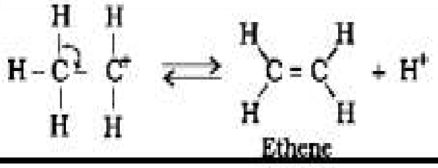
(i) 2-Chloro-3-methylpentane

	(ii) 1-Chloro-4-ethylcyclohexane **(iii) 4-tert. Butyl-3-iodoheptane** **(iv) 1,4-Dibromobut-2-ene** **(v) 1-Bromo-4-sec. butyl-2-methylbenzene** Ans4: (i)  $\overset{1}{C}H_3-\overset{2}{C}H(Cl)-\overset{3}{C}H(CH_3)-\overset{4}{C}H_2-\overset{5}{C}H_3$ (ii)  (iii)  4-Tert-Butyl-3-iodoheptane (iv)  $Br-\overset{1}{C}H_2-\overset{2}{C}H=\overset{3}{C}H-\overset{4}{C}H_2-Br$ (v) 
42	**(i) Define the following terms : (a) Enantiomers (b) Racemic mixture** **(ii) Which polyhalogen compounds is used as an antiseptic?:** **(iii) Use of $CHCl_3$ as anaesthetic is not preferred.** **(iv) C–Cl bond length in chlorobenzene is shorter than C–Cl bond in CH_3Cl.** Ans: (i) a) The stereoisomers related to each other as non-superimposable mirror images are called enantiomers. b) Equimolar mixture of d- and l- form is known as racemic mixture (ii) Antiseptics- polyhalogenated compounds like iodoform have an antibacterial effect. (iii) Because it led to liver injury (often delayed) and cardiac sensitization, this use has been generally eliminated. (iv) In chlorobenzene, each carbon atom is sp2 hybridised/ resonating structures / partial donable bond character

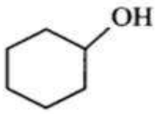
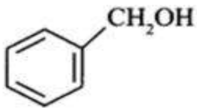
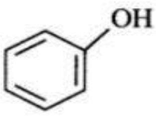
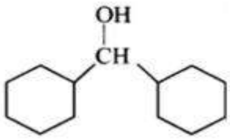
	UNIT 7 : ALCOHOLS, PHENOLS AND ETHERS **GIST OF THE CHAPTER**
1	**Physical Properties of Alcohols and Phenols** Boiling Points • Increase with increase in the number of carbon atoms (increase in van der Waal's forces). • In alcohols, the boiling points decrease with increase of branching in carbon chain (because of decrease in van der Waal's forces with decrease in surface area). • Due to the presence of intermolecular hydrogen bonding, boiling points of alcohols and phenols are higher in comparison to other classes of compounds, namely hydrocarbons, ethers, haloalkanes and haloarenes of comparable molecular masses. Solubility • Soluble in water due to their ability to form hydrogen bonds with water molecules. • The solubility decreases with increase in size of alkyl/aryl (hydrophobic) groups. • Several of the lower molecular mass alcohols are miscible with water in all proportions.
2	Lucas Test: - Used to distinguish primary, secondary and tertiary alcohols • Lucas reagent (conc. HCl and $ZnCl_2$) • Alcohols are soluble in Lucas reagent while Alkyl halides (RX) are immiscible and produce turbidity in solution. • tertiary alcohols- Immediate turbidity • Secondary alcohols- Turbidity appears After 5 minutes • Primary alcohols- No turbidity at room temperature.
3	**Classification of alcohols:** • Primary Alcohol CH_3CH_2OH, , Secondary Alcohol $(CH_3)_2CHOH$, Tertiary Alcohol $(CH_3)_3COH$ • Vinyl Alcohol : $CH_2=CH-OH$, Allyl Alcohol: $CH_2=CH-CH_2-OH$ • Benzyl Alcohol: $C_6H_5-CH_2OH$
4	**IUPAC Name Pattern:** Preffix + rootword+ primary suffix + ol
5	**Acidity of Alcohols & Phenols and their derivatives:** *Alcohols are weaker acid than water due to +I effect caused by Alkyl group decreases polarity of O H bond. *Order of acidity of Alcohols is $CH_3CH_2OH > (CH_3)_2CHOH > (CH_3)_3COH$ *Relative Order of acidity of alcoholsis $RCOOH > H_2CO_3 > C_6H_5OH > H_2O > ROH$. *Phenol is more acidic than Alcohols due stabilized phenoxide ion through resonance. *Presence of electron withdrawing groups in Phenol increases its acidic strength where as presence of electron realeasing groups in Phenol decreases its acidic strength. * Electron withdrawing groups are: $-NO_2$, -CN, -X etc. *Electron releasing groups are: -R, $-NH_2$, -OR etc. *Increasing order of acidic strength is o-cresol < p-cresol < m- cresol < Phenol < 0-Nitro Phenol < 2,4,6-Trinitrophenol(Picric acid) *Acidic strength is directly proportional to K_a value and inversely proportional to pK_a value.
6	**MechanismfortheHydrationofalkenestoalcohol** **Mechanism-**Themechanismofthereaction involvesthefollowingthreesteps: **Step1**:Protonationofalkenetoformcarbo cationbyelectrophilicattackof H_3O^+. $H_2O + H^+ \rightarrow H_3O^+$ 

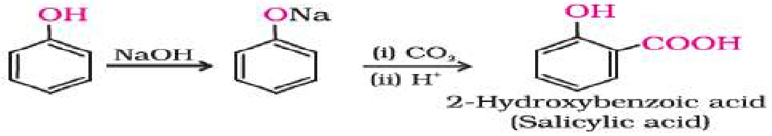
Step2: Nucleophilicattackofwateroncarbocation	
Step3: Deprotonationtoformanalcohol	

MechanismfortheacidicDehydrationofalcoholstogivealkenes:

Step1:Formationofprotonatedalcohol.	
Step2: Formationofcarbocation: Itistheslowheststepandhence,theratedeterminingstepofthereaction.	
Step3: Formationofethenebyeliminationofaproton	

1	**Which of the following will give a violet colour with neutral $FeCl_3$ solution?** A. Ethanol B. Phenol C. Methanol D. Diethyl ether **Ans - B**
2	**Which of the following alcohols will react fastest with Lucas reagent at room temperature?** A. 1-Butanol B. 2-Butanol C. 2-Methyl-2-propanol D. Ethanol **Ans - C**
3	**Which of the following reagents can be used to convert phenol to 2,4,6-tribromophenol?** A. Bromine water B. Br_2 in CCl_4 C. Aqueous Br^-/H^+ D. HBr **Ans – A**
4	**Williamson synthesis involves the reaction of sodium alkoxide with:** A. Alkene B. Alkyl halide C. Alcohol D. Ketone **Ans – B**
5	**Which compound among the following is most acidic?** A. Ethanol B. Phenol C. Water D. Cyclohexanol Ans – B
6	**What is the IUPAC name of $CH_3\text{-}O\text{-}CH_2CH_3$?** A. Ethyl methyl ether B. Methoxyethane C. Ethoxymethane D. Methyl ethyl ether Ans – B
7	**Dehydration of alcohols to alkenes is an example of:** A. Nucleophilic substitution B. Electrophilic substitution C. Elimination reaction D. Addition reaction **Ans – C**
8	**The major product of the reaction of ethanol with hot concentrated H_2SO_4 at 443 K is:** A. Diethyl ether B. Acetaldehyde C. Ethene D. Ethyl hydrogen sulphate **Ans – C**
9	**The correct order of reactivity of the following alcohols towards Lucas reagent is:** A. 1° > 2° > 3° B. 2° > 1° > 3° C. 3° > 2° > 1° D. 2° > 3° > 1° Ans – C
10	**Which of the following is the major product when anisole reacts with bromine in the presence of $FeBr_3$?** A. o-Bromoanisole B. m-Bromoanisole C. p-Bromoanisole D. A mixture of o- and p-Bromoanisole **Ans – D**
11	**Which of the reagents/test can be used to distinguish propan-1-ol and propan-2-ol?** A. Lucas reagent and Iodoform test B. Iodoform test and Tollens Reagent C. Tollen’s reagent and Fehling’s test D. Lucas reagent and Fehling’s test Ans:-A

12	**Which one is an example of allylic alcohol?** A. Prop-2-en-1-ol B. but-2-en-2-ol C. Prop-1-en-1-ol D. Prop-1-en-2-ol Ans:-A
13	**Which of the following reagents cannot be used to oxidise primary alcohols to aldehydes?** A. CrO3 in anhydrous medium. B. KMnO4 in acidic medium. C. Pyridinium chlorochromate. D. Heat in the presence of Cu at 573K Ans:-B
14	**Boiling point of alcohol is higher than ethers due to**: A. Ionic nature B. Hydrogen bonding C. Covalent bonding D. Lower molar mass **Ans**: B
15	**Which one of the following compounds has the most acidic nature?** (A)  (B)  (C)  (D)  **Ans:-C**
	For each question below, choose the correct option: **a) Both Assertion (A) and Reason (R) are true, and R is the correct explanation of A.** **b) Both A and R are true, but R is not the correct explanation of A.** **c) A is true, but R is false.** **d) A is false, but R is true**
16	**Assertion(A):** Phenol is more acidic than ethanol. **Reason (R):** Phenoxide ion formed after losing H^+ is stabilized by resonance. **Answer:** a) Both A and R are true, and R is the correct explanation of A.
17	**Assertion (A):** Ethers have low boiling points compared to alcohols. **Reason (R):** Ethers do not form hydrogen bonds with each other. **Answer**: a) Both A and R are true, and R is the correct explanation of A
18	**Assertion (A):** Lucas test is used to identify primary, secondary, and tertiary alcohols.

	Reason (R): Lucas reagent reacts immediately with primary alcohols. **Answer:** c) A is true, but R is false.
19	**Assertion(A):** Tertiary alcohols dehydrate more easily than primary alcohols. **Reason (R):** Tertiary carbocations are more stable than primary carbocations. **Answer:** a) Both A and R are true, and R is the correct explanation of A
20	**Assertion (A):**Alcohols show higher boiling points than ethers of similar molecular mass. **Reason (R):** Alcohols can form intermolecular hydrogen bonds, but ethers cannot. **Answer:** a) Both A and R are true, and R is the correct explanation of A.
	SHORT ANSWER QUESTIONS (2 MARKS)
21	**What happens when – (a) phenol reacts with sodium metal?** **(b) Phenol is heated with Zn dust ?** **Answer: (a)** $C_6H_5OH + Na \rightarrow C_6H_5ONa + \frac{1}{2}H_2$ **(b)** $C_6H_5OH + Zn \xrightarrow{\text{Heat}} C_6H_6 + ZnO$
22	**Give chemical tests to distinguish between:** **a) Phenol and Benzyl alcohol** **Answer**: Phenol gives violet colour with $FeCl_3$, benzyl alcohol does not. **b) Ethanol and Methanol** **Answer:** Iodoform test: Ethanol gives yellow ppt with iodine and NaOH; methanol does not.
23	**Write equations for the following conversions:** **a) Phenol to salicylic acid** **b) Ethanol to ethanoic acid** **Answer:** a)  b) $CH_3CH_2OH + [O] \rightarrow CH_3COOH$ (oxidation using $KMnO_4$ or $K_2Cr_2O_7$)
24	Write the mechanism for the acid-catalysed dehydration of ethanol. **Answer:** Step 1: Protonation of ethanol:- $CH_3CH_2OH + H^+ \rightarrow CH_3CH_2OH_2^+$ Step 2: Loss of water:- $CH_3CH_2OH_2^+ \rightarrow CH_3CH_2^+ + H_2O$ Step 3: Deprotonation:- $CH_3CH_2^+ \rightarrow CH_2{=}CH_2 + H^+$
25	**How can you prepare the following using Williamson Synthesis?** **a) Methoxybenzene** **b) Diethyl ether** **Answer:** a) $C_6H_5ONa + CH_3I \rightarrow C_6H_5OCH_3 + NaI$ b) $C_2H_5ONa + C_2H_5Br \rightarrow C_2H_5OC_2H_5 + NaBr$
26	**Give reasons:** **a) Alcohols have higher boiling points than ethers.** **b) Phenol does not react with sodium carbonate, but carboxylic acids do**. **Answer:** a) Alcohols form intermolecular hydrogen bonds; ethers do not.

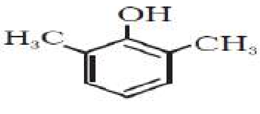
b) Phenol is less acidic than carboxylic acids and cannot liberate CO_2 from Na_2CO_3.

27 **How would you distinguish between:**

a) Ethanol and Diethyl ether
b) Phenol and Benzoic acid

Answer:
a) Iodoform test – Ethanol gives yellow ppt with iodine and NaOH; ether does not.
b) $NaHCO_3$ test – Benzoic acid gives brisk effervescence (CO_2) with $NaHCO_3$, phenol does not.

28 **Give the IUPAC names of the following compounds: -**

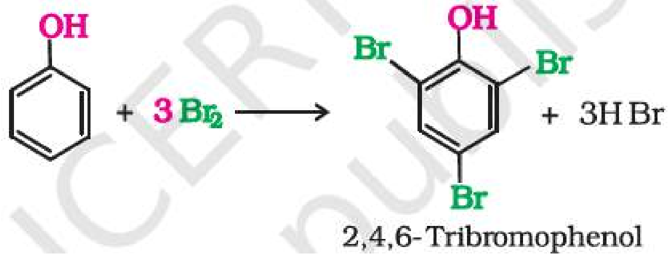
(i)


(ii)


Answer: -(i) 2,6-Dimethylphenol (ii) 1-Ethoxy-2-nitrocyclohexane

29 **Convert:**
(a) Phenol → 2,4,6-tribromophenol
(b) Ethanol → Ethene

Answer: (a)



(b) C_2H_5OH (conc. H_2SO_4, 443K) → $CH_2{=}CH_2 + H_2O$

30 **Arrange the following in the order specified and give reasons:**
a) Reactivity with Lucas Reagent (decreasing order): Butan-2-ol, Butan-1-ol, 2-Methylpropan-2-ol
b) Boiling point (increasing order): Methanol, Ethanol, Propanol

Answer:
a) 2-Methylpropan-2-ol > Butan-2-ol > Butan-1-ol – $3^0 > 2^0 > 1^0$ alcohol -more stable carbocation, faster turbidity.
b) Methanol < Ethanol < Propanol – more carbon atoms → stronger Van der Waals forces.

SHORT ANSWER QUESTIONS (3 MARKS)

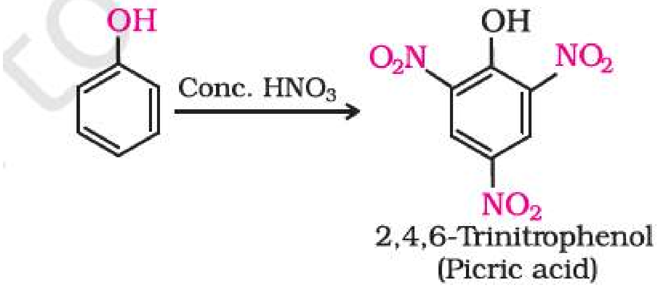
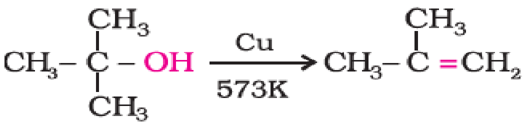
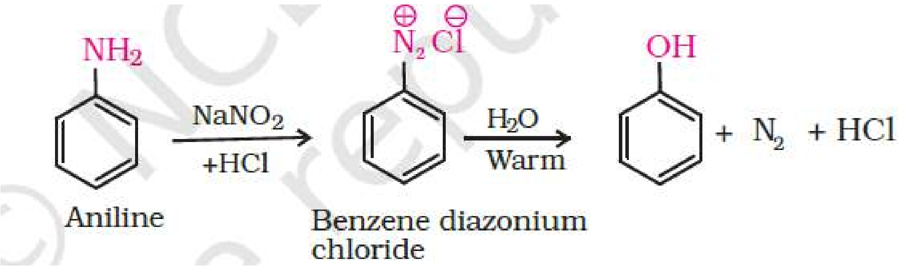
31 **(i) Give the structure and IUPAC name of the final product expected from the following reactions:**

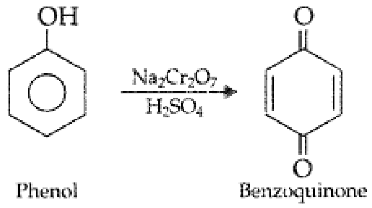
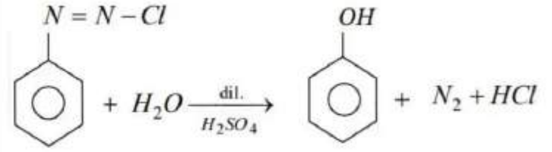
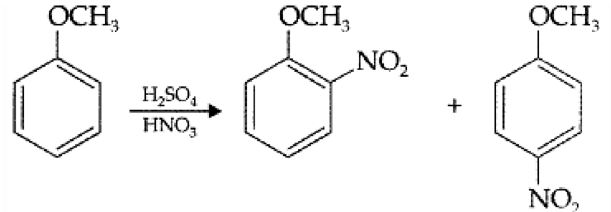
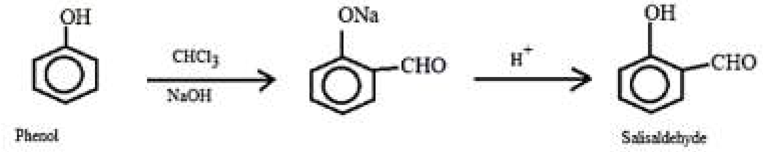
(a) Hydroboration of propene followed by oxidation with H_2O_2 in alkaline medium.

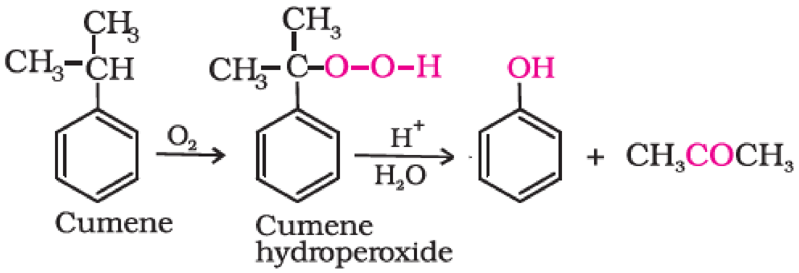
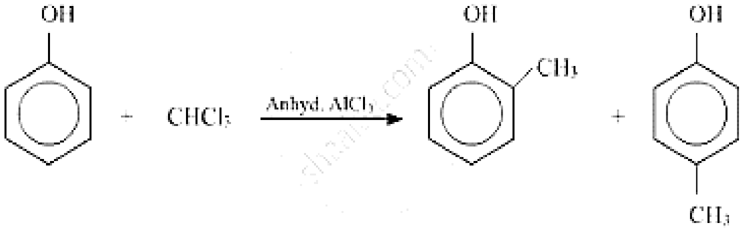
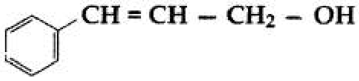
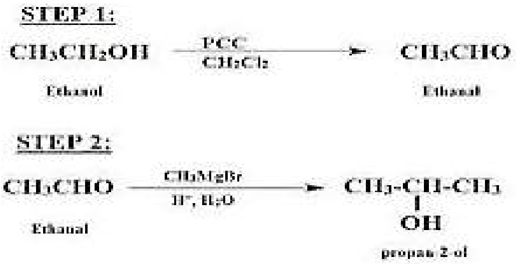
(b) Reaction of phenol with Br_2 (aq).

(ii) Give one chemical test to distinguish between methanol and benzoic acid.

Ans: (i) (a) Propan-1-ol $CH_3CH_2CH_2OH$ (b) 2,4,6-Tri bromo phenol.

	(ii) Sodium bicarbonate test: Benzoic acid gives brisk effervescence with $NaHCO_3$ solution whereas methanol does not
32	**Write the equations for the following conversions:** **(a) Phenol to 2,4,6-trinitrophenol** **(b) 2-methylpropan-2-ol to 2-methylpropene** **(c) Phenol to anisole** **Answer;- (a)**  (b)  $CH_3-\overset{CH_3}{\underset{CH_3}{C}}-OH \xrightarrow[573K]{Cu} CH_3-\overset{CH_3}{C}=CH_2$ (c) $C_6H_5OH + CH_3I$ (in presence of NaOH) → Anisole ($C_6H_5OCH_3$) + NaI
33	**Differentiate between primary, secondary, and tertiary alcohols using chemical tests**. **Answer:** Lucas Test: Given alcohol + conc.HCl and anhydrous $ZnCl_2$ Primary: No turbidity at room temp Secondary: Turbidity in 5 mins Tertiary: Immediate turbidity
34	**How would you convert:** **(a) Propene to propan-2-ol** **(b) Aniline to phenol** **(c) Phenol to p-nitrophenol** **Answer:** **(a) $CH_2=CH-CH_3 + H_2O \rightarrow CH_3-CHOH-CH_3$ (in acidic medium)** **(b)**  **(c)** 

35	**What happens (a) when phenol is oxidized by $Na_2Cr_2O_7/H_2SO_4$?** **Ans: (a)**  **(b) benzene diazonium chloride is heated with water?** **Ans:**  **(a) Anisole is nitrated with a mixture of concentrated HNO_3 and H_2SO_4** **Ans:**  *p*-nitro Anisol is major product
36	**(i) What happens when (write reactions involved)** **(a) Phenol is warmed with $CHCl_3$ in the presence of aqueous NaOH.** **b) Ethanol is treated with conc. H_2SO_4 at 413K.** **(ii) Write the structures of the isomers of alcohols with molecular formula $C_4H_{10}O$. Which of these will exhibit optical activity.** Ans: (i) a)  (a) $2\ C_2H_5OH$ →[conc. H_2SO_4, ~413 K] $C_2H_5–O–C_2H_5 + H_2O$ (ii) a) $CH_3CH_2CH_2CH_2OH$ b) $CH_3CH_3CH(OH)CH_3$ (Optically active) c) $(CH_3)_3C$-OH d) $(CH_3)_2CHCH_2OH$
37	**Write the reactions involved in the following:** **(a) Preparation of phenol from cumene** **(b) Friedel-Crafts alkylation of phenol.**

	Answer (a)  (b) Friedel-Crafts alkylation of phenol. 
38	**i) How do you convert ethanol to propan-2-ol.** **ii) Write the IUPAC name of the following compound:**  Ans:- (i)  (ii) 3-phenyl prop-2-en-1-ol
39	**Name the chemical test commonly used to distinguish between the following pairs of compounds.** **i) n-Propyl alcohol and isopropyl alcohol.** **ii) Propan-1-ol and ethanol** **iii)Cyclohexanol and phenol** **Ans: (i)** n-Propyl alcohol and isopropyl alcohol can be distinguished by the Lucas Test. When treated with conc.HCl and anh.$ZnCl_2$, isopropyl alcohol gives turbidity after some time where as n-Propylalcohol does not react at room temperature (ii) Iodoform test:-Ethanol gives yellow ppt with iodine and NaOH,where as propan-1-ol does not. (iii) Neutral $FeCl_3$ test:- Phenol gives violet colouration with neutral $FeCl_3$, cyclohexanol does not.
40	**Give reasons :** **a. O-nitrophenol is steam volatile whereas p-nitrophenol is not.** **b. O-nitrophenol has lower boiling point than p-nitrophenol.**

c. Nucleophilic substitution reactions are not very common in phenols.

Answer :

a. O-nitrophenol is steam volatile due to presence of intramolecular Hydrogen bonding whereas p-nitrophenol is not steam volatile due to presence of intermolecular Hydrogen bonding.
b. O-nitrophenol has lower boiling point than p-nitrophenol due to presence of intramolecular Hydrogen bonding in Ortho-nitro phenol and presence of intermolecular Hydrogen bonding in p-nitrophenol.
c. Phenols not undergo Nucleophilic substitution reaction easily because of double bond character between C=O bond which is difficult to break

CASE BASED QUESTIONS(CBQs) (4 MARKS)

41 **Phenol is widely used in the manufacture of antiseptics, plastics, and medicines. In laboratories, phenol is identified by its reaction with $FeCl_3$. It also undergoes electrophilic substitution more easily than benzene due to the –OH group being an activating group. When treated with bromine water, it forms a white precipitate. Phenol can also react with sodium to liberate hydrogen gas, indicating its acidic character.**

Answer the following:
(a) What happens when phenol reacts with sodium?

OR

Why is phenol more reactive than benzene in electrophilic substitution reactions?
(b) Write the observation when phenol is treated with neutral $FeCl_3$.

c) Arrange the following compounds in increasing order of their acid strength: Propan-1-ol, 2,4,6-trinitrophenol, 3-nitrophenol, 3,5-dinitrophenol, phenol, 4-methylphenol. Also give reasons for the same

Answer:

(a) $2C_6H_5OH + 2Na \rightarrow 2C_6H_5ONa + H_2\uparrow$
OR

–OH group donates electron density via resonance, activating the ring
(b) A violet-colored complex is formed

(c) Propan-1-ol, 4-methylphenol, phenol, 3-nitrophenol, 3,5-dinitrophenol,

2,4, 6-trinitrophenol.

Presence of EWG like -NO_2 group increases acidity of phenols where as presence of EDG like CH_3 decrease the acidity of phenols

42 **Boiling point is a physical property influenced by molecular mass, polarity, and the presence of intermolecular forces such as hydrogen bonding. In organic compounds, alcohols have higher boiling points than ethers and alkanes of similar molar masses due to strong hydrogen bonding.**

For example, the boiling points of some organic compounds are:

- **Methanol (CH_3OH): 65°C**
- **Ethanol (CH_3CH_2OH): 78°C**
- **Propanol ($CH_3CH_2CH_2OH$): 97°C**
- **Methoxyethane ($CH_3OCH_2CH_3$): 7°C**

- **Propane ($CH_3CH_2CH_3$): –42°C**

This trend shows that alcohols exhibit significantly higher boiling points due to hydrogen bonding, which is absent in ethers and alkanes.

Answer the following questions:

(a) Arrange the following compounds in increasing order of boiling point:
Propane, Methoxyethane, Ethanol

(b) Why does ethanol have a higher boiling point than methoxyethane, even though their molar masses are nearly the same?

OR

Predict which compound has stronger intermolecular hydrogen bonding: Methanol or Propanol? Justify.

(c) Among alcohols, what trend is observed in boiling point as the carbon chain length increases? Explain briefly.

Answer :

(a) Propane < Methoxyethane < Ethanol

(b) Ethanol forms intermolecular hydrogen bonds due to –OH group; methoxyethane cannot, leading to lower boiling point despite similar molar mass.

OR

Methanol has stronger hydrogen bonding per molecule due to its smaller size and higher polarity, though propanol has more surface area.

(c) Boiling point increases with increasing carbon chain length due to stronger Van der Waals forces (greater molecular surface area), in addition to hydrogen bonding

43 **The Lucas Test is a classical method to distinguish between primary (1°), secondary (2°), and tertiary (3°) alcohols based on their reactivity with Lucas reagent — a mixture of concentrated HCl and anhydrous $ZnCl_2$. The reaction follows an SN1 mechanism and proceeds via carbocation formation.**

The turbidity observed in the test is due to the formation of alkyl halides, which are insoluble in the aqueous medium. The order of reactivity is:

- **Tertiary alcohols: Immediate turbidity (most stable carbocation)**
- **Secondary alcohols: Turbidity appears within 5–10 minutes**
- **Primary alcohols: No turbidity at room temperature**

This test is commonly used in labs to identify the type of alcohol based on reaction rate.

Answer the following questions:

a)Name the components of Lucas reagent and mention its role.

b) Arrange the following alcohols in increasing order of turbidity appearance in the Lucas test:
Butan-2-ol, 2-methylpropan-2-ol, Butan-1-ol

OR

Write the reaction of 2-methylpropan-2-ol with Lucas reagent.

(c) Why does 3° alcohol give turbidity faster than 1° alcohol? Explain in terms of mechanism.

Answer :

(a) Lucas reagent = Concentrated HCl + anhydrous $ZnCl_2$; it facilitates substitution of –OH group with Cl by forming a carbocation intermediate.

(b) Butan-1-ol < Butan-2-ol < 2-methylpropan-2-ol

OR

$(CH_3)_3COH + HCl \rightarrow (CH_3)_3CCl + H_2O$ (in presence of $ZnCl_2$)

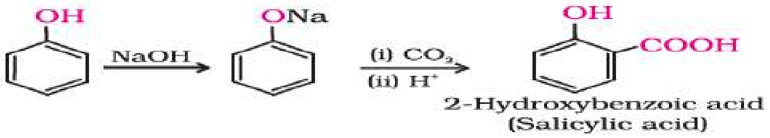
(c) 3° alcohol forms a highly stable tertiary carbocation, making the SN1 reaction proceed rapidly. In contrast, 1° alcohols form unstable carbocations and react very slowly, if at all, at room temperature.

LONG ANSWER QUESTIONS (5 MARKS)

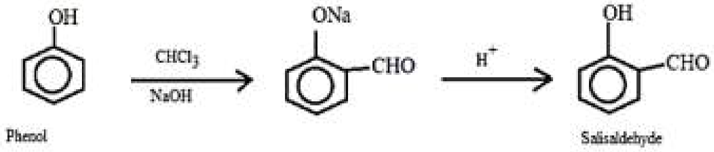
44 **Explain the following with suitable chemical equations:**
(a) Kolbe's reaction
(b) Reimer–Tiemann reaction
(c) Williamson's ether synthesis
(d) Dehydration of ethanol
(e) Iodoform test for alcohols

Answer:

a) **Kolbe's Reaction:**



b) **Reimer–Tiemann Reaction:**



(c) Williamson's Synthesis: $CH_3CH_2ONa + CH_3Br \rightarrow CH_3CH_2OCH_3 + NaBr$
(d) Dehydration of Ethanol: $CH_3CH_2OH \rightarrow$(conc. H_2SO_4, 443 K) $CH_2{=}CH_2 + H_2O$
(e) Iodoform Test: $CH_3CH(OH)CH_3 + I_2/NaOH \rightarrow CHI_3$ (yellow ppt) + CH_3COONa

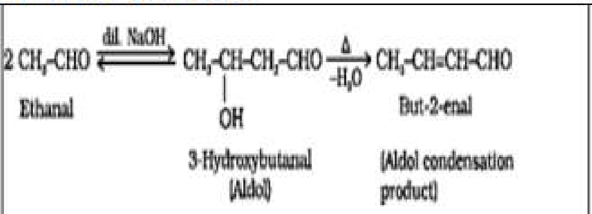
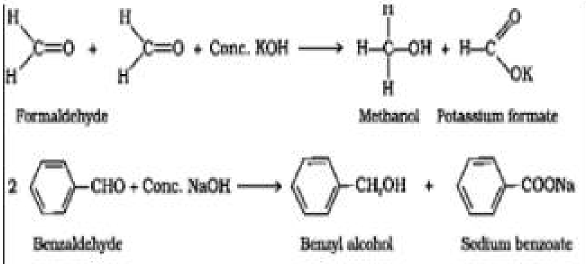
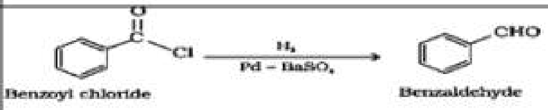
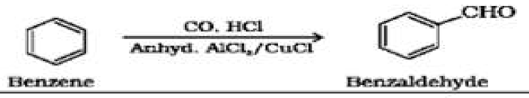
45 **a) Explain why:**
(i) Alcohols are more soluble in water than hydrocarbons.
(ii) Tertiary alcohols do not get easily oxidised.
(iii) Boiling point of phenol is higher than benzene.

(b) Write IUPAC names of the following:
(i) $CH_3CH(OH)CH_2CH_3$
(ii) $CH_3CH_2CH_2OCH$

Answers: (a) (i) Alcohols form **hydrogen bonds** with water due to –OH group → higher solubility. Hydrocarbons are **non-polar** → not soluble in polar solvents like water.
(ii) Tertiary alcohols lack **α-hydrogen**, so they resist oxidation easily.

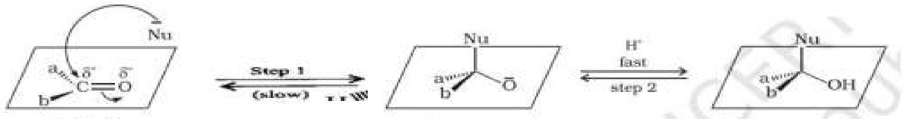
	(iii) Phenol forms strong **intermolecular hydrogen bonds**, raising its boiling point. Benzene cannot form H-bonds. **b) IUPAC Names:** (i) **Butan-2-ol** (ii) **1-Methoxypropane**
46	**Name the reagents used in the following reactions:** **a) Oxidation of a primary alcohol to carboxylic acid.** **b) Oxidation of a primary alcohol to aldehyde.** **c) Benzyl alcohol to benzoic acid.** **d) Dehydration of propan-2-ol to propene.** **e) Butan-2-one to butan-2-ol.** Answers:- a) Acidified potassium permanganate ($KMnO_4$) or Acidified potassium dichromate ($K_2Cr_2O_7/H_2SO_4$) b) Pyridinium chlorochromate (PCC) c) Acidified potassium permanganate ($KMnO_4$) (very effective for oxidizing side-chain alcohols on aromatic rings) d) Concentrated H_2SO_4, heated to around 443 K (170 °C) (Acts as a dehydrating agent) e) Reducing agent like $NaBH_4$ (sodium borohydride) or $LiAlH_4$ (lithium aluminium hydride)

Unit 8 : ALDEHYDE, KETONES AND CARBOXYLIC ACIDS
GIST OF THE CHAPTER

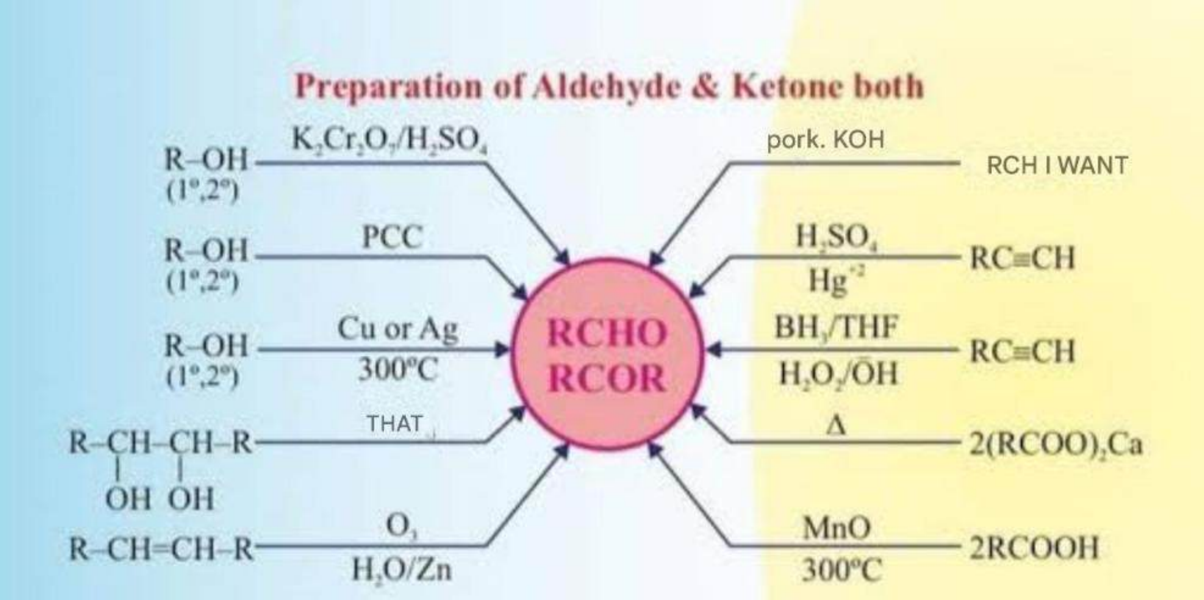
1	**Aldol Condensation :** Aldehydes and ketones *having at least one α – hydrogen* undergo a condensationreaction in the presence of **dilute alkali** (NaOH ,KOH etc.)as catalyst to form β-hydroxyaldehyde (aldol)or β – hydroxyketone (ketol) respectively	
2	**Cannizzaro Reaction:** Aldehydes, which do 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.	
3	**Clemmensen Reaction:** The carbonyl group of aldehydes and Ketones are reduced to CH_2 group ontreatment with zinc amalgam(Zn/Hg) and concentrated hydrochloric acid.(Conc.HCl)	$CH_3CH=O \xrightarrow{Zn-Hg,\ HCl} CH_3CH_3$ $CH_3CO\ CH_3 \xrightarrow{Zn-Hg\ HCl} CH_3CH_2CH_3$
	Wolf Kishner Reaction	$>C=O \xrightarrow[-H_2O]{NH_2NH_2} >C=NNH_2 \xrightarrow[Heat]{KOH/ethylene\ glycol} >CH_2 + N_2$
	Rosenmund Reaction: Acyl chloride (acid chloride) is hydrogenated over catalyst, palladium on barium sulphate.	
	Etard Reaction-	
	Stephen Reaction:	$RCN \xrightarrow[H_3\overset{+}{O}]{SnCl_2 + HCl} RCHO$
	Gatterman-Koch reaction:	
	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.	$\underset{Propene}{CH_3CH=CH_2} \xrightarrow[2.\ Zn\ +\ H_2O]{1.\ O_3} \underset{Ethanal}{CH_3\ CHO} + \underset{Methanal}{HCHO}$
	Decarboxylation : Sodium salts of acids when heated with soda lime, alkanes are formed.	$\underset{Sodium\ acetate}{CH_3\ COONa} + \underset{Sodium\ lime}{NaOH\ (CaO)} \rightarrow \underset{Methane}{CH_4} + Na_2CO_3$
	Hell Volhard Zelinsky: (HVZ) Carboxylic acids having an α-hydrogen are halogenated at the α-position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give α- halocarboxylic acids	 $RCH_2\text{-}COOH \xrightarrow[ii\ H_2O]{i\ X_2/\ Red\ phosphorus} \underset{X}{R\text{-}CH\text{-}COOH}$ X= Cl ,Br α –halocarboxylic acids

ALDEHYDES,KETONES&CARBOXYLICACIDS

GivemechanismforNucleophilicadditionreactionincarbonylcompounds



ALDEHYDES, KETONES AND CARBOXYLIC ACIDS



1	Which of the following compounds will give a positive Fehling's test? A. Acetophenone B. Benzaldehyde C. Formaldehyde D. Acetone **Answer: C. Formaldehyde**
2	Which reagent is used to convert a ketone into a secondary alcohol? A. PCC B. $KMnO_4$ C. $LiAlH_4$ D. HNO_3 **Answer: C. $LiAlH_4$**
3	Which of the following undergoes aldol condensation? A. Methanal B. Benzaldehyde C. Acetone D. Formaldehyde **Answer: C. Acetone**
4	Which test is used to distinguish between aldehydes and ketones? A. Tollen's test B. Benedict's test C. Baeyer's test D. Iodoform test **Answer: A. Tollen's test**
5	Which one of the following does not react with $NaHSO_3$? A. Acetone B. Formaldehyde C. Acetaldehyde D. Acetic acid **Answer: D. Acetic acid**
6	Which of the following represents the correct order of the acidity in the given compounds? (a) $FCH_2COOH > CH_3COOH > BrCH_2COOH > ClCH_2COOH$ (b) $BrCH_2COOH > ClCH_2COOH > FCH_2COOH > CH_3COOH$ (c) $FCH_2COOH > ClCH_2COOH > BrCH_2COOH > CH3COOH$ (d) $CH_3COOH > BrCH_2COOH > ClCH_2COOH > FCH_2COOH$ **Answer: C. (c) $FCH_2COOH > ClCH_2COOH > BrCH_2COOH > CH_3COOH$**
7	When Ethanal reacts with Propanal in the presence of a base, the number of products formed is (a) 2 (b) 3 (c) 4 (d) 5 **Answer: C.**
8	The major product of nitration of benzoic acid is -: (a) 3- Nitrobenzoic acid (b) 4- Nitrobenzoic acid (c) 2- Nitrobenzoic acid (d) 2, 4- dinitrobenzoic acid **Answer (a) 3- Nitrobenzoic acid**
9	Two compounds benzyl alcohol and benzoic acid are formed from this compound, when this compound is heated in the presence of Conc.NaOH, this compound is. (a) Benzaldehyde (b) Benzyl alcohol (c) Acetophenone (d) Benzophenone **Answer (a) Benzaldehyde**
10	10. The order of boiling point in the following class of organic compounds: a) Aldehyde < Alcohol < Acid b) Acid < Aldehyde < Alcohol

c) Alcohol < Aldehyde < Acid d) Aldehyde < Acid < Alcohol

Answer (a) Aldehyde < Alcohol < Acid

Assertion-Reason Type Questions -

Choose the correct option:

(A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
(B) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.
(C) Assertion is true, but Reason is false.
(D) Assertion is false, but Reason is true

11 **Assertion (A)**: Benzaldehyde gives Cannizzaro reaction.

Reason(R): It contains α-hydrogen which undergoes self-condensation.

Answer: (C)

12 **Assertion (A):** Ethanal reacts with HCN to give cyanohydrin.
Reason(R): Cyanide ion acts as a nucleophile and attacks the carbonyl carbon.
Answer : A

13 **Assertion(A)**: Aldehydes and ketones, both react with Tollen's reagent to form silver mirror.

Reason (R) : Both aldehydes and ketones contain a carbonyl group.
Answer: (D)

14 **Assertion(A)**: All aldehydes give Iodoform test.
Reason (R): Iodoform test is given by all compounds containing –CH_3 CO group.
Answer: (D)

15 **Assertion (A)**: Carboxylic acids are more acidic than phenols.
Reason (R): Phenols are ortho and para directing.
Answer (B)

SHORT ANSWER QUESTIONS (2M)

16 **Write the structure of A and B in the following reaction:**

Ans: A is CH_3 CHO (Ethanal) B is $CH_3CH{=}NOH$ (Acetaldoxime)

17 **How would you account for the following?**

a) Boiling points of aldehydes and ketones are lower than of the corresponding acids.

b) Aldehydes and Ketones have lower boiling points than corresponding alcohols.

Ans. a) Aldehydes and ketones have lower boiling point than carboxylic acids because they are not associated with intermolecular H-bonding whereas carboxylic acids are associated with Intermolecular H-bonding.
b) The boiling points of aldehydes and ketones are lower than that of corresponding alcohols and acids due to absence of intermolecular H–bonding in aldehydes and ketones.

18 Draw the structure of the following derivatives:
(a) Propanone oxime (b) Semicarbazone of the CH_3CHO
Ans a) $(CH_3)_2C{=}NOH$ b) $CH_3\text{-}CH{=}NNHCONH_2$

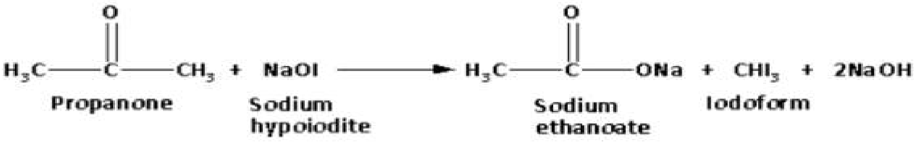
19 **Give simple chemical tests to distinguish between the following pairs of compounds:**

(a) Benzaldehyde and benzoic acid (b) Propanal and Propanone.

Ans a)Benzaldehyde does not react with $NaHCO_3$,Benzoic acid reacts with $NaHCO_3$ to produce brisk effervescence due to evolution of CO_2

$$C_6H_5COOH + NaHCO_3 \rightarrow C_6H_5COONa + CO_2 + H_2O$$

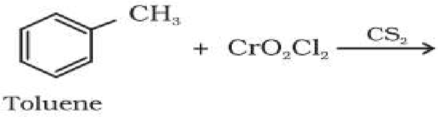
c) Propanone on reaction with sodium hypoiodite($NaOH/I_2$) forms a yellow coloured



precipitate of iodoform, Propanal does not The reaction of propanone with sodium hypoiodite is as follows:

20 **5. Write chemical equations to illustrate the following name bearing reaction**

A.

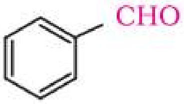


B.

$$R\text{-}CH_2\text{-}COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } X_2\text{/Red phosphorus}}$$

Ans. A. B.

$$R\text{-}\underset{\displaystyle X}{\underset{|}{CH}}\text{-}COOH$$



21 **Explain each of the following. (i) Cyanohydrin (ii) Acetal**

Ans: (i) Cyanohydrin: Compounds possessing hydroxyl and cyano groups on the same carbon atom are called cyanohydrins. These are produced by addition of HCN to aldehydes or ketones in a weakly basic medium.example $R_2C(OH)CN$

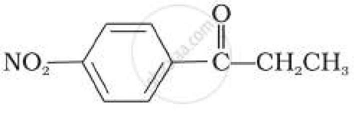
(ii) Acetal - Gem – Di alkoxy compounds in which the two alkoxy groups are present on theterminal carbon atom are called acetals. These are produced by the action of an aldehyde with two equivalents of a monohydric alcohol in presence of dry HCl gas.

example $RHC(OR')_2$

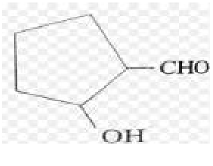
22 **Give the structure of the following compounds**.

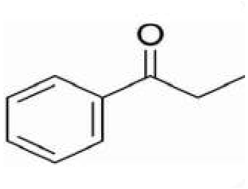
(a) 4-Nitropropiophenone (b) 2-Hydroxycyclopentanecarbaldehyde (c) propiophenone

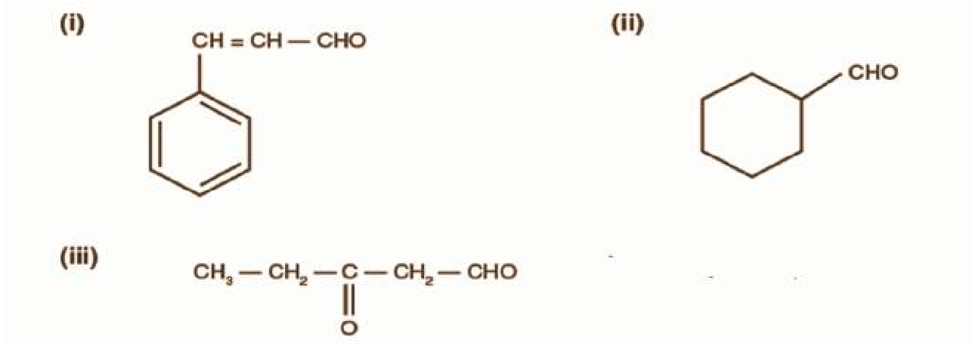
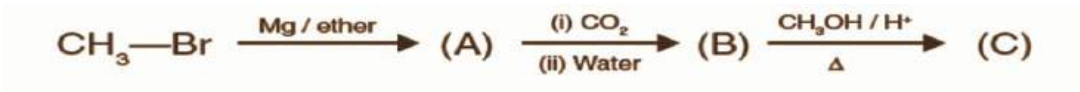
a) 4-Nitropropiophenone



b) 2-Hydroxycyclopentanecarbaldehyde c)





23	**Give names of the reagents to bring about the following transformations:** **(a) Hexan-1-ol to Hexanal (b) Cyclohexanol to Cyclohexanone** Ans (a) $C_5H_5NH^+CrO_3Cl^-$ (PCC) (b) Anhydrous CrO_3 or $K_2Cr_2O_7$ in acidic medium
24	**Name the following compounds according to IUPAC system of nomenclature**: **(a) $CH_3CH_2COCH(C_2H_5) CH_2CH_2Cl$ (b) $CH_3CH(CH_3) CH_2C(CH_3)_2COCH_3$** **Answer(a)** 6-chloro-4-ethyl hexan-3-one (b) 3,3,5-trimethyl hexane-2-one
25	i) **Why does benzaldehyde not give friedel craft reaction?** **ii) Why are carboxylic acids more acidic than phenols?** **Ans.** i) Because the lone pair of oxygen forms a compound with lewis acid $AlCl_3$ which deactivates the ring, hence it does not give Freidel craft reaction. ii) Carboxylic acids are more acidic than phenols due to the greater stability of their conjugate bases, carboxylate ions, compared to phenoxide ions. This increased stability arises from the more effective dispersal of the negative charge in carboxylate ions through resonance
	SHORT ANSWER QUESTIONS (3M)
26	**Give the IUPAC names of the following compounds.**  **Answer:** (i) 3-phenyl prop-2-en-1-al (ii) Cyclohexanecarbaldehyde (iii) 3-oxo-pentanal
27	**Compound 'A' was prepared by oxidation of compound 'B' with alkaline KMnO4 . Compound 'A' on reduction with lithium aluminium hydride gets converted back to compound 'B'. When compound 'A' is heated with compound B in the presence of H_2SO_4 it produces fruity smell of compound C to which family the compounds 'A', 'B' and 'C' belong to?** **Answer:** 'A' is a carboxylic acid, 'B' is an alcohol and 'C' is an ester
28	**Identify the compounds A, B and C in the following reaction**. $CH_3—Br \xrightarrow{Mg / ether} (A) \xrightarrow[(ii)\ Water]{(i)\ CO_2} (B) \xrightarrow[\Delta]{CH_3OH / H^+} (C)$ Answer: A= CH_3MgBr B= $CH_3COOMgBr$ C= CH_3COOCH_3

29 **How are the following conversions carried out?**

(i) Ethyl Cyanide to Propanamide

(ii) Butan-l-ol to butanoic acid

(*i*) Ethylcyanide to ethanoic acid

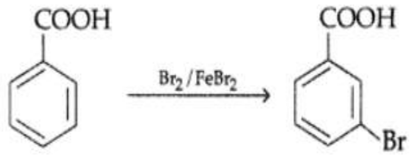
$$CH_3CH_2CN \xrightarrow{H_3O^+} CH_3CH_2COOH \xrightarrow[\Delta]{NH_3} CH_3CH_2CONH_2$$

$$\xrightarrow{Br_2/KOH} CH_3CH_2NH_2 \xrightarrow{HNO_2} CH_3CH_2OH \xrightarrow{KMnO_4} CH_3COOH$$

(*ii*) Butan-1-ol to butanoic acid

$$CH_3-CH_2-CH_2-CH_2-OH \xrightarrow{KMnO_4} CH_3CH_2CH_2COOH$$

(*iii*) Benzoic acid to m-bromobenzoic acid



(iii) Benzoic acid to m-bromobenzoic acid

30 **Arrange the following compounds in an increasing order of their property as indicated**

(i) Acetaldehyde, Acetone, Methyl tert-butyl ketone (reactivity towards HCN)

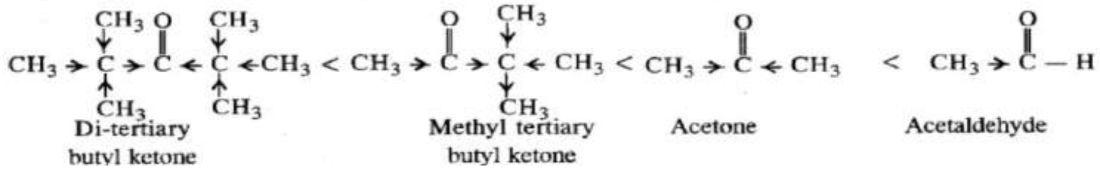
(ii) Benzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid (acid strength)

(iii) $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$,

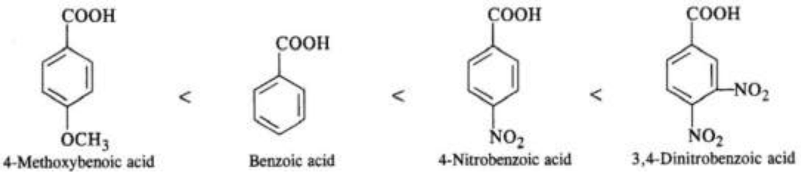
$CH_3CH_2CH_2COOH$ (acid strength)

Answer

i)



ii)



iii) $(CH_3)_2CHCOOH$,< $CH_3CH_2CH_2COOH$ < $CH_3CH(Br)CH_2COOH$ < $CH_3CH_2CH(Br)COOH$

31 **Give reasons:**

(a) Aldehydes are more reactive than ketones towards nucleophilic reagents.

(b) Electrophilic substitution in benzoic acid takes place at meta position.

(c) Carboxylic acids do not give the characteristic reactions of carbonyl group.

Answer: (a) Aldehydes are more reactive than ketones due to the following two reasons:

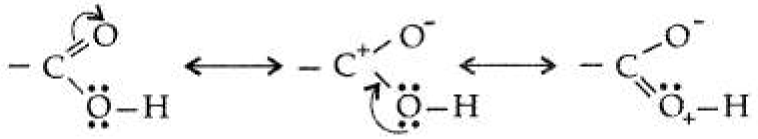
1. Due to smaller +1 effect of one alkyl group in aldehydes as compared to larger +1 effect of two alkyl groups, the magnitude of positive charge on the carbonyl carbon is more

in aldehydes than in ketones. As a result, nucleophilic addition reactions occur more readily in aldehydes than in ketones.

2.Greater steric hindrance in ketones for incoming nucleophile

(b) The benzene ring of benzoic acid undergoes electrophilic substitution reaction such as nitration, sulphonation etc. Since the — COOH group in benzene is an electron withdrawing group, therefore, it is meta directing group.

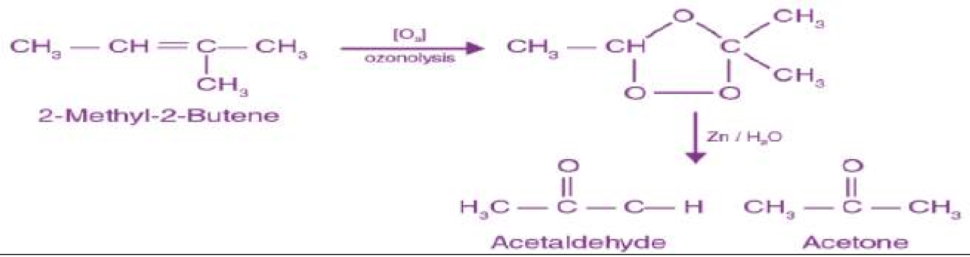
(c) The carboxylic carbon is less electrophilic than carbonyl carbon because of the following resonance structures



32 **An alkene ‘A’ (Mol. formula C_5H_{10}) on ozonolysis gives a mixture of two compounds, ‘B’ and ‘C’. Compound B’ gives positive Fehling’s test and forms iodoform on treatment with I_2 and NaOH. Compound C’ does not give Fehling’s test but forms iodoform. Identify the compounds A, B, and C. Write the reaction for ozonolysis and formation of iodoform from B and C.**

Answer

Compound B gives Fehling’s test, which means it is aldehyde, also It forms an iodoform, so compound B is acetaldehyde, among aldehydes.Compound C does not give Fehling’s test but gives iodoform, so ketone must have a methyl group attached to carbonyl. Reactions for ozonolysis and formation of iodoform from B and C:

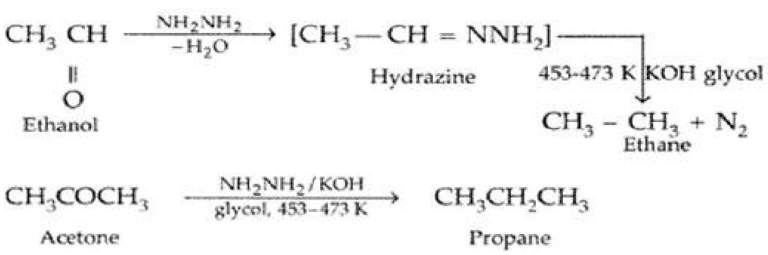


33 **Write the chemical equations to illustrate the following name reactions:**

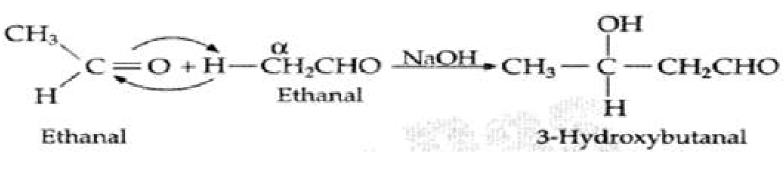
(a) Wolf-Kishner reduction (b) Aldol condensation (c) Cannizzaro reaction

Answer

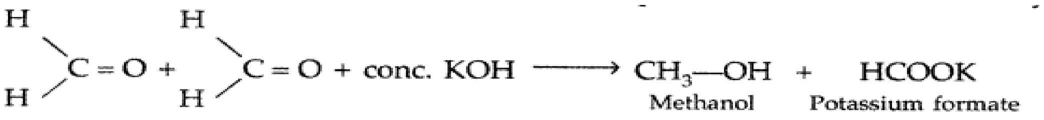
a) Wolf-Kishner reduction reaction



b)



c)



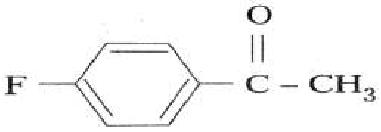
$$H_2C{=}O + H_2C{=}O + \text{conc. KOH} \longrightarrow \underset{\text{Methanol}}{CH_3{-}OH} + \underset{\text{Potassium formate}}{HCOOK}$$

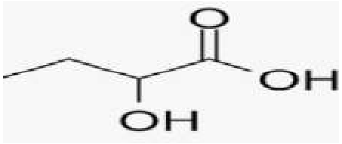
Case based; Source based Integrated Questions

34 **Read the following passage and answer the questions given below the passage.** Aldehydes and ketones are the simplest and most important carbonyl compounds. In aldehydes, the carbonyl group is bonded to a carbon and hydrogen while in the ketones, it is bonded to two carbon atoms. The IUPAC names of open chain aliphatic aldehydes and ketones are derived from the names of the corresponding alkanes by replacing the ending –e with –al and –one respectively. In case of aldehydes the longest carbon chain is numbered starting from the carbon of the aldehyde group while in case of ketones the numbering begins from the end nearer to the carbonyl group. The substituents are prefixed in alphabetical order along with numerals indicating their positions in the carbon chain. The same applies to cyclic ketones, where the carbonyl carbon is numbered one. When the aldehyde group is attached to a ring, the suffix carbaldehyde is added after the full name of the cycloalkane.

A) Write the structures of 4-Fluoroacetophenone & 2-Hydroxybutanal.

Answer :





B] **Write the IUPAC names of the following ketones and aldehydes.**

i) $CH_3CH{=}CHCHO$ ii) $CH_3CH_2CH_2COCH(C_2H_5)CH_2CH_2Cl$

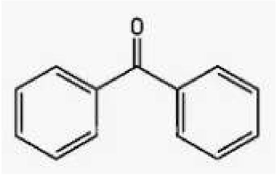
Ans: i) But-2-en-1-al or But-2-enal ii) 7-Chloro-5-ethyl heptan-4-one

OR

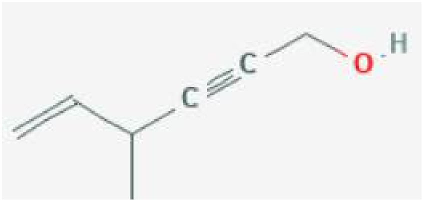
Write the structures of the following names:

a) benzophenone b) hex-2-en-4-yonic acid

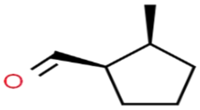
Ans: A.



B.



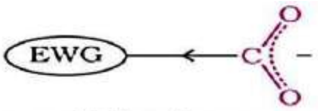
C] Name the compound represented by the formula



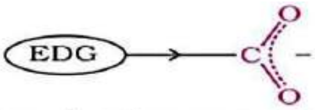
Ans: **C** methylcyclopentane carbaldehyde

35 **Read the following passage and answer the questions given below the passage.**

Effect of substituents on the acidity of carboxylic acids: Substituents may affect the stability of the conjugate base and thus, also affect the acidity of the carboxylic acids. Electron withdrawing groups increase the acidity of carboxylic acids by stabilising the conjugate base through delocalisation of the negative charge by inductive and/or resonance effects. Conversely, electron donating groups decrease the acidity by destabilising the conjugate base.



Electron withdrawing group (EWG) stabilises the carboxylate anion and strengthens the acid



Electron donating group (EDG) destabilises the carboxylate anion and weakens the acid

A] Which is more acid Acrylic acid CH_2=CHCOOH or Propanoic acid ? Why?

Ans: Acrylic acid is more acidic than Propanoic acid. In case of acrylic acid, the carbon atom of the carboxylic group (-COOH) is attached with SP^2hybridised carbon atom which has more s-character (33%) than SP^3hybridised carbon atom (25%), hence SP^2 hybridised carbon atom is more electronegative so the electron density shifts towards SP^2 carbon atom, So oxygen acquires positive charge hence it becomes easier to remove H^+ ion.

B] **Dichloroacetic acid is stronger acid than chloroacetic acid. Why?**

Ans: More the number of electron withdrawing groups the more is the acidic nature.

C] Arrange the following acids in the increasing order of acidic strength

Benzoic acid, 4- nitrobenzoic acid, 3,4-dinitro benzoic acid,4- methoxy benzoic acid

Ans: 4- methoxy benzoic acid<benzoic acid<4-nitrobenzoic acid<3,4- dinitrobenzoic acid.

OR

D] Name at least two products of aldol condensation of Propanone and Ethanal.

Ans: Any two of the following

1) But-2-enal 2) 2-Methylpent-2-enal

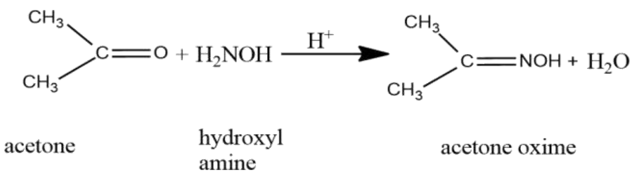
3) Pent-2-enal 4) 2-methyl but -2-enal

36 Reductive alkylation is the term applied to the process of introducing alkyl groups into ammonia or a primary or secondary amine by means of an aldehyde or ketone in the presence of a reducing agent. The present discussion is limited to those reductive alkylations in which the reducing agent is hydrogen and a catalyst or "nascent" hydrogen, usually from a metal acid combination; most of these reductive alkylations have been carried out with hydrogen and a catalyst. The principal variation excluded is that in which the reducing agent is formic acid or one of its derivatives; this modification is known as the Leuckart reaction. The process of reductive alkylation of ammonia consists in the addition of ammonia to a carbonyl compound and reduction of the addition compound or its dehydration product. The reaction usually is carried out in ethanol solution when the reduction is to be affected catalytically Since the primary amine is formed in the presence of the aldehyde it may react in the same way as ammonia, yielding an addition compound, a Schiff's base (RCH= NCH2R) and finally, a secondary amine. Similarly, the primary amine may react with the imine, forming an addition product which also is reduced to a secondary amine Finally, the secondary amine may react with either the aldehyde or the imine to give products which are reduced to tertiary amines. Similar reactions may occur when the carbonyl compound employed is a ketone

A] Write equations for the following reactions.

(i) Acetone with hydroxyl amine (ii) Ethanal with ammonia

Ans (i)Acetone with hydroxyl amine



(ii) Ethanoic acid with ammonia followed by heating

$CH_3CHO + NH_3$ —Δ—–> CH_3CONH_2

OR

A} Give reasons:

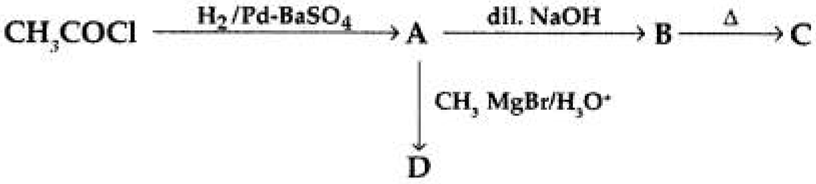
(i) **There are two – NH_2 groups in Semicarbazide. However, only one such group is involved in the formation of Semicarbazones.**

ii) Cyclohexanone forms cyanohydrin in good yield but 2, 4, 6-trimethylcyclohexanone does not.

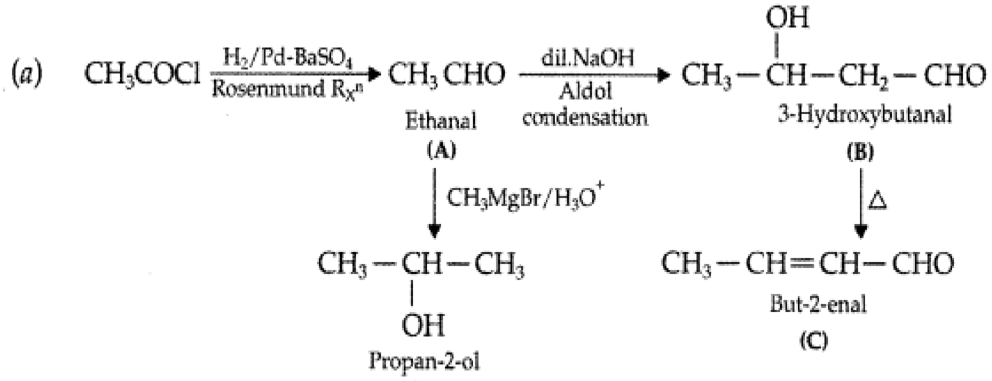
B] **A compound gives 2,4 DNP test, further it reduces Tollen's reagent. what conclusions can be drawn from this information?**
Ans: As the compound gives 2,4-DNP test.it must be an aldehyde or ketone. Further as it gives Tollen's test it is an aldehyde.
C] **What type of reaction takes place when aldehydes or ketones are treated with ammonia and its derivatives?**
Ans: Nucleophilic addition reaction.

<u>LONG ANSWER QUESTIONS: MARKS 5</u>

37 (**a) Write structures of A, B, C and D in the following reaction sequence** :

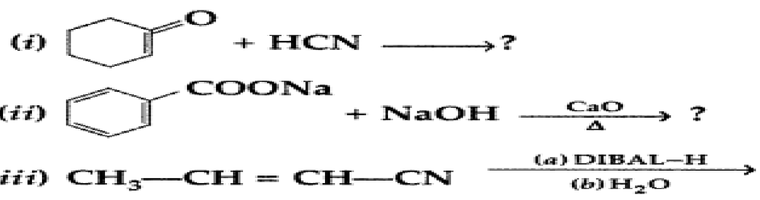


(b) **Arrange the following compounds in the increasing order of their boiling points :**
CH_3CHO, CH_3CH_2OH, CH_3OCH_3, CH_3COOH.
Answers



(b) $CH_3OCH_3 < CH_3CHO < CH_3CH_2OH < CH_3COOH$

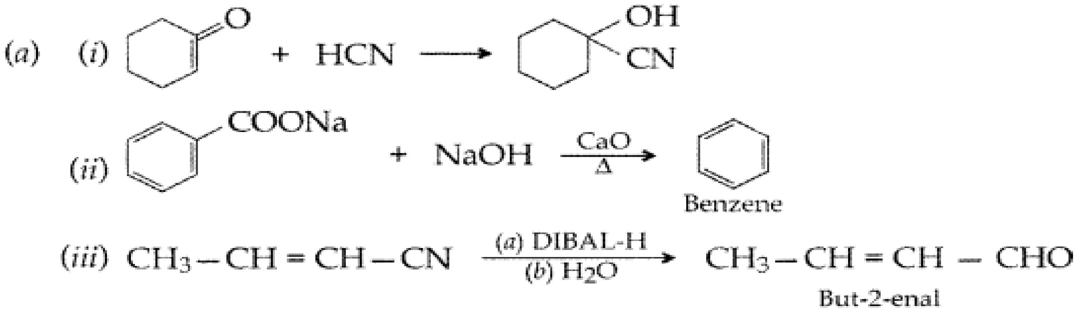
38 (a) **Write the product(s) in the following reactions**:



(b)**Give simple chemical tests to distinguish between the following pairs of compounds**

(i) Butanal and Butan-2-one (ii) Benzoic acid and Phenol

Answer:

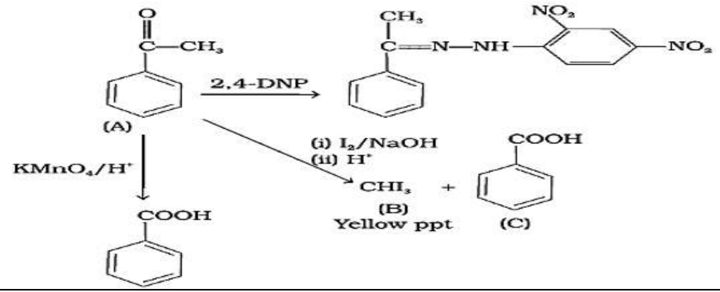


b) (i) Tollen's reagent test. Add ammoniacal solution of sliver nitrate (Tollen's Reagent) in both the solutions. Butanal gives silver mirror whereas Butan-2-one does not. Therefore Butanal gives Tollen's test.

(ii) Ferric chloride test. Add neutral $FeCl_3$ in both the solutions, phenol reacts with neutral $FeCl_3$ to form an iron-phenol complex giving violet colour but benzoic acid does not.

39 **An aromatic compound 'A' (Molecular formula C_8H_8O) gives positive 2,4-DNP test. It gives a yellow precipitate of compound 'B' on treatment with iodine and sodium hydroxide solution. Compound 'A' does not give Tollen's or Fehling's test. On drastic oxidation with potassium permanganate, it forms a carboxylic acid 'C' (Molecular formula $C_7H_6O_2$), which is also formed along with the yellow compound in the above reaction. Identify A, B and C and write all the reactions involved.**

Answer: A-Acetophenone B-Iodoform C- Benzoic acid



9. AMINES

Gist of the Chapter

1. Introduction

- **Amines** are organic compounds derived from **ammonia (NH_3)** by replacing one or more hydrogen atoms with **alkyl or aryl groups**.
- General formula: **$R–NH_2$, R_2NH, R_3N** (for primary, secondary, tertiary amines respectively).

---

2. Classification

- **Primary (1°)**: One alkyl/aryl group (e.g., CH_3NH_2).
- **Secondary (2°)**: Two alkyl/aryl groups (e.g., $(CH_3)_2NH$).
- **Tertiary (3°)**: Three alkyl/aryl groups (e.g., $(CH_3)_3N$).
- **Aromatic amines**: $–NH_2$ attached to an aromatic ring (e.g., aniline).

---

3. Nomenclature

- **Common names**: Alkylamine (e.g., methylamine).
- **IUPAC names**: Alkanamine (e.g., methanamine).
- For aromatic amines: **aniline**, **N-substituted anilines**.

---

4. Preparation of Amines

- **Reduction of nitro compounds** ($Ar–NO_2$ to $Ar–NH_2$).
- **Ammonolysis of alkyl halides**.
- **Gabriel phthalimide synthesis** (for primary amines).
- **Hofmann bromamide degradation** (amide → 1° amine).

---

5. Physical Properties

- Lower amines: Gases, soluble in water.
- Higher amines: Liquids or solids, less soluble.
- Have **hydrogen bonding**, so relatively higher boiling points.

---

6. Chemical Reactions

- **Basic character** (accepts protons).
- **Alkylation** and **acylation**.
- **Carbylamine test** (1° amines give isocyanide with $CHCl_3 + KOH$).
- **Reaction with nitrous acid**:
  - 1° aliphatic → alcohol + N_2.
  - 1° aromatic → diazonium salt.
- **Diazotization** (aniline + HNO_2 at 0–5°C → diazonium salt).
- **Coupling reactions** (azo dyes formation).

---

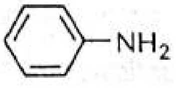
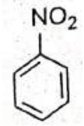
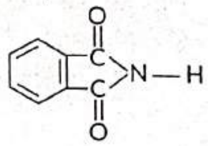
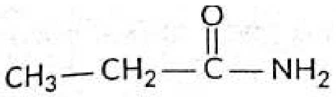
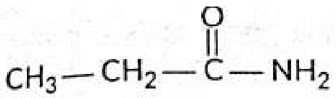
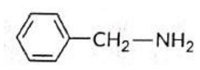
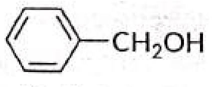
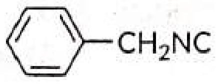
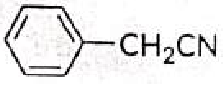
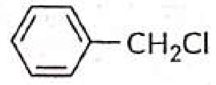
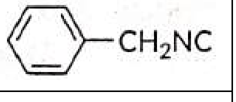
7. Diazonium Salts

- **Preparation**: From primary aromatic amines.
- **Reactions**: Sandmeyer, Gattermann, replacement with OH^-, H^+, I^-, etc.

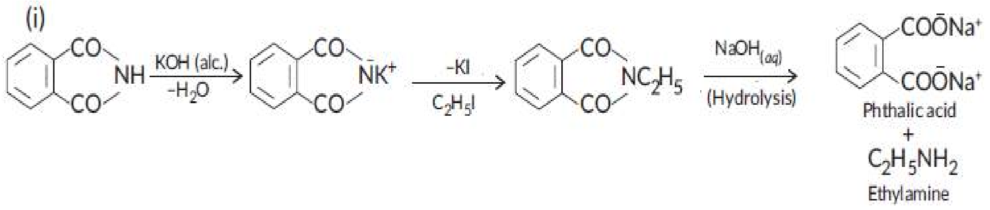
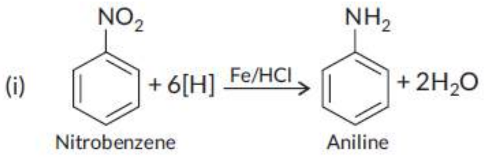
---

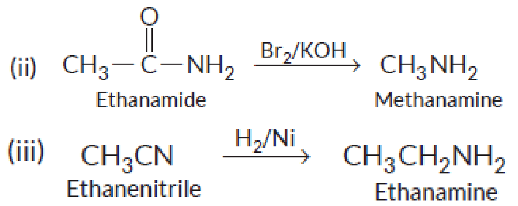
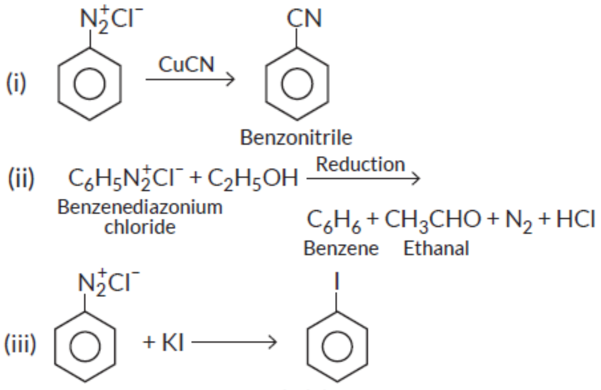
8. Uses of Amines

- Making dyes, drugs, polymers.
- As intermediates in organic synthesis.

1	Identify the primary amine from the given options (a) $(C_2H_5)_3N$ (b) $(C_2H_5)_2NH$ (c) $C_2H_5NH_2$ (d) $(CH_3)_3N$ **Answer: (c) $C_2H_5NH_2$**
2	CH_3CONH_2 on reaction with NaOH and Br_2 in alcoholic medium gives (a) CH_3COONa (b) CH_3NH_2 (c) CH_3CH_2Br (d) $CH_3CH_2NH_2$ **Answer: (b) CH_3NH_2**
3	Which of the following is least basic? (a) $(CH_3)_2NH$ (b) NH_3 (c)  (d) $(CH_3)_3N$ **Answer: (c)** 
4	In the reaction $C_6H_5NH_2 + CHCl_3 + 3KOH \rightarrow A + 3B + 3C$ The product A is (a) C_6H_5NC (b) C_6H_5CN (c) C_6H_5Cl (d) $C_6H_5NHCH_3$ **Answer: (a) C_6H_5NC**
5	Out of the following, the strongest base in aqueous solution is (a) Methylamine (b) Dimethylamine (c) Trimethylamine (d) Aniline. **Answer: (b) Dimethylamine**
6	Hoffmann bromamide degradation reaction is given by (a)  (b)  (c) CH3-C≡N (d)  $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-NH_2$ **Answer: (d)**  $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-NH_2$
7	Which of the following reagents is used for the Hinsberg test of amines ? (a) C_6H_5COCl (b) CH_3COCl (c) $C_6H_5-SO_3H$ (d) $C_6H_5-SO_2Cl$ **Answer: (d) $C_6H_5-SO_2Cl$**
8	Among the following amines, which one is expected to have the lowest boiling point? (a) $C_2H_5-NH_2$ (b) $(C_2H_5)_3N$ (c) $(C_2H_5)_2NH$ (d) CH_3-NH_2 **Answer: (b) $(C_2H_5)_3N$**
9	 on heating with $CHCl_3$ and alcoholic KOH gives foul smell of (a)  (b)  (c)  (d)  **Answer: (b)** 
10	10. The correct name of the given reaction is $Ar-N_2^+X^- \xrightarrow[\text{Cu powder}]{HBr} Ar-Br+N_2$ (a) Hoffmann bromamide degradation reaction (b) Gabriel phthalimide synthesis

	(c) Carbylamine reaction (d) Gatterman reaction **Answers: (d) Gatterman reaction**
	(II) Assertion-Reason
	Select the most appropriate answer from the options given below: (A) Both A and R are true and R is the correct explanation of A (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
11	**1.Assertion (A):** NH_2 group is o- and p-directing in electrophilic substitution reactions. **Reason (R):** Aniline cannot undergo Friedel-Crafts reaction. **Answer:** (B) Both A and R are true but R is not the correct explanation of A.
12	**Assertion (A):** Acetylation of aniline gives a monosubstituted product. **Reason (R):** Activating effect of $NHCOCH_3$ group is more than that of amino group. **Answer: (C)** A is true but R is false
13	**Assertion (A):**Aliphatic primary amines can be prepared by Gabriel Phthalimide synthesis. **Reason (R):**Alkyl halides undergo nucleophilic substitution with anion formed by phthalimide. **Answer: (A)** Both A and R are true and R is the correct explanation of A
14	**Assertion (A):**p-nitroaniline is a weaker base than p-toluidine. **Reason (R):**The electron withdrawing -NO_2 group inp-nitroaniline makes it a weaker base. **Answer: (A)** Both A and R are true and R is the correct explanation of A
15	**Assertion (A):**Aniline is a stronger base than ammonia. **Reason (R):**The unshared electron pair on nitrogen atom in aniline becomes less available for protonation due to resonance. **Answers: 1. (D)** A is false but R is true
	(III) SHORT ANSWER QUESTIONS (2M)
16	**Given reason :** **(i) Acetylation of aniline reduces its activation effect.** **(ii) Aniline do not undergo Friedel-Craft's reactions.** **Ans.**(i) The electron withdrawing acetyl group reduces the electron density on the nitrogen atom and its ability to donate electrons to the benzene ring. ii) Its amine group reacts with the Lewis acid catalyst forming a salt complex. This complex deactivates the benzene ring making it unreavtive towards Friedel-Craft's reactions.
17	**Give reasons :** **(i) Aniline on nitration gives good amount of m-nitroaniline, though – NH_2 group is o/p directing in electrophilic substitution reactions.** **(ii) Ammonolysis of alkyl halides is not a good method to prepare pure primary amines.** **Ans:** (i) Aniline on protonation forms anilinium ion which is meta-directing. (ii) Because it forms a mixture of amines that is difficult to separate
18	**Account for the following:** **(i) Methyl amine is more basic than aniline.** **(ii) Primary amines have higher boiling point than tertiary amines.** **Ans:** (i) Due to +I effect of methyl group there is higher electron density on nitrogen whereas in aniline lone pair of electrons on nitrogen is involved in resonance making it less available for protonation. (ii) Due to presence of hydrogen bonding in primary amines.

19	**Write the reaction involved in the following :** **(i) Carbylamine test (ii) Gabriel phthalimide synthesis** **Ans:** (i) $R-NH_2 + CHCl_3 + 3NaOH \longrightarrow RNC + 3NaCl + 3H_2O$ 
20	**Carry out the following conversions:** **(i) Nitrobenzene to aniline (ii) Propanamide to ethanamine** **Ans:**  (ii) $CH_3CH_2CONH_2 + Br_2 + 4NaOH \rightarrow CH_3CH_2NH_2 + 2NaBr + Na_2CO_3 + 2H_2O$
21	**Write the structures of A and B in the following reactions:** (i) $C_6H_5COOH \xrightarrow[\Delta]{NH3} A \xrightarrow{Br2+NaOH} B$ (ii) $C_6H_5NH_2 \xrightarrow[273\text{-}278\ K]{NaNO2+HCl} A \xrightarrow{C2H5OH} B$ Ans: (i) A= $C_6H_5CONH_2$; B = $C_6H_5NH_2$ (ii) A= $C6H5N_2^+Cl^-$; B = C_6H_6
22	**(i) What is Hinsberg's reagent and what is its role?** **(ii) Arrange following in increasing order of basic strength in gaseous phase :** **$C_2H_5NH_2$, $(C_2H_5)_3N$, $(C_2H_5)_2NH$** **Ans:**(i) Benzenesulphonyl chloride is Hinsberg's reagent and its role is to distinguish between 1°, 2° and 3°amines. (ii) $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$
23	**How will you distinguish between following pairs of compounds:** **(i) Primary amine and secondary amine** **(ii) Secondary amine and tertiary amine** **Ans:** (i) Carbylamine reaction given by primary amines only. 1° amines react with chloroform and alcoholic KOH to give foul smelling isocyanides. OR Hinsberg Test : 1° amines form a compound with Hinsberg's reagent which is soluble in alkali while 2° amines form a compound which is insoluble in alkali. (ii) Hinsberg Test : 2° amines form a compound with Hinsberg's reagent which is insoluble in alkali while 3° amines does not react with Hinsberg's reagent
24	**(i) Out of CH_3NH_2 and CH_3OH, which has higher boiling point and why?** **(ii) Write an isomer of C_3H_9N which (a) does not react with Hinsberg's reagent, (b) Forms a compound which is insoluble in alkali.** Ans: (i) CH_3OH because alcohols are more polar due to high electronegativity of oxygen than nitrogen. (ii) (a) $(CH_3)_3N$ (b) $(C_2H_5)NH(CH_3)$
25	**Arrange the following in decreasing order of pkb giving reason :** **(i) Aniline, p-nitroaniline and p-toluidine** **(ii) $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$ in aqueous state** **Ans:** (i) p-nitroaniline, Aniline, p-toluidine (Increasing order of basic strength) (ii) $C_2H_5NH_2$, $(C_2H_5)_3N$, $(C_2H_5)_2NH$ (Combined effect of hydration, steric hinderance and inductive effect)
	(IV) Short Answer Type Questions (3 Marks)
26	**How will you carry out the following conversions:**

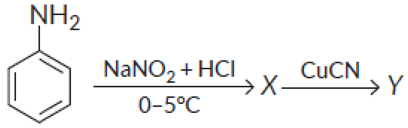
	(i) Aniline to benzene diazonium chloride **(ii) Ethanamide to methanamine** **(iii) Ethanenitrile to ethanamine** **Ans.** (i) $C_6H_5NH_2 \xrightarrow[273\text{-}278\ K]{NaNO2+HCl} C_6H_5N_2^+Cl^-$  (ii) $CH_3-\overset{O}{\overset{\parallel}{C}}-NH_2 \xrightarrow{Br_2/KOH} CH_3NH_2$ (iii) $CH_3CN \xrightarrow{H_2/Ni} CH_3CH_2NH_2$
27	**Account for the following:** **(a) Aniline is a weaker base compared to ethanamine.** **(b) Ethylamine is soluble in water whereas aniline is not.** **(c) Only aliphatic primary amines can be prepared by Gabriel Phthalimide synthesis.** **Ans.:** (a) Ethanamine is more basic than aniline **because in aniline lone pair of electrons on nitrogen are involved in resonance.** (b In aniline due to large hydrophobic aryl group the extent of hydrogen bonding decreases considerably and hence aniline is insoluble in water. (c) Aromatic 1° amines such as aniline, toluidine, etc. cannot be prepared by this method **because aryl halides do not undergo nucleophilic substitution reaction** with potassium phthalimide under mild conditions.
28	**(a) Give one chemical test to distinguish between the compounds of the following pairs** **(i) CH_3NH_2 and $(CH_3)_2NH$** **(ii) Aniline and ethanamine** **(b) Arrange the following in increasing order of boiling points :** **$(CH_3)_3N$, C_2H_5OH, $C_2H_5NH_2$** **Ans.**: (a) (i) Methylamine gives carbylamine test, *i.e.*, on treatment with alc. KOH and chloroform, followed by heating it gives offensive odour of methyl isocyanide. Dimethylamine does not give this test. (ii) Aniline being an aromatic primary amine on treatment with $HNO_2[NaNO_2 + HCl$ (*dil.*)] at 273–278 K followed by treatment with an alkaline solution of b-naphthol gives an orange coloured azo dye. Ethylamine does not give this test. (b) $(CH_3)_3N$, $C_2H_5NH_2$, C_2H_5OH
29	**Write the structures of main products when benzene diazonium chloride reacts with the following reagents :** **(i) CuCN (ii) CH_3CH_2OH (iii) KI** **Ans.:**  (ii) $C_6H_5N_2^+Cl^- + C_2H_5OH \xrightarrow{Reduction} C_6H_6 + CH_3CHO + N_2 + HCl$
30	**Arrange the following compounds as directed :** **(i) In increasing order of solubility in water** : $(CH_3)_2NH$, CH_3NH_2, $C_6H_5NH_2$

(ii) In increasing order of boiling point :
$(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_2H_5NH_2$

(iii) In decreasing order of basic strength in aqueous solution :
$(CH_3)_3N$, $(CH_3)_2NH$, CH_3NH_2

Ans.: (i) $C_6H_5NH_2 < (CH_3)_2NH < CH_3NH_2$
(ii) $(C_2H_5)_3N < (C_2H_5)_2NH < C_2H_5NH_2$.
(iii) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$

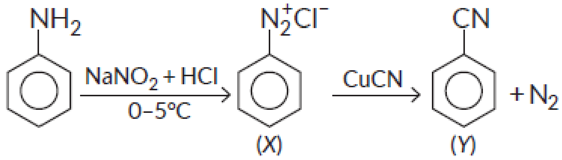
31 **(i) Illustrate the following reaction giving suitable example in each case:**
Hoffmann bromamide degradation reaction.
(ii) Identify *X* and *Y* in the following :



Ans.(i)

$$\underset{\text{Alkyl amide}}{R\text{—}CONH_2} + Br_2 + 4NaOH \longrightarrow \underset{1°\text{ amine}}{R\text{—}NH_2} + Na_2CO_3 + 2NaBr + 2H_2O$$

(ii)



32 **Give the structures of products *A*, *B* and *C* in the following reactions :**

(i) $CH_3CH_2Br \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0°C]{HNO_2} C$

(ii) $CH_3COOH \xrightarrow[\Delta]{NH_3} A \xrightarrow{NaOH + Br_2} B \xrightarrow[alc.\ NaOH]{CHCl_3 +} C$

Ans.

(i) $CH_3CH_2Br \xrightarrow{KCN} \underset{(A)}{CH_3CH_2CN} \xrightarrow{LiAlH_4} \underset{(B)}{CH_3CH_2CH_2NH_2} \xrightarrow[HNO_2]{273\ K} \underset{(C)}{CH_3CH_2CH_2OH}$

(ii) $CH_3COOH \xrightarrow[\Delta]{NH_3} \underset{(A)}{CH_3CONH_2} \xrightarrow{Br_2 + NaOH} \underset{(B)}{CH_3NH_2} \xrightarrow{CHCl_3 + NaOH} \underset{(C)}{CH_3NC}$

33 **Give the structures of *A*, *B* and *C* in the following reactions :**

(i) $C_6H_5NO_2 \xrightarrow{Sn + HCl} A \xrightarrow[273\ K]{NaNO_2 + HCl} B \xrightarrow{H_2O} C$

(ii) $CH_3CN \xrightarrow{H_2O/H^+} A \xrightarrow[\Delta]{NH_3} B \xrightarrow{Br_2 + KOH} C$

Ans.

(i) $C_6H_5NO_2 \xrightarrow{Sn + HCl} \underset{A}{C_6H_5NH_2} \xrightarrow{NaNO_2 + HCl} \underset{B}{C_6H_5N_2^+Cl^-} \xrightarrow{H_2O} \underset{C}{C_6H_5OH}$

(ii) $CH_3CN \xrightarrow{H_2O/H^+} \underset{A}{CH_3COOH} \xrightarrow{NH_3} \underset{B}{CH_3CONH_2} \xrightarrow{Br_2 + KOH} \underset{C}{CH_3NH_2}$

(V) CASE BASED QUESTIONS

34 Amines are classifed as primary, secondary and tertiary amines. Primary amines cannot be obtained by ammonolysis of alkyl halide because we will get mixture of 1°, 2° and 3° amines. Cyanides, on reduction give primary amines where as isocyanides on reduction give secondary amines. Nitro compounds, on reduction also give primary amines. Primary amines react with $CHCl_3$ and KOH to form foul smelling isocyanide. They react with HNO_2 and liberate N_2 gas. They react with Hinsberg's reagent to form salt soluble in KOH. Secondary amine form yellow oily compounds with HNO_2 and salt formed with $C_6H_5SO_2Cl$, is insoluble in KOH. 3° amines form salt soluble in water with HNO_2 but does not react with $C_6H_5SO_2Cl$. Diazonium salts are

prepared by reaction of Aniline with $NaNO_2$ and conc. HCl at 0 – 5 °C. Aromatic diazonium salts are more stable because phenyl diazonium ion is stabilized by resonance. Benzene diazonium chloride can be used to prepare halo benzene, phenol, nitro benzene, benzene, p -hydroxy azo benzene (azo dye) and large number of useful compounds.

Answer the following:

(a) Write the isomer of C_3H_9N which does not react with Hinsberg reagent.

(b) CH_3NH_2 , on heating with $CHCl_3$ and KOH gives 'X'. Identify 'X'.

(c) (i)Convert Aniline to phenol.

(ii) Distinguish between Aniline and ethyl amine.

OR

(c) Complete the following reaction.

(i) $C_6H_5NO_2 \xrightarrow{Fe/HCl} A \xrightarrow[0-5\,°C]{NaNO_2 + HCl} B$

(ii) $A \xrightarrow[Ethanol]{H2\text{-}Pd} C_6H_5NH_2 \xleftarrow[NaOH]{Br2} B$

Ans.(a) $(CH_3)_3N$; N, N–dimethylmethanamine

(b) CH_3NC, a foul smelling compound

(c) (i) $C_6H_5NH_2 \xrightarrow[0-5\,°C]{NaNO\ 2 + HCl} C_6H_5N_2^+Cl^- \xrightarrow[Warm]{H2O} C_6H_5OH$

(ii) Add $NaNO_2$ and conc. HCl. Cool it to 0 to 5° C. Then add alkaline solution of phenol. Aniline gives orange dye where as ethyl amine does not.

OR

(c) (i) 'A' is $C_6H_5NH_2$ 'B' is $C_6H_5N_2^+Cl^-$

(ii) 'A' is $C_6H_5NO_2$ 'B' is $C_6H_5CONH_2$

35 Organic compounds containing amine as functional group are present in wide variety of compounds namely amino acids, hormones, neurotransmitters, DNA, alkaloids, dyes etc. Drugs including nicotine, morphine, codein, heroin etc. which have physiological effects on human also contain —NH_2 group in one form or another. Amines are basic in nature due to presence of lone pair of electron on nitrogen. Adrenaline hormone and ephedrine drug, both contain second amino group are used for increasing blood pressure. Novacain, a synthetic compound contains both primary and tertiary amino group, is used as anaesthetic in dentistry. Benadryl, a widely used antihistamine drug contains tertiary amino group, Quarternary ammonium salts of long chain, tertiary amines are used as cationic detergents. Diazonium salts are used for synthesis of azodyes and useful aromatic compounds.

(a) Write the formula of primary and secondary amine with molecular formula C_3H_9N, which react with Hinsberg reagent?

(b) How will you distinguish between aniline and benzylamine?

(c) Write the structures of A and B in the following reactions :

OR

(**c)) Give one chemical test to distinguish between the compounds of the following pairs : (i) CH_3NH_2 and $(CH_3)_2NH$ (ii) Aniline and N-Methylaniline**

Ans. (a) Primary amine: $CH_3CH_2CH_2NH_2$; secondary amine: $(C_2H_5)NH(CH_3)$

(b) Add $NaNO_2$ and conc. HCl. Cool it to 0 – 5 °C. Then add alkaline solution of phenol. Aniline will give orange, azo dye, whereas Benzyl amine does not.

(c) (i) A= C_6H_5CN; B= C_6H_5COOH

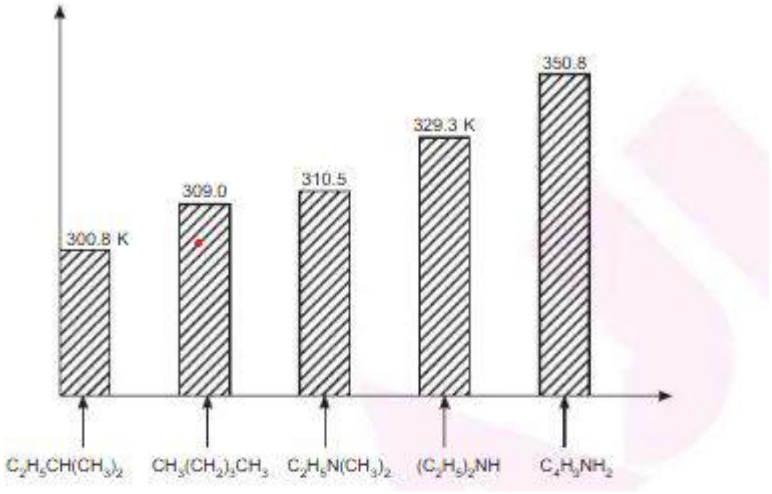
(ii) A= CH_3CONH_2; B= CH_3NH_2

OR

(c) (i) CH_3NH_2 will gives Carbylamine test $(CH_3)_2NH$ does not.

(ii) Aniline gives Carbylamine test N-Methylaniline does not

36 Observe the histogram showing boiling points of pentane, iso pentane, 1°, 2° and 3 ° amines. Answer the questions that follow based on table and related concepts:



(a) Why does $CH_3CH_2CH_2CH_2NH_2$ (1° amine) has higher boiling point than $(C_2H_5)_2NH$ and $C_2H_5\ N(CH_3)_2$?
(b) Why does ethanol have higher boiling point than ethanamine?
(c) (i) Why amines are more basic than alcohol?
(ii) Why are Primary amines more soluble in water than 2° and 3° amines?

OR

(c) Arrange the compounds shown in graph, increasing order of boiling points. Give reason.

Ans.(a) It is because extent of H-bonding is more in $CH_3CH_2CH_2CH_2NH_2$ than 2° and 3° amines.

(b) It is because H-bonds are stronger in alcohol s than amines because 'O' is more electronegative than'N'.
(c) (i) It is because $RNH_3^{\oplus}$ is more stable than $ROH_2^{\oplus}$, +ve charge on oxygen is not stable.

(ii) It is because primary amines can form H-bonds with water to more extent.

OR
(c) $C_2H_5CH(CH_3)_2 < CH_3(CH_2)_3CH_3 < C_2H_5N(CH_3)_2 < (C_2H_5)_2NH < C_4H_9NH_2$
Isopentane has lower boiling point that n -Pentane due to branching less surface area, less van der Waals' forces of attraction. 3° < 2° < 1° is order of boiling point in amines because extent of H-bonding increases.

(VI) Long Answer Type Questions (5 Marks)

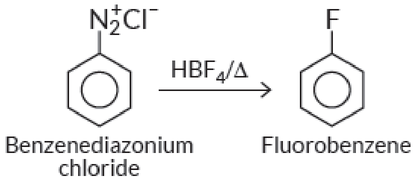
37 **(i) Write the structures of main products when benzenediazonium chloride ($C_6H_5N_2^+Cl^-$)**
reacts with the following reagents :
(a) HBF_4/Δ (b) Cu/HBr
(ii) Write the structures of *A*, *B* and *C* in the following reactions :

(a) $C_6H_5NO_2 \xrightarrow{Sn + HCl} A \xrightarrow[273\ K]{NaNO_2 + HCl} B \xrightarrow[\Delta]{H_2O} C$

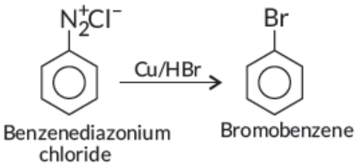
(b) $CH_3Cl \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow{HNO_2} C$

Ans.

I. (i) (a)



(b)



(ii) (a) $C_6H_5NO_2 \xrightarrow{Sn + HCl} \underset{A}{C_6H_5NH_2} \xrightarrow[273\,K]{NaNO_2 + HCl} \underset{B}{C_6H_5N_2^+Cl^-} \xrightarrow{H_2O} \underset{C}{C_6H_5OH}$

(b) $CH_3Cl \xrightarrow{KCN} \underset{A}{CH_3CN} \xrightarrow{LiAlH_4} \underset{B}{CH_3CH_2NH_2} \xrightarrow[273\,K]{HNO_2} \underset{C}{CH_3CH_2OH}$

38 **a) Distinguish between the following :**

(i) $CH_3CH_2NH_2$ and $(CH_3CH_2)_2NH$

(ii) Aniline and CH_3NH_2

(b) Write equations involved in the following reactions :

(i) Ethanamine reacts with acetyl chloride.

(ii) Aniline reacts with bromine water at room temperature.

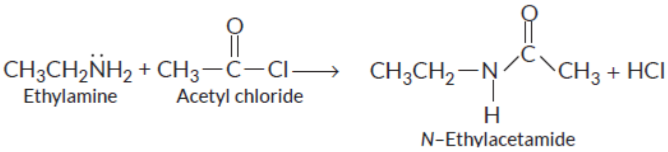
(iii) Aniline reacts with chloroform and ethanolic potassium hydroxide.

Ans. (a) (i) When heated with an alcoholic solution of KOH and CHCl3, ethylamine gives foul smelling ethyl isocyanide. Diethylamine does not give this test.

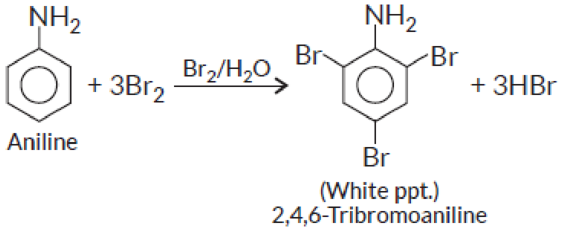
(ii) Aniline gives white or brown precipitate with bromine water. Methylamine does not react with bromine water.

(b)

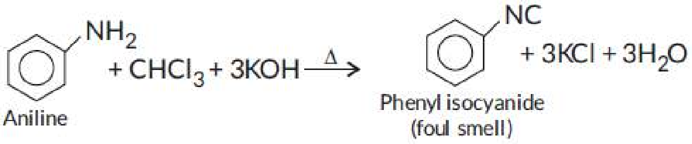
(i)


$CH_3CH_2\ddot{N}H_2 + CH_3-\overset{O}{\overset{\|}{C}}-Cl \longrightarrow CH_3CH_2-\underset{H}{\underset{|}{N}}-\overset{O}{\overset{\|}{C}}-CH_3 + HCl$

(ii)



(iii)



39 **(i) Arrange the following compounds in the increasing order of their basic strength in**

aqueous solution : CH3NH2, (CH3)3N, (CH3)2NH

(ii) Write equation involve in Sandmeyer's reaction.

(iii) What is the role of pyridine in the acylation reaction of amines ?

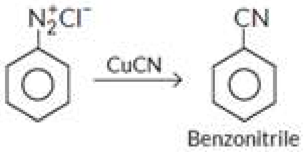
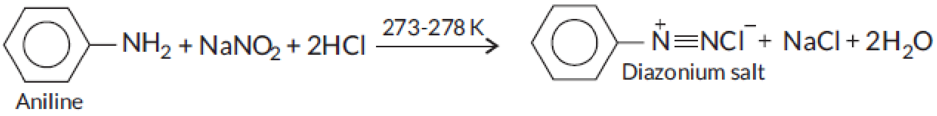
(b) (i) Write the reaction involved in the following :

Diazotisation

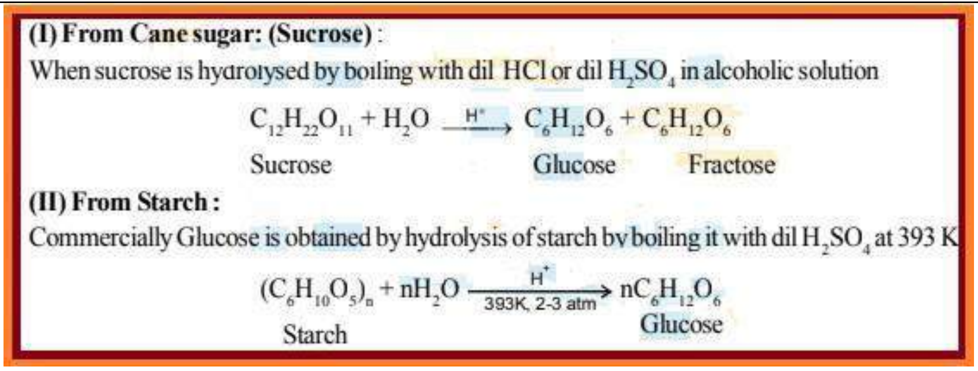
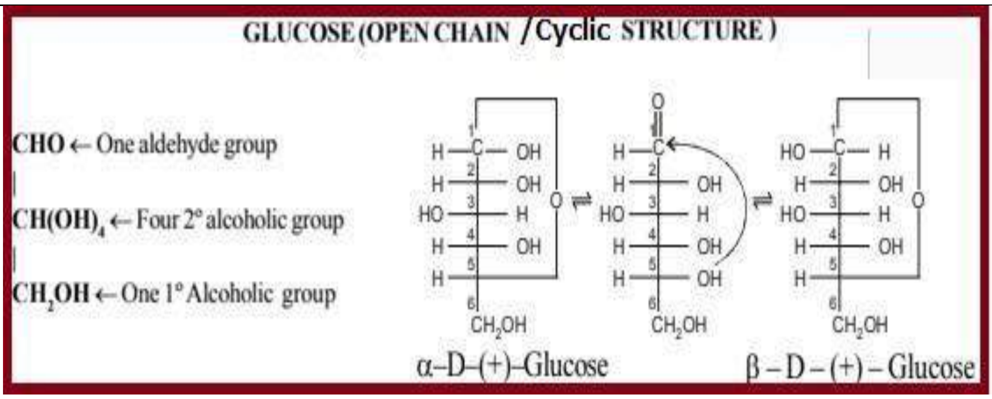
(ii) Give reason :

Aromatic diazonium salts are more stable than aliphatic diazonium salts.

Ans. (a) (i) (CH3)3N < CH3-NH2 < (CH3)2NH

	 (ii) (iii) Acylation of amines is a nucleophilic substitution reaction. This reaction occurs in the presence of a base stronger than amine like pyridine. It removes HCl formed in the reaction and shifts the equilibrium to the right hand side. (b) (i)  (ii) Diazonium salts carry a nitrogen atom with a positive charge. This positive charge is well dispersed in aromatic diazonium salts through resonance. Such a charge delocalisation is not possible in aliphatic diazonium salts and hence they are less stable than aromatic diazonium salts.

.

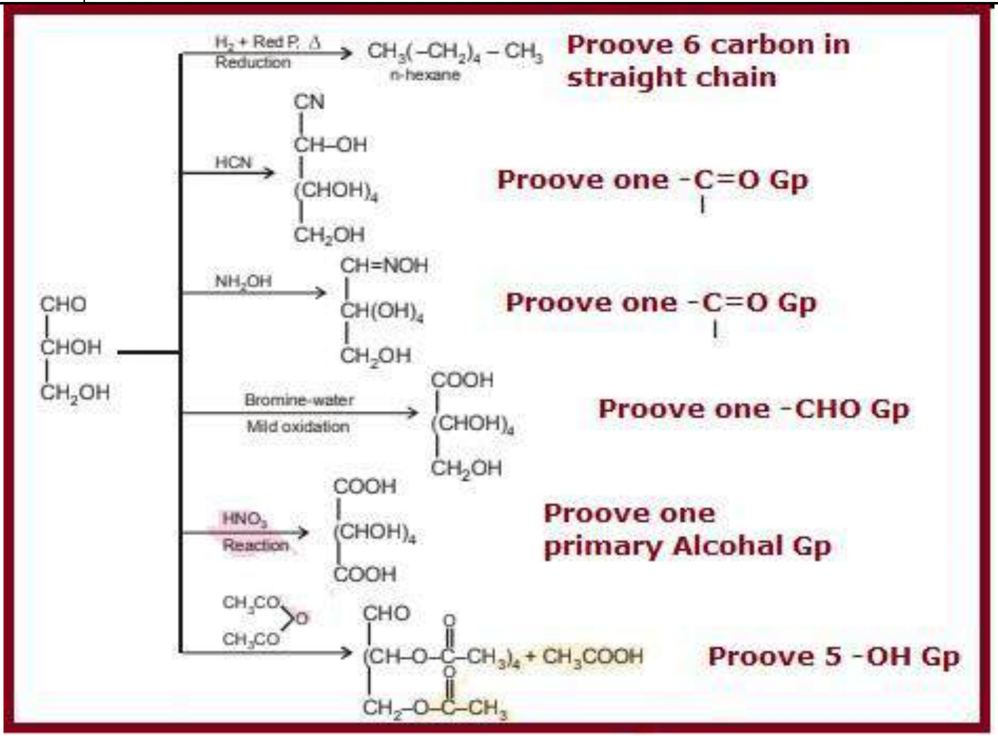
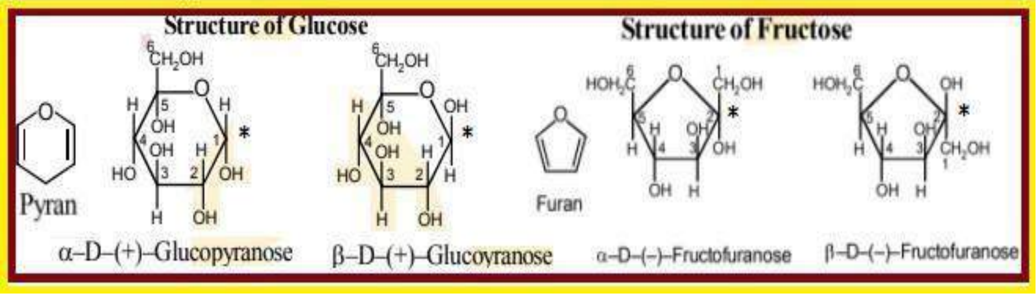
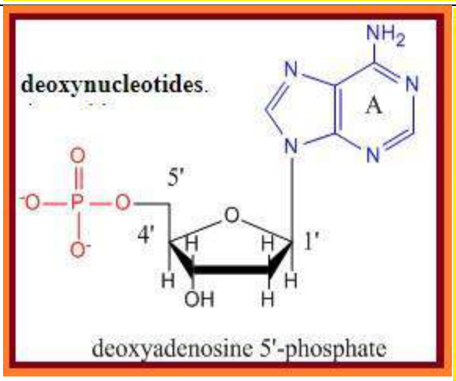
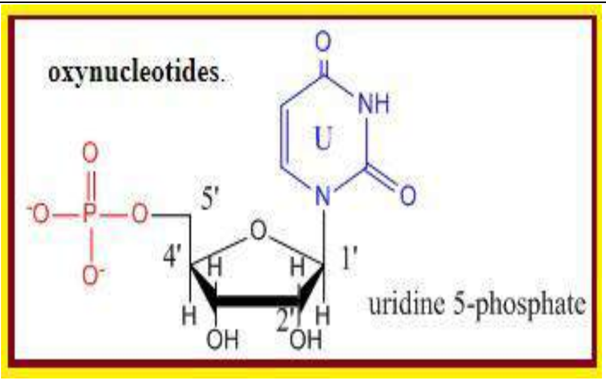
RNA	N-Bases: A,G C & U, Single helix, Contains Ribose sugar, Helps in proteins synthesis.
Preparation of glucose	 **(I) From Cane sugar: (Sucrose)** : When sucrose is hydrolysed by boiling with dil HCl or dil H_2SO_4 in alcoholic solution $C_{12}H_{22}O_{11} + H_2O \xrightarrow{H^+} C_6H_{12}O_6 + C_6H_{12}O_6$ Sucrose Glucose Fractose **(II) From Starch :** Commercially Glucose is obtained by hydrolysis of starch bv boiling it with dil H_2SO_4 at 393 K $(C_6H_{10}O_5)_n + nH_2O \xrightarrow[393K,\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$ Starch Glucose
Structure of glucose	

10. 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 polyhydroxy aldehyde or ketone is called a monosaccharide. examples are glucose, fructose, ribose, etc.
Oligosaccharides:	Carbohydrates that yield two to ten monosaccharide units, on hydrolysis, are called oligosaccharides. They are further classified as disaccharides, trisaccharides, tetra saccharides, etc., depending upon the number of monosaccharides, they provide on hydrolysis. For example, sucrose on hydrolysis gives one molecule each of glucose and fructose.
Polysaccharides:	Carbohydrates which yield a large number of monosaccharide units on hydrolysis are called polysaccharides. Some common examples are starch, cellulose, glycogen, gums, etc. Polysaccharides are not sweet in taste, hence they are also called non-sugars.
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. All polysaccharides 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 $-C\equiv G-$, and $-A=T-$ Purines : A & G And Pyrimidines : C, U & T

DNA	N-Bases : A,G ,C &T, Double helix, Contains 2-deoxy ribose sugar, Transfer heredity characters.

Reaction of glucose	
Reaction 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 (□&□). □ All observations indicate that free aldehydic group is not present in glucose.
Cyclic structure of glucose	
Structure of Nucleotide	 

1	Deficiency of vitamin B₁ causes: A) Convulsions B) Beriberi C) Cheilosis D) Sterility Answer: B) Beriberi
2	Maltose is made up of: A) Two α D glucose B)Two β D glucose

	C) One α and one β D glucose D) Fructose + glucose Answer: A) Two α D glucose
3	An example of a non-reducing sugar is: A) Sucrose B) Lactose C) Maltose D)None Answer: A) Sucrose
4	The anomeric carbon in the ring structure of glucose is carbon: A) C 2 B) C 3 C) C 4 D. C 1 Answer: D) C 1
5	On hydrolysis, which carbohydrate gives only glucose? A. Starch B. Fructose C. Lactose D) Sucrose Answer:A) Starch
6	The sugar present in RNA is: A) Glucose B) Deoxyribose C) Fructose D) Ribose Answer: D) Ribose
7	The bond between two amino acids is called: A) Glycosidic bond B) Hydrogen bond C) Peptide bond D) Ester bond Answer: C) Peptide bond
8	Proteins are made of: A) Sugars B) Nucleotides C) Fatty acids D) Amino acids Answer: D) Amino acids
9	A nucleotide is made of: A) Sugar + base B) Sugar + phosphate C) Base + phosphate D) Sugar + base + phosphate Answer: (d) Sugar + base + phosphate
10	The α helix and β pleated sheet represent which level of protein structure? (A) Primary (B) Secondary (C) Tertiary (D) Quaternary Answer: (b) Secondary
	ASSERTION -REASON QUESTIONS(1 MARKS EACH) A statement of assertion is followed by a statement of reason. Mark the correct choice from the options given below. (a) Both the assertion and reason is the correct and reason is the correct explanation of assertion. (b)Both the assertion and reason is the correct and reason is not the correct explanation of assertion. (c) Assertion is true but reason is false. (d) Both assertion and reason are false
11	**Assertion:** α-Amino acids are the building blocks of proteins. **Reason**: natural amino acids are mostly α-Amino acids. **Answer: (b**) Both the assertion and reason is the correct and reason is not the correct explanation of assertion.
12	**Assertion** – Vitamin C can't be stored in our body. **Reason** – Vitamin C is water soluble and is excreted from the body through urine. **Answer: (a)** Both the assertion and reason are correct, and reason is the correct explanation of the assertion.
13	**Assertion** – Adenine and Guanine are the purines present in both nucleic acids. **Reason** – Thiamine and Uracil are the pyrimidine present in DNA. **Answer: (c)** Assertion is true but reason is false

14	**Assertion** – Proteins are polymers of alpha amino acids connected by peptide bonds. **Reason –** A tripeptide contains 3 amino acids linked by 3 peptide bonds. **Answer: (c)** Assertion is true but reason is false
15	**Assertion:** Proteins are made of amino acids. **Reason:** Amino acids join together by glycosidic bonds. **Answer: (c)** Assertion is true but reason is false
	SAQ (2 MARKS EACH)
16	**Describe what do you understand by primary structure and secondary structure of proteins**. **Answer: Primary structure** : The specific sequence in which the various a-amino acids present in a protein are linked to one another is called its primary structure. Any change in the primary structure creates a different protein . **Secondary Structure** : The conformation which the polypeptide chain assumes as a result of hydrogen bonding is known as secondary structure. The two of secondary structures are α-helix and β-pleated sheet structures
17	**(i)Which of the following is a polysaccharide:Starch, maltose, fructose, glucose. (ii)Write the name of the vitamin responsible for the coagulation of blood** **Answer:** . I) Starch ii) Vitamin K
18	**(.i)Write one reaction of D-glucose which cannot be explained by its open chain structure.** **(ii)What type of linkage is present in nucleic acids?** **Answer:(** i) Despite having aldehydic (-CHO) group. Glucose does not react with NaHSO3 to orm addition product ii) Phosphodiester linkage.
19	**What is the basic structural difference between glucose and fructose?** **Answer**: Glucose is an aldohexose (contains an aldehyde group), while Fructose is a ketohexose (contains a ketone group).
20	**Write the products obtained after hydrolysis of lactose.** **Answer:** Glucose and Galactose
21	**Name the sugar present in milk. How many monosaccharide units are present in it? What are such oligosaccharides called?** **Answer**: Lactose is present in milk. It has 2 monosaccharide units. They are glucose and galactose. These are called disaccharides
22	**What is the effect of denaturation on the structure of proteins?** **Answer:** During denaturation, the protein molecules uncoil from an ordered and specific conformation into a more random confirmation. Denaturation does not change the primary structure of protein but results from arrangement of secondary and tertiary structures
23	**What is meant by 'reducing sugars'?**

Answer: Reducing sugars are carbohydrates that can reduce Fehling's solution or Tollen’s reagent due to the presence of a free aldehyde or ketone group

24 **Name the four bases present in DNA. Which one of these is not present in RNA?**

Answer: Adenine (A) , Guanine (G) , Cytosine (C), Thymine (T).Thymine is not present in RNA; it is replaced by Uracil (U).

25 **Give one example each for fibrous protein and globular protein.**

Answer: Fibrous protein: Collagen

Globular protein: Hemoglobin

SAQ (3 MARKS EACH)

26 **Write the reactions involved when D-glucose is treated with the following reagents:**

(i) Br_2 water

(ii) H_2N-OH

(iii) $(CH_3CO)_2O$

Answer:

(i)Bromine water selectively oxidizes the aldehyde group at C-1 of D-glucose to a carboxylic acid without affecting the alcohol groups.

(ii)Hydroxylamine reacts with the aldehyde group of glucose to form an oxime, which helps confirm the presence of an aldehyde group in glucose.

(iii)All five hydroxyl groups in D-glucose (four alcoholic –OH and one hemiacetal –OH) are acetylated to form glucose pentaacetate. This reaction is generally carried out in the presence of a base like pyridine.

27 **Write chemical reactions to show that open structure of D-glucose contains the following:**

(i) Straight chain (ii) Five alcohol groups (iii) Aldehyde as carbonyl group

Answer: (i) Straight chain: Glucose forms oxime and hydrazone with hydroxylamine and phenylhydrazine, indicating a free carbonyl group in open-chain form.

(ii) Five alcohol (–OH) groups:On reaction with acetic anhydride, glucose forms pentaacetate, suggesting five hydroxyl groups.

(iii) Aldehyde group:Glucose reduces Tollen’s reagent and Fehling’s solution, confirming presence of an aldehyde group.

28 a**)Amino acids show amphoteric behaviour. Why?**

(b)Write one difference between α-helix and β-pleated structures of proteins.

Answer: a)Amino acids contain both acidic (-COOH) and basic ($-NH_2$) groups, so they can act as acids or bases → Amphoteric behavior.

b) One difference between α-helix and β-pleated sheet:

Feature-	α-Helix	β-Pleated Sheet
Structure-	Coiled, helical	Sheet-like, folded

Hydrogen Bonding	Intrachain	Interchain or intrachain

29	**What happens when D-glucose is treated with the following ? Give equations to support your answer.** **(a) HI (b) HNO_3** **Answer:** (a)D-glucose is reduced to n-hexane (a straight-chain alkane).This shows that glucose has a straight, unbranched six-carbon chain. (b) When D-glucose is treated with HNO_3 (Nitric acid):D-glucose is oxidized by strong oxidizing agent HNO_3. Both the aldehyde group (–CHO) and the primary alcohol group (–CH_2OH) are oxidized to carboxylic acids.
30	**Amino acids may be acidic, alkaline or neutral, how does this happen? What are essential and nonessential amino acids? Name one of each type**. **Answer:** Acidic amino acids have extra –COOH group (e.g., Glutamic acid).Basic amino acids have extra –NH_2 group (e.g., Lysine).Neutral amino acids have equal number of –COOH and –NH_2 (e.g., Glycine).
31	**Write any two reactions of glucose which cannot be explained be the open chain structure of glucose molecule**. **Answer:** (i) Glucose does not react with Schiff's reagent, although it contains an aldehyde.(ii) Glucose forms a cyclic hemiacetal structure and exists mainly in α and β anomers, not explained by open-chain structure.
32	**Define the following terms:** **a) Peptide bond** **b) Denaturation of protein** **Answer**: (a) Peptide bond:A peptide bond is an amide linkage formed between the –COOH group of one amino acid and –NH_2 group of another. –CO–NH—CO–NH– (b) Denaturation of protein:Loss of biological activity and native structure of a protein due to changes in temperature, pH, or chemicals
33	***a*) Why Vitamin C cannot be stored in our body?** **b) Write the name of Vitamin whose deficiency causes bone deformities in children.** **c) Deficiency of which Vitamin cause night blindness.** **Answer:** a)Vitamin C is water-soluble, so it dissolves in water and is excreted through urine. Hence, it cannot be stored in the body, and regular intake is necessary through diet. b) Vitamin D,Deficiency causes rickets, a disease leading to soft and deformed bones in children. c) Vitamin A
34	**Define the following with a suitable example.** **a) Oligosaccharides** **b) Denaturation of proteins**

c) Vitamins

Answer: a) Oligosaccharides: Oligosaccharides are carbohydrates that yield 2 to 10 monosaccharide units on hydrolysis. They are formed by the condensation of simple sugars through glycosidic linkages.Example: Sucrose (composed of glucose and fructose) is a disaccharide, a type of oligosaccharide.

b) Denaturation of proteins: Denaturation of proteins is the process in which a protein loses its native structure (secondary and tertiary structure) due to physical or chemical factors such as heat, pH change, or exposure to chemicals, resulting in loss of biological activity.Example: Boiling an egg causes the egg white (albumin) to become solid due to denaturation.

c) Vitamins: Vitamins are organic compounds required by the body in small amounts for various physiological and metabolic functions. They do not provide energy but are essential for maintaining health.

35 **Define the following terms:**

- **a) Zwitter ion**
- **b) Isoelectric point**

Answer: a) Zwitter-ion: A zwitterion is a molecule that contains both a positive and a negative charge, but is overall electrically neutral. In amino acids, the amino group ($-NH_2$) accepts a proton to become $-NH_3^+$, and the carboxyl group (-COOH) loses a proton to become $-COO^-$, forming a zwitterionic structure.

b) Isoelectric point :The isoelectric point is the pH at which an amino acid exists as a zwitterion and thus has no net electric charge.

36 **Read the paragraph carefully and give answers of the questions followed-**

Vitamins are vital for life. A, D, E, K are fat soluble vitamins whereas B1, B2, B3, B5, B6, B7, B9, C are water soluble vitamins. Vitamin A helps in improving eye sight. Vitamin C prevents scurvy and increases immunity. Vitamin D helps in strong bones and teeth. Our requirement of vitamin D is 15mcg. We get vitamin D from sunlight, eggs, dairy products, orange, oats and mushroom etc. Citrus fruits 161 | Page contain vitamin C. Carrot contains vitamin A. We should include chick pea flour in our diet to prevent inflammation. It has phytonutrients and fibres which have anti-inflammatory properties. It prevents accumulation of fats. It contains Fe, Cu, Mg, fibre, K which are essential to control our wait. It increases our immune system. It contains proteins, amino acids, Mg, vitamin B and P. Pomegranates are good source of vitamin C which our body needs to make collagen. It is rich source of B-complex, vitamin B5 folates pyridoxine and vitamin K. It contains essential minerals like Ca, Cu, Mg and Mn. Pomegranates are rich source of insoluble fibres which help us keep fuller for longer time and regulate bowel function. Answer the following questions:

a) **Why should vitamin B and C must be taken regularly in diet?**
b) Which vitamin deficiency causes pernicious anemia ? Is it fat or water soluble?
c) i) What is meant by vitamin B-complex?
ii) What is deficiency and source of vitamin E?

OR

c) i) Which vitamin deficiency leads to bleeding for long time? What is its source?
ii) What is the role of fibre in our body?

Answer a) It is because vitamin B and C are water soluble and excreted through urine.
it should be taken regularly.
b) Vitamin B12. It is neither fat nor water soluble
c) i) It consists of vitamin B1, B2, B3, B5, B6, B7, B9 and B12.
ii) Vitamin E deficiency leads to dry skin and loss of reproductive power. Its source is oils like cotton seed oil.

OR

c) i) Vitamin K. It is present in green leafy vegetables.

ii) Fiber helps in digestion and helps to reduce weight

37 The particles in the nucleus of the cell, responsible for heredity, are called chromosomes which are made up of proteins and another type of biomolecules called nucleic acids. These are mainly of two types, DNA and RNA. Nucleic acids on hydrolysis yield a pentose sugar, phosphoric acid and nitrogen containing heterocyclic compound. Nucleic acids have a very diverse set of functions, such as cell creation, the storage and processing of genetic information, protein synthesis and the generation of energy cells. Although their functions may differ, the structure of DNA and RNA are very similar, with only a few fundamental differences in their molecular make-up.

Based on the above information, answer the following questions :

(a) Write two functions of DNA.

(b) What products will be formed when a nucleotide from DNA containing Adenine is hydrolyzed ?

(c) What are nucleic acids ? What is the difference between nucleotide and nucleoside.

OR

(C) Give one similarity and one difference between DNA andRNA.

Answer: a)1.DNA stores hereditary information that determines the structure and function of cells and organisms.

2.DNA controls protein synthesis through **transcription** (to mRNA) and **translation**, ensuring proper functioning of cells.

b)Nucleotide (Adenine)→Adenine+Deoxyribose+Phosphate group

Nucleotide (Adenine)→Adenine+Deoxyribose+Phosphate group

c) Nucleic acids are biopolymers made of nucleotides, responsible for storing and transferring genetic information.

There are two main types:DNA (Deoxyribonucleic Acid),RNA (Ribonucleic Acid)

Difference between Nucleotide and Nucleoside:

Nucleoside	Nucleotide
Nitrogenous base + sugar	Nitrogenous base + sugar + phosphate group
Example: Adenosine	Example: AMP (adenosine monophosphate)

OR

C) Similarity: Both are made of nucleotides and contain genetic information.

Difference: Sugar: DNA contains deoxyribose sugar, RNA contains ribose sugar, DNA has thymine and RNA has uracil .

38 **Read the following passage carefully and answer the questions:**

Proteins are complex biomolecules made up of long chains of α-amino acids linked by peptide bonds. They play vital roles in biological systems as enzymes, hormones, antibodies, and structural components. Proteins have primary, secondary, tertiary, and quaternary structures, which define their shape and function. The denaturation of proteins leads to the loss of their biological activity without breaking peptide bonds. Proteins can be classified as fibrous or globular based on their shape and solubility. The body requires 20 different amino acids, some of which are essential, meaning they must be obtained from the diet.

Questions:

1. What type of bond connect amino acids in a protein molecule?

2.Write the function of aminoacid.

3. What happens to a protein during denaturation?

OR

3. What is the difference between essential and non-essential amino acids?

Answers:

	1. Peptide bond(An amide bond formed between the –COOH of one amino acid and the $-NH_2$ of another.) 2. Amino acids play vital roles in biological systems as enzymes, hormones, antibodies, and structural components. 3.During denaturation, the protein loses its secondary and tertiary structure, resulting in loss of biological activity, but peptide bonds remain intact. **OR** 3.Essential amino acids: Cannot be synthesized by the body; must be taken in diet (e.g., Valine),Non-essential amino acids: Can be synthesized in the body (e.g., Alanine).
	LAQ(MARKS -5)
39	**Do any five of the following** : **(a) Pentaacetate of glucose does not react with hydroxylamine. Give reason.** **(b) Despite having the aldehyde group, glucose does not give 2, 4-DNP test or Schiff's** **(c)Why must water soluble vitamins be taken regularly in diet ?** **(d)Why are the two strands in DNA complementary to each other ?** **(e) Vitamin C is not stored in our body?** **Answer:a)** In pentaacetate form, all hydroxyl groups (including the anomeric -OH) are acetylated, preventing the molecule from opening into the open-chain aldehyde form needed for reaction with hydroxylamine (NH_2OH), which typically reacts with aldehydes or ketones. (b) Due to internal cycling, there is no free aldehydic group (c) Water-soluble vitamins (like vitamin B-complex and C) must be taken regularly because they are **not stored in the body**. Excess amounts are excreted in urine, so a constant supply is needed through diet to prevent deficiency. (d) The two strands in DNA are complementary because of specific base pairing rules governed by hydrogen bonding between nitrogenous bases: Adenine (A) always pairs with Thymine (T) using 2 hydrogen bonds,Guanine (G) always pairs with Cytosine (C) using 3 hydrogen bonds (e.)Because it is water soluble and is excreted out with sweat and urine
40	**(i). Give reactions of glucose with the following:** **(a) HCN (b) Concentrated HNO_3** **(ii)(a) What are essential amino acids?** **(b) What is meant by the zwitter ionic form of amino acids?** **(iii) What is the structural feature which characterizes a reducing sugar?** **Answer** **(i).** a) With HCN (Hydrogen Cyanide):Glucose reacts with HCN to form cyanohydrin. The reaction occurs at the aldehyde group (–CHO) of glucose.Reaction:Glucose (open-chain form)+HCN→Glucose cyanohydrin (b) When glucose is oxidized by conc. HNO_3, both the aldehyde group (–CHO) and the primary alcohol group ($-CH_2OH$) are oxidized to carboxylic acids, producing saccharic acid (glucaric acid). **(ii).(**a)Essential amino acids are amino acids that cannot be synthesized by the human body and must be obtained through diet.Examples: Valine, Leucine, Lysine, etc. (b) Amino acids exist as zwitterions in aqueous solutions. In this form, the amino group ($-NH_2$) is protonated to $-NH_3^+$, and the carboxyl group (–COOH) is deprotonated to $-COO^-$.This form contains both positive and negative charges but is overall electrically neutral. **(iii)**A reducing sugar has a free aldehyde group (–CHO) or a free ketone group (–C=O) in its open-chain form that can reduce Tollens' reagent or Fehling's solution
41	**Answer the following questions:** **(a) Name the isomers of glucose which in the cyclic form differ only in the configuration of the –OH group at C-1.** **(b) Name the polysaccharide which is known as 'animal starch'. Why is it called 'animal starch'?** **(c) Difference Between Nucleoside and Nucleotide.**

Answer:a) They are anomers, differing in configuration around the anomeric carbon (C-1).In α-glucose, the –OH at C-1 is down (opposite to CH_2OH group).In β-glucose, the –OH at C-1 is up (same side as CH_2OH group).

b) The polysaccharide is glycogen.It is called 'animal starch' because it serves the same energy storage function in animals as starch does in plants.

c) . Structural Difference Between Nucleoside and Nucleotide

Feature	**Nucleoside**	**Nucleotide**
Components	Nitrogenous base + Sugar	Nitrogenous base + Sugar + Phosphate group
Example	Adenosine (adenine + ribose)	AMP (adenosine monophosphate)

Worksheet -1 SOLUTIONS

1. **What is the SI unit of molality?**
   Answer: ----------------

2. **Which has higher boiling point: pure water or sugar solution?**
   Answer: ------------------

3. **Name the colligative property used to determine molar mass of a solute.**
   Answer: --------------------------------------

4. **What is meant by an ideal solution?**
   Answer: --

5. **Name one pair of liquids that forms an ideal solution.**
   Answer: ---------------------------------

6. **What is the value of van’t Hoff factor (i) for glucose?**
   Answer: ------------

7. **What is the relation between vapour pressure and temperature?**
   Answer: ------------------------

8. **Why is the boiling point of a solution higher than that of the pure solvent?**
   Answer: --------------------------

9. **Which law explains the solubility of gases in liquids?**
   Answer: ---------------------------

10. **What happens to the vapour pressure when a non-volatile solute is added to a solvent?**
    Answer: ------------------------------------

Worksheet 2

1. **What are colligative properties dependent on?**
   Answer: ----------------------------

2. **What is the effect on boiling point when a non-volatile solute is added to a solvent?**
   Answer: -------------------------

3. **Define abnormal molar mass.**
   Answer: --
   --

4. **What is the van't Hoff factor (i) for a solute that does not dissociate or associate in solution?**
   Answer: ----------

5. **Give one reason for observing abnormal molar mass in acetic acid dissolved in benzene.**
   Answer: --------------------------

6. **What is the van't Hoff factor (i) for KCl in aqueous solution (assume complete dissociation)?**
   Answer: ----------

7. **State the relation between observed and expected molar mass in case of dissociation.**
   Answer: --------------------------------.

8. **State the relation between observed and expected molar mass in case of association.**
   Answer: -----------------------------------

9. **Which colligative property is used to detect abnormal molar masses?**
   Answer: --------------------------------------

10. **What is the effect of association of solute molecules on colligative property value?**
    Answer: -------------------------

Chapter: Electrochemistry

Worksheet No.- 01

Total Marks: 15 **Time: 30 minutes**

SECTION A: Multiple Choice Questions (1 mark each) – [3 × 1 = 3 marks]

Q1. The cell reaction in a Daniell cell is:
$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
Which of the following statements is correct?
a) Zn is oxidized and Cu is reduced
b) Cu is oxidized and Zn is reduced
c) Both undergo reduction
d) Both undergo oxidation

Q2. Which of the following increases with dilution for a weak electrolyte?
a) Specific conductivity b) Molar conductivity
c) Number of ions d) Cell constant

Q3. The unit of molar conductivity is:
a) S m b) $S\ cm^{-1}$ c) $S\ cm^2\ mol^{-1}$ d) ohm^{-1}

SECTION B: Assertion-Reason Questions (1 mark each) – [2 × 1 = 2 marks]

Directions: Each question contains Assertion (A) and Reason (R). Choose the correct option:
- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Q4.Assertion (A): Electrolysis of molten NaCl gives sodium metal at the cathode.
Reason (R): Sodium ions gain electrons and get reduced at cathode. ANS-________

Q5. Assertion (A): Molar conductivity of strong electrolytes increases with dilution.
Reason (R): Number of ions increases significantly with dilution. ANS-________

SECTION C: Short Answer Questions (2 marks each) – [2 × 2 = 4 marks]

Q6. Define the following terms:
a) Standard electrode potential -________________________________

____ b)
Cell constant-____

Q7. Write the Nernst equation for the following cell and calculate its EMF at 298 K:
$Zn|Zn^{2+}(0.1M)||Cu^{2+}(1.0M)|Cu$
Given: $E°(Zn^{2+}/Zn) = -0.76\ V$, $E°(Cu^{2+}/Cu) = +0.34\ V$

Ans.-

____

____

____

____

____

____

SECTION D: Long Answer Questions (3 marks each) – [2 × 3 = 6 marks]

Q8. (i) State Kohlrausch’s Law of Independent Migration of Ions.
(ii) How can it be used to determine the molar conductivity at infinite dilution of acetic acid?

Ans-

Q9. A conductivity cell has a cell constant of 0.5 cm^{-1}.The conductance of 0.01 M KCl solution is measured to be 0.00141 S. Calculate:

a) Conductivity
b) Molar conductivity
c) Comment on how molar conductivity changes with dilution.

Ans.-

Chapter: Electrochemistry

Worksheet No.- 02

Total Marks: 15 **Time: 30 minutes**

SECTION A: Multiple Choice Questions (1 mark each) – [3 × 1 = 3 marks]

Q1. Which of the following is correct regarding Faraday's First Law of Electrolysis?
a) Mass of substance deposited is independent of charge passed
b) Mass of substance deposited is directly proportional to charge passed
c) It depends only on the atomic mass
d) None of the above

Q2. Which of the following is NOT a primary cell?
a) Daniel cell b) Dry cell c) Lead-acid battery d) Mercury cell

Q3. The process of corrosion of iron is essentially:
a) Oxidation b) Reduction c) Electrolysis d) Photolysis

SECTION B: Assertion-Reason Questions (1 mark each) – [2 × 1 = 2 marks]

Directions: Each question contains Assertion (A) and Reason (R). Choose the correct option:
- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Q4. Assertion (A): In electrolysis of molten NaCl, sodium is deposited at the cathode.
Reason (R): Sodium is more electropositive than hydrogen. ANS-____________

Q5. Assertion (A): A lead storage battery can be recharged.
Reason (R): In lead storage battery, the reaction is reversible. ANS-___________

SECTION C: Short Answer Questions (2 marks each) – [2 × 2 = 4 marks]

Q6. (i) State Faraday's second law of electrolysis.

(ii) Calculate the mass of copper deposited when 2 Faradays of electricity is passed through $CuSO_4$ solution.

ANS-
(i)____
____
____

(ii)
____
____
____
____
____
____
____
____

Q7. A fuel cell using hydrogen and oxygen is known for its high efficiency. Write the half-cell reactions and the overall reaction occurring in a hydrogen-oxygen fuel cell. Why fuel cells are considered a better alternative to conventional energy sources?

ANS-

SECTION D: Short Answer Questions (3 marks each) – [2 × 3= 6 marks]

Q8. A current of 3 amperes was passed through an aqueous solution of $AgNO_3$ for 10 minutes. Calculate:
a) The amount of silver deposited (Ag = 108 g/mol)
b) Number of moles of Ag deposited
c) Which law of electrolysis does it illustrate?

ANS-

Q9. A student performed electrolysis of an aqueous solution of NaCl using inert electrodes. She noticed that a gas was evolved at both electrodes.
(a) Identify the gases evolved.
(b) Write the reactions at both electrodes.
(c) What is the pH of the resulting solution?Explain with reason.

ANS-

Worksheet-1CHEMICAL KINETICS

Topic: Order, Molecularity, and Finding the Rate Constant

Name: ________________ Roll No: __________ Date: __________

Section A: (MCQs)

1. 1. For the reaction: $2A + B \rightarrow$ Products, the rate law is:
   Rate = $k[A]^2[B]$
   What is the order of the reaction?
   a) 1 b) 2 c) 3 d) 0
   Answer: ___________

2. 2. Molecularity of a reaction:
   a) Can be zero b) Is always an integer c) Can be a fraction d) Is equal to the order
   Answer: ___________

3. 3. Which of the following is a unimolecular reaction?
   a) $A + B \rightarrow C$ b) $2A \rightarrow B$ c) $A \rightarrow B$ d) $A + B + C \rightarrow D$
   Answer: ___________

4. 4. The unit of rate constant for a second-order reaction is:
   a) $mol\ L^{-1}\ s^{-1}$ b) s^{-1} c) $L\ mol^{-1}\ s^{-1}$ d) $L^2\ mol^{-2}\ s^{-1}$
   Answer: ___________

Section B: Assertion and Reason Questions

5. 1. Assertion (A): Order of a reaction is determined experimentally.
   Reason (R): Order depends on the stoichiometry of the reaction.
   a) Both A and R are true, and R is the correct explanation of A.
   b) Both A and R are true, but R is not the correct explanation of A.
   c) A is true but R is false.
   d) A is false but R is true.
   Answer: ___________

6. 2. Assertion (A): Molecularity can never be more than three.
   Reason (R): High molecular collisions are rare in elementary reactions.
   Answer: ___________

Section C: Short Answer Questions

7. 1. Define order and molecularity of a reaction. How are they different?

Answer: ____

____

8. 2. Give one example each of a unimolecular and a bimolecular reaction.

Answer: ____

____

9. 3. What information does the rate constant (k) provide about a reaction?

Answer: ____

____

Section D: Numerical Questions

10. 1. For a first-order reaction, A → B, if $[A]_0 = 1.0$ mol/L, and after 10 minutes $[A] = 0.25$ mol/L, find the rate constant.
Use: $k = (2.303 / t) * \log([A]_0 / [A])$

Solution: ____

____

11. 2. The rate of a reaction is given by:
$\text{Rate} = k[A]^2[B]$
When $[A] = 0.5$ mol/L, $[B] = 1.0$ mol/L, Rate = 0.05 mol L^{-1} s^{-1}
Calculate the value of the rate constant k.

Solution: ____

____

Section E: Competency-Based Question:

1. A student performs an experiment and finds that doubling the concentration of reactant A quadruples the rate of reaction, while changing B has no effect.
   a) What is the order of the reaction with respect to A and B?
   b) Write the rate law expression.
   c) Identify whether the reaction is elementary or complex. Justify.

Answer: ____

____

____

Worksheet-2

Topic: Integrated Rate Equations

Name: ________________ Roll No: ___________ Date: ___________

Section A: Conceptual Questions:

12. 1. Derive the integrated rate equation for a zero order reaction.

Answer: ____

____

13. 2. Derive the integrated rate equation for a first order reaction.

Answer: ____

____

14. 3. How is the half-life related to the rate constant in a first order reaction? Derive the expression.

Answer: ____

____

15. 4. What is the significance of the slope in the plot of ln[A] vs time for a first order reaction?

Answer: ____

____

Section B: Numerical Problems:

16. 1. For a first order reaction, the initial concentration of the reactant is 0.6 mol/L and after 20 minutes it is 0.3 mol/L. Calculate the rate constant.
(Use: $k = (2.303/t) * \log([A]_0 / [A])$)

Solution: ____

____

17. 2. The decomposition of a compound is a zero order reaction. The initial concentration is 0.5 mol/L and it becomes zero in 50 seconds. Calculate the rate constant.

Solution: ____

____

18. 3. A first order reaction is 50% complete in 30 minutes. Calculate the rate constant and half-life of the reaction.

Solution: ____

____

19. 4. For a reaction $A \rightarrow B$, the rate constant is $1.5 \times 10^{-3}\ s^{-1}$. Calculate the time required for the concentration of A to fall from 1.0 mol/L to 0.25 mol/L.

Solution: ____

____

20. For a first-order reaction, the time taken for 75% completion is 60 minutes. What is the rate constant?

Solution:____

____

____

____

____

21. A reaction is 25% complete in 30 minutes. Assuming first-order kinetics, calculate the rate constant.

Solution: ____

____

____

____

Section C: Application-Based Question:

1. A student noted that in a reaction of hydrogen peroxide decomposition, the volume of oxygen gas collected at different time intervals showed a linear increase. Based on this observation, answer the following:

a) What is the likely order of this reaction?

b) Justify your answer based on the shape of the graph.

c) Write the integrated rate law for this reaction.

Answer: ____

____

____

WORK SHEET NO-1 d & f - BLOCK ELEMENTS

TIME: 30 MINUTES **MM-15**

- ***(a)*** *Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).*
- ***(b)*** *Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).*
- ***(c)*** *Assertion (A) is true, and the Reason (R) is false.*
- ***(d)*** *Assertion (A) is false, but the Reason (R) is true.*

1. **Assertion:** There is a continuous decrease in the size of lanthanoids.
Reason: Lanthanoids shows lanthanoid contraction.
Answer: ___________________

2. **Assertion:** Actinoids form relatively less stable complexes as compared to lanthanoids.
Reason: Actinoids can utilise their 5f orbitals along with 6d orbitals in bonding but lanthanoids do not use their 4f orbital for bonding.
Ans-----------

3. **Assertion:** It is not possible to obtain anhydrous $ZnCl_2$ by heating $ZnCI_2.2H2O$.
Reason: $ZnCI_2.2H_2O$. undergoes hydrolysis to produce $Zn(OH)_2$ and HCl.
Ans------------

Short Answer Type Question

4. Give reason:
   - **a.** Scandium is a transition element but zinc is not.
   - **b.** Actinoid contraction is greater from element to element than lanthanoid contraction.

   Ans-(a) --
   Ans-(b) --

5. Give reason:
   - **a.** Transition metals show several (variable) oxidation states.
   - **b.** The enthalpies of atomization of transition metals are high.

   Ans-(a) --

   Ans-(b) --

   ----

6. The Elements of 3d transition series are given as:

Atomic No	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Element	**Sc**	**Ti**	**V**	**Cr**	**Mn**	**Fe**	**Co**	**Ni**	**Cu**	**Zn**

7. **Answer the following:**
   - **a.** Write the name of element which is not regarded as transition element.
   Ans ---

   - **b.** Write the element which can show an oxidation state of +1.
   Ans- --

   ----

c.Why Zinc salts are colourless?

Ans- --

d. Which element shows maximum number of oxidation states.

Ans- ---

e. Which element is a strong reducing agent in +2 oxidation state and why?

Ans- --

8. Assign reasons for the following.

(a) Scandium is a transition element but Zinc is not.

Ans- --

(b) Silver atom has completely filled d orbital ($4d^{10}$) in its ground state, yet it is transition element.

Ans- --

(c) In the series Sc (Z = 21) to Zn (Z = 30), the enthalpy of atomisation of zinc is the lowest.

Ans- --

WORK SHEET NO.-2

MM-15 **TIME-30MIN**

Q.1 Which of the 3d series of the transition metals exhibits the largest number of oxidation states and why?

Q.2. Explain why Cu+ ion is not stable in aqueous solutions?

Q.3 Explain giving reasons:
(i)Transition metals and many of their compounds are weakly attracted in the external magnetic field.

(ii)The enthalpies of atomisation of the transition metals are high.

(iii)Compare the properties of interstitial compounds with that of the pure metals from which they are made.

Q.4 Manav poured some potassium chromate solution in test tube for qualitative analysis. The yellow colour of potassium chromate soon turned orange in colour. Manav realised that this happened because the test tube was not clean and contained a few drops of some liquid. Which of the following were the liquid drops most likely to be.
(a) Drops of water (b) methyl orange solution (c) NaOH solution (d) HCl solution

Q.5 Describe the preparation of potassium dichromate from iron chromite ore. What is the effect of increasing pH on a solution of potassium dichromate?

Q.6. Describe the oxidising action of potassium dichromate and write the ionic equations for its reaction with:
(i) Iodide

(ii) Iron (II) solution

(iii)H_2S

Q.7. Compare the chemistry of actinoids with that of the lanthanoids with special reference to

(i)electronic configuration,

(ii)atomic and ionic sizes and

(iii)oxidation state

WORKSHEET 1 COORDINATION COMPOUNDS

Class XII , Subject: Chemistry

Marks: 20 Time: 45 minutes

1. Define a coordination compound. Give one example. (1 mark)

Ans: …………………………………………………………………………………………………

……………………………………………………………………………………………………..

2. Write IUPAC names of the following: (1 x2= 2 marks)

a) $[Co(NH_3)_5Cl]Cl_2$ b) $K_3[Fe(CN)_6]$

Ans: …………………………………………………………………………………………………

……………………………………………………………………………………………………..

3. What is the coordination number and oxidation number of the metal in $[Cr(H_2O)_6]Cl_3$?

(2 marks)

Ans: …………………………………………………………………………………………………

……………………………………………………………………………………………………..

4. Differentiate between ionisation isomerism and linkage isomerism with suitable examples.

(3 marks)

Ans: …………………………………………………………………………………………………

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

5. Explain chelation and its effect on the stability of coordination complexes. (2 marks)

Ans: …………………………………………………………………………………………………

……………………………………………………………………………………………………..

6. Assertion-Reason:

Assertion (A): [Ni(CO)4][Ni(CO)_4][Ni(CO)4] is diamagnetic.
Reason (R): CO is a strong field ligand.
Choose the correct option: (1 mark)
a) Both A and R are true and R is the correct explanation of A
b) Both A and R are true but R is not the correct explanation
c) A is true but R is false
d) A is false but R is true

Ans: …………………………………………………………………………………………………

7. Assertion-Reason:

Assertion (A): $[Fe(CN)_6]^{4-}$ is diamagnetic. (1 mark)
Reason (R): CN^- causes pairing of electrons.
Choose the correct option: a / b / c / d

Ans: …………………………………………………………………………………………………

8. Read the passage and answer the following:

A complex compound $[Co(en)_2Cl_2]Cl$ exhibits isomerism. It forms two geometrical isomers, one of which shows optical activity. (3 marks)

a) What is the denticity of 'en'?
b) Name the type of isomerism shown.
c) Draw the geometrical isomers.

Ans: ………………………………………………………………………………………………

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

9. Explain the Crystal Field Theory for octahedral complexes. Use it to describe the color and magnetic behavior of:
(3 marks)

a) $[Fe(H_2O)_6]^{3+}$ b) $[Fe(CN)_6]^{3-}$

Ans: ………………………………………………………………………………………………

……………………………………………………………………………………………………..

……………………………………………………………………………………………………..

WORKSHEET 2

Class XII , Subject: Chemistry

Marks: 20 Time: 45 minutes

21. Explain the term ‘ligand’. Give two examples each of unidentate and bidentate ligands. (2 marks)

Ans:…………………………………………………………………………………………………
……
……

22. What is the difference between double salts and coordination compounds? Give one example of each. (2 marks)

Ans:…………………………………………………………………………………………………
……
……

23. Write the IUPAC name and draw the structure of $[Pt(NH_3)_2Cl_2]$. (2 marks)

Ans:…………………………………………………………………………………………………
……
……

24. State and explain the chelate effect with one example. (2 marks)

Ans:…………………………………………………………………………………………………
……
……

25. Identify the hybridisation and geometry of the following:
    a) $[Ni(CN)_4]^{2-}$
    b) $[Ni(CO)_4]$ (2 marks)

Ans:…………………………………………………………………………………………………
……
……

26. Assertion (A): $[Cu(NH_3)_4]^{2+}$ is coloured.
    Reason (R): It has unpaired electrons which can undergo d-d transitions.
    Choose the correct option:
    a) Both A and R are true and R is the correct explanation of A
    b) Both A and R are true but R is not the correct explanation
    c) A is true but R is false
    d) A is false but R is true (1 mark)

Ans:…………………………………………………………………………………………
…

27. Assertion (A): EDTA is used to remove hardness of water.
Reason (R): EDTA forms stable chelates with Ca^{2+} and Mg^{2+} ions.
Choose the correct option: a / b / c / d (1 mark)

Ans:…………………………………………………………………………………………
…

28. Read the passage and answer the following:
A student is given two compounds: $[Fe(H_2O)_6]^{2+}$ and $[Fe(CN)_6]^{4-}$. One is pale green and paramagnetic, the other is colorless and diamagnetic.
a) Which one is paramagnetic and why?
b) Name the type of ligand in both complexes.
c) Explain the reason for the difference in color.
d) State the hybridisation of Fe in each complex. (3 marks)

Ans:…………………………………………………………………………………………
…

……………………………………………………………………………………………
…

……………………………………………………………………………………………
…

……………………………………………………………………………………………
…

29. What is isomerism in coordination compounds? Explain different types of structural isomerism with suitable examples. (2 marks)

Ans:…………………………………………………………………………………………
……………………………………………………………………………………………
……

30. Explain the bonding in coordination compounds using Valence Bond Theory (VBT). Discuss the geometry and magnetic behaviour of:
a) $[CoF_6]^{3-}$
b) $[Co(NH_3)_6]^{3+}$ (3 marks)

Ans:…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
…………

WORKSHEET NO. – 1

CHAPTER – HALOALKANES AND HALOARENES

MARKS - 15 **TIME 30 mins**

MCQ (1 mark)

1.Ethyl bromide is separately treated with NaNO2 and AgNO2. The products formed respectively are

(a) C_2H_5ONO, $C_2H_5NH_2$ (b) C_2H_5ONO, $C_2H_3NO_2$

(c) $C_2H_3NO_2$, C_2H_5ONO (d) $C_2H_5NH_2$, C_2H_2ONO

Matching Type Questions (1 mark)

1. Column I (Reaction)	Column II (Major Product)
(i) $CH_3CH_2CH(Br)CH_3 \xrightarrow{\text{alc. KOH}}$	(a) $CH_3CH_2CH = CH_2$
(ii) $CH_3CH_2CH(Br)CH_3 \xrightarrow{\text{aq. KOH}}$	(b) $CH_3CH=CHCH_3$
	(c) $CH_3CH_2CH(OH)CH_3$

Assertion-Reason Type Questions (1 mark each)

Directions: Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c), (d) are given as follows.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).

(b) Both (A) and (R) are true but (R) is not a correct explanation of (A).

(c) (A) is true but (R) in false

(d) (A) is false, but (R) is true.

3. Assertion. Bromoethane reacts with silver nitrite to form nitroethane as the major product.

   Reason. Nitrite ion is an ambident nucleophile.

----

4. Assertion. 1-Chlorobutane on heating with alcoholic KOH gives but-1-ene at the major product.

   Reason. But-1-ene is more stable than but-2-ene.

Short Answer Questions (2 marks each)

5. How will you convert: Chlorobenzene to biphenyl ? Give reaction.

----

6. The presence of nitro group (- NO2) at o/p-positions increases the reactivity of haloarenes towards nucleophile substitution reactions. Give reasons.

----

7. Why is boiling point of o-dichlorobenzene higher than p- dichloro benzene, but melting point of para- isomer is higher than ortho-isomer ?

LONG ANSWER QUESTIONS (5 marks)

7. Identify the compounds X and Y in each of the following sequence of reactions:

    (i) $C_2H_4 \xrightarrow{HBr} X \xrightarrow{aq.\ KOH} Y$

    (ii) $C_2H_5Br \xrightarrow{alc.\ KOH} X \xrightarrow{Br_2} Y$

    (iii) $C_6H_6 \xrightarrow{Cl_2\ /\ Fe} X \xrightarrow{CuCN,\ pyridine,\ \Delta} Y$

    (iv) $C_6H_5NH_2 \xrightarrow{NaNO_2,\ HCl,\ 273\text{–}278\ K} X \xrightarrow{CuBr\ /\ HBr} Y$

    (v) $C_6H_6 \xrightarrow{CH_3Cl,\ Anhyd.\ AlCl_3} X \xrightarrow{Cl_2\ (1\ mole),\ sunlight} Y$

WORKSHEET NO. – 2

CHAPTER – HALOALKANES AND HALOARENES

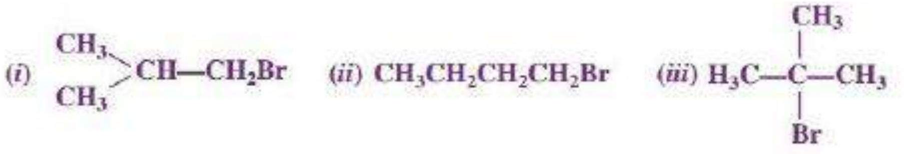
MARKS - 15 **TIME 30 mins**

MCQ (1 mark each)

1. Ethylene chloride and ethylidene chloride are isomers. Identify the correct statements.
(i) Both the compounds form same product on treatment with alcoholic KOH.
(ii) Both the compounds form same product on treatment with aq. NaOH.
(iii) Both the compounds form same product on reduction.
(iv) Both the compounds are optically active.
(a) (i) and (iii) (b) (ii) and (iii) (c) (i) and (iv) (d) (i) and (ii)

----

2. Arrange the following compounds in increasing order of their boiling points.



(a) (ii) < (i) < (iii) (b) (i) < (ii) < (iii)
(c) (iii) < (ii) < (i) (d) (iii) < (i) < (ii)

----

3. Chlorobenzene is formed by reaction of chlorine with benzene in the presence of $AlCl_3$. Which of the following species attacks the benzene ring in this reaction?
(a) Cl^- (b) Cl^+ (c) $AlCl_3$ (d) $[AlCl_4]^-$

Assertion-Reason Type Questions (1 mark each)
Directions: Two statements are given one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c), (d) are given as follows.
(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) Both (A) and (R) are true but (R) is not a correct explanation of (A).
(c) (A) is true but (R) in false
(d) (A) is false, but (R) is true.
4. Assertion (A): S_N2 reactions do not proceed with retention of configuration.
Reason (R): S_N2 reactions proceed in a single step.

----

5. Assertion (A): Electron withdrawing groups in aryl halides increase the reactivity towards nucleophilic substitution.
Reason (R): 2, 4-dinitrochlorobenzene is less reactive than chlorobenzene

----

Short Answer Questions (2 marks each)

6. Which one of the following compounds is more easily hydrolysed by KOH and why?
$CH_3CHClCH_2CH_3$ or $CH_3CH_2CH_2Cl$

----

7. How do you convert the following:
(i) Prop-1-ene to 1-fluoropropane **(ii) Chlorobenzene to 2-chlorotoluene**
(iii) Ethanol to propanenitrile

----

8. Write equations for the following:
(i) Oxidation of chloroform by air and light
(ii) Reaction of chlorobenzene with CH3Cl/anhyd. AICI$_3$

CASE BASED QUESTIONS (4 marks)

9. Grignard reagents are alkyl magnesium halides. Due to large electronegativity difference between carbon and magnesium, the carbon-magnesium bond has significant ionic character. The hydrocarbon part of the Grignard reagents acts as a source of carbanions. Therefore, Grignard reagents readily undergo nucleophilic addition reactions to aldehydes and ketones forming the addition products which upon hydrolysis yield alcohols.

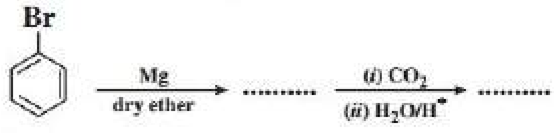
(a). What will be the product formed when chlorobenzene reacts with magnesium in presence of dry ether?
(b) Write the structure of B in the following reactions.

$$CH_3—CH_2—OH \xrightarrow[573\,K]{Cu} A \xrightarrow[(ii)\ H_2O]{(i)\ CH_3MgBr} B$$

(c). Give the mechanism of addition of Grignard reagent to carbonyl compound forming an alcohol.

OR

Complete the following:



Worksheet 1 : ALCOHOLS, PHENOLS & ETHERS

Class: XII | **Subject:** Chemistry | **Marks:** 15 | **Time:** 35 minutes

Instructions:

- Attempt all questions.
- Show proper reasoning and reactions wherever required.
- Use neat and labelled chemical equations.

☐ Section A: Very Short Answer Questions (1 mark each × 3 = 3 marks)

Q1. Write the IUPAC name of the following compound:
$CH_3–CH_2–O–CH_3$

Ans- --

Q2. What happens when phenol reacts with bromine water?

Ans---

Q3. Among ethanol, phenol, and water, which one has the highest acidity and why?

____

☐ Section B: Short Answer Questions (2 marks each × 2 = 4 marks)

Q4. What is Lucas test? How does it help to distinguish between primary, secondary, and tertiary alcohols?

____

____

Q5. Write the mechanism of acid-catalyzed dehydration of ethanol to form ethene.

Section C: Long Answer Questions (3 marks each × 2 = 6 marks)

Q6. How will you distinguish between the following pairs of compounds using chemical tests?
(a) Ethanol and phenol

____

(b) Methanol and tert-butyl alcohol

Q7. Write the steps involved in the preparation of **salicylic acid** from **phenol** (Kolbe's reaction). Give relevant chemical equations.

Section D: Application-Based Question (5 marks)

Q8.

(a) What is Williamson synthesis? Explain with an example. (2 marks)

(b) Why is the reaction between sodium ethoxide and tertiary butyl bromide not suitable for preparing tert-butyl ethyl ether? (1 mark)

(c) Write the equation for the reaction of anisole with bromine in the presence of $FeBr_3$. (2 marks)

Worksheet 2: ALCOHOLS, PHENOLS & ETHERS

Class: XII | **Subject:** Chemistry | **Marks:** 15 | **Time:** 35 minutes

Instructions:

- Attempt all questions.
- Show proper reasoning and reactions wherever required.
- Use neat and labelled chemical equations.

1.	In the reaction of phenol with bromine water, the major product is: A. o-Bromophenol B. m-Bromophenol C. p-Bromophenol D. 2,4,6-Tribromophenol	1
2.	Which reagent is used to convert alcohol into aldehyde? A. $KMnO_4$ B. PCC (Pyridinium chlorochromate) C. Conc. H_2SO_4 D. Zn/HCl	1
3.	Which one of the following compounds will react fastest with Lucas reagent at room temperature? A. 1-Butanol B. 2-Butanol C. 2-Methyl-2-propanol D. Ethanol	1
4.	Which of the following explains the high boiling point of alcohols as compared to alkanes of similar molecular mass? A. Dipole-dipole interactions B. London dispersion forces C. Intermolecular hydrogen bonding D. Ionic bonding	1
	Choose the correct option: (A) Both Assertion and Reason are true and Reason is the correct explanation. **(B) Both Assertion and Reason are true but Reason is not the correct explanation.** **(C) Assertion is true but Reason is false.** **(D) Assertion is false but Reason is true.**	
5.	**Assertion (A):** Phenol is more acidic than ethanol. **Reason (R):** Phenoxide ion is stabilized by resonance, while ethoxide ion is not. **Answer:**	1
6.	**Assertion (A):** Ethers are less reactive than alcohols. **Reason (R):** Ethers do not form hydrogen bonds and lack -OH group. **Answer:**	1
7.	**Assertion (A)** : Ortho and para-nitrophenols can be separated by steam distillation. **Reason (R)** : Ortho isomer associates through intermolecular hydrogen bonding while Para isomer associates through intramolecular hydrogen bonding. **Answer:**	1
8.	On treatment with hot HI, ethers give __________ and __________. **Answer:**	1

9.	Give simple chemical test to distinguish between Ethanol and Phenol. **Answer:**	1
10.	Write the structure of the alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane with alcoholic KOH. **Answer :**	1
11.	Which of the isomers is more volatile: o-nitrophenol or p-nitrophenol and why? **Answer:**	1
12.	Write the equations involved in the following reactions: (i) Reimer-Tiemann reaction (ii) Kolbe's reaction **Answer:**	2
13.	Predict the products of the following reactions: (i) $\mathrm{CH3CH2OH} \xrightarrow{\text{Cu/573 K}}$ (ii) $\mathrm{C6H5OH} \xrightarrow{\text{Br2(aq)}}$	2

Worksheet 3: Alcohols, Phenols and Ethers

Class: XII | **Subject:** Chemistry | **Marks:** 15 | **Time:** 35 minutes

1	**The most suitable reagent for the conversion CH_3CH_2OH can be converted into CH_3CHO by......** **(a) catalytic hydrogenation** **(b) (b) treatment with $LiAlH_4$** **(c) treatment with pyridinium chlorochromate** **(d) treatment with $KMnO_4$**	**1**
2	**Iodoform can be prepared from all except-** **(a) Ethyl methyl ketone** **(b) Isopropyl alcohol** **(c) 3–Methyl – 2– butanone** **(d) Isobutyl alcohol**	**1**

Assertion- Reason Question

Given below are two statements labelled as Assertion (A) and Reason (R) Select the most appropriate answer from the options given below: **1**

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

3. Assertion : In Lucas test, 3^o alcohols react immediately.
Reason : An equimolar mixture of anhyd. $ZnCl_2$ and conc. HCl is called Lucas reagent.

Ans:...

4	Write the structures of the products when Butan-2-ol reacts with the following: (a) CrO_3 (b) $SOCl_2$	2
5	Illustrate the following name reactions : (a) Reimer-Tiemann Reaction (b) Kolbe's reaction	2

3 MARKS QUESTIONS

6	An organic compound A having molecular formula C_3H_6 on treatment with aq.H_2SO_4 give ‘B’ which on treatment with Lucas reagent gives ‘C’. The compound ‘C’ on treatment with ethanolic KOH gives back ‘A’ Identify A, B , C . Ans:-	3

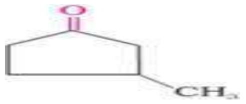
5 MARKS QUESTIONS

7	(a) What happens when- (i) propene is treated with B_2H_6 followed by H_2O_2/ OH^- Ans. (ii) Ethanol reacts with CH_3COCl/ pyridine? Ans (b) A compound 'A' is optically active. On mild oxidation, it gives a compound 'B' but on vigorous oxidation gives another compound 'C'. C along with D is also formed from B by reaction with iodine and alkali. Deduce the structures of A, B, C, and D. Ans:-	5

ALDEHYDES, KETONES & CARBOXYLIC ACIDS(Worksheet-1)

TIME 30 minutes

MARKS-15

Q: 1 **Ans.**	Why is oxidation of alcohols to get aldehydes carried out under controlled conditions? 1 -- -
Q: 2 Ans.	Which of the following does not give reddish brown precipitate on heating with Fehling solutions? Acetaldehyde or Benzaldehyde 1 -- -
Q: 3 Ans.	Distinguish between the following:- Ethanal and propanal 1 -- -
Q : 4 Ans.	Give names of the reagents to bring about the following transformations: 2 (i) Hexan-1-ol to hexanal (ii) Cyclohexanol to cyclohexanone -- -
Q: 5 Ans	Write the IUPAC name of HOOC -$(CH_2)_2$-COOH and 
Q: 6 Ans.	Name the following compounds according to IUPAC system of nomenclature: 2 (i) CH3CH2COCH(C2H5) CH2CH2Cl (ii) CH3CH(CH3) CH2C(CH3)2COCH3 -- -
Q: 7 Ans.	Arrange the following in increasing order of reactivity towards HCN Acetaldehyde, 1 Acetone, di-tert-butyl ketone, Methyl tert-butyl ketone -- -
Q: 8 Ans.	Why HCOOH does not give HVZ reaction while CH3COOH does? 1 -- -
Q: 9 Ans.	Why does methanal undergo cannizaro's reaction? 1 -- -
Q: 10 Ans.	Which acid is stronger and why? F3C-C6H4COOH and CH3 C6H4COOH 1 -- -
Q: 11 Ans.	Why formaldehyde cannot be prepared by Rosenmund's reduction? 1 -- -

Worksheet- 2

Class:12th Chapter- ALDEHYDES, KETONES & CARBOXYLIC ACIDS Time: 35 mins.

This section contains three questions of one marks each.

1) Clemmensen reduction of a Ketone is carried out in the presence of which of following reagent?
(a) Zn-Hg with HCl
(b) LiAlH4
(c) H2 and Pt as catalyst
(d) Glycal with KOH

2) Which of following aldehydes does not give Cannizzaro Reaction?
(a) Formaldehyde
(b) Acetaldehyde
(c) Trimethyl acetaldehyde
(d) Benzaldehyde

3) The major product of oxidation of secondary alcohol is:
(a) Aldehyde
(b) Ketone
(c) Carboxylic acid
(d) Ether

4) This section contains two questions of 2 marks.
(a) How will you convert Ethyl benzene to Benzoic acid
Propanone to propene

5) Write the equations involved in following reactions:
(a) Aldol condensation
(b) Cannizzaro Reaction

6) This section contains one question of 3 marks.
(a) Give a chemical test to distinguish between Ethanol and Propenal

________________________________ ________________________________

____

(ii) Benzoic acid and Ethylbenzoate

________________________________ ________________________________

____

(iii) Acetophenone and benzaldehyde

This section contains one question of 5 marks.

7) (a) Give reasons: -
(i) Carboxylic acids do not give characteristic reactions of carbonyl group. -----
(ii) Formaldehyde does not take part in Aldol condensation. why?

i Aldehydes and Ketones have lower boiling points than. Corresponding alcohols. Why?

Dry either

i $CH_3HgBr + CO_2 \xrightarrow{H_3O^+ \text{ Red.P}}$

i $CH_3CH_2COOH + Br_2 \rightarrow$

WORKSHEET - 1 AMINES

Q1. Hinsberg's reagent is
(a) $C_6H_5SO_2Cl$ (b) $C_6H_5CH_2Cl$ (c) $C_6H_5CH_2COCl$ (d) C_6H_5COCl

Q2. Ankit has been given four organic compounds: a primary amine, a secondary amine, a secondary alcohol and a tertiary alcohol. Which of the following can Ankit use to identify all the compounds?
(a) Tollen’s reagent and bromine water (b) 2,4-DNP and Lucas reagent
(c) Hinsberg's reagent and Lucas reagent (d) Sodium metal and Hinsberg’s reagent

Q3.Assertion: Diazonium salts of aromatic amines are more stable than those of aliphatic amines.
Reason: Diazonium salts of aliphatic amines show resonance.

Q4. Assertion: Aromatic primary amines can be prepared by Gabriel phthalimide synthesis.
Reason: Alkyl halides undergoes substitution with anion formed by phthalimide.

Q5. Carry out the following conversions: 2
(i) Aniline to phenol (ii) Propanenitrile to ethyl amine

Ans:

____

____

____

____

Q6. Parul was given two test tubes. One of the test tubes contained ethyl amine and the other contained aniline. To distinguish between the two compounds, she adds a reagent X to both the test tubes. She observes that in only one of the test tubes a yellow dye is formed.
3 (a) Identify the reagent X.
(b) Describe how this reagent is prepared and give a reason why it is not readily available in a laboratory. (c) Which of the two compounds forms the yellow dye? Draw the structure of the yellow dye formed.

Ans:

____

____

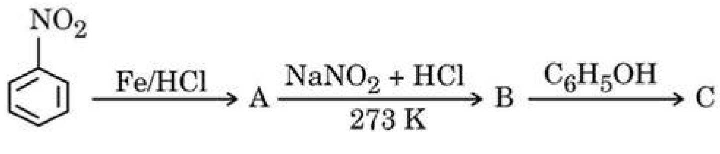
____

____

Q7. Give the structures of A, B and C : 3

(a) $CH_3CH_2Cl \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0°C]{HNO_2} C$

(b)



Ans:

Q8. Give reason for the following: 3

(i) Methyl amine is more basic than aniline.
(ii) Aniline readily reacts with bromine water to give 2,4,6-tribromoaniline.
(iii) Primary amines have higher boiling points than tertiary amines.

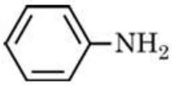
Ans:

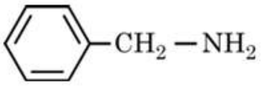
WORKSHEET- 2 AMINES

Q1. CH_3CONH_2 on reaction with NaOH and Br_2 in alcoholic medium gives :
(a) CH_3COONa (b) CH_3NH_2 (c) CH_3CH_2Br (d) $CH_3CH_2NH_2$

Q2. Which of the following is least basic ?
(a) $(CH_3)_2NH$ (b) NH_3 (c) CH_3NH_2 (d) $(CH_3)_3N$

Q3. Among the following, which has the highest value of pK_b ?

(a)


(b)


(c)


(d)


Q4. Assertion (A) : NH_2 group is o- and p-directing in electrophilic substitution reactions.
Reason (R) : Aniline cannot undergo Friedel-Crafts reaction.

Q5. Assertion (A) : Ammonolysis of alkyl halides is not a suitable method for the preparation of pure primary amines.
Reason (R) : Ammonolysis of alkyl halides yields mainly secondary amines.

Q6.(i) Why aniline does not undergo Friedal-Crafts reaction ? 2
(ii) Arrange the following in increasing order of their boiling point : C_2H_5OH, $C_2H_5NH_2$, $(C_2H_5)_3N$

Ans:

Q7. Convert Propanamide to the following compounds in not more than two steps:
(i) N- Ethylpropanamine (ii) Ethanol 2

Ans:

Q8. How can you obtain the following from aniline ? Give only chemical equation. 3×1=3
(a) p-nitroaniline (b) Chlorobenzene (c) Phenol

Ans:

Q9. Write the reactions involved in:
(i) Hoffmann Degradation reaction (ii) Carbylamine reaction (c) Gabriel Phthalimide reaction

Ans:

WORKSHEET-1

TOPIC: BIOMOLECULES **MM:15** **TIME: 30min**

Section A: Multiple Choice Questions *(1 mark × 3 = 3 marks)*

Q1. Which of the following is a disaccharide?
a) Glucose
b) Fructose
c) Maltose
d) Ribose

Q2. The number of peptide bonds in a tripeptide is:
a) 1
b) 2
c) 3
d) 4

Q3. Which vitamin helps in blood clotting?
a) Vitamin A
b) Vitamin D
c) Vitamin K
d) Vitamin B12

Section B: Assertion and Reason *(1 mark each × 2 = 2 marks)*

Choose the correct option:

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Q4.
Assertion (A): Enzymes are highly specific in their action.
Reason (R): Enzymes are consumed during chemical reactions.

Q5.
Assertion (A): Cellulose is not digestible by humans.
Reason (R): Humans lack the enzyme to hydrolyze β-glycosidic linkage.

Section C: Short Answer Questions *(2 marks each × 3 = 6 marks)*

Q6. What is the difference between a reducing and a non-reducing sugar? Give one example of each.

Q7. What is the denaturation of proteins? Give one example from daily life.

Q8. Write the name and structural formula of an essential amino acid. Why is it called ‘essential’?

Section D: Case-Based Question (CBQ) ***(4 marks = 1 case × 4 sub-questions)***

Q9. Read the passage and answer the questions:

Glucose is a simple sugar with the molecular formula $C_6H_{12}O_6$. It exists in two cyclic forms—α and β—which are interconvertible in aqueous solution. It contains an aldehyde group and multiple hydroxyl groups. When heated with Tollens' reagent, glucose gives a silver mirror.

a. What is the functional group present in glucose that gives a positive Tollens’ test? *(1 mark)*

answer-

b. Name the type of isomerism shown by α and β forms of glucose. *(1 mark)*

c. Is glucose a reducing or non-reducing sugar? Justify. *(1 mark)*

d. Write the Haworth structure of α-D-glucose. *(1 mark)*

WORKSHEET: 2

TOPIC: BIOMOLICULES **MM:15** **TIME: 30min**

Section A: Multiple Choice Questions *(1 mark × 3 = 3 marks)*

Q1. Which of the following is not a protein?
a) Insulin
b) Hemoglobin
c) Albumin
d) Cellulose

Q2. Which of the following is a keto sugar?
a) Glucose
b) Ribose
c) Fructose
d) Galactose

Q3. Which of the following vitamins is fat-soluble?
a) Vitamin B1
b) Vitamin B2
c) Vitamin C
d) Vitamin D

Section B: Assertion & Reason *(1 mark × 2 = 2 marks)*

Choose the correct option:

- (a) Both A and R are true and R is the correct explanation of A
- (b) Both A and R are true but R is not the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Q4.
Assertion (A): Proteins are biopolymers.
Reason (R): They are formed by repeated units of fatty acids.

Q5.
Assertion (A): Sucrose is a non-reducing sugar.
Reason (R): It has a free aldehydic group.

Section C: Short Answer Questions *(2 marks × 3 = 6 marks)*

Q6. What are enzymes? Write any two characteristics of enzymes.

Q7. What is a glycosidic bond? Illustrate it with an example.

Q8. Define the terms:
a) Polypeptide

b) Zwitterion

Section D: Case-Based Question (CBQ) ***(4 marks total)***

Q9. Read the following passage and answer the questions:

Amino acids are the building blocks of proteins. They contain both an amino group (–NH_2) and a carboxylic group (–COOH). In an aqueous solution, amino acids exist in the zwitterionic form. Depending on the number and position of amino acids, proteins can be classified as primary, secondary, tertiary, or quaternary structures.

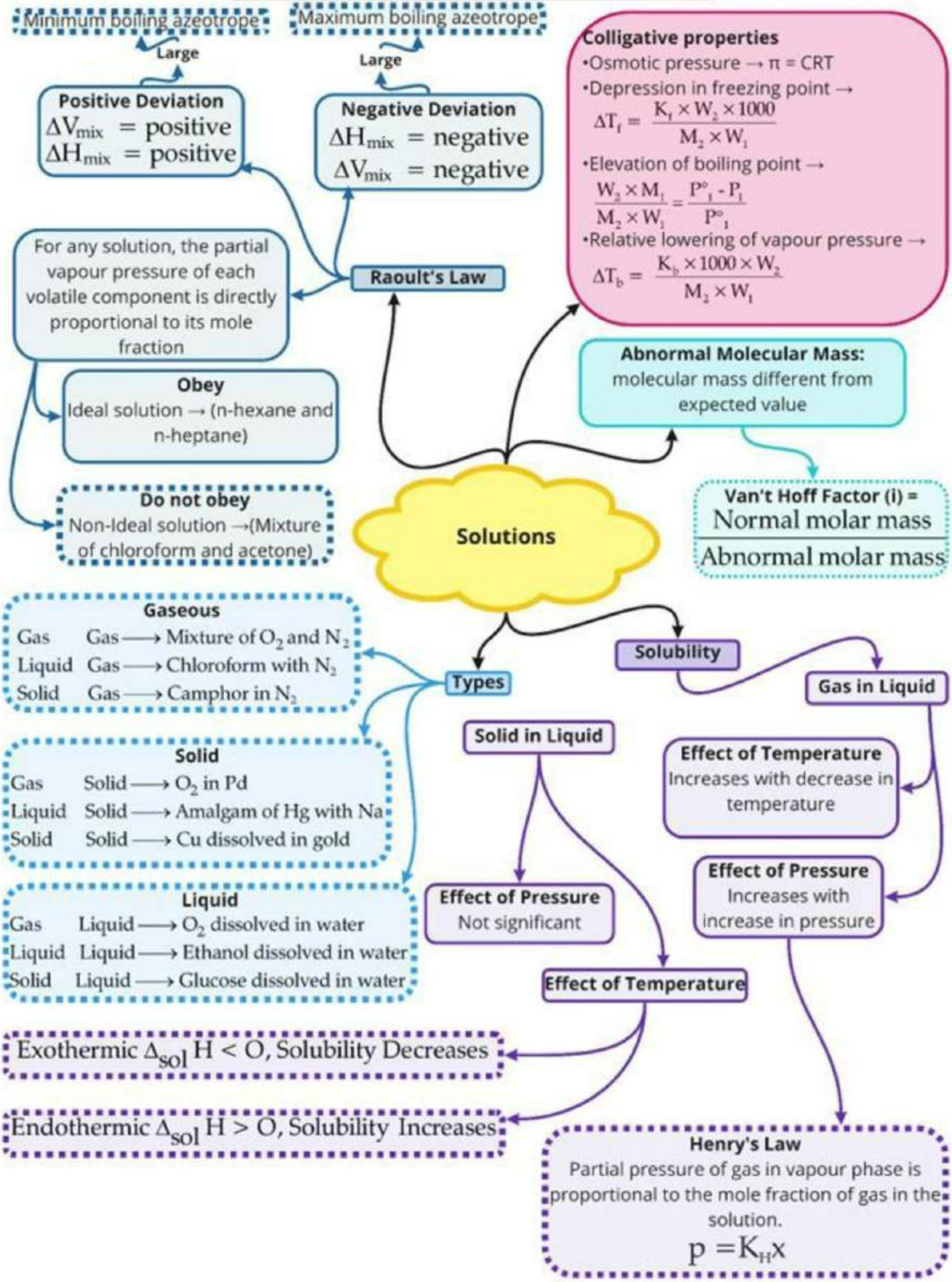
a. What is a zwitterion? *(1 mark)*

b. What are essential amino acids? *(1 mark)*

c. Name the bond responsible for linking amino acids in a protein. *(1 mark)*

d. Draw the structure of glycine. *(1 mark)*

Class : 12th Chemistry
Chapter-2 : Solutions (Part_1)



Solutions

Raoult's Law

For any solution, the partial vapour pressure of each volatile component is directly proportional to its mole fraction

Positive Deviation
$\Delta V_{mix} = \text{positive}$
$\Delta H_{mix} = \text{positive}$

Large

Minimum boiling azeotrope

Negative Deviation
$\Delta H_{mix} = \text{negative}$
$\Delta V_{mix} = \text{negative}$

Large

Maximum boiling azeotrope

Obey
Ideal solution → (n-hexane and n-heptane)

Do not obey
Non-Ideal solution →(Mixture of chloroform and acetone)

Colligative properties

- Osmotic pressure → $\pi = CRT$
- Depression in freezing point → $\Delta T_f = \frac{K_f \times W_2 \times 1000}{M_2 \times W_1}$
- Elevation of boiling point → $\frac{W_2 \times M_1}{M_2 \times W_1} = \frac{P^\circ_1 - P_1}{P^\circ_1}$
- Relative lowering of vapour pressure → $\Delta T_b = \frac{K_b \times 1000 \times W_2}{M_2 \times W_1}$

Abnormal Molecular Mass:
molecular mass different from expected value

Van't Hoff Factor (i) = $\frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$

Types

Gaseous
Gas Gas $\longrightarrow$ Mixture of O_2 and N_2
Liquid Gas $\longrightarrow$ Chloroform with N_2
Solid Gas $\longrightarrow$ Camphor in N_2

Solid
Gas Solid $\longrightarrow$ O_2 in Pd
Liquid Solid $\longrightarrow$ Amalgam of Hg with Na
Solid Solid $\longrightarrow$ Cu dissolved in gold

Liquid
Gas Liquid $\longrightarrow$ O_2 dissolved in water
Liquid Liquid $\longrightarrow$ Ethanol dissolved in water
Solid Liquid $\longrightarrow$ Glucose dissolved in water

Solubility

Solid in Liquid

Effect of Pressure
Not significant

Effect of Temperature

Exothermic $\Delta_{sol} H < O$, Solubility Decreases

Endothermic $\Delta_{sol} H > O$, Solubility Increases

Gas in Liquid

Effect of Temperature
Increases with decrease in temperature

Effect of Pressure
Increases with increase in pressure

Henry's Law
Partial pressure of gas in vapour phase is proportional to the mole fraction of gas in the solution.
$p = K_H x$

Class : 12th Chemistry
Chapter-2 : Solutions (Part_2)

Solutions

Parts per million : For trace quantities

$$\frac{\text{No. of parts of components} \times 10^6}{\text{Total no. parts of components of solution}}$$

Normality: Number of gram equivalents of the solute dissolved in one litre of solution

$$\frac{\text{No. of gram equivalent of solute} \times 100}{\text{Volume of solution}}$$

$$\downarrow$$

Gram Equivalents of solute

$$= \frac{\text{Mass of solute}}{\text{Equivalent weight}}$$

$$\downarrow$$

$$\text{Equivalent weight} = \frac{\text{Molecular mass}}{\text{Valency}}$$

Mass by volume percentage (w/v)

$$\frac{\text{Mass of solute}}{\text{Volume of solution}} \times 100$$

Mass percentage w/w

$$\frac{\text{Mass of component in solution}}{\text{Total mass of solution}} \times 100$$

Volume percentage v/v

$$\frac{\text{Volume of component}}{\text{Total volume of solution}} \times 100$$

Mole fraction

$$\frac{\text{No. of moles of component}}{\text{Total No. of moles of all components}}$$

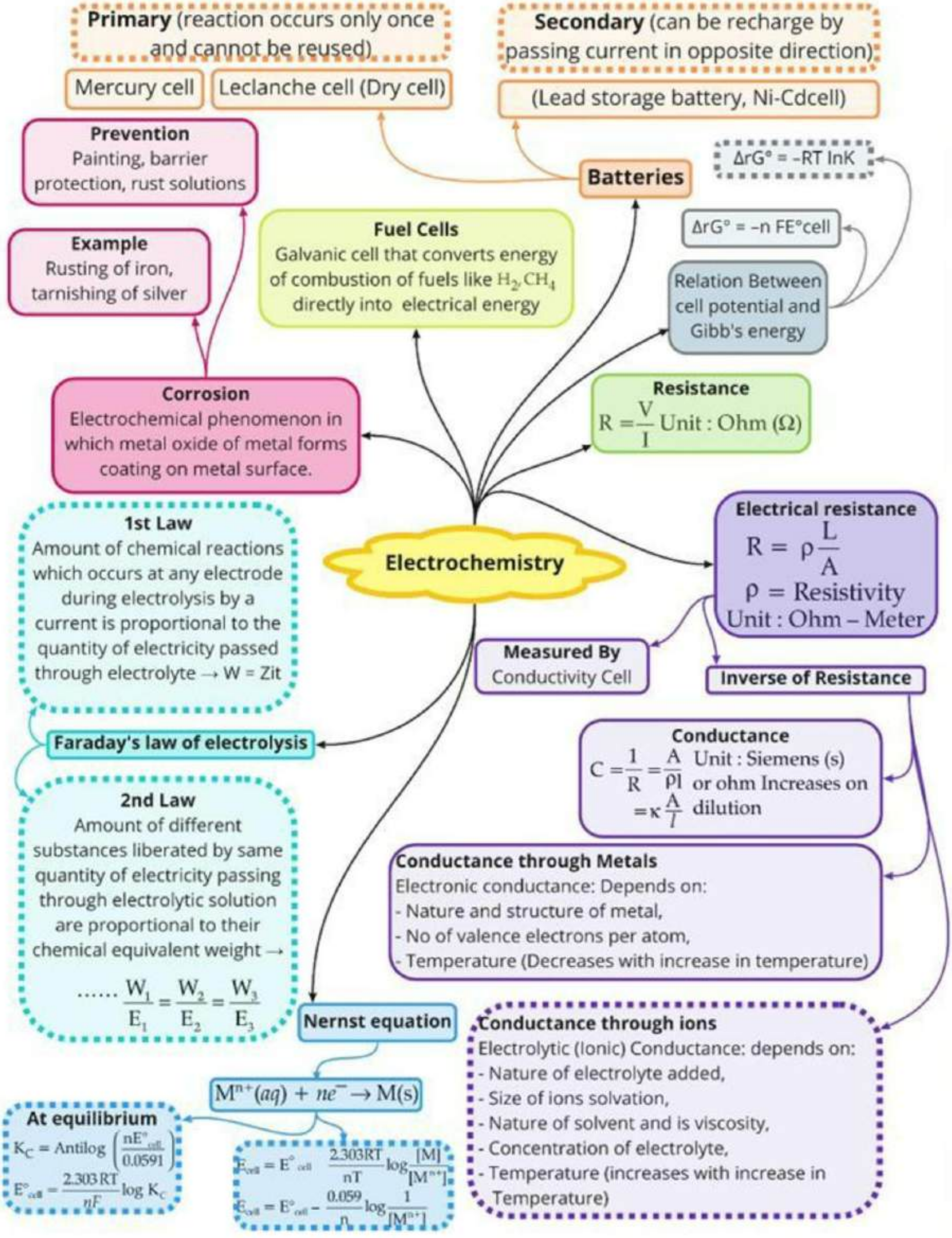
Molality: Number of moles of solute per kilogram of the solvent

$$\frac{\text{No. of moles of solute} \times 100}{\text{Mass of solvent}}$$

Molarity: Number of moles of solute in 1L solution

$$\frac{\text{No. of moles of solute} \times 100}{\text{Volume of solution}}$$

Class : 12th Chemistry
Chapter-3 : Electrochemistry (Part_1)



Electrochemistry

Batteries

Primary (reaction occurs only once and cannot be reused)

Mercury cell

Leclanche cell (Dry cell)

Secondary (can be recharge by passing current in opposite direction)

(Lead storage battery, Ni-Cdcell)

Relation Between cell potential and Gibb's energy

$\Delta rG^{\circ} = -n\,FE^{\circ}cell$

$\Delta rG^{\circ} = -RT\ \ln K$

Fuel Cells
Galvanic cell that converts energy of combustion of fuels like H_2, CH_4 directly into electrical energy

Resistance
$R = \frac{V}{I}$ Unit : Ohm (Ω)

Corrosion
Electrochemical phenomenon in which metal oxide of metal forms coating on metal surface.

Example
Rusting of iron, tarnishing of silver

Prevention
Painting, barrier protection, rust solutions

Electrical resistance
$R = \rho\frac{L}{A}$
ρ = Resistivity
Unit : Ohm – Meter

Measured By
Conductivity Cell

Inverse of Resistance

Conductance
$C = \frac{1}{R} = \frac{A}{\rho l} = \kappa\frac{A}{l}$ Unit : Siemens (s) or ohm Increases on dilution

Conductance through Metals
Electronic conductance: Depends on:
- Nature and structure of metal,
- No of valence electrons per atom,
- Temperature (Decreases with increase in temperature)

Conductance through ions
Electrolytic (Ionic) Conductance: depends on:
- Nature of electrolyte added,
- Size of ions solvation,
- Nature of solvent and is viscosity,
- Concentration of electrolyte,
- Temperature (increases with increase in Temperature)

Faraday's law of electrolysis

1st Law
Amount of chemical reactions which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through electrolyte → W = Zit

2nd Law
Amount of different substances liberated by same quantity of electricity passing through electrolytic solution are proportional to their chemical equivalent weight →

$$\ldots\ldots \frac{W_1}{E_1} = \frac{W_2}{E_2} = \frac{W_3}{E_3}$$

Nernst equation

$$M^{n+}(aq) + ne^- \rightarrow M(s)$$

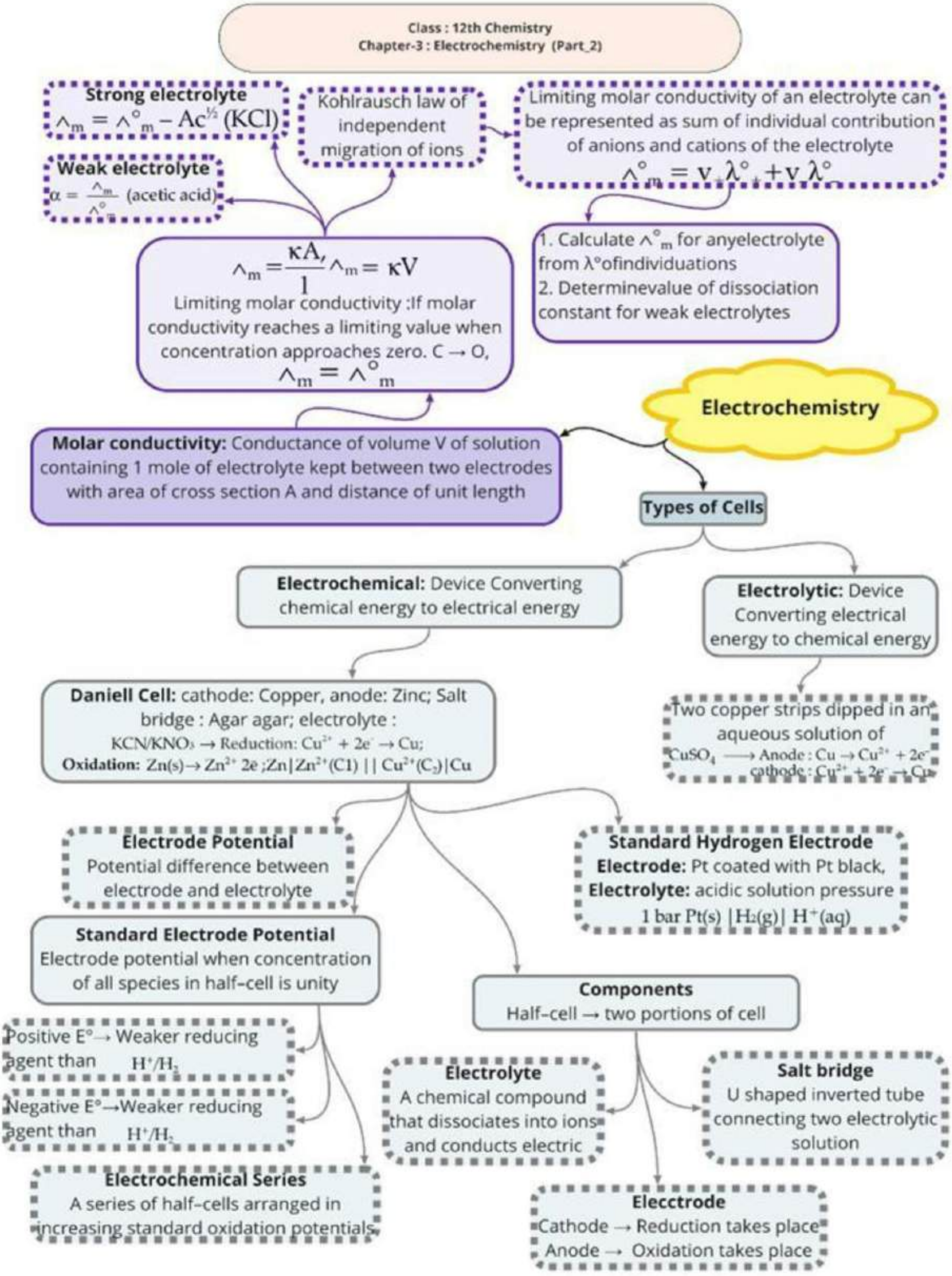
$$E_{cell} = E^{\circ}_{cell} \quad \frac{2.303RT}{nT}\log\frac{[M]}{[M^{n+}]}$$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.059}{n}\log\frac{1}{[M^{n+}]}$$

At equilibrium

$$K_C = \text{Antilog}\left(\frac{nE^{\circ}_{cell}}{0.0591}\right)$$

$$E^{\circ}_{cell} = \frac{2.303\,RT}{nF}\log K_C$$



Class : 12th Chemistry
Chapter-3 : Electrochemistry (Part_2)

Strong electrolyte
$\wedge_m = \wedge^\circ_m - Ac^{1/2}$ (KCl)

Weak electrolyte
$\alpha = \frac{\wedge_m}{\wedge^\circ_m}$ (acetic acid)

Kohlrausch law of independent migration of ions

Limiting molar conductivity of an electrolyte can be represented as sum of individual contribution of anions and cations of the electrolyte
$\wedge^\circ_m = v_+\lambda^\circ_+ + v_-\lambda^\circ_-$

1. Calculate $\wedge^\circ_m$ for anyelectrolyte from λ°ofindividuations
2. Determinevalue of dissociation constant for weak electrolytes

$\wedge_m = \frac{\kappa A}{l}$, $\wedge_m = \kappa V$
Limiting molar conductivity ;If molar conductivity reaches a limiting value when concentration approaches zero. C → O,
$\wedge_m = \wedge^\circ_m$

Electrochemistry

Molar conductivity: Conductance of volume V of solution containing 1 mole of electrolyte kept between two electrodes with area of cross section A and distance of unit length

Types of Cells

Electrochemical: Device Converting chemical energy to electrical energy

Electrolytic: Device Converting electrical energy to chemical energy

Two copper strips dipped in an aqueous solution of
$CuSO_4 \longrightarrow$ Anode : $Cu \rightarrow Cu^{2+} + 2e^-$
cathode : $Cu^{2+} + 2e^- \rightarrow Cu$

Daniell Cell: cathode: Copper, anode: Zinc; Salt bridge : Agar agar; electrolyte :
KCN/KNO_3 → Reduction: $Cu^{2+} + 2e^- \rightarrow Cu$;
Oxidation: $Zn(s) \rightarrow Zn^{2+}\ 2e$;$Zn|Zn^{2+}(C1)\ ||\ Cu^{2+}(C_2)|Cu$

Electrode Potential
Potential difference between electrode and electrolyte

Standard Hydrogen Electrode
Electrode: Pt coated with Pt black,
Electrolyte: acidic solution pressure 1 bar $Pt(s)\ |H_2(g)|\ H^+(aq)$

Standard Electrode Potential
Electrode potential when concentration of all species in half-cell is unity

Positive E°→ Weaker reducing agent than H^+/H_2

Negative E°→Weaker reducing agent than H^+/H_2

Electrochemical Series
A series of half-cells arranged in increasing standard oxidation potentials

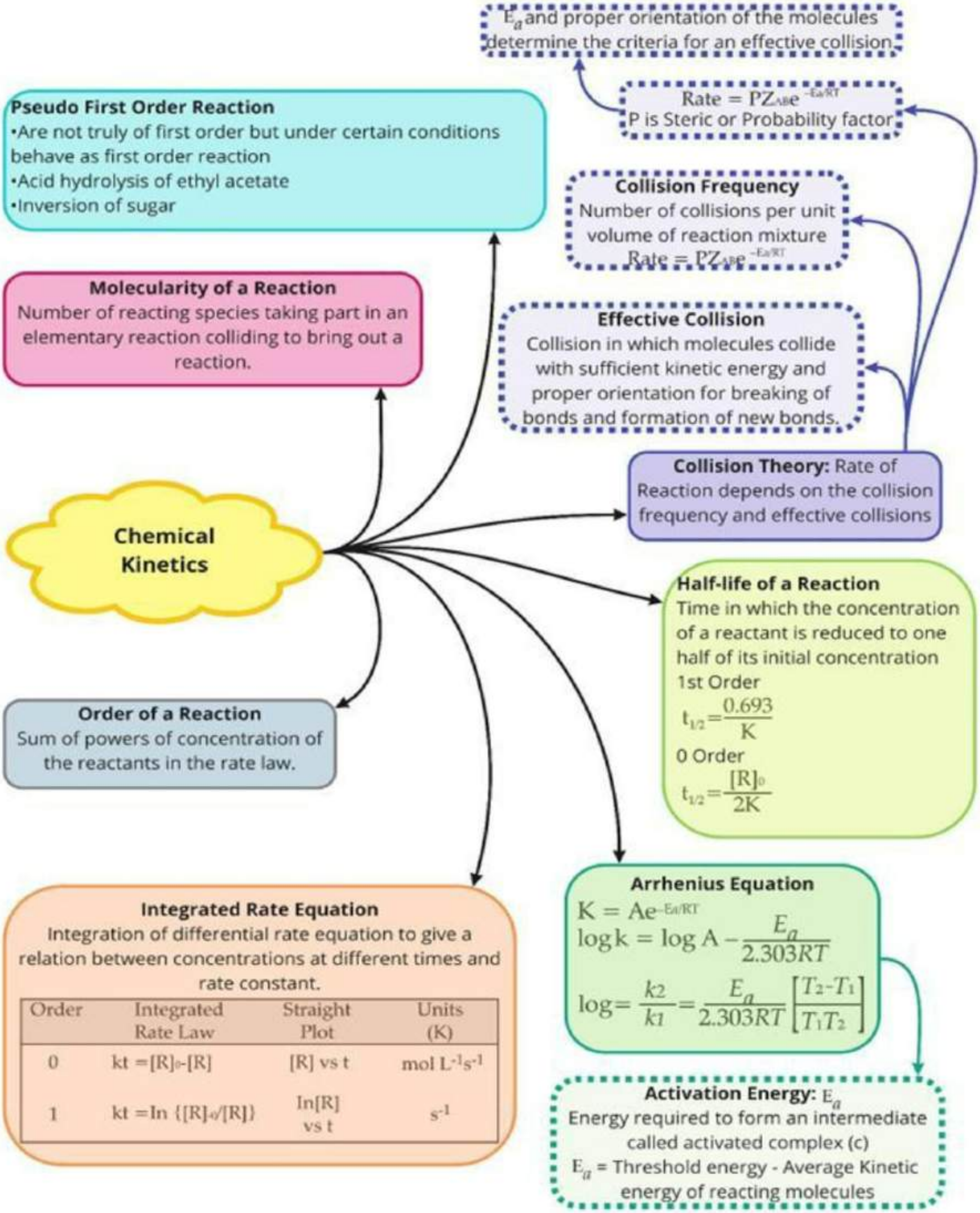
Components
Half-cell → two portions of cell

Electrolyte
A chemical compound that dissociates into ions and conducts electric

Salt bridge
U shaped inverted tube connecting two electrolytic solution

Elecctrode
Cathode → Reduction takes place
Anode → Oxidation takes place

Class : 12th Chemistry
Chapter-4 : Chemical Kinetics (Part_1)



Chemical Kinetics

Pseudo First Order Reaction

- Are not truly of first order but under certain conditions behave as first order reaction
- Acid hydrolysis of ethyl acetate
- Inversion of sugar

Molecularity of a Reaction

Number of reacting species taking part in an elementary reaction colliding to bring out a reaction.

Order of a Reaction

Sum of powers of concentration of the reactants in the rate law.

Integrated Rate Equation

Integration of differential rate equation to give a relation between concentrations at different times and rate constant.

Order	Integrated Rate Law	Straight Plot	Units (K)
0	$kt = [R]_0 - [R]$	[R] vs t	$mol\ L^{-1} s^{-1}$
1	$kt = \ln \{[R]_0/[R]\}$	In[R] vs t	s^{-1}

E_a and proper orientation of the molecules determine the criteria for an effective collision.

$\text{Rate} = PZ_{AB}e^{-Ea/RT}$

P is Steric or Probability factor

Collision Frequency

Number of collisions per unit volume of reaction mixture

$\text{Rate} = PZ_{AB}e^{-Ea/RT}$

Effective Collision

Collision in which molecules collide with sufficient kinetic energy and proper orientation for breaking of bonds and formation of new bonds.

Collision Theory: Rate of Reaction depends on the collision frequency and effective collisions

Half-life of a Reaction

Time in which the concentration of a reactant is reduced to one half of its initial concentration

1st Order

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

0 Order

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

Arrhenius Equation

$$K = Ae^{-Ea/RT}$$

$$\log k = \log A - \frac{E_a}{2.303RT}$$

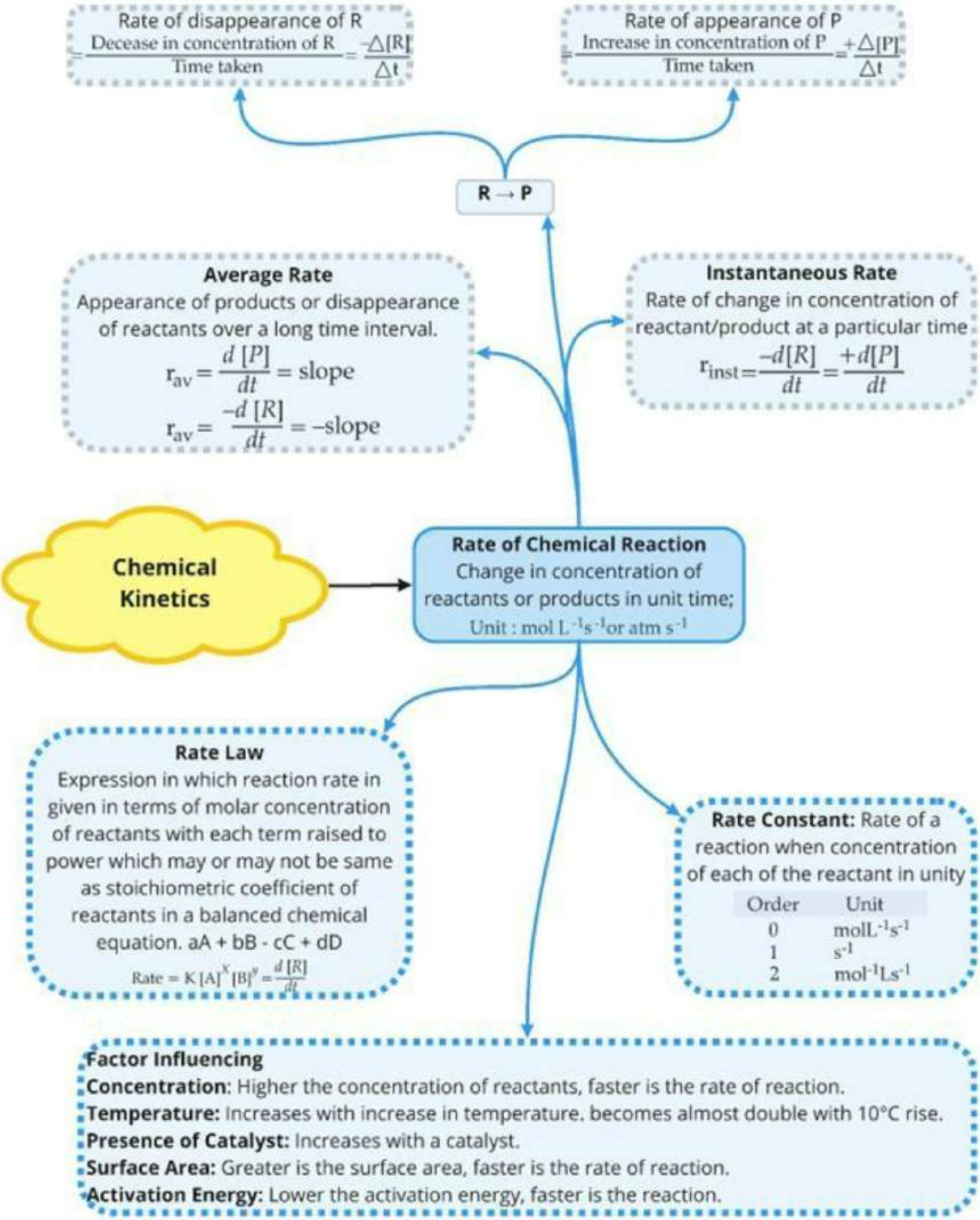
$$\log = \frac{k_2}{k_1} = \frac{E_a}{2.303RT}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

Activation Energy: E_a

Energy required to form an intermediate called activated complex (c)

E_a = Threshold energy - Average Kinetic energy of reacting molecules

Class : 12th Chemistry
Chapter-4 : Chemical Kinetics (Part_2)



Chemical Kinetics

Rate of Chemical Reaction
Change in concentration of reactants or products in unit time;
Unit : mol $L^{-1}s^{-1}$or atm s^{-1}

R → P

Rate of disappearance of R

$$= \frac{\text{Decease in concentration of R}}{\text{Time taken}} = \frac{-\Delta[R]}{\Delta t}$$

Rate of appearance of P

$$= \frac{\text{Increase in concentration of P}}{\text{Time taken}} = \frac{+\Delta[P]}{\Delta t}$$

Average Rate
Appearance of products or disappearance of reactants over a long time interval.

$$r_{av} = \frac{d\,[P]}{dt} = \text{slope}$$

$$r_{av} = \frac{-d\,[R]}{dt} = -\text{slope}$$

Instantaneous Rate
Rate of change in concentration of reactant/product at a particular time

$$r_{inst} = \frac{-d[R]}{dt} = \frac{+d[P]}{dt}$$

Rate Law
Expression in which reaction rate in given in terms of molar concentration of reactants with each term raised to power which may or may not be same as stoichiometric coefficient of reactants in a balanced chemical equation. aA + bB - cC + dD

$$\text{Rate} = K\,[A]^{X}\,[B]^{y} = \frac{d\,[R]}{dt}$$

Rate Constant: Rate of a reaction when concentration of each of the reactant in unity

Order	Unit
0	mol$L^{-1}s^{-1}$
1	s^{-1}
2	$mol^{-1}Ls^{-1}$

Factor Influencing
Concentration: Higher the concentration of reactants, faster is the rate of reaction.
Temperature: Increases with increase in temperature. becomes almost double with 10°C rise.
Presence of Catalyst: Increases with a catalyst.
Surface Area: Greater is the surface area, faster is the rate of reaction.
Activation Energy: Lower the activation energy, faster is the reaction.

MIND MAP : LEARNING MADE SIMPLE

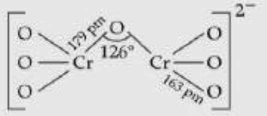
The d– And F– Block Elements

d– Block transition elements groups 3–12

- Position : Between s–and p–blocks
- Electronic configuration : $(n-1)d^{1-10}ns^{1-2}$
- Physical properties : Show typical metallic properties, melting and boiling point are high; High enthalpies of atomization
- Decrease in radius with increasing atomic number. Lanthanoid contraction is due to imperfect shielding of one e^- by another in same set of orbitals.
- Ionisation enthalpies : Increases from left to right
- Oxidation states : Variable ;higher ON stable
- Trends in M^{2+}/M E° : E° for Mn, Ni and Zn are more negative than expected.
- Trends in M^{3+}/M^{2+} E° : variable
- Chemical reactivity and E° values : Variable; Ti^{2+}, V^{2+} and Cr^{2+} are strong reducing agents.
- Magnetic properties : Diamagnetism and paramagnetism. Magnetic moment increases with increasing atomic number.
- Formation of coloured ions : Form coloured compounds due to d – d transitions
- Formation of complex compounds : Form a large number of complex compounds
- Catalytic properties : Due to variable oxidation states and ability to form complexes.
- Forms interstitial compounds : Non - stoichiometric and are neither ionic nor covalent.
- Alloy formation : Due to similar atomic sizes.

Oxides and oxoanions of metals

- Potassium dichromate $K_2Cr_2O_7$
  Preparation : $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$
  $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$
  $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$
  Properties : $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$
  Oxidises iodides to iodine, H_2S to S, SO_3^{2-} to SO_4^{2-}, NO_2^- to NO_3^-



- Potassium permanganate $KMnO_4$
  Preparation : $2MnO_2 + 4KOH + O_2 \rightarrow 2KMnO_4 + 2H_2O$
  $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O^+$
  $2Mn^{2+} + 5S_2O_3 \quad + 8H_2O \rightarrow 2MnO_4^- + 10SO_4^{2-} + 16H^+$
  Properties : Intense colour, weak temperature dependent paramagnetism
  $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
  Oxidizes I^- to I_2, Fe^{2+} to Fe^{3+}, $C_2O_4^{2-}$ to CO_2, S^{2-} to S, SO_3^{2-} to SO_4^{2-}, NO_2^- to NO_3^-

Uses

- Helps in production of iron and steels.
- TiO in pigment industry
- MnO_2 in dry battery cells.
- As catalysts in industry.
- Ni complexes useful in the polymerization of alkynes and other organic compounds such as benzene.
- Ag Br in photographic industry.

Lanthanoid contraction is progressive decrease in atomic/ionic radii from La^{3+} to Lu^{3+}

f– Block Transition Elements

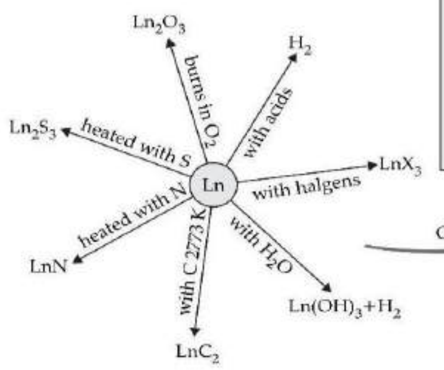
Actinoids

- Electronic : configuration $[Rn]5f^{1-14}6d^{0-2}7s^2$
- Ionic sizes : Gradual decrease along the series
- Oxidation states : Most common is +3. They show ON of +4, +5, +6 and +7.
- **General characteristics :**
  –Silvery in appearance
  –Display variety of structures
  –Highly reactive metals
  –Irregularities in metallic radii, greater than in Lanthanoids.
  –Magnetic properties more complex than lanthanoids.

Lanthanoids

- Electronic configuration
  $4f^{1-14}\ 5d^{0-1}\ 6s^2$
- Atomic and ionic sizes
  Decreases from La to Lu
- Oxidation states
  Most common is +3. Some elements exhibit +2 and +4.
- General characteristics
  - Silvery while soft metals and tarnish rapidly in air.
  - Hardness increases with increasing atomic number.
  - Metallic structure and good conductors of heat and electricity.
  - Variable density
  - Trivalent Lanthanoid ions are coloured.
- Ionisation Enthalpies : Low third ionisation enthalpies
- Good reducing agents

Chemical Properties



Class : 12th Chemistry
Chapter-9 : Coordination Compounds (Part_1)

Coordination Compounds

Werner's Theory: Postulates

- In coordination compounds metals show primary and secondary linkages (valances)
- Primary valences are ionisable and are satisfied by negative ions.
- Secondary valences are non-ionisable and are satisfied by neutral molecules or negative ions.
- Ions/groups bound by secondary linkages to metal have characteristic spatial arrangements corresponding to different coordination numbers.

Colour

Caused by d-d transition; the colour is complementary to wavelength absorbed

Bonding

Crystal field theory

Ligands are point charges and there is electrostatic force of attraction between ligands and metal atom/ion. Degeneracy of d orbitals is lighted causing splitting of d orbitals. Δ0 depends upon the field produced by the ligand and charge on metal ion.

In metal carbonyls

Metal–carbon bond possess both σ and π character

Valance bond theory

Metal atom/ion under the influence of ligands can use its (n–1)d, ns, np or ns, np, nd orbitals for hybridisation; sp^3(Tetrahedral), dsp^2(square) planar, sp^3d (Trigonal pyramidal), sp^3d^2 and d^2sp^3 (Octahedral); Magnetic moment = $\sqrt{n(n+2)}$ BM

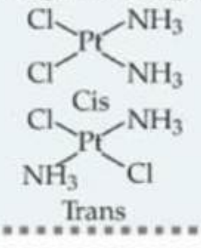
Uses

- In qualitative and quantitative chemical analysis.
- Estimation of hardness of water.
- In extraction metals.
- In purification of metals.
- In biological systems.
- As catalysts for industrial processes.
- In black and white photography.
- In medicinal chemistry.

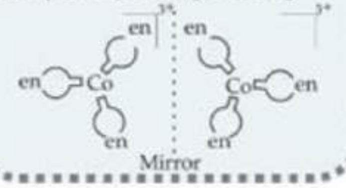
Isomerism

Stereoisomerism: different spatial arrangements

Geometrical: different arrangements Ligand



Optical: images which cannot be superimposed $[Co(en)_3]^{3+}$



Structural: different bonds

Ionisation counter ion is a potential ligand and can displace a ligand
$[Co(NH_3)_5SO_4]Br$
$[CO(NH_3)_5Br]SO_4$

Coordination interchange of ligands between catonic and anionic entities of different metal ions
$[CO(NH_3)_6]\ [Cr(CN)_6]$
$[Cr(NH_3)_6]\ [CO(CN)_6]$

Solvate differ in number of water molecules attached to metal atom/ion
$[Cr(H_2O)_6]Cl_3$
$[Cr(H_2O)_5Cl]Cl_2.H_2O$

Linkage occurs in ambidentate ligand
$[CO(NO_2)(NH_3)_5]Cl$
$[CO(ONO)(NH_3)_5]Cl$

Class : 12th Chemistry
Chapter-9 : Coordination Compounds (Part_2)

Formulas of monomuclear

- Central atom is listed first
- Ligands in alphabetical order.
- Formula is enclosed in square bracket.
- Polyatomic ligands in parenthesis.
- No space between ligand and metal.
- Charge is indicated outside brackets.
- Charge of cation(s) balanced by charge of anion(s)

Naming of monomuclear

- Cation is named first.
- Naming of ligands in alphabetical order.
- Anionic ligands end in-o, neutral and cationic are same
- Prefixes mono, di, tri etc. are used.
- Followed by roman numeral in parentheses.

Coordination Compounds

Complex compound: do not dissociate into simple ions when dissolved in water ($K_4[Fe(Cn)]_6$)

Stability: expressed by equilibrium constant
$Br = K_1 \times K_2 \times K_3 .... K_n$

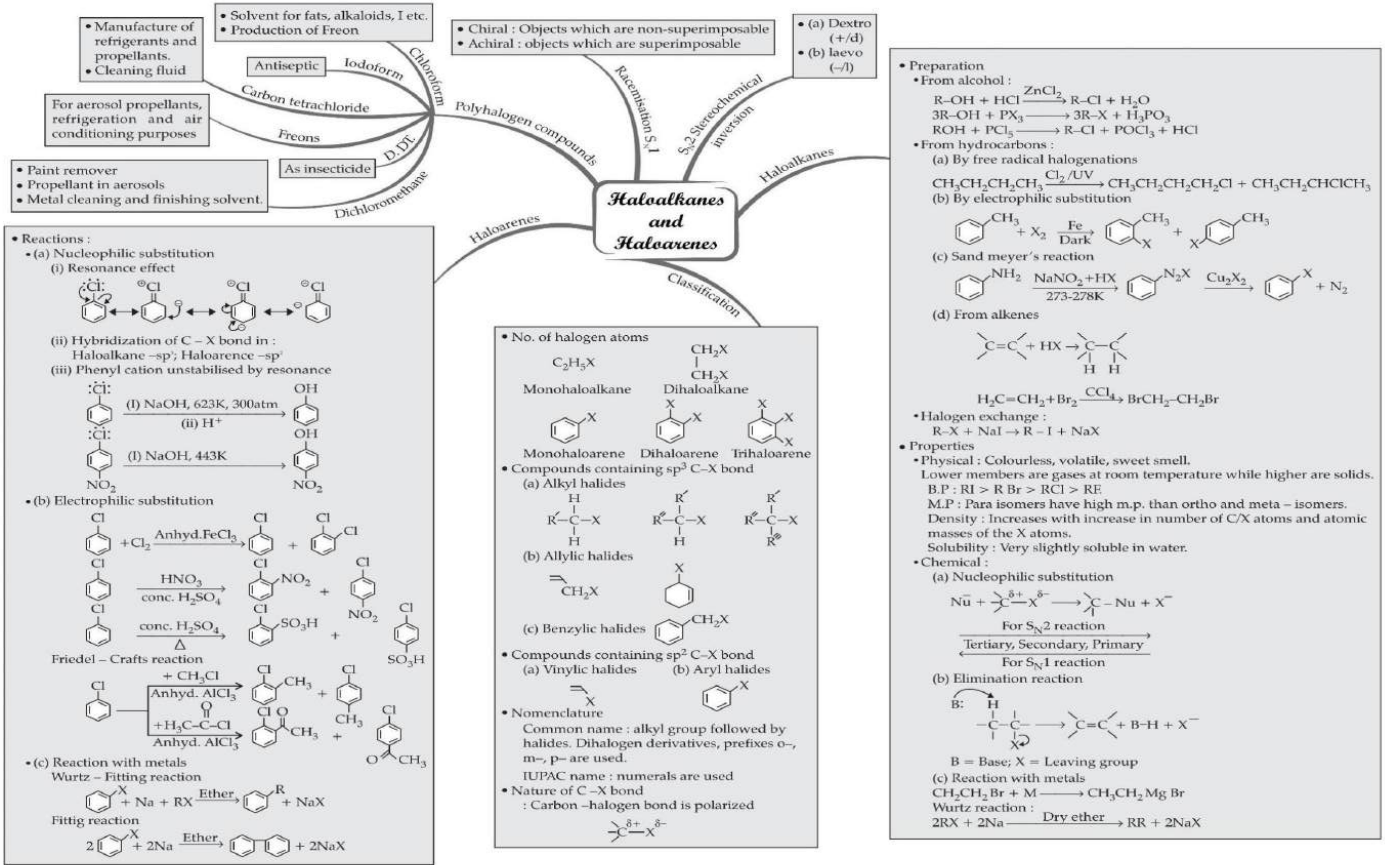
Double salt: Dissociate completely into simple ions when dissolved in water.
(Mohr's salt $FeSO_4 . (NH_4)2SO_4 . 6H_2O$)

Compounds in which a central metal atom or ion is linked to a fixed number of ions or molecules through coordinate bonds.

Terms

- Coordination entity : A central metal atom/ion bonded to fixed number of ions or molecules. $[Ni(CO)_4]$
- Central atom/ion : Atom/ion to which a fixed number of ions/groups are bound in a definite geometrical arrangement.
- Ligands : Ions or molecules bound to central atom/ion types :
  Unidentate – single donor, Didentate –two donors
  Polydentate – several donors,
  Chelating – Di-or polydentate which forms more than one coordinate bonds.
  Ambidentate : Can ligate through two different atoms.
- Coordination number : No. of ligand donor atoms to which metal is directly bonded
- Coordination sphere : Central atom/ion and the ligands attached to it and enclosed in square bracket.
- Oxidation number : Charge of central atom if all ligands are removed along with e– pairs shared with central atom.
- Homoleptic complex : Metal is bound to one type of donor groups. $[Co(NH_3)_6]_{3+}$
- Heteroleptic complex: Metal is bound to more than one type of donor groups

MIND MAP : LEARNING MADE SIMPLE



Haloalkanes and Haloarenes

Polyhalogen compounds

Chloroform
- Solvent for fats, alkaloids, I etc.
- Production of Freon

Iodoform — Antiseptic

Carbon tetrachloride
- Manufacture of refrigerants and propellants.
- Cleaning fluid

Freons — For aerosol propellants, refrigeration and air conditioning purposes

D.D.T. — As insecticide

Dichloromethane
- Paint remover
- Propellant in aerosols
- Metal cleaning and finishing solvent.

Racemisation S_N1
- Chiral : Objects which are non-superimposable
- Achiral : objects which are superimposable

S_N2 Stereochemical inversion
- (a) Dextro (+/d)
- (b) laevo (–/l)

Haloalkanes

- Preparation
  - From alcohol :

    $R–OH + HCl \xrightarrow{ZnCl_2} R–Cl + H_2O$

    $3R–OH + PX_3 \longrightarrow 3R–X + H_3PO_3$

    $ROH + PCl_5 \longrightarrow R–Cl + POCl_3 + HCl$
  - From hydrocarbons :
    - (a) By free radical halogenations

      $CH_3CH_2CH_2CH_3 \xrightarrow{Cl_2/UV} CH_3CH_2CH_2CH_2Cl + CH_3CH_2CHClCH_3$
    - (b) By electrophilic substitution

      $+ X_2 \xrightarrow[Dark]{Fe}$
    - (c) Sand meyer's reaction

      $\xrightarrow[273\text{-}278K]{NaNO_2+HX}$ $\xrightarrow{Cu_2X_2}$ $+ N_2$
    - (d) From alkenes

      $+ HX \rightarrow$

      $H_2C{=}CH_2 + Br_2 \xrightarrow{CCl_4} BrCH_2–CH_2Br$
  - Halogen exchange :

    $R–X + NaI \rightarrow R – I + NaX$
- Properties
  - Physical : Colourless, volatile, sweet smell.

    Lower members are gases at room temperature while higher are solids.

    B.P : RI > R Br > RCl > RE

    M.P : Para isomers have high m.p. than ortho and meta – isomers.

    Density : Increases with increase in number of C/X atoms and atomic masses of the X atoms.

    Solubility : Very slightly soluble in water.
  - Chemical :
    - (a) Nucleophilic substitution

      $\bar{Nu} + \overset{\delta+}{C}–\overset{\delta-}{X} \longrightarrow C – Nu + X^-$

      For S_N2 reaction →

      Tertiary, Secondary, Primary

      ← For S_N1 reaction
    - (b) Elimination reaction

      $\longrightarrow C{=}C + B–H + X^-$

      B = Base; X = Leaving group
    - (c) Reaction with metals

      $CH_3CH_2Br + M \longrightarrow CH_3CH_2MgBr$

      Wurtz reaction :

      $2RX + 2Na \xrightarrow{Dry\ ether} RR + 2NaX$

Haloarenes

- Reactions :
  - (a) Nucleophilic substitution
    - (i) Resonance effect
    - (ii) Hybridization of C – X bond in :

      Haloalkane –sp³; Haloarence –sp²
    - (iii) Phenyl cation unstabilised by resonance

      $\xrightarrow[(ii)\ H^+]{(I)\ NaOH,\ 623K,\ 300atm}$

      $\xrightarrow{(I)\ NaOH,\ 443K}$
  - (b) Electrophilic substitution

    $+ Cl_2 \xrightarrow{Anhyd.FeCl_3}$

    $\xrightarrow{HNO_3 \atop conc.\ H_2SO_4}$

    $\xrightarrow[\Delta]{conc.\ H_2SO_4}$

    Friedel – Crafts reaction

    $\xrightarrow[Anhyd.\ AlCl_3]{+ CH_3Cl}$

    $\xrightarrow[Anhyd.\ AlCl_3]{+H_3C–CO–Cl}$
  - (c) Reaction with metals

    Wurtz – Fitting reaction

    $+ Na + RX \xrightarrow{Ether} \quad + NaX$

    Fittig reaction

    $2 \quad + 2Na \xrightarrow{Ether} \quad + 2NaX$

Classification

- No. of halogen atoms

  C_2H_5X — Monohaloalkane

  $CH_2X–CH_2X$ — Dihaloalkane

  Monohaloarene, Dihaloarene, Trihaloarene
- Compounds containing sp³ C–X bond
  - (a) Alkyl halides
  - (b) Allylic halides
  - (c) Benzylic halides
- Compounds containing sp² C–X bond
  - (a) Vinylic halides
  - (b) Aryl halides
- Nomenclature

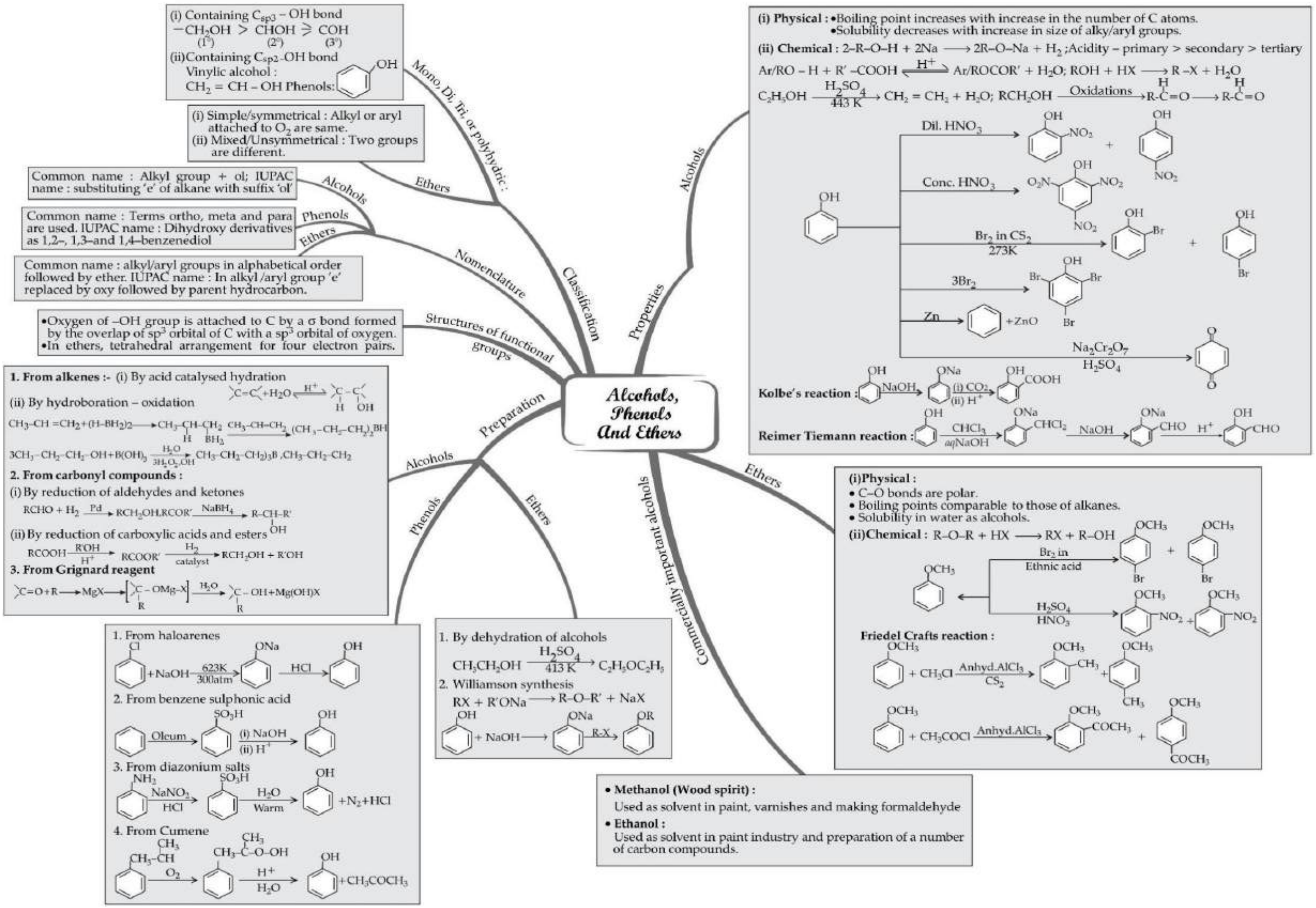
  Common name : alkyl group followed by halides. Dihalogen derivatives, prefixes o–, m–, p– are used.

  IUPAC name : numerals are used
- Nature of C –X bond

  : Carbon –halogen bond is polarized

  $\overset{\delta+}{C}–\overset{\delta-}{X}$

MIND MAP : LEARNING MADE SIMPLE



(i) Containing C_{sp^3} – OH bond
$-CH_2OH > CHOH \geqslant COH$
(1°) (2°) (3°)
(ii) Containing C_{sp^2}-OH bond
Vinylic alcohol :
$CH_2 = CH - OH$ Phenols:

(i) Simple/symmetrical : Alkyl or aryl attached to O_2 are same.
(ii) Mixed/Unsymmetrical : Two groups are different.

Common name : Alkyl group + ol; IUPAC name : substituting 'e' of alkane with suffix 'ol'

Common name : Terms ortho, meta and para are used. IUPAC name : Dihydroxy derivatives as 1,2–, 1,3–and 1,4–benzenediol

Common name : alkyl/aryl groups in alphabetical order followed by ether. IUPAC name : In alkyl /aryl group 'e' replaced by oxy followed by parent hydrocarbon.

- Oxygen of –OH group is attached to C by a σ bond formed by the overlap of sp^3 orbital of C with a sp^3 orbital of oxygen.
- In ethers, tetrahedral arrangement for four electron pairs.

1. From alkenes :- (i) By acid catalysed hydration

$$>C=C< + H_2O \xrightleftharpoons{H^+} >\underset{H}{C}-\underset{OH}{C}<$$

(ii) By hydroboration – oxidation

$$CH_3-CH=CH_2+(H-BH_2)_2 \longrightarrow CH_3-\underset{H}{CH}-\underset{BH_2}{CH_2} \xrightarrow{CH_3-CH=CH_2} (CH_3-CH_2-CH_2)_2BH$$

$$3CH_3-CH_2-CH_2-OH+B(OH)_3 \xrightarrow[3H_2O_2,\,OH]{H_2O} CH_3-CH_2-CH_2)_3B\;,CH_3-CH_2-CH_2$$

2. From carbonyl compounds :

(i) By reduction of aldehydes and ketones

$$RCHO + H_2 \xrightarrow{Pd} RCH_2OH, RCOR' \xrightarrow{NaBH_4} R-\underset{OH}{CH}-R'$$

(ii) By reduction of carboxylic acids and esters

$$RCOOH \xrightarrow[H^+]{R'OH} RCOOR' \xrightarrow[catalyst]{H_2} RCH_2OH + R'OH$$

3. From Grignard reagent

$$>C=O+R \longrightarrow MgX \longrightarrow \left[>\underset{R}{C}-OMg-X\right] \xrightarrow{H_2O} >\underset{R}{C}-OH+Mg(OH)X$$

1. From haloarenes
2. From benzene sulphonic acid
3. From diazonium salts
4. From Cumene

1. By dehydration of alcohols

$$CH_3CH_2OH \xrightarrow[413\,K]{H_2SO_4} C_2H_5OC_2H_5$$

2. Williamson synthesis

$$RX + R'ONa \longrightarrow R-O-R' + NaX$$

(i) **Physical :** •Boiling point increases with increase in the number of C atoms.
•Solubility decreases with increase in size of alky/aryl groups.

(ii) **Chemical :** $2\text{–}R\text{–}O\text{–}H + 2Na \longrightarrow 2R\text{–}O\text{–}Na + H_2$;Acidity – primary > secondary > tertiary

$$Ar/RO-H + R'-COOH \xrightleftharpoons{H^+} Ar/ROCOR' + H_2O;\; ROH + HX \longrightarrow R-X + H_2O$$

$$C_2H_5OH \xrightarrow[443\,K]{H_2SO_4} CH_2 = CH_2 + H_2O;\; RCH_2OH \xrightarrow{\text{Oxidations}} R\text{-}\overset{H}{C}=O \longrightarrow R\text{-}\overset{H}{C}=O$$

Kolbe's reaction :

Reimer Tiemann reaction :

(i) **Physical :**
- C–O bonds are polar.
- Boiling points comparable to those of alkanes.
- Solubility in water as alcohols.

(ii) **Chemical :** $R\text{–}O\text{–}R + HX \longrightarrow RX + R\text{–}OH$

Friedel Crafts reaction :

- **Methanol (Wood spirit) :**
  Used as solvent in paint, varnishes and making formaldehyde
- **Ethanol :**
  Used as solvent in paint industry and preparation of a number of carbon compounds.

Class : 12th Chemistry
Chapter-13 : Amines (Part_1)

Amines

Diazonium Salts RN_2X

Diazonium Salts

Preparation :

$$C_6H_5NH_2 + NaNO_2 + 2HCl \xrightarrow{273\text{-}278K} C_6H_5N_2Cl + NaCl + 2H_2O$$

Physical properties : Colourless crystalline solid, soluble in water, stable in cold but reacts with water on warming.

Chemical properties :

(i) Sandmeyer reaction:

$$ArN_2X \xrightarrow{Cu_2Cl_2/HCl} ArCl + N_2$$
$$ArN_2X \xrightarrow{Cu_2Br_2/HBr} ArBr + N_2$$
$$ArN_2X \xrightarrow{CuCN/KCN}$$

Gattermann reaction :

$$ArN_2X \xrightarrow{Cu/HCl} ArCl + N_2 + CuX$$
$$ArN_2X \xrightarrow{Cu/HBr} ArBr + N_2 + CuX$$

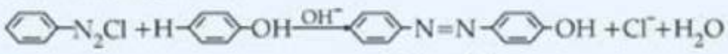
(ii) $ArN_2Cl + KI \longrightarrow ArI + KCl + N_2$

(iii) $ArN_2Cl + HBF_4 \longrightarrow ArN_2BF_4 \xrightarrow{\Delta} ArF + BF_3 + N_2$

(iv) $ArN_2Cl + H_3PO_2 + H_2O \longrightarrow ArH + N_2 + H_3PO_3 + HCl$

(v) $ArN_2Cl + H_2O \longrightarrow ArOH + N_2 + HCl$

(iv) **Coupling reaction :**

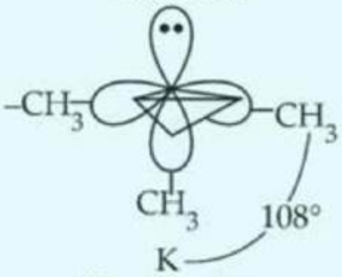


(Orange dye)

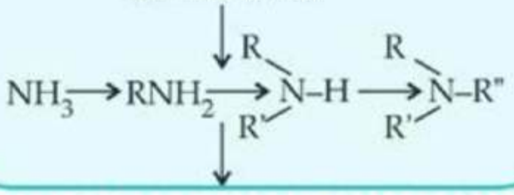
(Yellow dye)

Derivatives of ammonia, obtained by replacement of one, two or all the three Hatoms by alkyl and/or groups

Structure



Classification



$$NH_3 \rightarrow RNH_2 \rightarrow R(R')N\text{–}H \rightarrow R(R')N\text{–}R''$$

Physicals Properties

- Lower aliphatic amines are gases. Primary amines with three or more C atoms are liquid and higher ones are solid.
- Arylamines are colourless but get coloured on storage.
- Lower aliphatic amines are soluble in water, while higher are insoluble.
- Primary and secondary amines form intermolecular association
- Boiling point : primary > secondary > tertiary

Nomenclature:

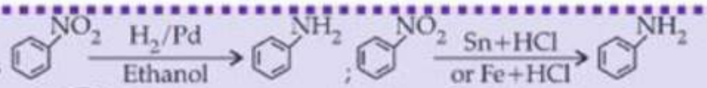
Common name: Aliphatic amine is named by prefixing alkyl group to amine. In secondary and tertiary amines prefix di or tri is put before name of alkyl group. IUPAC name : replacement of 'e' of alkane by the word amine. Suffix 'e' of arene is replaced by amine.

Class : 12th Chemistry
Chapter-13 : Amines (Part_2)

Amines

Preparation

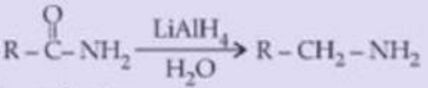
1.Reduction of nitro compounds



2. Ammonolysis of alkyl halides $NH_3 + R-X \longrightarrow R-\overset{+}{N}H_3\overset{-}{X}$

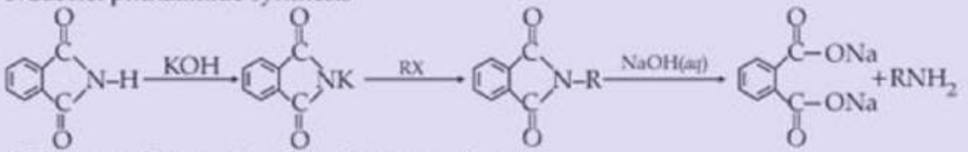
3.Reduction of nitriles $R-C\equiv N \xrightarrow[Na(Hg)/C_2H_5]{H_2/Ni} R-CH_2NH_2$

4.Reduction of amides

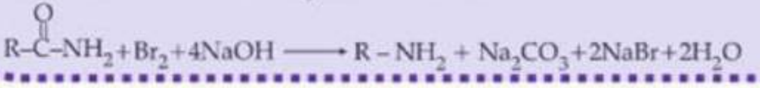


$R-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[H_2O]{LiAlH_4} R-CH_2-NH_2$

5.Gabriel phthalimide synthesis



6.Hoffmann bromamide degradation reaction

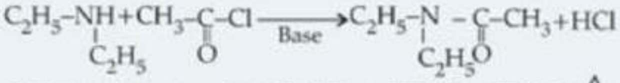


$R-\overset{O}{\overset{\|}{C}}-NH_2+Br_2+4NaOH \longrightarrow R-NH_2 + Na_2CO_3+2NaBr+2H_2O$

Chemical Reaction

(i) Basic character of amines

- Reacts with acids to form salts $R-NH_2 + HX \rightleftharpoons R-NH_3X$ (salt)
- Reacts with base to regenerate parent amines $RNH_3X + OH \longrightarrow RNH_2 + H_2O + X$
- Order of stability of ions : 1° > 2° > 3°



(ii) $C_2H_5-\underset{C_2H_5}{NH}+CH_3-\underset{O}{C}-Cl \xrightarrow{Base} C_2H_5-\underset{C_2H_5}{N}-\underset{O}{C}-CH_3+HCl$

(iii) Carbylamines reaction : $R-NH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} R-NC + 3KCl + 3H_2O$

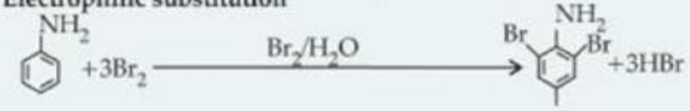
(iv) With nitrous acid

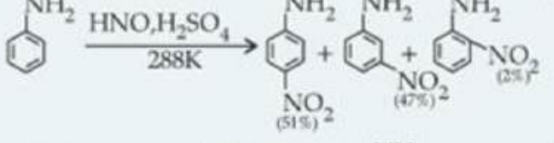
$RNH_2 + HNO_2 \xrightarrow{NaNO_2+HCl} [R-N_2Cl] \xrightarrow{H_2O} ROH + N_2 + HCl$

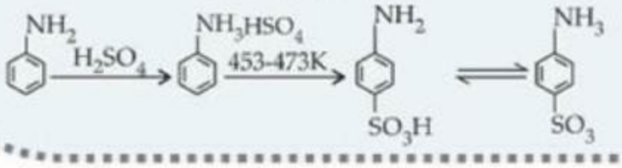
$C_6H_5NH_2 \xrightarrow[273\text{-}278K]{NaNO_2+HCl} C_6H_5N_2Cl + NaCl + 2H_2O$

(v)

(vi) Electrophilic substitution



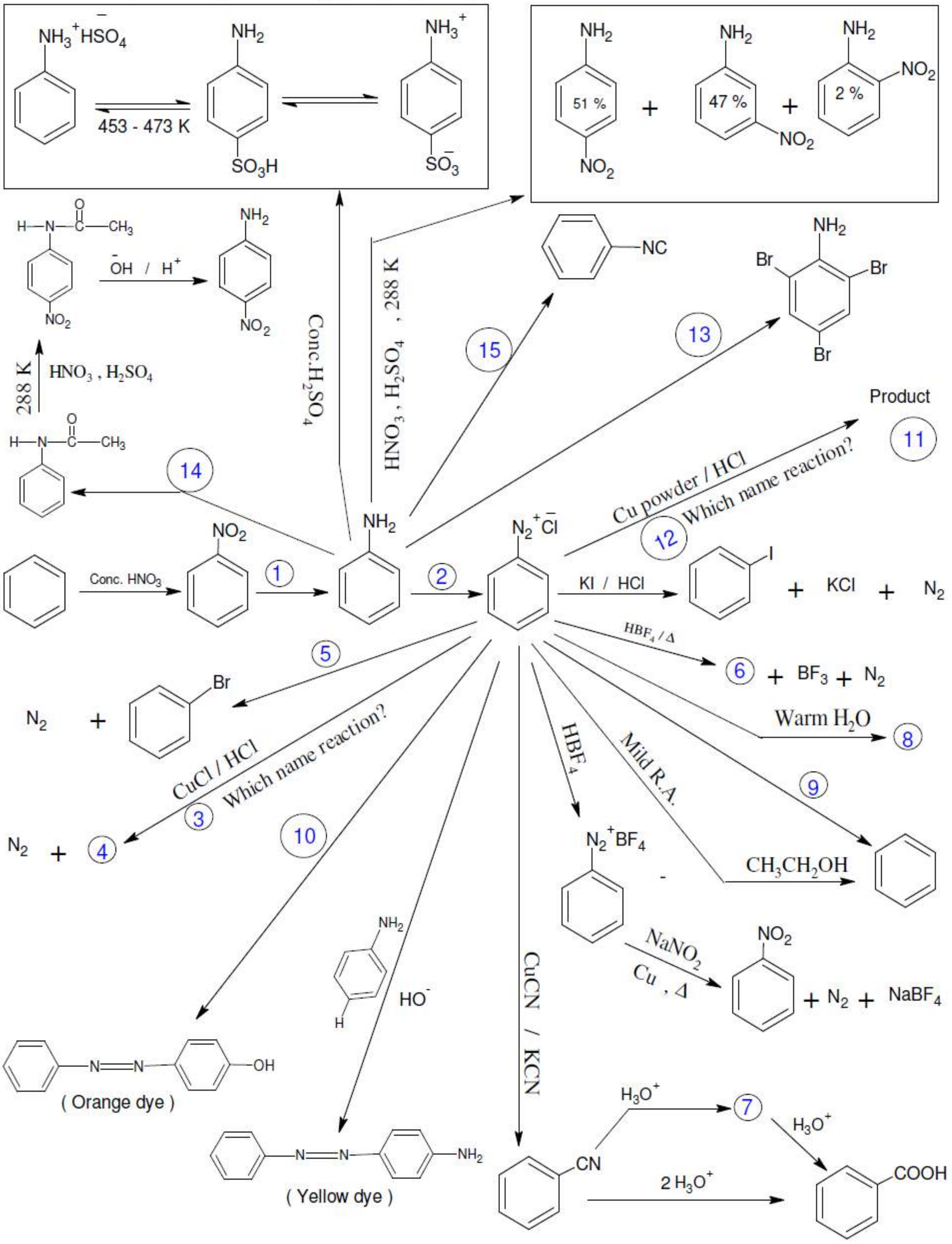




Importance of diazonium salts in synthesis of aromatic compounds:
In preparation of substituted aromatic compounds which cannot be prepared by direct substitution in benzene/ substituted benzene.

AMINES - MEMORY MAP

protecting the - NH_2 group by acetylation reaction with acetic anhydride.



MIND MAP : LEARNING MADE SIMPLE

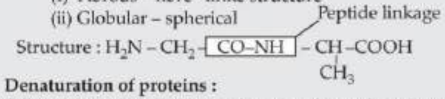
Biomolecules

Proteins

(Polymers of α–amino acids)
Amino acids contain $-NH_2$ and $-COOH$ group.

Classification:

- On the basis of relative number of $-NH_2$ and $-COOH$ group
  - (I) Neutral–equal number of $-NH_2$ and $-COOH$ group.
  - (ii) Basic – more number of $-NH_2$ than $-COOH$ group.
  - (iii) Acidic – more number of $-COOH$ than $-NH_2$ group.
- On the basis of place of synthesis
  - (i) Essential – cannot be synthesized in the body.
  - (ii) Non-essential – synthesized in the body.
- On the basis of shape
  - (I) Fibrous – fibre –linke structure
  - (ii) Globular – spherical



Structure : $H_2N-CH_2-\boxed{CO-NH}-\underset{CH_3}{\underset{|}{CH}}-COOH$

Denaturation of proteins :
When a protein in its native form is subjected to physical change, globules unfold, helix get uncoiled and protein loses its biological activity.

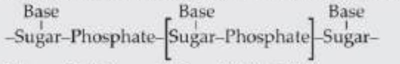
Vitamins

Organic compounds required in diet in small amounts to perform specific biological functions for maintenance and growth.

Classification:
(i) Fat soluble : Soluble in fats and oils but insoluble in water. (vitamins A,D,E and K)
(ii) Water soluble : B group and vitamin C are soluble in water.

Nucleic Acids

Chromosomes : Particles in nucleus responsible for heredity. Chromosomes are made up of proteins and nucleic acid.
Two types : Deoxyribonucleic acid (DNA), ribonucleic acid (RNA)
Composition : In DNA, sugar is β–D–2–deoxyribose whereas in RNA is β–D–ribose. DNA contains A,G,C,T whereas RNA has A,G,C,U.
Structure : –
Nucleoside : Formed by attachment of a base to 1′ of sugar′
Nucleotide : Formed by link to phosphoric acid at 5′ of sugar.



$-\overset{\overset{Base}{|}}{Sugar}-Phosphate-\left[\overset{\overset{Base}{|}}{Sugar}-Phosphate\right]-\overset{\overset{Base}{|}}{Sugar}-$

Types of RNA : m–RNA, r–RNA, t–RNA

Biological Functions :

- Chemical basis of heredity.
- Responsible for identity of different species of organisms.
- Nucleic acids are responsible for protein synthesis in cell.

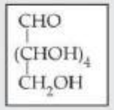
Carbohydrates

Optically active polyhydroxy aldehydes or ketones or compounds which produce such units on hydrolysis.

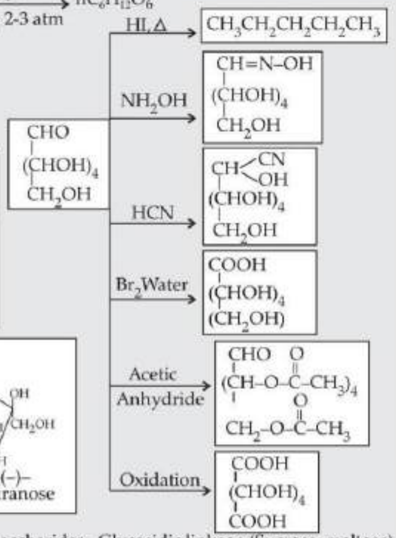
- **Classification:**

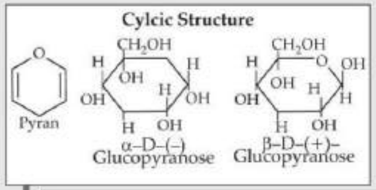
(I) Monosaccharides : (Aldehyde group – aldose, keto group –ketose)
Glucose : Preparation :
(a) From sucrose : $\underset{Sucrose}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{Glucose}{C_6H_{12}O_6} + \underset{Fructose}{C_6H_{12}O_6}$
(b) From starch : $(C_6H_{10}O_5)n + nH_2O \xrightarrow[393K;\ 2\text{-}3\ atm]{H^+} nC_6H_{12}O_6$

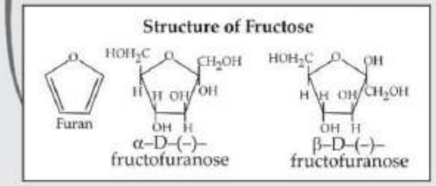
- **Structure:**



$$\begin{array}{l}CHO\\ |\\ (CHOH)_4\\ |\\ CH_2OH\end{array}$$







(ii) Disaccharides : Linkage between 2 monosaccharides– Glycosidic linkage (Sucrose, maltose)
(iii) Polysaccharides : Large number of monosaccharides units joined by glycosidic linkages.
(a) Starch : Polymer of α–glucose with two components amylase and amylopectin
(b) Cellulose
(c) Glycogen

Importance:

- Form a major portion of food.
- As storage molecules.
- Cellulose forms cell wall of bacteria and plants.
- Raw materials for industries like textiles, paper, lacquers and breweries.

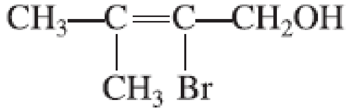
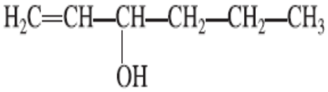
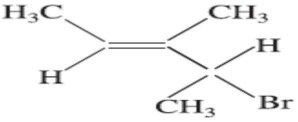
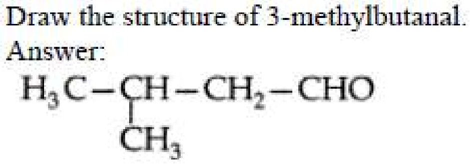
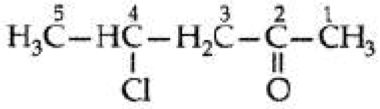
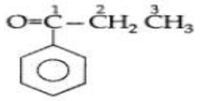
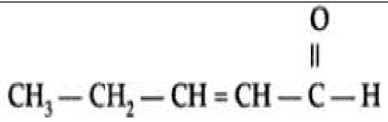
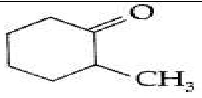
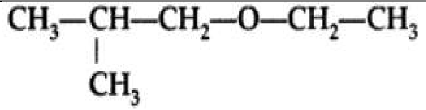
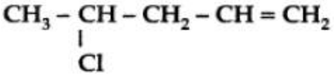
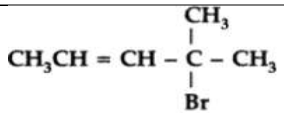
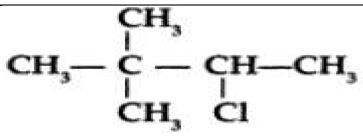
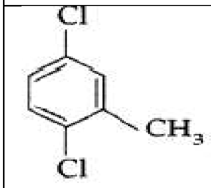
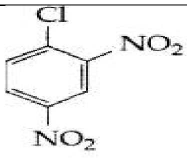
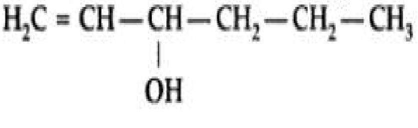
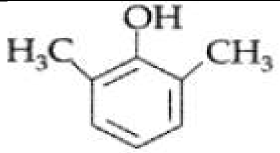
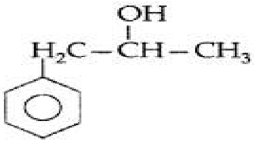
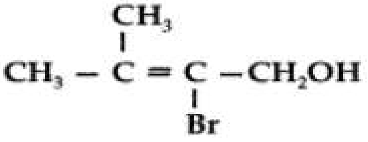
Enzymes

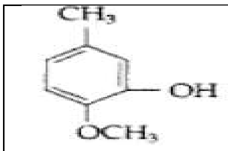
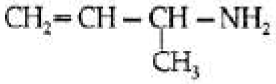
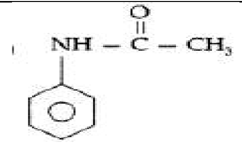
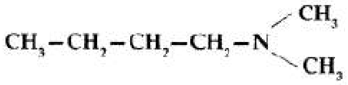
Globular proteins specific for particular reaction and for particular substrate. Mechanism : Reduces the magnitude of activation energy

DNA Fingerprinting:Unique sequence of bases on DNA.

ORGANIC CHEMISTRY KA CAPSOULE JO AAPKO BANAYEGA CBSE 2026 KA CHAMPION

FAQ ON IUPAC NOMENCLATURE OF ORGANIC COMPOUNDS

 $CH_3-\underset{CH_3}{C}=\underset{Br}{C}-CH_2OH$ 2-bromo-3-methyl but-2-en-1-ol	 $H_2C=CH-\underset{OH}{CH}-CH_2-CH_2-CH_3$ Hex-1-en-3-ol	**1-phenyl pentane-1- one** $O=C(C_6H_5$ $-CH_2CH_2CH_2CH_3$
 4-bromo -3-methyl-pent-1-ene	**3-oxo-pentanal** **CH_3-CH_2-CO-CH_2-CH_2CHO**	 Draw the structure of 3-methylbutanal. Answer: $H_3C-\underset{CH_3}{CH}-CH_2-CHO$
Draw structure of 4-chloro pentan-2-one  $H_3\overset{5}{C}-H\underset{Cl}{\overset{4}{C}}-H_2\overset{3}{C}-\underset{O}{\overset{2}{C}}-\overset{1}{C}H_3$	Draw structure of 1-phenyl propan-1-one 	 $CH_3-CH_2-CH=CH-\overset{O}{C}-H$ Pent-2-en-al
Ph-CH=CH-CHO 3-Phenyl prop2-enal	 2-methylcyclohexanone	 $CH_3-\underset{CH_3}{CH}-CH_2-O-CH_2-CH_3$ 1-ethoxy-2-methylpropane
 $CH_3-\underset{Cl}{CH}-CH_2-CH=CH_2$ 4-chloropent-1-ene	 $CH_3CH=CH-\underset{Br}{\overset{CH_3}{C}}-CH_3$ 4-bromo-4-methylpent-2-ene	 $CH_3-\underset{CH_3}{\overset{CH_3}{C}}-\underset{Cl}{CH}-CH_3$ 2-chloro- 2,2- dimethyl butane
 2,5-dichloromethylbenzene	 2,4 -dinitrochlorobenzene	 $H_2C=CH-\underset{OH}{CH}-CH_2-CH_2-CH_3$ Hex-1-en-3-ol
 2,6 – dimethyl phenol	Draw 1-phenylpropan-2-ol 	 $CH_3-\overset{CH_3}{C}=\underset{Br}{C}-CH_2OH$ 2-bromo-3-methylbut-2-en-1-ol

 2-methoxy-4-methylphenol	 $CH_2=CH-\underset{CH_3}{\underset{\vert}{CH}}-NH_2$ But-3-en-amine	 N- phenyl ethanamide
 N,N-dimethylbutanamine	CH_3CH_2-$NHCH(CH_3)_2$ N-ethyl propan-2-amine	$(CH_3CH_2)_2$ N CH_3 N-ethyl, N-methyl ethanamine

ORGNIC REASONING

Q1. Why are halo alkanes more reactive than haloarenes?.

Ans. (i) In haloarenes, there is double bond character between carbon and halogen due to resonance effect which makes it less reactive.

(ii) In benzene, carbon atom is sp^2 hybridised which is shorter than sp^3 present in halo alkanes. Hence C-Cl bond in aryl halides is shorter and stronger.

Q2. Why do halo alkanes undergo nucleophillic substitution where as haloarenes undergo electophillic substitution.

Ans. Due to more electro negative nature of halogen atom in halo alkanes carbon atom becomes slightly positive and is easily attacked by nucleophillic reagents. While in halo arenes due to resonance, carbon atom becomes slightly negative and attacked by electrophillic reagents.

Q3. When an alkyl halide is treated with ethanolic solution of KCN, the major product is alkylcyanide where as if alkyl halide is treated with AgCN, the major product is alkyl isocyanide.

Ans. KCN is predominantly ionic and provides cyanide ions in solution. Although both carbon and nitrogen atoms are in a position to donate electron pairs, the attack takes place mainly through carbon atom and not through nitrogen atom since C—C bond is more stable than C—N
bond. However, AgCN is mainly covalent in nature and nitrogen is free to donate electron pair forming isocyanide as the main product..

Q4. Aryl halides cannot be prepared by the action of sodium halide on phenol in the presence H_2SO_4. Why?

Ans. Due to resonance the carbon-oxygen bond in phenol has partial double bond character and it is stronger than carbon oxygen single bond.

Q5. Grignard reagent should be prepared under anhydrous conditions. Why?

Ans. Grignard reagent reacts with H_2O (moisture) to form alkanes, therefore they are prepared under anhydrous condition.

Q6.Why is Sulphuric acid not used during the reaction of alcohols with KI?

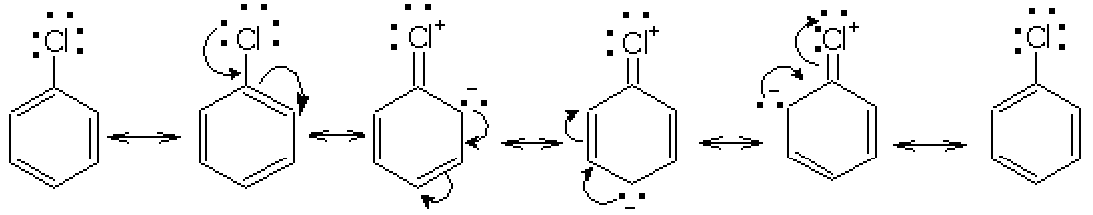
Ans. It is because HI formed will get oxidized to $I_2$by concentrated Sulphuric acid which is an oxidizing agent.

Q7. p-dichloro benzene has higher m.p.than those of ortho and m-isomers.?

Ans. p-dichloro benzene is symmetrical, fits into crystal lattice more readily and has higher melting point.

Q8. Although chlorine is an electron-with drawing group, it is ortho and para directing in electrophillic aromatic substitution reactions. Why?

Ans. Chlorobenzene is resonance hybrid, there is –ve charge at ortho and para positions, electro phallic substitution reaction will take place at ortho and para position due to +R effect which dominating over the –I effect



Q9.The treatment of alkyl chlorides with aqueous KOH lead to the formation of alcohols but in presence of alcoholic KOH alkenes are major products. Explain?

Ans. In aqueous KOH, (OH-) is nucleophile which replaces another nucleophile.

$$R\text{-}X + KOH \longrightarrow R\text{-}OH + KX$$

Where as in alcoholic KOH alkoxide ion (RO^-) produces which is a strong base so it extract H^+ and elimination takes place.

$$C_2H_5OH + KOH \longrightarrow C_2H_5O^- + K^+$$

$$CH_3CH_2\text{-}Cl + \text{alco.}KOH \longrightarrow CH_2{=}CH_2 + C_2H_5OH$$

Q10. Explain why vinylchloride is unreactive in nucleophillic substitution reaction?

Ans. Vinylchloride is unreactive in nucleophillic substitution reaction because of double bond character between =C=C-Cl bond which is difficult to break.

Q11. Alcohols react with halogen acids to form haloalkenes but phenol does not form halo benzene. Explain.

Ans. The C-O bond in phenol acquires partial double bond character due to resonance. Hence it is not Cleaved by X- ions to form halobenzenes. But in alcohols a pure single bond C—O bond is maintained and can be cleaved by X– ions.

Q. 12. Why is (+ -) butan-2-ol is optically inactive?

Ans. (+ -) butan-2-ol is a equimolar mixture of dextro and leavo form so cancel their optical rotation and it is optically inactive

Q.13. The C-Cl bond length in chlorobenzene is shorter than that in CH_3Cl why?

Ans. 1. In haloarenes, there is double bond character between carbon and halogen due to resonance effect as a result C-Cl bond length decreases.

2. In Haloarene the carbon to which halogen is attached is SP^2 hybridised and in CH_3Cl it is SP^3 hybridised. The electronegativity of SP^2 hybridised carbon is more thanSP^3 hybridised carbon so bond length decreases.

Q. 14. Haloalkanes are only slightly soluble in water but dissolve easily in organic solvent why?

OR

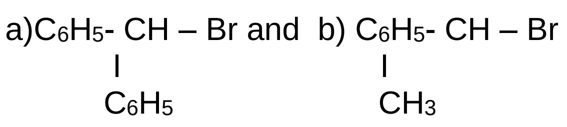
Haloalkanes easily dissolve in organic solvent why?

Ans. *The haloalkanes are only very slightly soluble in water.* In order for a haloalkane to dissolve in water, energy is required to overcome the attractions between the haloalkane molecules and break the hydrogen bonds between water molecules. Less energy is released when new attractions are set up between the haloalkane and the water molecules as these are not as strong as the original hydrogen bonds in water. As aresult, the solubility of haloalkanes in water is low.

However, haloalkanes tend to dissolve in organic solvents because the new intermolecular attractions between haloalkanes and solvent molecules have much the same strength as the ones being broken in the separate haloalkane and solvent molecules.

Q. 15 The dipole moment of chlorobenzene is lower than cyclohexyl chloride why?

Ans. The dipole moment of chlorobenzene is less than cyclohexyl chloride as in chloro benzene C-Cl bond is SP^2 hybridised where as in cyclohexyl chloride the C-Cl bond is SP^3 Hybridised . as SP^2 hybridise has more s character and more electronegative than SP^3 so bond length decreases . So chlorobezene is less polar.



Q. 16 Of the 2 bromoderivatives a)$C_6H_5\text{-}\underset{\substack{|\\ C_6H_5}}{CH}\text{ – }Br$ and b) $C_6H_5\text{-}\underset{\substack{|\\ CH_3}}{CH}\text{ – }Br$,which one is more reactive in SN^1 reaction.and why?

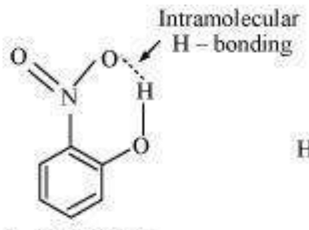
Ans a is more reactive as intermediate carbcation form is more stabilized by resonance.

Q. 17 Ethyl iodide undergoes SN^2 faster than ethylbromide why?
Ans:- Due to large size Iodine is a better leaving group.

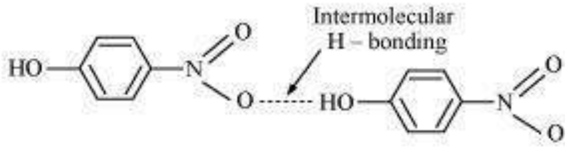
Q. 18 **Explain why propanol has higher boiling point than that of the hydrocarbon, butane?**
Ans, Propanol undergoes intermolecular H-bonding because of the presence of −OH group. On the other hand, butane does not Therefore, extra energy is required to break hydrogen bonds. For this reason, propanol has a higher boiling point than hydrocarbon butane.

Q. 19 Alcohols are soluble in water than hydrocarbons of comparable molecular masses. Explain this fact.
Ans. Alcohols form H-bonds with water due to the presence of −OH group. However, hydrocarbons cannot form H-bonds with water. As a result, alcohols are comparatively more soluble in water than hydrocarbons of comparable molecular masses.

Q.20. **While separating a mixture of *ortho* and *para* nitrophenols by steam distillation, name the isomer which will be steam volatile. Give reason.**
Ans. Intramolecular H-bonding is present in *o*-nitrophenol. In *p*-nitrophenol, the molecules are strongly associated due to the presence of intermolecular bonding. Hence, *o*-nitrophenol is steam volatile.



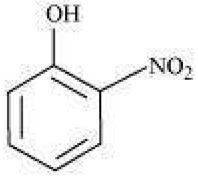
o - Nitrophenol



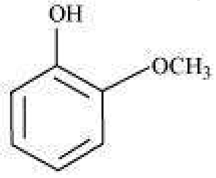
p - Nitrophenol

Q. 21.Explain why is *ortho* nitrophenol more acidic than *ortho* methoxy phenol?
Ans. The nitro-group is an electron-withdrawing group. The presence of this group in the ortho position decreases the electron density in the O−H bond. As a result, it is easier to lose a proton. Also, the *o*-nitrophenoxide ion formed after the loss of protons is stabilized by resonance. Hence, *ortho* nitrophenol is a stronger acid.

On the other hand, methoxy group is an electron-releasing group. Thus, it increases the electron density in the O−H bond and hence, the proton cannot be given out easily. For this reason, ortho-nitro phenol is more acidic than ortho-methoxy phenol.

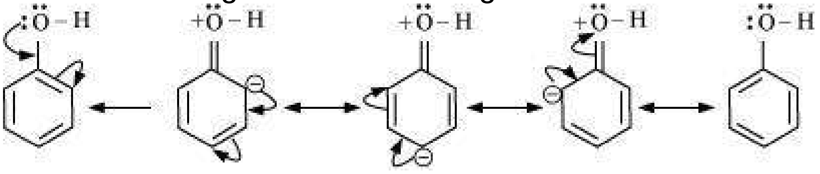


o – Nitrophenol



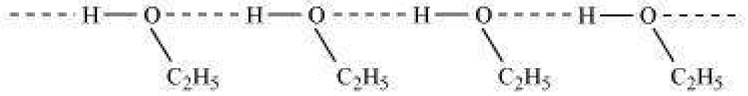
o – Methoxyphenol

Q.22 Explain how does the −OH group attached to a carbon of benzene ring activate it towards electrophilic substitution?
Ans. The −OH group is an electron-donating group. Thus, it increases the electron density in the benzene ring as shown in the given resonance structure of phenol.



As a result, the benzene ring is activated towards electrophilic substitution.

Q.23. Give reason for the higher boiling point of ethanol in comparison to methoxymethane.
Ans.Ethanol undergoes intermolecular H-bonding due to the presence of −OH group, resulting in the association of molecules. Extra energy is required to break these hydrogen bonds. On the other hand, methoxymethane does not undergo H-bonding. Hence, the boiling point of ethanol is higher than that of Methoxymethane.



Q. 24.Preparation of ethers by acid dehydration of secondary or tertiary alcohols is not a suitable method. Give reason.
Ans. The formation of ethers by dehydration of alcohol is a bimolecular reaction (SN2) involving the attack of an alcohol molecule on a protonated alcohol molecule. In the method, the alkyl group should be unhindered. In case of secondary or tertiary alcohols, the alkyl group is hindered. As a result, elimination dominates substitution. Hence, in place of ethers, alkenes are formed.

Q.25 Phenols do not give protonation reactions readily. Why?
Ans. The lone pair on oxygen of O-H in phenol is being shared with benzene ring through resonance. Thus, lone pair is not fully present on oxygen and hence phenols do not undergo protonation reactions.

Q.26 Which out of propan-1-ol and propan-2-ol is stronger acid?
Ans. Propan-1-ol is stronger acid than propan-2-ol. The acidic strength of alcohols is in the order $1^o>2^0>3^0$.

Q.27. Diethyl ether does not react with sodium. Explain.
Ans. Diethyl ether does not contain any active hydrogen

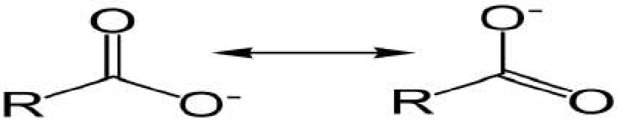
Q.28. Why is the Dipole moment of methanol higher than that of phenol?
Ans. Due to electron withdrawing effect of phenyl group, the C— O bond in phenol is less polar, Whereas in case of methanol the methyl group has electron releasing effect and hence C—O bond in it is more polar.

Q.29. Explain why phenols do not undergo substitution of the –OH group like alcohols.
Ans. C—O bond in phenols has partial double bond character due to resonance and hence is difficult to cleave.

Q.30. Boiling point of the C_2H_5OH is more than that of C_2H_5Cl
Ans. Because of hydrogen bonding in C_2H_5OH and not in C_2H_5Cl.

Q.31. The solubility of alcohols in water decreases with increase in molecular mass.
Ans. With increase in molecular mass the non-polar alkyl group become more predominant.

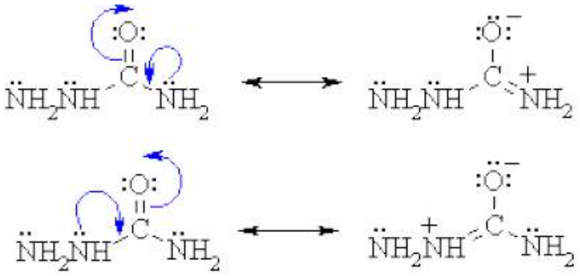
Q.32. Phenoxide ion has more no. of resonating structures than carboxylate ion, carboxylic acid is a stronger acid why?
Ans:- The phenoxide ion has non equivalent resonance structures in which
negative charge is at less electronegative C atom and +ve charge as at more electronegative O-atom.
In carboxylate ion negativeve charge is delocalized on two electronegative O-atoms hence resonance is more effective and a stronger acid.



Q.33 Why Carboxylic acid have higher boiling point than alcohols as alcohol forms strongest intermolecular hydrogen bonding?
Ans As Carboxylic acid forms a dimer due to which their surface area increases and forms strong intermolecular H-bonding. It is having higher boiling point than alcohols.

Q.34. There are two-NH2 groups in semi carbazide. However **only one is involved in formation of semi carbazones. Why?**
Ans.
Due to resonance one NH_2 group undergoes or involved in resonance and hence can’t participate in the formation of semicarbazone. Lone pair of NH_2 group is not involved in resonance and is available for nucleophillic attack

semicarbazone



Q.35. Why does solubility decreases with increasing molecular mass in carboxylic acid?

Ans. Because of increase in alkyl chain length which is hydrophobic in nature. Hence solubility decreases.

Q.36. Why are aldehydes are more reactive than ketones when undergo nucleophillic addition reaction?

Ans **(a) + I effect:-** The alkyl group in Ketones due to their e-releasing character decrease the +ve charge on C-Atom and thus reduce its reactivity.

(b) Steric hindrance :- the presence of two relatively large substituents in ketones hinders the approach of nucleophile to carbonyl carbon than in aldehydes having only one such substituent..

Q.37 Why PCC cannot oxidize methanol to methanoic acid and while $KMnO_4$ can?

Ans. This is because PCC is a mild oxidising agent and can oxide methanol to methanal only.While $KMnO_4$ being strong oxidising agent oxidises it to methanoic acid.

Q.38 During preparation of esters from a carboxylic acid and an alcohol in the presence of acid catalyst water or ester formed should be removed as soon as it is formed.

Ans. The formation of esters from a carboxylic acid and an alcohol in the presence of acid catalyst is a reversible reaction.

$$R\text{–}COOH + R'OH \rightleftharpoons R\text{–}COOR' + H_2O$$

To shift the equilibrium in forward direction, the water or ester formed should be removed as fast as it is formed.

Q.39. Why HCOOH does not give HVZ reaction while CH_3COOH does?

Ans. CH_3COOH contains α-hydrogens and hence give HVZ reaction but HCOOH does not contain α-hydrogen and hence does not give HVZ reaction.

Q.40. Suggest a reason for the large difference in the boling point of butanol and butanal although they have same solubility in water.

Ans. Because Butanol has strong inter molecular H-bonding while butanal has weak dipole-dipole interaction. However both of them form H-bonds with water and hence are soluble.

Q.41. Would you expect benzaldehyde to be more reactive or less reactive in nuderophillic addition reaction than propanol. Explain.

Ans. C-atom of Carbonyl group of benzaldehyde is less electrophilic than C- atom of Carbonyl group in propanol. Polarity of Carbonyl group is in benzaldehyde reduced due to resonance making it less reactive in nucleophillic addition reactions.

Q.42 Why does methanal not give aldol condensation while ethanol gives?

Ans. This is because only those compounds which have α-hydrogen atoms can undergo aldol reaction ethanol pessess α-hydrogen and undergo esaldol condensation Methanal has no alpha hydrogen atoms hence does not undergo aldol condensation.

Q.43 Why does methanal undergo cannizaro's reaction?

Ans :- as it does not contin α - hydrogen atom

Q.44 Which acid is stronger and why? F_3C-C_6H_4COOH and $CH_3C_6H_4COOH$

Ans . CF3-has strong (-I) effect where as, CH_3-has strong (+I)effect Due to greater stability of $F_3CC_6H_4COO$ ion over CH_3-C_6H_4COO ion $CF_3C_6H_4COOH$ is much stronger acis than CH_3-C_6H_4COOH.

Q.45 why do Carboxylic acids not give the characteristic reactions of a carbonyl group?

Ans. Due to resonance, it doesn't give the characteristics reactions of carbonyl group. It does not have free C=O group

Q.46. Cyclohexanone forms cyanohydrin in good yield but 2,2,6 tri methyl cyclohexanone does not. Why?
Ans. In 2,2,6 trimethyl cyclohexaunone there is streric hindrance of 3 methyl groups, It does not form cynohydrin in good yield.

Q.47. Why is carboxyl group in benzoic acid meta directing?
Ans. In benzoic acid the Carboxyl group is meta directing because it is electron-withdrawing There is +ve charge on ortho acid para positions Electrophillic substitution takes place at meta-position.

Q.48. Sodium Bisulphite is used for the purification of aldehydes and Ketones. Explain.
Aldehydes and Ketones form addition compounds with $NaHSO_3$ where as impurities do not. On hydrolysis we get pure aldehydes and Ketones back.

Q.49 Why formic acid is stronger acid than acetic acid?
Ans. Due to +I effect, CH_3- group in acetic acid increases electron density on carbon atom which makes it. Weak acid. While in formic acid no such pushing group is present, hence is more stronger acid than acetic acid. .

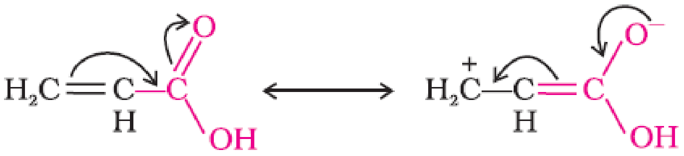
Q.50. Melting point of an acid with even no. of carbon atoms is higher than those of its neighbour with odd no. of carbon atoms.
Ans. They fit into crystal lattice more readily than odd ones that is why they have higher lattice energy and higher melting point.

Q.51 Why do aldehydes have lower boiling point than corresponding alcohols?
Ans. aldehydes have lower boiling point as they are not associated with intermolecular where as alcohals are associated with intermoleculer H-bonding. Aldehydes have lower B.p.

Q.52. Ethers possess a dipole moment even if the alkyl radicals in the molecule are identical. Why?
Ans. It is because ethers are bent molecles, dipole do not get cancelled.

Q.53 The aldehyde and ketones undergo a number of addition reaction why?
Ans. Aldehyde and ketones have polar carbonyl group so undergoes nucleophillic addition reaction.

Q. 54. Ethanoic acid is a weaker acid than benzoic acid why?
Ans. Direct attachment of groups such as phenyl or vinyl to the carboxylic acid, increases the acidity of corresponding carboxylic acid, due to resonance effect



Q. 55. Monochloroethanoic acid has a higher PKa value than Dichloroethanoic acid why?
Ans. Due to presence of two electron withdrawing –I group in dichloroethanoic acid it stablise carboxylate ion more than Monochloroethanoic acid which have only one such group so dichloroethanoic acid is stronger acid.

Q. 56. $(CH_3)_3$-C-CHO does not undergo Aldol condensation.
Ans. Aldol condensation is given by aldehyde containing -α- hydrogen atom but $(CH_3)_3$-C-CHO have **no -α- hydrogen atom** so does not undergo Aldol condensation.

Q. 57. pKb of aniline is more than that of methylamine.
Ans. Aniline undergoes resonance and as a result, the electrons on the N-atom are delocalized over the benzene ring. Therefore, the electrons on the N-atom are less available to donate.

On the other hand, in case of methyl amine (due to the +I effect of methyl group), the electron density on the N-atom is increased. As a result, aniline is less basic than methylamine. Thus, pKb of aniline is more than that of methylamine.

Q. 58. Ethylamine is soluble in water whereas aniline is not.
Ans. Ethylamine when added to water forms intermolecular H−bonds with water. Hence, it is soluble in water. But aniline does not undergo H−bonding with water to a very large extent due to the presence of a large hydrophobic−C_6H_5 group. Hence, aniline is insoluble in water.

Q. 59. Methylamine in water reacts with ferric chloride to precipitate hydrated ferric oxide.

Ans. Due to the +I effect of $-CH_3$group, methylamine is more basic than water. Therefore, in water, methylamine produces OH^- ions by accepting H^+ ions from water.
Ferric chloride ($FeCl3$) dissociates in water to form $Fe^{3+}$and Cl^- ions.
Then, OH^- ion reacts with Fe^{3+}ion to form a precipitate of hydrated ferric oxide.

$$2Fe^{3+} + 6OH^- \longrightarrow \underset{\text{Hydrated ferric oxide}}{Fe_2O_3 \cdot 3H_2O}$$

Q. 60. Although amino group is o– and p– directing in aromatic electrophilic substitution reactions, aniline on nitration gives a substantial amount of m-nitroaniline.

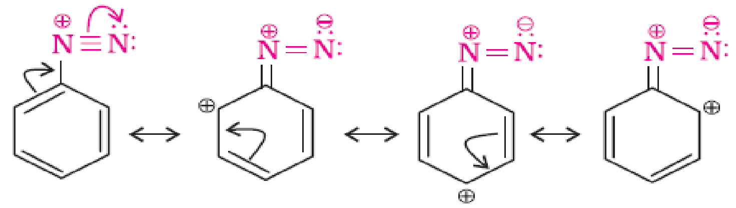
Ans Nitration is carried out in an acidic medium. In an acidic medium, aniline is protonated to give anilinium ion (which is meta-directing).
For this reason, aniline on nitration gives a substantial amount of m-nitroaniline.

Q. 61. Aniline does not undergo Friedel-Crafts reaction.

Ans. Friedel-Crafts reaction is carried out in the presence of anhydrous $AlCl_3$. But anhydrous $AlCl_3$ is acidic in nature, while aniline is a strong base. Thus, aniline reacts with an. $AlCl_3$ to form a salt Due to the positive charge on the N-atom, electrophilic substitution in the benzene ring is deactivated. Hence, aniline does not undergo the Friedel-Crafts reaction.

Q. 62. Diazonium salts of aromatic amines are more stable than those of aliphatic amines.

Ans. The diazonium ion undergoes resonance as shown below:



This resonance accounts for the stability of the diazonium ion. Hence, diazonium salts of aromatic amines are more stable than those of aliphatic amines.

Q. 63. Gabriel phthalimide synthesis is preferred for synthesizing primary amines.

Ans. Gabriel phthalimide synthesis results in the formation of 1° amine only. 2°or 3°aminesare not formed in this synthesis. Thus, a pure 1°amine can be obtained .Therefore,Gabriel phthalimide synthesis is preferred for synthesizing primary amines.

Q.64. Gabriel Phthalimide synthesis is not suitable for preparation of secondary and tertiary amines.

Ans- Since the reaction involves SN^2 mechanism, only a primary alkyl group can approach the sterically hindered Phthalimide ring .

Q.65.Why cannot aromatic primary amines be prepared by Gabriel phthalimide synthesis?

Ans. Gabriel phthalimide synthesis is used for the preparation of aliphatic primary amines. It involves nucleophilic substitution (SN^2) of alkyl halides by the anion formed by the phthalimide.
But aryl halides do not undergo nucleophilic substitution with the anion formed by the Phthalimde. Hence, aromatic primary amines cannot be prepared by this process.

Q.66. Why do primary amines have higher boiling point than tertiary amines? Ans.In a molecule of tertiary amine, there are no H−atoms where as in primary amines,two hydrogen atoms are present . Due to the presence of H−atoms, primary amines undergo extensive intermolecular H−bonding. As a result, extra energy is required to separate the molecules of primary amines. Hence, primary amines have higher boiling points than tertiary amines.

Q.67. Alkylamines are more basic than ammonia why?

Ans. Due to electron releasing +I group in alkylamine electron density on nitrogen increases and it increase basic nature of ammine. No such group present in ammonia so it is weaker base.

Q.68. Amines ($R\text{-}NH_2$) are lower boiling than alcohols (R-OH)

OR

Amines ($R\text{-}NH_2$) are less soluble than alcohols (R-OH)

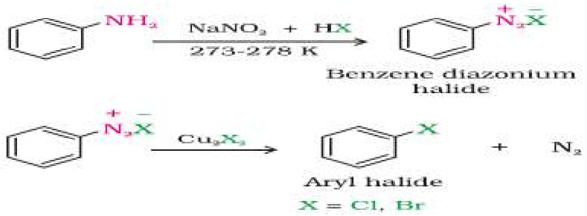
Ans. In alcohol the inter molecular H-bonding is stronger because O is more electronegative than N.

Q. 69. Acylation of aniline is carried out in presence of pyridine

Ans. Pyridine removes HCl produced during reaction and favours forward reaction.

IMPORTANT NAMED REACTIONS.

1. **SANDMEYER REACTION:-** When a primary aromatic amine, dissolved or suspended in cold aqueous mineral acid, is treated with sodium nitrite, a diazonium salt is formed . diazonium salt when mixed with cuprous chloride or cuprous bromide haloarene is formed.



2. **FINKELSTEIN REACTION:-** Alkyl iodides are prepared by the reaction of alkyl chlorides or bromides with NaI in dry acetone. This reaction is known as **Finkelstein reaction.**

$$CH_3\text{-}CH_2\text{-}Cl + NaI \xrightarrow{\text{Dry acetone}} CH_3\text{-}CH_2\text{-}I + NaCl$$

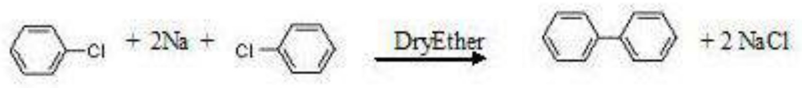
3. **SWARTS REACTION:-** alkyl fluorides is best prepared by heating an alkyl chloride/bromide in the presence of a metallic fluoride such as AgF, Hg_2F_2, CoF_2 or SbF_3. The reaction is termed as **Swarts reaction**.

$$CH_3\text{-}CH_2\text{-}Cl + AgF \longrightarrow CH_3\text{-}CH_2\text{-}F + AgCl$$

4. **WURTZ REACTION :-**Alkyl halides react with sodium in dry ether to give hydrocarbons containing double the number of carbon atoms present in the halide. This reaction is known as Wurtz reaction

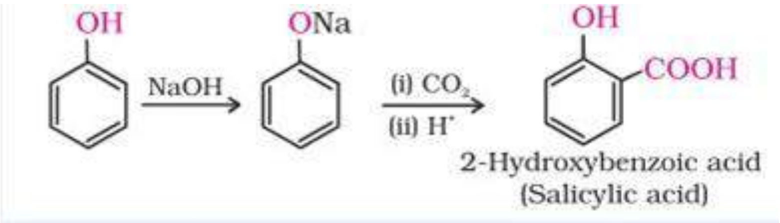
$$2\ CH_3\text{-}CH_2\text{-}Cl + 2Na \xrightarrow{\text{Dry ether}} CH_3\text{-}CH_2\text{-}CH_2CH_3 + 2NaCl$$

5. **FITTIG REACTION:-** Aryl halides when treated with sodium in dry ether, in which two aryl groups are joined together. It is called Fittig reaction.

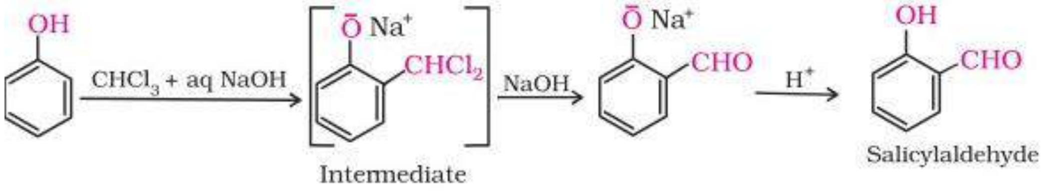


6. **WURTZ FITTIG REACTION:-** A mixture of an alkyl halide and aryl halide gives an alkylarene when treated with sodium in dry ether and is called Wurtz-Fittig reaction.

7. KOLBE'S REACTION:- Phenol reacts with sodium hydroxide to give sodium phenoxide which then reacts with carbondioxide in acidic medium to give 2-hydroxybenzoic acid.



8. **Reimer-Tiemann Reaction:-** On treating phenol with chloroform in the presence of sodium hydroxide, a –CHO group is introduced at *ortho* position of benzene ring. This reaction is known as *Reimer - Tiemann reaction*.

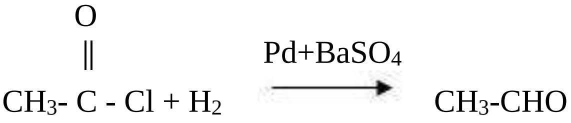


9. **Williamson's Synthesis** :- Reaction between sodium alkoxide and alkyl halide to form ether is known as Williamson's Synthesis.

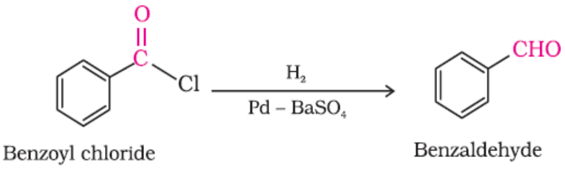
$$R\text{-}X + R\grave{}\text{-}ONa \longrightarrow R\text{-}O\text{-}R\grave{} + NaX$$

$$CH_3Cl + C_2H_5\text{–}ONa \longrightarrow CH_3\text{-}O\text{-}C_2H_5 + NaCl$$

10. . **Rosenmund reduction: -** Catalytic reduction of acyl chlorides to Aldehyde in presence of catalyst palladium suspended over barium sulphate.



$$CH_3\text{-}\overset{\overset{\displaystyle O}{\|}}{C}\text{-}Cl + H_2 \xrightarrow{Pd+BaSO_4} CH_3\text{-}CHO$$

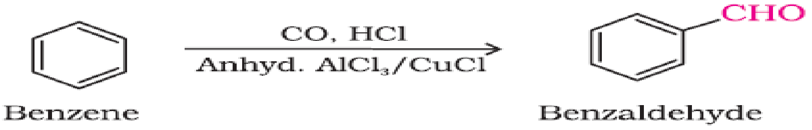


11. **Stephens Reaction:-** Nitriles are reduced to corresponding imine with $SnCl_2$ in the presence of HCl, which on hydrolysis give corresponding aldehyde. This reaction is called **Stephen reaction.**

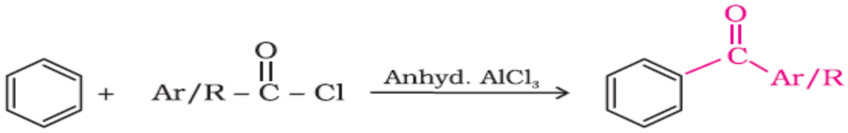
$$RCN + SnCl_2 + HCl \longrightarrow RCH = NH \xrightarrow{H_3\overset{+}{O}} RCHO$$

12. **Etard Reaction :-(CrO_2Cl_2)** Chromyl chloride oxidizes methyl group to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.

13. ***Gatterman – Koch reaction :-***When benzene or its derivative is treated with carbon monoxide and hydrogen chloride in the presence of anhydrous aluminium chloride or cuprous chloride, it gives benzaldehyde this reaction is called as Gatterman – Koch reaction.



14. **Friedal – Crafts acylation reaction** When benzene or substituted benzene is treated with acid chloride in the presence of anhydrous aluminium chloride, it gives the corresponding ketone. This reaction is known as **Friedel-Crafts acylation reaction**



15. **Clemmensen Reduction:-** The carbonyl group of aldehydes and ketones is reduced to CH_2 group or hydrocarbon on treatment with zinc - amalgam and concentrated hydrochloric acid called **Clemmensen reduction**.

$$CH_3\text{-}CHO \xrightarrow{\text{Zn-Hg/ HCl}} CH_3\text{- }CH_3 + H_2O$$

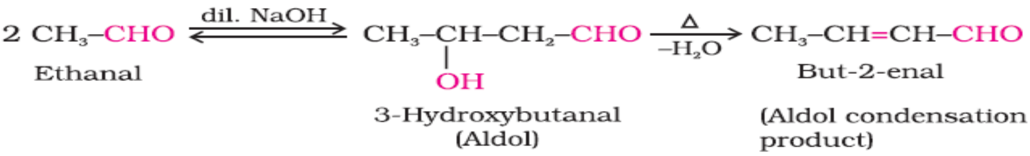
16. <u>Wolff-Kishner Reduction</u> :- Reaction of carbonyl compound with Hydrazine followed by heating with KOH in boiling solvent Ethylene glycol.

$$CH_3\text{-}CHO \xrightarrow[-H_2O]{NH_2\text{-}NH_2} CH_3\text{-}CH{=}N\text{-}NH_2 \xrightarrow[400\ K]{KOH} CH_3\text{-}CH_3 + N_2$$

17. **Haloform Reaction:-** Aldehydes and ketones having **at least one methyl group linked to the carbonyl carbon atom** (**methyl ketones**) are oxidised by sodium hypohalite to sodium salts of corresponding carboxylic acids having one carbon atom less than that of carbonyl compound. The methyl group is converted to haloform.

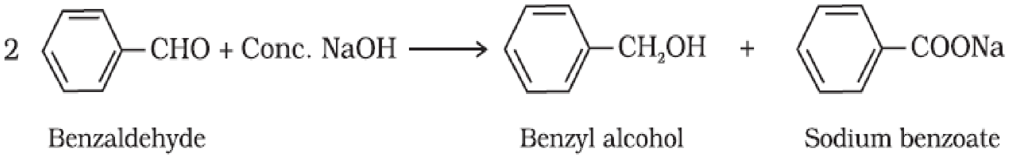
$$R\text{—}\overset{\overset{\displaystyle O}{\|}}{C}\text{—}CH_3 \xrightarrow{NaOX} R\text{—}\overset{\overset{\displaystyle O}{\|}}{C}\text{—}ONa \quad + \quad CHX_3 \quad (X{=}Cl,\ Br,\ I)$$

18. **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.**



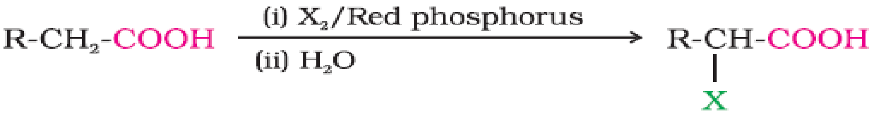
19. CannizzaroReaction :- Aldehydes which **do not have an α-hydrogen atom**, undergo self oxidation and reduction (disproportionation) reaction on treatment with concentrated alkali. In this reaction, one molecule of the aldehyde is reduced to alcohol while another is oxidised to carboxylic acid salt.

$$2\ HCHO \xrightarrow{\text{Conc. NaOH}} CH_3OH + HCOONa$$



20. **Hell-Volhard- Zelinsky reaction (HVZ reaction):-** Carboxylic acids having an α-hydrogen are halogenated at the α-position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give α-halocarboxylic acids. The reaction is known as **Hell-Volhard-Zelinsky reaction.**

$$CH_3 - COOH + Cl_2 \xrightarrow{\text{Red P}} ClCH_2 - COOH + HCl$$

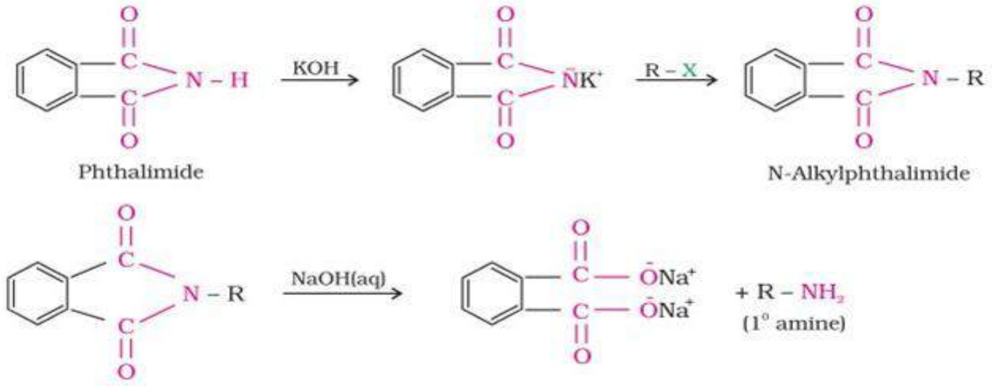


$$R\text{-}CH_2\text{-}COOH \xrightarrow[\text{(ii) } H_2O]{\text{(i) } X_2/\text{Red phosphorus}} R\text{-}\underset{\underset{X}{|}}{CH}\text{-}COOH$$

X = Cl, Br

α – Halocarboxylic acid

21. **Gabriel phthalimide synthesis:-** Phthalimide on treatment with ethanolic potassium hydroxide forms potassium salt of phthalimide which on heating with alkyl halide followed by alkaline hydrolysis produces the corresponding primary amine.



22. **Hoffmann Bromamide reaction :-** Reaction of primary amide with Br_2 in presence of KOH to form primary amines.
The amine so formed contains one carbon atom less than that present in the amide.

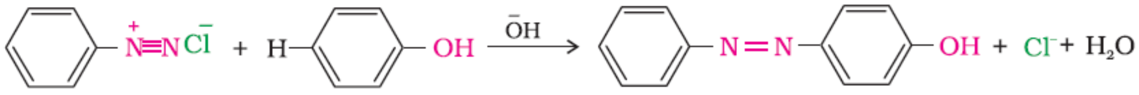
$$CH_3CONH_2 + Br_2 \xrightarrow{KOH} CH_3NH_2 + K_2CO_3 + 2KBr + 2H_2O$$

23. **Carbylamine reaction:-** Aliphatic and aromatic primary amines on heating with chloroform and ethanolic potassium hydroxide form isocyanides or carbylamines which are foul smelling substances.

$$R{-}NH_2 + CHCl_3 + 3KOH \xrightarrow{\text{Heat}} R{-}NC + 3KCl + 3H_2O$$

$$CH_3CH_2NH_2 + CHCl_3 + 3KOH \longrightarrow CH_3CH_2NC + 3KCl + 3H_20$$

24. **Coupling rection:-** Reaction of diazonium salt with phenols or aryl amines in basic medium to form azo dye called coupling reaction.



p-Hydroxyazobenzene (orange dye)

Distinction between organic compound:-

1. **Test for alcohol:-**

Lucas test: - Lucas reagent ($ZnCl_2$+conc.HCl)Used for distinction between 1^o, 2^o and 3^o alcohols.

Test	Primary	Secondary	Tertiary
Treat the given sample of O.C. with Lucas reagent ($ZnCl_2$+conc.HCl)	No reaction	Turbidity appears after some time.	Turbidity Appears immediately.

Iodoform Test: - This test is given by Ethanol and alcohol with 2-ol

Ex:- pentane 2-ol give iodoform test but not pentane- 3 ol .

2. **Test for PHENOL:-**

FeCl3 Test: Phenol + $FeCl_3$ $\longrightarrow$ Violet colour

Phenol and Ethanol/Methanol:-

Test	Ethanol	Phenol
1. Litmus Test :-	No effect on litmus	Blue litmus turns red
2. $FeCl_3$ Test: - O.C. +$FeCl_3$.	No reaction	Give violet colour.

3. **Test For Carbonyl Compounds: -**

2,4-DNP test : - used to distinguish between carbonyl compounds and others.(Carbonyl compounds + 2,4- DNP –orange red ppt.)

*** For distinguish between aldehydes and ketons:**

Tollens test :

Aldehyde + Tollens Reagent Ag mirror formed.
Ketone + Tollens Reagent No Reaction.

Fehlings test :

Aldehyde + Fehlings Reagent Red ppt
Ketone + Fehling Reagent No reation.

*** Distinction between aldehyde- aldehyde And Ketone-Ketone:**

Iodoform Test: Aldehyde and Ketons having CH_3 –CO– group give yellow ppt with I_2/NaOH. eg.

*** Distinction between aromatic aldehyde- aliphatic aldehyde:**

Aromatic aldehyde + Tollens Reagent Ag mirror formed
Aromatic aldehyde + Fehling Reagent No Reaction.

(A)Formaldehyde (Methanal) and Acetaldehyde (Ethanal):-

Test	Methanal/	Ethanal CH_3CHO
Iodoform Test:-	No Reaction	Yellow ppt of CHI_3formed.

(B) propanal and Acetaldehyde (Ethanal):-

Test	Propanal	Ethanal CH_3CHO
Iodoform Test:-	No Reaction	Yellow ppt of CHI_3formed.

(C) Acetaldehyde/ Formaldehyde and Acetone (Propanone):-

Test	Acetaldehyde	Acetone
Tolloen's Test	Silver mirror formed	No Reaction
Fehling Test	Red ppt	No Reaction

(D) Acetaldehyde and Benzaldehyde:-

Test	Acetaldehyde	Benzaldehyde
O.C.+Fehling's sol.	Red ppt	No Reaction
O.C.+I_2 + aq. NaOH	Yellow ppt	No Reaction

(E) Pentan-2-one and Pentan-3-one:-

Test	Pentan-2-one	Pentan-3-one
Iodoform test(I_2 +NaOH)	Yellow ppt	No Reaction

(F) Acetophenone and Benzophenone:-

Test	Acetophenone	Benzophenone
O.C. + I_2 and aq. NaOH	Yellow ppt	No Reaction
Tollens test	Silver mirror form	No Reaction

4. Test of carboxylic acid .

<u>$NaHCO_3$ Test</u>: Acid + $NaHCO_3$ → Brisk Effervescences

(A) Phenol and Benzoic acid /Acetic acid :-

Test	Phenol	Benzoic acid
$NaHCO_3$ test :- O.C.+ $NaHCO_3$ soln.	No reaction	Brisk effervescence
$FeCl_3$ Test	Voilet Colour	No Reaction

(B) Acetic acid and Formic acid:-

Test	Acetic acid	Formic acid
Treat with Tollen's reagent	No Reaction	Ag mirror formed

(C) Acetic acid and Ethyl ethanoate:-

Test	Acetic acid	Ethyl ethanoate
$NaHCO_3$ test :- O.C.+ $NaHCO_3$ soln	Brisk effervescence	No Reaction

5. Test for Amines:-

***Distinction of 1^o, 2^o and 3^o amines:** <u>Hinsberg Test</u>: Hinsberg Reagent (Benzene sulphonyl chloride $C_6H_5SO_2Cl$)

1^o amine + Hinsberg reagent → Product is soluble in NaOH.

2^o amine + Hinsberg reagent → Product is insoluble in NaOH

3^o amine + Hinsberg reagent → No reaction.

*** Distinction of 1^o amine with other amines:** <u>Carbylamine's Reaction</u>:

1^o amine (aliphatic or aromatic) + $CHCl_3$ and alc KOH → Offensive smell

. (2^o & 3^o amine do not give this test.)

*** Distinction of aromatic 1º amine with other amines:**

Azo Dye Test: Aniline + Benzene diazonium chloride → Orange Dye

(A) Methanamine/Benzylamine/ethylamine and Aniline:-

Test	**Methanamine/Benzylamine**	**Aniline**
Azo dye test	Dye not formed	Orange Dye formed

(C) Ethylamine and N-Ethylethanamine:-

Test	**Ethyleamine**	**N-Ethylethanamine**
O.C.+$CHCl_3$ +Alc KOH/ Carbylamine	Offensive smell	No Smell

(D) Aniline and N-methyl aniline:-

Test	**Aniline**	**N-Methyl aniline**
Carbylamine's Reaction :	Offensive Smell	No Reaction

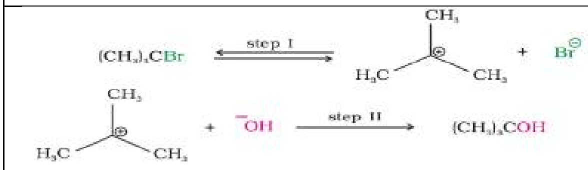
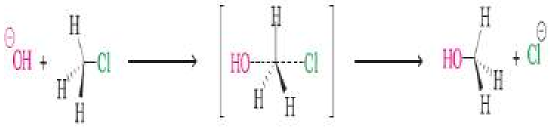
MECHANISM IN ORGANIC REACTIONS:-

Nucleophilic substitution Reaction:- it involves the replacement of an atom or group of atoms by a nucleophile (electron rich species)

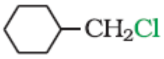
A-B + Nu → A-Nu +B

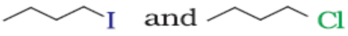
It is of two types:-

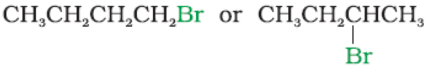
a) Unimolecular nucleophi lic substitution reaction (SN^1)
b) Bimolecular nucleophilic substitution reaction (SN^2)

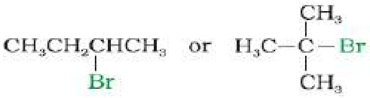
(SN^1)	(SN^2)
It is Unimolecular reaction	it is Bimolecular Reaction
It follow 1st Order kinetics	Follow 2nd Order kinetics
Takes place in two steps through carbocation as the intermediate.	Takes place in one step through transition state.
Rate of reaction :3° > 2° > 1° > $+CH_3$ Greater the stability of carbocation, faster will be the reaction	Rate :CH3 > 1° > 2° > 3° halides Less the steric hindrance in T.S., faster will be the reaction.
Occur with racemisation	Occur with inversion of configuration
	

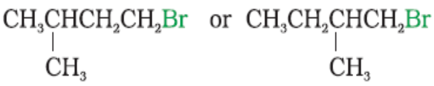
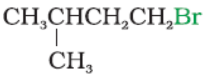
Q. Which will give SN^2 faster.

1.  Ans.  it is 1 degree halide

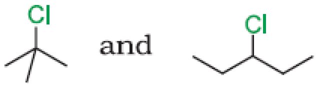
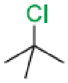
2.  Ans.  iodine better leaving group

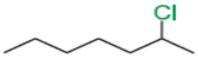
3. 
$CH_3CH_2CH_2CH_2Br$ or $CH_3CH_2\underset{Br}{CH}CH_3$
Ans. $CH_3CH_2CH_2CH_2Br$ It is 1 degree halide

4. 
$CH_3CH_2\underset{Br}{CH}CH_3$ or $H_3C-\overset{CH_3}{\underset{CH_3}{C}}-Br$
Ans. 
$CH_3CH_2\underset{Br}{CH}CH_3$
it is 2 degree halide give faster than 3 degree

5. 
$CH_3\underset{CH_3}{CH}CH_2CH_2Br$ or $CH_3CH_2\underset{CH_3}{CH}CH_2Br$
Ans. 
$CH_3\underset{CH_3}{CH}CH_2CH_2Br$
It is 1^0 with less hindered

Q. Which will give SN^1 faster.

1. (i)  Ans.  It is three degree form stable carbcation

2.  Ans.  2^0 stable carbcation .

Practice:-. Predict the order of reactivity of the following compounds in S N^1 and SN^2 reactions:

1. $C_6H_5CH_2Br$, $C_6H_5CH(C_6H_5)Br$, $C_6H_5CH(CH_3)Br$, $C_6H_5C(CH_3)(C_6H_5)Br$
2. $CH_3CH_2CH_2CH_2Br$, $(CH_3)_2CHCH_2Br$, $CH_3CH_2CH(Br)CH_3$, $(CH_3)_3CBr$
3. 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane
4. 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 3-Bromo-2-methylbutane

Reactivity toward nucleophilic addition reaction:-

1. Ketone < aldehyde
2. Aromatic aldehyde <aliphatic aldehyde

Q. Arrange in the order of increasing reactivity toward nucleophilic addition reaction.

(i) **Methanal, Ethanal, Propanal, Propanone, Butanone**.
Ans. Butanone < Propanone <Propanal <Ethanal <Methanal
(ii) **Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone**.
Ans. Acetophenone < *p*-Tolualdehyde < Benzaldehyde < *p*-Nitrobenzaldehyde.
Ketone < electron donating group <no effect < - R nitro group
iii) **Acetaldehyde, Acetone, Di-*tert*-butyl ketone, Methyl *tert*-butyl ketone**
Di- tert-butylketone < Methyl *tert*-butyl ketone <Acetone < Acetaldehyde
iv) **CH_3CHO ,CH_3COCH_3 ,$C_6H_5COCH_3$** Ans $C_6H_5COCH_3 < CH_3COCH_3 < CH_3CHO$

Trends in Physical properties :-
Solubility:-
1. Solubility decreases with increases in molecular mass or size of non polar hydrocarbon chain of organic compounds as it is hydrophobic.
2.Solubility increase with increase in branching as size of non polar part decreases.

1. $CH_3OH > CH_3CH_2OH > CH_3CH_2CH_2OH > C_6H_5OH$
2. $C_6H_5COOH < CH_3CH_2COOH < CH_3COOH < HCOOH$
3. $C_6H_5 –O- CH_3 < C_2H_5 -O- C_2H_5 < CH_3 –O-CH_3$
4. $C_6H_5NH_2 < CH_3CH_2CH_2NH_2 < CH_3CH_2NH_2 < CH_3NH_2$

BOILING POINT:-

1.Boiling point of organic compound increases with increase in no. of carbon atom OR molecular mass. As vanderwall force of attraction increases with increase in size.

2.Boiling point decreases with branching as surface area decreases with branching and hence force of attraction.

a) Boiling point of amines:- Primary > Secondary > Tertiary
b) Order of boiling point in different classes of organic compounds of nearly same molar mass.

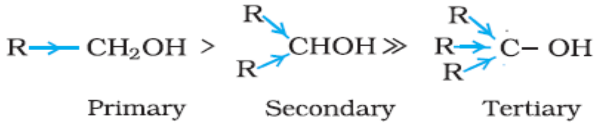
Hydrocarbon <Haloalkanes<Ether <Aldehyde <Amines <Alcohol <Aarboxylic acid

1. $CH_3Cl < CH_3CH_2Cl < CH_3CH_2CH_2Cl < CH_3CH_2CH_2CH_2Cl$ (B.P α no. of carbon)
2. $CH_3F < CH_3Cl < CH_3Br < CH_3I$ (B.P α size)
3. $CH_3Cl < CH_2Cl_2 < CHCl_3 < CCl_4$ (B.P α molar mass)
4. $(CH_3)_3C Cl < CH_3CH_2CH(Cl)CH_3 < CH_3CH_3CH_2CH_2CH_2Cl$
(B.P decreases with branching)
5. $CH_3OH < CH_3CH_2OH < CH_3CH_2CH_2OH < CH_3CH_2CH_2CH_2OH$
6. $(CH_3)_3C-OH < CH_3CH_2CH(OH)CH_3 < CH_3CH_3CH_2CH_2CH_2-OH$
7. $CH_3NH_2 < CH_3CH_2NH_2 < CH_3CH_2CH_2NH_2 < CH_3CH_2CH_2CH_2NH_2$
8., $(CH_3)_3N < CH_3CH_2 NHCH_3 < CH_3CH_2CH_2NH_2$
9. $CH_3CH_2CH_3 < CH_3CH_2Cl < CH_3 - O - CH_3 < CH_3CHO < CH_3CH_2OH < CH_3COOH$
hydrocarbon < halide < ether < aldehyde < hydrogen bond < form Dimer

Assignment:-
Q. arrange in order of increasing boiling point
1. Bromomethane, Bromoform, Chloromethane, Dibromomethane.
2. 1-Chloropropane, Isopropyl chloride, 1-Chlorobutane.
3 Pentan-1-ol, butan-1-ol, butan-2-ol, ethanol, propan-1-ol, methanol.
4. Pentan-1-ol, n-butane, pentanal, ethoxyethane. .
5. $CH_3CH_2CH_2CHO$, $CH_3CH_2CH_2CH_2OH$, $H_5C_2-O-C_2H_5$, $CH_3CH_2CH_2CH_2CH_3$
6. CH_3CHO, CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$
7. C_2H_5OH, $(CH_3)_2NH$, $C_2H_5NH_2$

Acidic Nature of alcohol, phenol and carboxylic acid:-

Trends in acidic nature;-
1. Alcohol < H_2O < Phenol < Carboxylic Acid
2.**In alcohol** :- with increase in NO. of +I group acidic nature decreases.



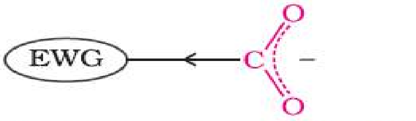
3. **In Phenol** if EWG (electron withdrawing group - NO_2, -CHO ,-CN, >C=O) attached than it stabilize phenoxide ion and increase acidic strength and EDG(electron donating group -NH_2 ,-OH ,-OCH_3 Alkyl) destabilize phenoxide ion and decrease acidic strength.

a) Propan-1-ol (alcohol) < 4-methylphenol (methyl is EDG) < phenol < 3-nitrophenol (nitro EWG) < 3,5-dinitrophenol (2 EWG) < 2,4, 6-trinitrophenol. (3EWG)

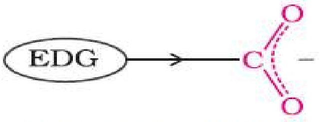
4. **Carboxylic acid :- a).** The conjugate base of carboxylic acid, a carboxylate ion, is stabilised by two equivalent resonance structures in which the negative charge is at the more electronegative oxygen atom so it is better proton donor than phenol.

b). Greater is Ka stronger is acid **or** Smaller the p*Ka*, the stronger the acid (the better it is as a proton donor). Strong acids have p*Ka* values < 1 **.**

c). Effect of substituents:-



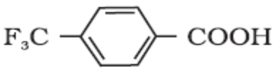
Electron withdrawing group (EWG) stabilises the carboxylate anion and strengthens the acid



Electron donating group (EDG) destabilises the carboxylate anion and weakens the acid

Arrange in order of increasing acidic strength :-

1. **$HCOOH$, CH_3COOH , CH_3CH_2COOH ,$ClCH_2COOH$**
   CH_3CH_2COOH **<** CH_3COOH (EDG methyl) <$HCOOH$ < $ClCH_2COOH$ (EWG Cl)
2. **FCH_2COOH , $ClCH_2COOH$, NO_2CH_2COOH ,$BrCH_2COOH$, $HCOOH$**
   $HCOOH$ < $BrCH_2COOH$ < $ClCH_2COOH$ < FCH_2COOH < NO_2CH_2COOH **acidic strength increases with strength of EWG**
3. **CF_3COOH , $ClCH_2COOH$, CCl_3COOH , $CHCl_2COOH$, $ClCH_2COOH$**
   $ClCH_2COOH$ < $CHCl_2COOH$ <CCl_3COOH < CF_3COOH (acidic strength increases with increase in no. of electron withdrawing group)
4. **C_6H_5COOH , CH_3COOH** **(** CH_3COOH < C_6H_5COOH **)**
5. **CH_3COOH , CH_2FCOOH** (CH_3COOH <CH_2FCOOH)
6. **CH_2FCOOH , $CH_2ClCOOH$** ($CH_2ClCOOH$ <CH_2FCOOH)
7. **$CH_2FCH_2CH_2COOH$, CH_3CHFCH_2COOH**
   ($CH_2FCH_2CH_2COOH$, CH_3CHFCH_2COOH **)**
8. 

   (

   EWG)

ASSIGNMENT:- arrange in increasing order of acid strength.

i)$CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $(CH_3)_2CHCOOH$, $CH_3CH_2CH_2COOH$
(ii) Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid

BASIC NATURE OF AMINES:-

1. Amines have an unshared pair of electrons on nitrogen atom due to which they behave as **Lewis base.**
2. larger the Kb or smaller the PKb stronger is base.
3. electron donating group increase basic strength and electron withdrawing group decrease basic strength.
4. Aromatic amines (weaker base as lone pair in Resonance) < Ammonia < Aliphatic amines (stronger due to +I alkyl group)
5.**In gas Phase $3^0 > 2^0 > 1^0$ amine**
6. In aqueous solution for **methyl amines $2^0 > 1^0 > 3^0$ for ethyl amines $2^0 > 3^0 > 1^0$**
(C2H5)$_2$NH > $(C_2H_5)_3N$ > $C_2H_5NH_2$ > NH_3 >Aniline
$(CH_3)_2NH$ > CH_3NH_2 > $(CH_3)_3N$ > NH_3 >Aniline

Arrange in increasing order of basic strength:-

1. $C_6H_5NH_2$, $C_2H_5NH_2$, $(C_2H_5)_2NH$, NH_3 ($C_6H_5NH_2$ < NH_3 < $C_2H_5NH_2$< $(C_2H_5)_2NH$)
. (aromatic <ammonia <aliphatic 1^0 <aliphatic2^0) 2.
$C_2H_5NH_2$, $C_6H_5NH_2$, NH_3, $C_6H_5CH_2NH_2$ and $(C_2H_5)_2NH$
3 . $C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, $C_6H_5NH_2$

4. CH_3NH_2, $(CH_3)_2NH$, $(CH_3)_3N$, $C_6H_5NH_2$, $C_6H_5CH_2NH_2$.
5. $C_6H_5NH_2$, $C_6H_5NHCH_3$, $C_6H_5CH_2NH_2$.
6. $C_6H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$ and CH_3NH_2

Solution :- 2. $C_6H_5NH_2 < NH_3 < C_6H_5CH_2NH_2 < C_2H_5NH_2 < (C_2H_5)_2NH$
3. $C_6H_5NH_2 < C_2H_5NH_2. < (C_2H_5)_3N < (C_2H_5)_2NH$
4. $C_6H_5NH_2 < C_6H_5CH_2NH_2 < (CH_3)_3N < CH_3NH_2 < (CH_3)_2NH$
5. $C_6H_5NH_2 < C_6H_5NHCH_3 < C_6H_5CH_2NH_2$ (aliphatic)
6. $C_6H_5NH_2 < C_6H_5N(CH_3)_2 < CH_3NH_2 < (C_2H_5)_2NH$

ORGANIC REAGENTS AND FUNCTION:-

REAGENT	FUNCTION	EXAMPLE
NaI /	Convert Alkyl halide to alkyl iodide	$R\text{-}Cl + NaI \longrightarrow R\text{-}I + NaCl$
AgF	Alkyl chloride to fluoride	$R\text{-}Cl + AgF \longrightarrow R\text{-}F + AgCl$
Aq. KOH/ Aq NaOH	Alkyl halide to Alcohol	$R\text{-}Cl + \text{aq. } KOH \longrightarrow R\text{-}OH$
Alc. KOH	Elimination (Alkyl halide to alkene)	$CH_3CH_2Cl + \text{alc. } KOH \longrightarrow CH_2{=}CH_2$
Na / dry ether	Alkyl halide to alkane	$2RX + Na \longrightarrow R \text{----} R$
$NaBH_4$	Reducing agent reduce Aldehyde to 1^0 alcohol Ketone to 2^0 alcohol	$RCHO \longrightarrow RCH_2OH$
$LiAlH_4$	Reducing agent Reduce acid to alcohol	$RCOOH \longrightarrow RCH_2OH$
Conc. H_2SO_4 a 443k	Convert alcohol to alkene	$CH_3CH_2OH \longrightarrow CH_2{=}CH_2$
Conc. H_2SO_4 a 413k	Convert alcohol to ether	$2CH_3CH_2OH \longrightarrow CH_3CH_2OCH_2CH_3$
Anhy. CrO_3	Oxidize alcohol to aldehyde	$RCH2OH \longrightarrow RCHO$
pyridinium chlorochromate (PCC)	Convert alcohol to aldehyde Not affecting double bond	$RCH{=}CH - CH_2\text{-} CH_2\text{-}OH \longrightarrow$ $RCH{=}CH - CH_2\text{-} CHO$
Cu / 573 K	Convert 1^0 alcohol to aldehyde Convert 2^0 alcohol to ketone 3^0 to alkene	

$KMnO_4$ / H^+ **OR** $K_2Cr_2O_7$ /H^+	Primary alcohol to carboxylic acid	$CH_3CH_2OH \longrightarrow CH_3COOH$
Pd +$BaSO_4$	Rosenmund	$RCOCl \longrightarrow RCHO$
$SnCl_2$ + HCl **OR** DIBAL -H	Convert nitrile to adehyde. DIBAL- H not affect the double bond	$R–CH2\text{-}\ \mathbf{CN} \longrightarrow R\text{-}CH_2\text{-}\mathbf{CHO}$
$[Ag(NH_3)_2]^+$ Tollens reagent	Oxidize aldehyde to acid (siler mirror form)	$R\text{-}\mathbf{CHO} \longrightarrow \mathbf{RCOOH\ +\ Ag}$
Fehling reagent	A . Aq copper sulphate B Na, K tartrate	$RCHO \longrightarrow RCOO^- + Cu_2O$
NaOH + I_2	Methyl ketone to acid having one carbon less and it does not affect double bond	$R\text{-}CO\text{-}\ \mathbf{CH_3} \longrightarrow R\text{-}CO\text{-}\mathbf{ONa\ +\ CHI_3}$
$SOCl_2$, PCl_5, PCl_3	Chlorinating agent Alcohol to alkyl halide Acid to alkanoyl halide	$CH_3CH_2OH \longrightarrow CH_3CH_2Cl$ $CH_3COOH \longrightarrow CH_3COCl$
CrO_2Cl_2 + H_3O^+	Converts toluene to benzaidehyde	Etard reaction
O_3/H_2O-Zn dust	Alkene to carbonyl	$CH_3\text{-}CH_2{=}CH_2 \longrightarrow CH_3CHO + HCHO$
Red P_4 + X_2	Acid to alpha halo acid	$R\text{-}\mathbf{CH_2}\text{-}COOH \longrightarrow R\text{-}\mathbf{CH(X)}–COOH$
$KMn0_4$ +KOH	Alkyl bezene to benzoic acid	
$NH_2\text{-}NH_2$ + KOH in ethylene glycol	Reduce Aldehyde /ketone to hydrocarbon	$CH_3CHO \longrightarrow CH_3\text{-}\ CH_3$ (Wolf- kishner)
Zn-Hg + Conc HCl	Reduce Aldehyde /ketone to hydrocarbon	$CH_3CHO \longrightarrow CH_3\text{-}\ CH_3$ (clemensen)
NaOH + CaO + Heat	Decarboxylation convert sodium salt of acid to alkane havin one carbon less	$R\text{-}CH_2\text{-}\mathbf{COONa} \longrightarrow$ $R–CH_2\text{-}\ \mathbf{H} + Na_2CO_3$

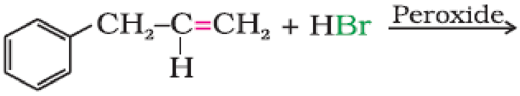
HNO_2 at 0-5⁰C		R-CH_2-**NH_2** → R-CH_2-**OH** **(Alipahatic amines) --- alcohol**
HNO_2 at 0-5⁰C		C6H5-**NH2** (Aniline) → C6H5-**N=N-Cl**

COMPLETE THE REACTION :- (Frequently asked in CBSE Examination)

1. $CH_3\,CH_2\,CH=CH_2$ **+ HBr** →

2. $CH_3\,CH_2\,CH=CH_2$ **+ HBr** $\xrightarrow{\text{peroxide}}$

3.



4. $CH_3\,CH_2\,CH_2 – Br$ + NaI →

5.

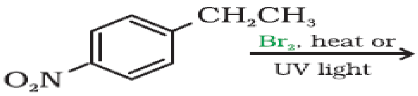
6.

7. $CH_3\,CH_2\,CH_2 – Br$ + AgF →

8. $CH_3\,CH_2\,CH_2 – OH$ +PCl5 →

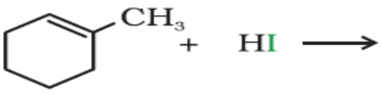
9. $CH_3\,CH_2\,CH_2 – Br$ + AgCN →

10.

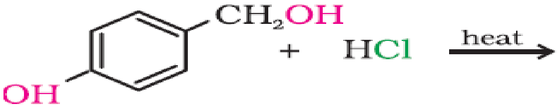


11. $CH_3\,CH_2\,CH_2\,Br$ + Na $\xrightarrow{\text{Dry ether}}$

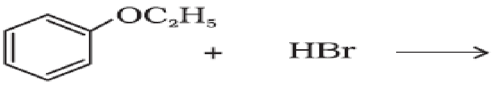
12.



13.



14.



15. $CH_3CH_2CH_2\text{-}O\text{-}CH_3$ + HI →

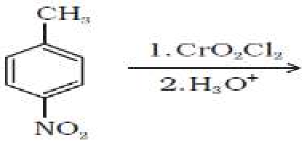
16. $(CH_3)_3\,C\text{- }O\text{- }CH_3$ + HI →

17. $CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2(Br)\,CH_3$ + alc. KOH →

18. $CH_3\text{-}CH_2\text{-}CH=CH\text{-}CH_2CN$ + DIBAL-H →

19. 2 HCHO + conc. NaOH →

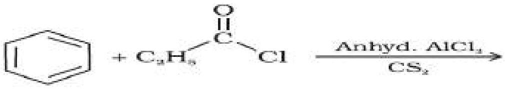
20.



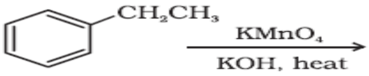
21.

$H_3C-C\equiv C-H \xrightarrow{Hg^{2+},\ H_2SO_4}$

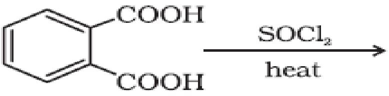
22.



23.



24.



25. $CH_3CHO + HCN \longrightarrow$

26. $CH_3COOH \xrightarrow{Br_2/\text{ red P}}$

27. $CH_3CHO + H_2NCONHNH_2 \longrightarrow$

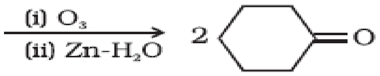
28. $C_6H_5CONH_2 \xrightarrow{H_3O^+/\text{heat}}$

29. $RCONH_2 \xrightarrow{LiAlH_4\ /H_2O}$

30. $CH_3COCH_3 \xrightarrow{\text{Zn-Hg/HCl}}$

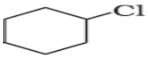
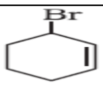
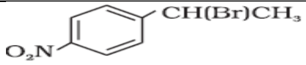
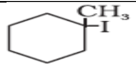
31. $CH_3COCl + H_2 \xrightarrow{Pd/BaSO_4}$

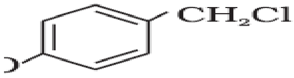
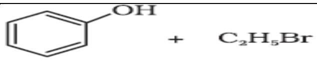
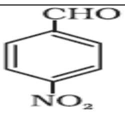
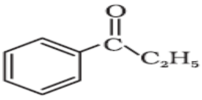
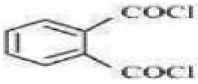
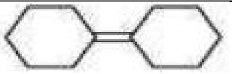
32.



33. $CH_3CH_2\text{-}NH_2 \xrightarrow{HNO_2/0^0\ C}$

Ans.

1. $CH_3\ CH_2\ CH_2(Br)CH_3$	2. $CH_3\ CH_2\ CH_2\text{-}CH_2$ **-Br**	3. 
4. $CH_3\ CH_2\ CH_2 - I$ Finkelstein reaction	5. 	6  Allylic substitution
7. $CH_3\ CH_2\ CH_2 - F$	8.$CH_3\ CH_2\ CH_2\text{- }Cl$	9. $CH_3\ CH_2\ CH_2\text{-}NC$
10. 	11 n- hexane	12 

13. 	14. 	15 $CH_3CH_2CH_2$-OH + CH_3 I Both 1^0 radical so SN^2 occur
16$(CH_3)_3$ C-I + CH_3 - OH	17.CH_3-CH_2-CH_2-CH= CH_2	18CH_3-CH_2-CH=CH-CH_2CHO
19. CH_3OH + HCOONa	20  Etard	21 CH_3COCH_3
22 	23 C_6H_5COOH	24 
25. $CH_3CH(CN)OH$	26. Cl- CH_2COOH	27. CH_3CH= NNH_2CONH_2
28. C_6H_5COOH	29. RCH_2NH_2	30. $CH_3CH_2CH_3$
31.CH_3CHO	32. 	33. CH_3CH_2-OH

Class XII
Chemistry
Ch. 2: Solutions

Important formulae & Concepts

1. Mass percentage of a component (w/w)
$$= \frac{\text{Mass of component in solution}}{\text{Toal mass of solution}} \times 100$$
Volume percentage of a component (v/v)
2. $$= \frac{\text{Volume of the component}}{\text{Total volume of solution}} \times 100$$
3. Mole fraction of a component (x) $= \frac{\text{Number of moles of the component}}{\text{Total number of moles of all components}}$
4. $$\text{Parts per million} = \frac{\text{Number of parts of component}}{\text{Total number of parts of all components of solution}} \times 10^6$$
5. $$\text{Molarity} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in litres}}$$
6. $$\text{Molality} = \frac{\text{Number of moles of solute}}{\text{Mass of solvent in kilograms}}$$
7. $$\text{Normality} = \frac{\text{Number of gram equivalent of solute}}{\text{Volume of solution in litres}}$$
8. $$\frac{p_1^o - p_1}{p_1^o} = x_2$$
9. $\Delta T = T_b - T_b^0$
$$\Delta T_b = \frac{K_b \times 1000 \times w_2}{M_2 \times w_1}$$
10. $\Delta T = T_f^0 - T_f$
$$\Delta T_f = \frac{K_f \times 1000 \times w_2}{M_2 \times w_1}$$

11. $\pi = CRT$
12. $M_2 = \frac{w_2 RT}{\pi V}$
13.
$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$
$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$
$$= \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Total number of moles of particles before association/dissociation}}$$
14. Inclusion of van't Hoff factor modified the equations for colligative properties as:
$$\frac{p_1^o - p_1}{p_1^o} = i.\frac{n_2}{n_1}$$
$$\Delta T_b = i.\frac{K_b \times 1000 \times w_2}{M_2 \times w_1}$$
$$\Delta T_f = i.\frac{K_f \times 1000 \times w_2}{M_2 \times w_1}$$
$$\pi = i.\frac{n_2 RT}{V}$$

15. According to Raoult's law for a solution of volatile liquids the partial vapour pressure of each component in the solution is directly proportional to its mole fraction.
$p_1 = p^o_1 x_1$; $p_2 = p^o_2 x_2$
Using Dalton's law of partial pressures the total pressure of solution is calculated.
$p_{total} = p_1^o + (p_2^o - p_1^o) x_2$

XII Chemistry

CHAPTER 3 - ELECTROCHEMISTRY

1. $E^{\ominus}_{cell} = E^{\ominus}_{cathode} - E^{\ominus}_{anode}$
2. $E = E^{\ominus} - \frac{0.059}{n} \log \frac{1}{[M^{n+}]}$ (At 298 K)
3. $E_{cell} = E^{\ominus}_{cell} - \frac{2.303RT}{nF} \log \frac{[\text{Anode ion}]}{[\text{Cathode ion}]}$
4. $E^{\ominus}_{cell} = \frac{0.059}{n} \log K_c$ (At 298 K)
5. $\Delta G^{\ominus} = -nFE^{\ominus}_{cell}$
6. $R = \rho \frac{l}{A} = \frac{1}{\kappa} \frac{l}{A}$
7. $\text{Conductance:} G = \frac{1}{R}$
8. Conductivity = Conductance × Cell constant
9. $\kappa = \frac{1}{\rho} = \frac{1}{R}(\frac{l}{A}) = G \frac{l}{A}$
10. Cell constant and is denoted by the symbol G^*
11. $\Lambda_m = \frac{\text{Specific conductance}}{\text{Molarity}} = \frac{\kappa}{C}$
12. $\Lambda_m = \frac{\kappa \times 1000}{C}$

    Remember:

    Unit of Λ_m in above formula is Scm^2mol^{-1}
13. $\alpha = \frac{\wedge_m^c}{\wedge_m^0}$
14. $K_a = \frac{c\alpha^2}{1-\alpha}$

15. Kohlrausch's Law of independent migration of ions:

If the limiting molar conductivity of the cations is denoted by λ_+^0 and that of the anions by λ_-^0 then the limiting molar conductivity of electrolyte is:

$$\wedge_m^0 = v_+\lambda_+^0 + v_-\lambda_-^0$$

Where v_+ and v_- are the number of cations and anions per formula of electrolyte.

16. Faraday constant: It is equal to 96487 C mol^{-1} or approximately equal to 96500 C mol^{-1}.

CHAPTER 4 - CHEMICAL KINETICS

1. Instantaneous rate = $\frac{dx}{dt}$, where dx is small change in conc. and dt is the smallest interval of time.

2. Average rate = $\frac{\Delta x}{\Delta t}$, where Δx is change in concentration and Δt is large interval of time.

3. $A + B \rightarrow C + D$

   Rate of disappearance of A = $\frac{-d[A]}{dt}$, where d[A] is small change in conc. of 'A' and dt is small interval of time

   Rate of disappearance of B = $\frac{-d[B]}{dt}$,

   Rate of appearance of C = $\frac{+d[C]}{dt}$

   Rate of appearance of D = $\frac{+d[D]}{dt}$

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

   Unit of rate of reaction = mol $L^{-1}s^{-1}$

4. Order of reaction:

   If rate law expression for a reaction is

   Rate = $k\,[A]^x\,[B]^y$

   Order of reaction = $x + y$

   Remember: Order cannot be determined with a given balanced chemical equation. It can be experimentally determined.

5. Integrated rate law for zero order reaction:

$R \rightarrow P$

$$\frac{dx}{dt} = k[R]^0$$

Unit of 'k' is mol $L^{-1}s^{-1}$

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

If we plot a graph between concentration of R vs time, the graph is a straight line with slope equal to -k and intercept is equal to $[R_o]$

6. Half- life reaction for a for zero order reaction:

$$t_{1/2} = \frac{[R_0]}{2k}$$

7. Rate law for 1st order reaction:

$R \rightarrow P$

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

where 'k' is rate constant, $[R_o]$ is initial molar conc., [R] is final molar conc. after time 't'

8. Half- Life for a first order reaction is:

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

9. Formula to calculate rate constant for first order gas phase reaction of the type

$A(g) \rightarrow B(g) + C(g)$

$$k = \frac{2.303}{t}\log\frac{p_i}{(2p_i - p_t)}$$

Where:

p_i is initial pressure of A

p_t is total pressure of gaseous mixture containing A , B, C

Remember:

$p_t = p_A + p_B + p_C$

10. Arrhenius equation:

$$k = A\,e^{-E_a/RT}$$

11. $$\log\frac{k_2}{k_1} = \frac{E_a}{2.303\,R}\left(\frac{T_2 - T_1}{T_1T_2}\right)$$

12. $$\text{Rate} = P\,Z_{AB}.e^{\frac{-E_a}{RT}}$$

Where:

Z_{AB} represents the collision frequency of reactants, A and B

P is called the probability or steric factor.

BLUE PRINT

CHEMISTRY CLASS – XII

CHAPTER'S NAME	VSA (1MARK)	SA (2 MARKS)	SA (3 MARKS)	CBQ (4 MARKS)	LA (5 MARKS)	TOTAL
SOLUTIONS	-	1(2)	-	-	1(5)	2(7)
ELECTROCHEMISTRY	1(1)	1(2)	2(6)	-	-	4(9)
CHEMICAL KINETICS	3(3)	-	-	1(4)	-	4(7)
d- & f- BLOCK ELEMENTS	2(2)	1(2)	1(3)	-	-	4(7)
COORDINATION COMPOUNDS	2(2)	-	-	-	1(5)	3(7)
HALOALKANES & HALOARENES	1(1)	1(2)	1(3)	-	-	3(6)
ALCOHOLS, PHENOLS & ETHERS	1(1)	-	-	-	1(5)	2(6)
ALDEHYDES, KETONES & CARBOXYLIC ACIDS	2(2)	-	2(6)	-	-	4(8)
AMINES	2(2)	-	-	1(4)	-	3(6)
BIOMOLECULES	2(2)	1(2)	1(3)	-	-	4(7)
TOTAL	**16(16)**	**5(10)**	**7(21)**	**2(8)**	**3(15)**	**33(70)**

PRACTICE - SET

Class: XII **Subject: CHEMISTRY**

M.M.: 70 **Time: 3.00 Hrs.**

General Instructions:

Read the following instructions carefully.

(a) There are 33 questions in this question paper with internal choice.
(b) SECTION A consists of 16 multiple choice questions carrying 1 mark each.
(c) SECTION B consists of 5 short answer questions carrying 2 marks each.
(d) SECTION C consists of 7 short answer questions carrying 3 marks each.
(e) SECTION D consists of 2 case-based questions carrying 4 marks each.
(f) SECTION E consists of 3 long answer questions carrying 5 marks each.
(g) All questions are compulsory.
(h) Use of log tables and calculators is not allowed.

SECTION – A

The following questions are multiple-choice questions with one correct answer. Each question carries 1 mark. There is no internal choice in this section.

1. Three isomeric amines (1^0, 2^0 & 3^0) react with Hinsberg's reagent followed by the addition of an alkali. Which of the following observations is incorrect?

   (a) Product of primary amine is soluble in alkali.

   (b) Product of secondary amine is insoluble in alkali.

   (c) Product of tertiary amine is soluble in alkali.

   (d) All observations are incorrect.

2. Which isomer of Pentane (C_5H_{12}) will give four isomeric monochlorides on photochemical chlorination?

   (a) n- pentane (b) 2-methyl butane

   (c) 2,2-dimethylpropane (d) both (b) & (c)

3. Match the properties given in column II with the metals in column I.

Column I	Column II
) (i) Th	(a) Lanthanoid shows +4 oxidation state
(ii) Ce	(b) Lanthanoid having $4f^{14},5d^1,6s^2$ configuration
(iii) Gd	(c) 1st element of Actinoid series

   (a) (i) – (b), (ii) – (c), (iii) – (a) (b) (i) – (a), (ii) – (b), (iii) – (c)

   (c) (i) – (c), (ii) – (a), (iii) – (b) (d) (i) – (a), (ii) – (c), (iii) – (b)

4. Correct order of pKa is:

   (a) Cresol< Nitrophenol< Phenol (b) Phenol< Cresol< Nitrophenol

   (c) Cresol< Phenol< Nitrophenol (d) Nitrophenol< Phenol< Cresol

5. Ethanoic acid is heated with P_2O_5 gives:

(a) CH_3COCH_3 (b) $CH_3COOCOCH_3$

(c) $CH_3COOC_2H_5$ (d) $C_2H_5COOCH_3$

6. A cobalt (III)-ammonia complex solution shows conductivity to 1:2 electrolyte and gives 2 moles of AgCl when reacts with $AgNO_3$ solution. The complex is:

(a) $[Co(NH_3)_5Cl]Cl_2$ (b) $[Co(NH_3)_4Cl_2]Cl$

(c) $[Co(NH_3)_6]Cl_3$ (d) $[Co(NH_3)_3Cl_3]$

7. Glycosidic linkage present in Amylopectin component of starch is:

(a) C_1-C_4 glycosidic linkage (b) C_2-C_4 glycosidic linkage

(c) C_1-C_6 glycosidic linkage (d) both (a) & (c)

8. Arrange the following ions in increasing order of paramagnetic property:

Cu^{2+}, Mn^{2+}, Cr^{3+}, Fe^{2+} (Cu= 29, Mn= 25, Cr= 24, Fe= 26)

(a) $Cu^{2+}<Mn^{2+}<Cr^{3+}<Fe^{2+}$ (b) $Cu^{2+}<Cr^{3+}<Fe^{2+}<Mn^{2+}$

(c) $Cu^{2+}<Fe^{2+}<Mn^{2+}<Cr^{3+}$ (d) $Cu^{2+}< Cr^{3+}<Mn^{2+}<Fe^{2+}$

9. Rate constant of a reaction, $2NH_3(g)$ -----------> $N_2(g) + 3H_2(g)$ is $2.5x10^{-4}$ $molL^{-1}s^{-1}$. Rate of formation of H_2 will be:

(a) $2.5x10^{-4}$ $molL^{-1}s^{-1}$ (b) $5.0x10^{-4}$ $molL^{-1}s^{-1}$

(c) $7.5x10^{-4}$ $molL^{-1}s^{-1}$ (d) $1.0x10^{-3}$ $molL^{-1}s^{-1}$

10. Kohlrausch gave the following relation for strong electrolytes- $\Lambda=\Lambda^0-A\sqrt{C}$. Which of the following equality holds true?

(a) $\Lambda=\Lambda^0$ as C---->$\sqrt{A}$ (b) $\Lambda=\Lambda^0$ as C------>0

(c) $\Lambda=\Lambda^0$ as C ---->∞ (d) $\Lambda=\Lambda^0$ as C---->1

11. Half life of a 1st order reaction is 30 seconds. Its rate constant will be:

(a) $2.31x10^{-2}$ s^{-1} (b) $2.32x10^{-2}$ mol L^{-1} s^{-1}

(b) $2.31x10^{-2}$ mol^{-1} L s^{-1} (d) 4.62x10-2 s^{-1}

12. Sucrose is dextrorotatory but its hydrolysis product is levorotatory. The process of change of specific rotation during hydrolysis of sucrose is called:

(a) Mutarotation (b) Inversion

(b) Specific rotation (d) Racemization

13. ASSERTION - The $t_{1/2}$ of a 1st order reaction is independent of the initial concentration of the reactant.

REASON – The 1st order reaction takes infinite time for completion.

(a) A & R both are correct statement and R is the correct explanation of A.

(b) A & R both are correct statement but R is not the correct explanation of A.

(c) A is correct statement but R is wrong statement.

(d) A is wrong statement but R is correct statement.

14. ASSERTION – Transition metals show the highest oxidation state with oxygen not with fluorine.

REASON – The ability of oxygen to form multiple bonds to metals.

(a) A & R both are correct statement and R is the correct explanation of A.

(b) A & R both are correct statement but R is not the correct explanation of A.

(c) A is correct statement but R is wrong statement.

(d) A is wrong statement but R is correct statement.

15. ASSERTION – All the aldehydes must have α-H atom take part in aldol condensation.

REASON – Aldehydes are less reactive towards nucleophilic addition reaction than that of ketones.

(a) A & R both are correct statement and R is the correct explanation of A.

(b) A & R both are correct statement but R is not the correct explanation of A.

(c) A is correct statement but R is wrong statement.

(d) A is wrong statement but R is correct statement.

16. ASSERTION – Protection of amino group by acetylation is not required to get monobromo aniline from aniline.

REASON – Acetylation decreases the activation effect of amino group.

(a) A & R both are correct statement and R is the correct explanation of A.

(b) A & R both are correct statement but R is not the correct explanation of A.

(c) A is correct statement but R is wrong statement.

(d) A is wrong statement but R is correct statement.

SECTION – B

This section contains 5 questions with internal choice in one question. The following questions are very short answer type and carry 2 marks each.

17. (a) Mole fraction of N_2 gas at 293 K increases or decreases in its solution when partial pressure of N_2 gas over the solution increases.

(Assume kH of N_2 at 293 K = 76.46 K bar)

(b)Chloroform (B.P. = 61.2 ^{0}C) and acetone (B.P. = 56 ^{0}C) are mixed to form an azeotropic mixture which has B.P. about 60 ^{0}C. Identify the type of deviation shown by the mixture and the type of azeotrope formed.

OR

The boiling point of solution increases when 1 mole of NaCl is added to 1 L of water while addition of 1 mole of CH_3OH to 1 L of water decreases its boiling point. Explain the above observations.

18. (a) What is the quantity of electricity in coulombs needed to reduce 1 mole of $Cr_2O_7^{2-}$ to Cr^{3+}?

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$ ----------> $2Cr^{3+}(aq) + 7H_2O(l)$

(b) How many seconds does it require to reduce 3 moles Fe^{3+} to Fe^{2+} with 2A of current? $3Fe^{3+}(aq) + 3e^-$ ---------> $3Fe^{2+}(aq)$,(1F = 96500C)

19. Complete and balance the following reactions:

(a) $2MnO_4^-(aq)$ $5C_2O_4^{2-}(aq)$ H+(aq) -------> ------- + -------- + ---------

(b) $MnO_4^-(aq) + 5Fe^{2+}(aq) + H^+(aq)$ ------> ------- + -------- + ---------

20. (a) Alkyl halides react with KCN to give alkyl cyanide as a major product. Why?

(b) Identify the major product of dehydrohalogenation of 2-chlorobutane.

21. Write chemical equations of Glucose which confirms the presence of - (i) straight chain of 6 C atoms in it & (ii) 5 -OH groups present in it.

SECTION – C

This section contains 7 questions with internal choice in one question. The following questions are short answer type and carry 3 marks each.

22. (a) write down the products of electrolysis of the following electrolyte using inert electrodes.

(i) Dilute H_2SO_4 (ii) Dilute $CuCl_2$

(b) How can we determine the Λ^0m of water? Write equation only.

23. (a) Calculate the E^0cell for the cell in which following reaction takes place-

$Cu(s) + 2Ag^+(aq)$ ----------> $Cu^{2+}(aq) + 2Ag(s)$, $Kc = 3.92 \times 10^{15}$

(b) What will be the value of E^0Ag^+/Ag, if E^0Cu^{2+}/Cu is +0.34V?

[E^0cell = 0.059/n log Kc, log $3.92 \times 10^{15} = 15.6$]

24. Account for the following:

(a) Cr^{2+} is reducing whereas Mn^{3+} is oxidizing although both are having $3d^4$ configuration.

(b) Transition metals exhibit variable oxidation states.

(c) Actinoid contraction from element to element is greater than lanthanoid contraction.

25. (a) Why is the dipole moment of chlorobenzene lower than that of cyclohexyl chloride?

(b) Which isomer of C_4H_9Cl gives SN^1reaction mechanism faster?

(c) As per the stereo chemical aspect of haloalkanes, racemization takes place in ------- mechanism while inversion of configuration takes place in -------- mechanism.

26. (a) Write the structure of 2, 4-DNP derivative of acetaldehyde.

(b) Benzoic acid does not give Friedel Craft reaction. Why?

(c) Give an example of Hell-Volhard-Zelinsky reaction.

OR

An organic compound $C_5H_{10}O$ does not give Tollen's test but form oxime with $H_2N\text{-}OH$ and give positive iodoform test. On vigorous oxidation it gives ethanoic and propanoic acid. Identify the organic compound and write the chemical reactions involved.

27. (a) What happens when methanal is heated with conc. NaOH? Write chemical equation only.

(b) Give a suitable chemical test to distinguish between the following pairs of compounds:

(i) Propanal and propanone (ii) Phenol and benzoic acid

28. (a) What is peptide linkage? Show the peptide linkage by taking an example of Ala-Gly dipeptide.

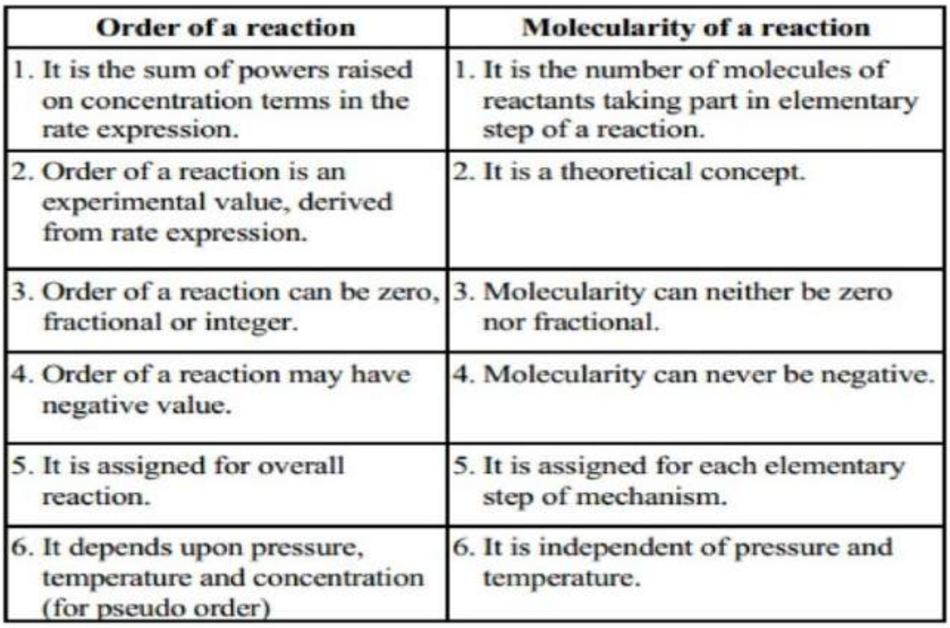
(b) What happens when a protein is subjected to heating?

(c) Name the nitrogenous base which is uncommon in DNA & RNA.

SECTION – D

The following questions are case-based questions. Each question has an internal choice and carries 4 (2+1+1) marks each. Read the passage and answer the questions that follow.

29. Here is the difference in between order and molecularity of a reaction.



Order of a reaction	Molecularity of a reaction
1. It is the sum of powers raised on concentration terms in the rate expression.	1. It is the number of molecules of reactants taking part in elementary step of a reaction.
2. Order of a reaction is an experimental value, derived from rate expression.	2. It is a theoretical concept.
3. Order of a reaction can be zero, fractional or integer.	3. Molecularity can neither be zero nor fractional.
4. Order of a reaction may have negative value.	4. Molecularity can never be negative.
5. It is assigned for overall reaction.	5. It is assigned for each elementary step of mechanism.
6. It depends upon pressure, temperature and concentration (for pseudo order)	6. It is independent of pressure and temperature.

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

OR

(a) The rate of a reaction quadruples when temperature changes from 293 K to 313 K. Calculate Ea of the reaction assuming that it does not change with temperature.
[Log 2 = 0.30, Log 4 = 0.60]

(b) For a reaction A + B ---------> Product, the rate law is given by, $r = K [A]^{1/2}. [B]$. What is the order of the reaction?

(c) For the reaction given in (b) question, how is the rate of the reaction being affected if the concentration of the reactant A is doubled?

30. Read the following hints regarding amines and diazonium salts carefully.

- All the amines (aliphatic and aromatic) are basic in nature due to having a pair of electrons over N atom.
- Various factors affect the basic strength of amines in aqueous medium as - +I effect of R radicals, Steric hinderance and stability of conjugated acid through H- bonds in water.
- Aniline gives diazonium salts when treated with $NaNO_2$ & HCl mixture at $0-5^0C$.
- The diazonium salt is very important compound to get a variety of aromatic compounds such as Phenol, benzene, halo arenes etc.
- An amide is when heated with Br_2 & KOH, an amine of one carbon less is formed. This reaction is named as Hoffmann- bromamide degradation.

(a) Explain why the 2^0 amines are highly basic in aqueous medium that its corresponding 1^0 and 3^0 amines?

OR

(a) Arrange the following amines in order as indicated:
CH_3NH_2, $(CH_3)_3N$, $(CH_3)_2NH$, $C_6H_5NH_2$
(i) Decreasing order of pKb &

(ii) Decreasing order of basic strength.

(b) Identify compound C in the reaction:

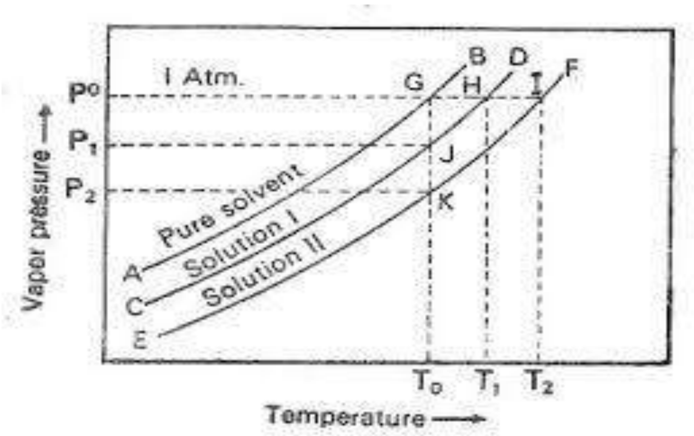
$$C_6H_5NO_2 \xrightarrow[\Delta]{Fe/HCl} A \xrightarrow[0\text{-}5^0C]{NaNO_2/HCl} B \xrightarrow{H_2O/H^+} C$$

(c) An amide when heated with Br_2 and KOH gives ethanamine. Identify the amide and give its IUPAC name.

SECTION – E

This section contains 3 questions with internal choice in the entire three questions. The following questions are long answer type and carry 5 marks each.

31. (a) We have two equimolar solutions Na_2SO_4 and Glucose. In the following figure, identify that which curve is represented for Na_2SO_4 and which curve for Glucose solution? Justify your answer.



(b) The osmotic pressure of a solution 1M glucose at 300 K is 0.75 atm. Calculate the osmotic pressure of the same solution, if its concentration becomes 0.5 M. Is there any way to change the osmotic pressure of the same solution without changing the concentration? If yes, then give reason. ($R=0.081$ L.atm. K^{-1}. Mol^{-1})

OR

(a) Find out the vant-Hoff factor for the following:

(i) NaCl solution, if it is 50% dissociated.

(ii) Phenol in benzene, if it is 50% associated.

(b) A 5% solution (by mass) of cane sugar (342g/mol) in water has F.P. 271K. Calculate the F.P. of 5% solution (by mass) of Glucose (180g/mol) in water, if F.P. of pure water is 273.15K.

32. (a) Following complexes of Ni show different complimentary colour to their solutions. Justify the observation.

(i) $[Ni(H_2O)_6]^{2+}$ = Green

(ii) $[Ni(H_2O)_4en]^{2+}$ = Pale blue

(iii) $[Ni(en)_3]^{2+}$ = Violet

(b) A metal ion M^{n+} has d^6 configuration combines with the 3 bidentate ligands. Assuming $\Delta o < P$-

(i) Draw the crystal field energy level diagram for the complex showing electronic configuration in t_2g and eg levels.

(ii) What is the hybrid state of M^{n+} ion in its complex?

(iii) What type of isomerism exhibited by the complex?

OR

(a) Complexes $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ have tetrahedral geometry but their magnetic behavior is different. Why?

(b) Using VBT, identify A, B, C, D, E & F in the following table.

S.No	Complex	Configuration of M^{n+}	Hybrid state of M^{n+}	Geometry of the complex	Magnetic behavior
1.	$[Ti(H_2O)_6]^{2+}$	**A**	d^2sp^3	Octahedral	**B**
2.	$[Co(NH_3)_6]^{3+}$	$3d^6$	**C**	D	Diamagnetic
3.	$[CoF_6]^{3-}$	$3d^6$	**E**	Octahedral	**F**

33. (a) Give reason:

(i) Bond angle (C-O-C) in ethers is slightly greater than the tetrahedral angle.

(ii) Alcohols have higher boiling point than that of aldehydes and ethers of comparable molecular mass.

(b) Identify the alkyl halide and sodium alkoxide used for the preparation of 2-methoxy-2-methylpropane.

(c) Convert:

(i) Chloroethane to n-butane.

(ii) Phenol to Methoxybenzene (Anisole)

OR

(a) Give mechanism involved in acid catalyzed hydration of ethene to ethanol.

(b) Phenol is more acidic than that of an alcohol. Why?

(c) What happens when ethanol is heated with-

(i) Conc. H_2SO_4 at 443K?

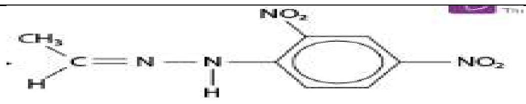
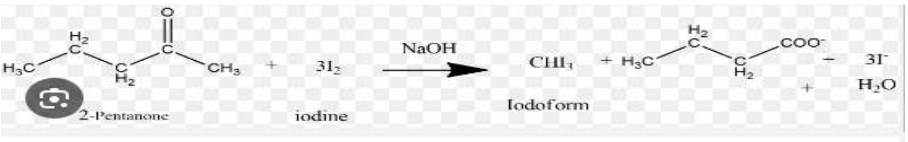
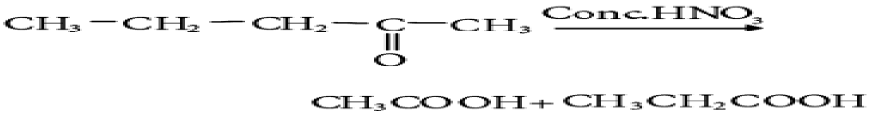
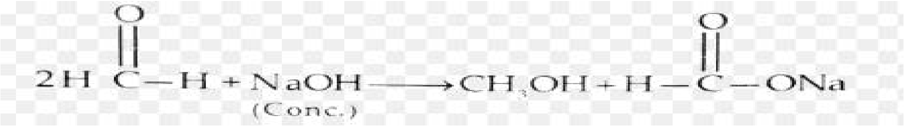
(ii) Conc. H_2SO_4 at 413K?

Class: XII **Subject: CHEMISTRY**

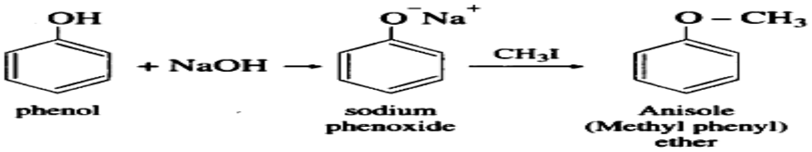
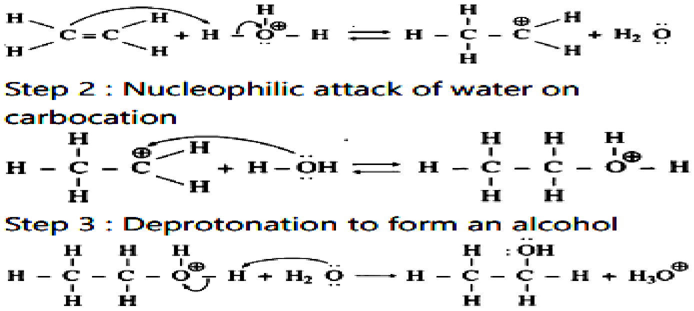
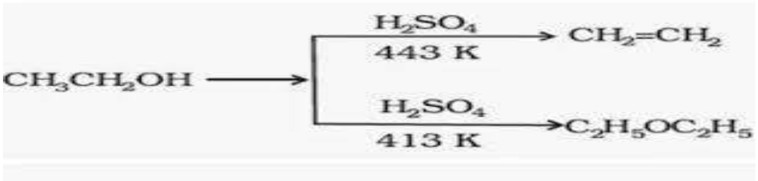
MARKING SCHEME PRACTICE SET

Q.No	EXPECTED ANSWER	MARKS
	SECTION - A	
1.	(c) Product of tertiary amine is soluble in alkali.	1
2.	(b) 2-methylbutane	1
3.	(c) (i) – (c), (ii) – (a), (iii) – (b)	1
4.	(d) Nitrophenol< Phenol< Cresol	1
5.	(b) $CH_3COOCOCH_3$	1
6.	(a)$[Co(NH_3)_5Cl]Cl_{2(a)}$	1
7.	(d) both (a) & (c)	1
8.	(b) $Cu^{2+}<Cr^{3+}<Fe^{2+}<Mn^{2+}$	1
9.	(c) $7.5x10^{-4}$ $molL^{-1}s^{-1}$	1
10.	(b) $\Lambda=\Lambda^0$ as C------>0	1
11.	(a) $2.31x10^{-2}$ s^{-1}	1
12.	(b) Inversion	1
13.	(b) A & R both are correct statement but R is not the correct explanation of A.	1
14.	(e) A & R both are correct statement and R is the correct explanation of A.	1
15.	(c) A is correct statement but R is wrong statement.	1
16.	(d) A is wrong statement but R is correct statement.	1
	SECTION – B	
17.	(a) Mole fraction of N_2 gas in the solution increases. (b) Negative deviation is shown by the mixture and maximum boiling azeotrope is formed. OR Boiling point of NaCl solution increases because NaCl is a non-volatile solute and decreases the vapour pressure of the solution while boiling point of CH_3OH solution increases because CH_3OH & water intermolecular interaction decreases and hence vapour pressure increases.	1+1
18.	(a) = 6 x 96500 C = 5,79,000 C	1+1

	(b) t(s) = 3 x 96500 / 2 = 1,44,750 seconds	
19.	(a)$2MnO_4^-(aq)$ $5C_2O_4^{2-}(aq) + 16H+(aq)$ -------> $2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$ (b)$MnO_4^-(aq) + 5Fe^{2+}(aq) + 8H^+(aq)$ ------> $Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(l)$	1+1
20.	(a) KCN is a strong electrolyte and gives CN- ion and C-C bond is stronger than C-N bond. (b) But-2-ene is the major product of dehydrohalogenation of 2-chlorobutane.	1+1
21.	Prolonged heating (i)$C_6H_{12}O_6$ ------------------------> C_6H_{14} (n-hexane) (ii)$C_6H_{12}O_6 + 5(CH_3CO)_2O$ --------> $CHO(CHOCOCH_3)_4CH_2OCOCH_3$ Glucose pentaacetate	1+1
SECTION – C		
22.	(a) (i) at anode O_2 gas is released and at cathode H_2 gas is released. (ii) at anode Cl_2 gas is released and at cathode Cu is deposited. (f) $\Lambda^0m\ (H_2O) = \Lambda^0m\ (HCl) + \Lambda^0m(NaOH) - \Lambda^0m\ (NaCl)$	2+1
23.	(a) E^0cell = 0.059/2 log 3.92×10^{15} = 0.059 x 15.60/2 = 0.46 V (b) E^0cell = E^0 Cathode – E^0Anode 0.46 V = E^0 Cathode – 0.34 V E^0 Cathode = 0.80 V	2+1
24.	(a) Cr^{2+} oxidizes to gain stable t_2g^3 electronic configuration while Mn^{3+} reduces to gain $3d^5$ stable electronic configuration. (b) Variable oxidation state and greater surface area. (c) Greater effective nuclear charge due to very poor shielding effect of 5f orbitals in actinoids	1+1+1
25.	(a) less difference in electronegativities of sp^2 hybrid C-Cl bond in chlorobenzene. (b) 2-methyl-2-chloropropane being a tertiary halide gives SN^1 reaction faster. (c) SN^1 & SN^2	1+1+1
26.	(a)	1+1+1

	 (b) –COOH group is deactivating group and form compound with Anhy, AlCl$_3$. (c) $CH_3CH_2COOH \xrightarrow{Cl_2/red\ P} CH_3CH(Cl)COOH$ OR The organic compound is 2-pentanone $CH_3COCH_2CH_2CH_3$   $CH_3-CH_2-CH_2-\underset{\underset{O}{\Vert}}{C}-CH_3 \xrightarrow{Conc.HNO_3} CH_3COOH + CH_3CH_2COOH$	
27.	(a) When methanal is heated with Conc. NaOH, self-oxidation and reduction of methanal takes place and methanol and sodium methanoate are formed. (Cannizzaro reaction).  $2H-\overset{\overset{O}{\Vert}}{C}-H + \underset{(Conc.)}{NaOH} \longrightarrow CH_3OH + H-\overset{\overset{O}{\Vert}}{C}-ONa$ (b) (i) Propanal gives Tollen’s test whereas propanone does not or any other test. (ii) Phenol gives red coloration with neutral FeCl$_3$ whereas benzoic acid does not or any other test.	1+2
28.	(a) An amide linkage (-NH---CO-) between two amino acids is called a peptide linkage. HOOC-CH(CH$_3$) – [NH------CO] – CH$_2$ – NH$_2$ OR H$_2$N – CH (CH$_3$) – CO ------ NH – CH$_2$ – COOH (b) Denaturation of protein takes place. (c) Cytosine in DNA & Uracil in RNA.	1+1+1
	SECTION – D	

29.	(a) t90 = 2.303/k . log 100/10, t90 = 2.303/k t99 = 2.303/k . log 100/1, t99 = 2.303/k . 2 t99 = t90 x 2 (proved) OR (a) Log k2/k1 = Ea/2.303R. [T2-T1/ T1. T2] Log 4 = Ea / 2.303R. [308-298 / 298 x 308] Ea = 0.60 x 2.303 x 8.314 x 298 x 308 / 20 Ea = 52.86 kj/mol (b) Order of reaction = 1.5 (c) Rate of reaction becomes 1.414 times.	2+1+1
30.	(a) (i) $C_6H_5NH_2 > (CH_3)_3N > CH_3NH_2 > (CH_3)_2NH$ (ii) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > C_6H_5NH_2$ OR (a) In secondary amines - +I effect is greater than 1^0 amines, steric hindrance is less than 3^0 amines and its conjugate acid is more stable than 3^0 amines i.e. the cumulative effect of the three factors favour to increase the basic strength of 2^0 amines than 1^0 & 3^0 amines. (b) C is Phenol. (c) The amine is Propanamide $CH_3CH_2CONH_2$	2+1+1
SECTION – E		
31.	(a) Solution II curve is represented by Na_2SO_4 because it is ionised to give 2 Na^+ & 1 SO_4^- ions and therefore the solution of Na_2SO_4 has greater B.P. Solution I curve is represented by Glucose solution because it is neither associated nor dissociated in the solution and has lesser B.P. (b) π = CRT 0.75 = 1 x 0.081 x 300K & π2 = 0.5 x 0.081 x 300K comparing both the equation we get- π2 = 0.375 atm By changing temperature osmotic pressure of the same solution may be changed because osmotic pressure is proportional to temperature also. OR (a) i= no of particles after association or dissociation / no of particles taken (i) i = 150/100 = 1.5 (ii) i = 75/100 = 0.75 (b) $\Delta T_f = K_f$ x W_B x 1000/ M_B x W_A 2.71= K_f x 5 x 1000/ 342 x 95	2+3

	$\Delta T_{f\,2} = K_f \times 5 \times 1000/ 180 \times 95$ Compare both the equation we get $\Delta T_f = 4.09$K therefore F.P. of the glucose solution will be = 273.15 – 4.09 = 269.06K	
32.	(a) As we can see that all the three complexes are having different ligands and strength of different ligand is different so the CFSE in all the three complexes is different therefore the complexes absorb different wavelength for d-d transition and exhibit different complimentary colour. (b) (i) Draw the crystal field splitting diagram and fill the electrons in t_2g & eg level as t_2g^4, eg^2. (ii) sp^3d^2 hybridisation. (iii) Optical isomerism. OR (a) $[NiCl_4]^{2-}$ and $[Ni(CO)_4]$ both are tetrahedral but due to presence of two unpaired electrons in $[NiCl_4]^{2-}$ complex it is paramagnetic and due to absence of unpaired electrons $[Ni(CO)_4]$ is diamagnetic. Show with the electronic configurations. (b) A = $3d^1$, B = paramagnetic, C = d^2sp^3, D = octahedral, E = sp^3d^2, F = paramagnetic	2+3
33.	(a) (i) due to greater repulsion between 2 alkyl radicals. (ii) due to intermolecular H- bonding between the molecules of alcohols. (b) Methyl chloride and sodium tertiary butoxide (c) (i) $2CH_3CH_2\text{-}Cl + 2Na \text{----------->} CH_3CH_2CH_2CH_3$ (Wurtz reaction) (ii)  OR (a)  (b) Due to resonance effect – (i) phenol gives H^+ ion easily & (ii) phenoxide ion is more stable. (c) (i) & (ii) 	2+1+2

CBSE Question Paper 56/2/1 2024-25

Set-1

SECTION-A 16 x 1 = 16

Question No. 1 to 16 are Multiple Choice type questions carrying 1 mark each.

1. The charge required for the reduction of 1 mol of MnO^{-}_4, to MnO_2, is

(A) 1 F (B) 3 F

(C) 5 F (D) 6

2. Which among the following is a false statement?

(A) Rate of zero order reaction is independent of initial concentration of reactant.

(B) Half-life of a zero order reaction is inversely proportional to the rate constant.

(C) Molecularity of a reaction may be zero.

(D) For a first order reaction, $t_{1/2}= 0.693 / k$

3. The number of molecules that react with each other in an elementary reaction is a measure of the:

(A) activation energy of the reaction (C) molecularity of the reaction

(B) stoichiometry of the reaction (D) order of the reaction

4. The element having $[Ar]3d^{10}4s^1$ electronic configuration is

(A) Cu (C) Cr

(B) Zn (D) Mn

5. The complex ions $[Co(NH_3)_5(NO_2)]^{2+}$ and $[Co(NH_3)_5(ONO)]^{2+}$ are called

(A) Ionization isomers (B) Linkage isomers

(C) Co-ordination isomers (D) Geometrical isomers

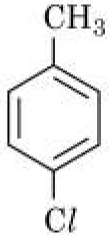
6. The diamagnetic species is:

(A) $[Ni(CN)_4]^{2-}$ (C) $[Fe(CN)_6]^{3-}$

(B) $[NiCl_4]^{2-}$ (D) $[CoF_6]^{3-}$

[At. No. Co= 27 ,Fe = 26 ,Ni = 28]

7. Which is the correct IUPAC name for



(A) Methylchlorobenzene
(C) 1-Chloro-4-Methylbenzene
(B) Toluene
(D) 1-Methyl-4-Chlorobenzene

8. What will be formed after oxidation reaction of secondary alcohol with chromic anhydride (CrO_3)?

(A) Aldehyde
(B) Ketone
(C) Carboxylic acid
(D) Ester

9. The conversion of phenol to salicylic acid can be accomplished by

(A) Reimer-Tiemann reaction
(C) Kolbe reaction
(B) Friedel-Crafts reaction
(D) Coupling reaction

10. Which of the following is/are examples of denaturation of protein?

(A) Coagulation of egg white
(C) Clotting of blood
(B) Curdling of milk
(D) Both (A) and (B)

11. Nucleotides are joined together by

(A) Glycosidic linkage
(C) Hydrogen bonding
(B) Peptide linkage
(D) Phosphodiester linkage

12. Scurvy is caused due to deficiency of

(A) Vitamin B1
(C) Ascorbic acid

(B) Vitamin B2
(D) Glutamic acid

For question number **13** to **16**, two statements are given-- one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

13. **Assertion (A)** In a first order reaction, if the concentration of the reactant is doubled, its half-life is also doubled.

Reason (R): The half-life of a reaction does not depend upon the initial concentration of the reactant in a first order reaction.

14. **Assertion (A):** Cu cannot liberate H_2 on reaction with dilute mineral acids.

Reason (R): Cu has positive electrode potential.

15. **Assertion (A):** Aromatic primary amines cannot be prepared by Gabriel Phthalimide synthesis.

Reason (R) : Aryl halides do not undergo nucleophilic substitution reaction with the anion formed by phthalimide.

16. **Assertion (A):** Vitamin D cannot be stored in our body.

Reason (R): Vitamin D is fat soluble vitamin and is not excreted from the body in urine.

SECTION-B

17. (A) The rate constant for a zero order reaction A → P is 0.0030 mol L^{-1} s^{-1} How long will it take for the initial concentration of A to fall from 0.10 M to 0.075 M? **2**

OR

(B) The decomposition of NH_3, on platinum surface is zero order reaction. What are the rates of production of N_2, and H_2 if $k = 2.5 \times 10^{-4}$ mol L^{-1} s^{-1} ?

18. Define the following terms: **2x1**

(a) Pseudo first order reaction

(b) Half-life period of reaction ($t_{1/2}$)

19. Examine the following observations: **2x1**

(a) Transition elements generally form coloured compounds.

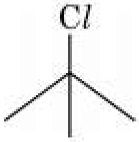
(b) Zinc is not regarded as a transition element.

20. Name the following coordination compounds according to IUPAC norms: **2x1**

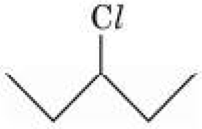
(a) $[Co(NH_3)_4(H_2O)Cl]Cl_2$

(b) $[CrCl_2 (en)_2] Cl$

21. (a) In the following pair of halogen compounds, which compound undergoes S_N1 reaction faster and why?



and



(b) Arrange the following compounds in increasing order of their reactivity towards S_N2 displacement:
2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane.

SECTION-C

22. At 25 °C the saturated vapour pressure of water is 24 mm Hg. Find the saturated vapour pressure of a 5% aqueous solution of urea at the same temperature. (Molar mass of urea = 60 g mol^{-1})

23. The electrical resistance of a column of 0.05 M NaOH solution of area 0.8 cm^2 and length 40 cm is 5×10^3 ohm. Calculate its resistivity, conductivity and molar conductivity.

24. Complete and balance the following chemical equations: 3x1

(a) $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow$

(b) $KMnO_4 \xrightarrow[513\ K]{Heat}$

(c) $Cr_2O_7^{2-} + H_2S + H^+ \longrightarrow$

25. Using valence bond theory, explain the hybridization and magnetic character of the following: **2x1 $^{1/2}$=3**

(a) $[Co(NH_3)_6]^{3+}$

(b) $[Ni(CO)_4]$

[At. no.: Co=27, Ni = 28]

26. (a) Define the following: **2+1=3**

(i) Enantiomers
(ii) Racemic mixture

(b) Why is chlorobenzene resistant to nucleophilic substitution reaction?
27. (A) Explain the following reactions and write chemical equation involved: **3x1=3**

(a) Wolff-Kishner reduction
(b) Etard reaction
(c) Cannizzaro reaction

OR

(B) Write the structures of A, B and C in the following sequence of reactions: **2x1=3**

(a) $CH_3COOH \xrightarrow{SOCl_2} A \xrightarrow{H_2,\ Pd\text{-}BaSO_4} B \xrightarrow{H_2N\text{–}NH_2} C$

(b) $CH_3CN \xrightarrow[2.\ H_2O]{1.(DIBAL\text{–}H)} A \xrightarrow{Dil.\ NaOH} B \xrightarrow{\Delta} C$

28. Define the following terms: **3x1=3**

(a) Glycosidic linkage
(b) Invert sugar
(c) Oligosaccharides

SECTION-D

29. The spontaneous flow of the solvent through a semipermeable membrane from a pure solvent to a solution or from a dilute solution to a concentrated solution is called osmosis. The phenomenon of osmosis can be demonstrated by taking two eggs of the same size. In an egg, the membrane below the shell and around the egg material is semipermeable. The outer hard shell can be removed by putting the egg in dilute hydrochloric acid. After removing the hard shell, one egg is placed in distilled water and the other in a saturated salt solution. After some time, the egg placed in distilled water swells-up while the egg placed in salt solution shrinks. The external pressure applied to stop the osmosis is termed as osmotic pressure (a colligative property). Reverse osmosis takes place when the applied external pressure becomes larger than the osmotic pressure.

(a) Define reverse osmosis. Name one SPM which can be used in the process of reverse osmosis. **2**

(b) (i) What do you expect to happen when red blood corpuscles (RBC's) are placed in 0.5% NaCl solution? **1**

OR

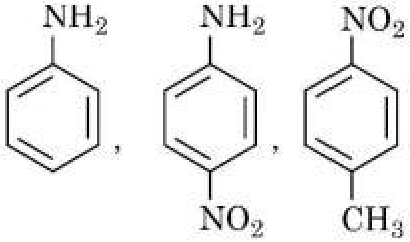
(b) (ii) Which one of the following will have higher osmotic pressure in 1 M KCl or 1 M urea solution. Justify your answer. **1**

(c) Why osmotic pressure is a colligative property?

30. Amines have a lone pair of electrons on nitrogen atom due to which they behave as Lewis base. Greater the value of K_b or smaller the value of pK_b stronger is the base. Amines are more basic than alcohols, ethers, esters, etc. The basic character of aliphatic amines should increase with the increase of alkyl substitution. But it does not occur in a regular manner as a secondary aliphatic

amine is unexpectedly more basic than a tertiary amine in aqueous solutions. Aromatic amines are weaker bases than ammonia and aliphatic amines. Electron releasing groups such as
–CH_3, -OCH_3, -NH_2, etc., increase the basicity while electron-withdrawing substituents such as -NO_2, CN, halogens etc., decrease the basicity of amines. The effect of these substitute is more at p^- than at m^- position.

(a) Arrange the following in the increasing order of their basic character.
Give reason:



(b) Why pK_b of aniline is more than that of methylamine?
(c) (i) Arrange the following in the increasing order of their basic character
in an aqueous solution: **1**

$$(CH_3)_3N, (CH_3)_2NH, NH_3, CH_3NH_2$$

OR

(c) (ii) Why ammonolysis of alkyl halides is not a good method to prepare pure amines ? **1**

SECTION-E

31. (A) (a) Give IUPAC name of CH_3-CH=CH-CHO.

(b) Give a simple chemical test to distinguish between propanal and propanone.

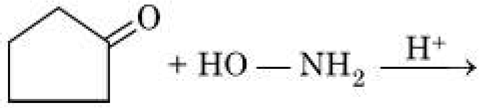
(c) How will you convert the following: 3

(i) Toluene to benzoic acid
(ii) Ethanol to propan-2-ol
(iii) Propanal to 2-hydroxy propanoic acid

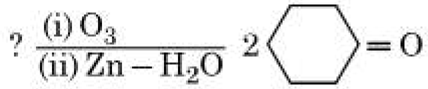
OR

31. (B) Complete each synthesis by giving missing starting material, reagent or products: **5x1=5**

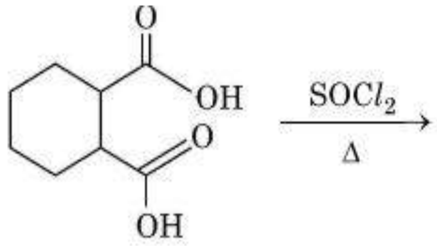
(a)



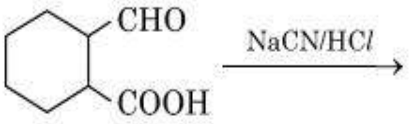
(b)



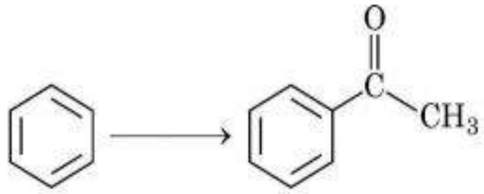
(c)



(d)



(e)



32. (A) (a)

Calculate the standard Gibbs energy ($\Delta_r G^\circ$) of the following reaction at 25 °C : **3 + 2**

$Au(s) + Ca^{2+}(1M) \rightarrow Au^{3+}(1M) + Ca(s)$

$E^\circ_{Au^{3+}/Au} = +1.5\ V$, $E^\circ_{Ca^{2+}/Ca} = -2.87\ V$

Predict whether the reaction will be spontaneous or not at 25 °C.

[1 F = 96500 C mol^{-1}]

(b) Tarnished silver contains Ag_2S. Can this tarnish be removed by placing tarnished silverware in an aluminium pan containing an inert electrolytic solution such as NaCl? The standard electrode potential for half reaction:

$Ag_2S(s) + 2e^- \longrightarrow 2Ag(s) + S^{2-}$ is -0.71 V and for

$Al^{3+} + 3e^- \longrightarrow 2Al(s)$ is -1.66 V

OR

32. (B) (a) Define the following: **2+3**

(i) Cell potential

(ii) Fuel cell

(b) Calculate emf of the following cell at 25 °C:

$$Zn(s)\,|\,Zn^{2+}_{(0.1M)}\,||\,Cd^{2+}_{(0.01M)}\,|\,Cd(s)$$

$$\text{Given: } E^{o}_{Cd^{2+}/Cd} = -0.40\ V$$

$$E^{o}_{Zn^{2+}/Zn} = -0.76\ V$$

$$[\log 10 = 1]$$

33. (A) An organic compound 'A', molecular formula C_2H_6O oxidises with CrO_3 to form a compound 'B'. Compound 'B' on warming with iodine and aqueous solution of NaOH gives a yellow precipitate of compound 'C'. When compound 'A' is heated with conc. H_2SO_4 at 413 K gives a compound 'D', which on reaction with excess HI gives compound 'E'. Identify compounds 'A', 'B', 'C', 'D' and 'E' and write chemical equations involved. **5**

OR

33. (B) (a) Write chemical equations of the following reactions: **3+1+1=5**

(i) Phenol is treated with conc. HNO_3

(ii) Propene is treated with B_2H_4 followed by oxidation by H_2O_2/OH^-.

(iii) Sodium t-butoxide is treated with CH_3Cl.

(b) Give a simple chemical test to distinguish between butan-1-ol and butan-2-ol.

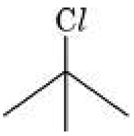
(c) Arrange the following in increasing order of acid strength: phenol, ethanol, water

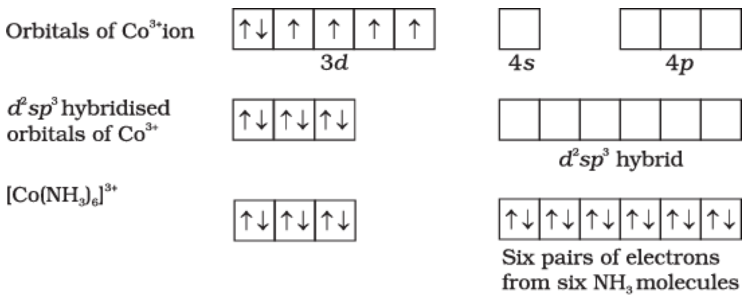
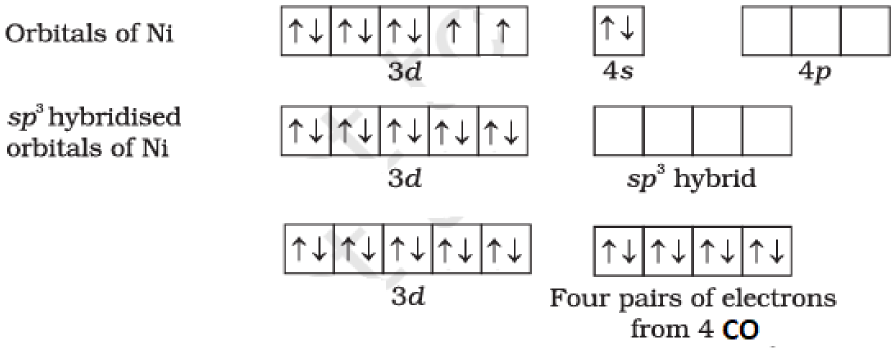
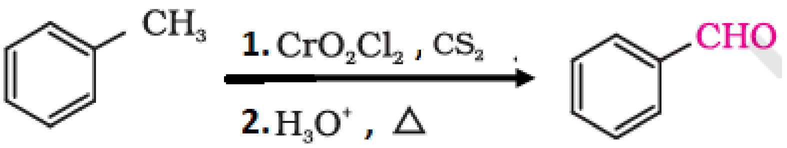
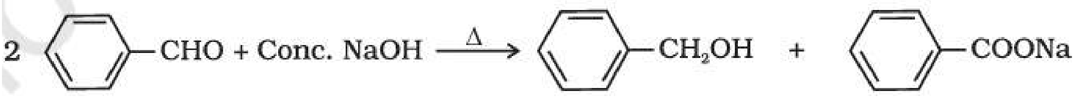
MARKING SCHEME 2024-25

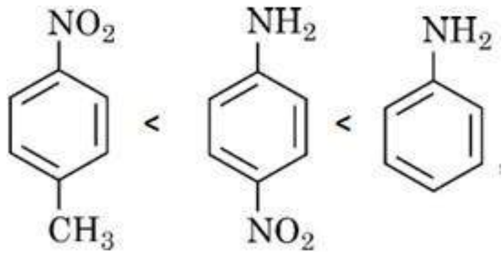
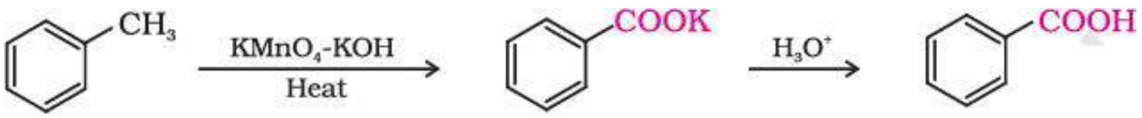
CHEMISTRY (Theory)- 043

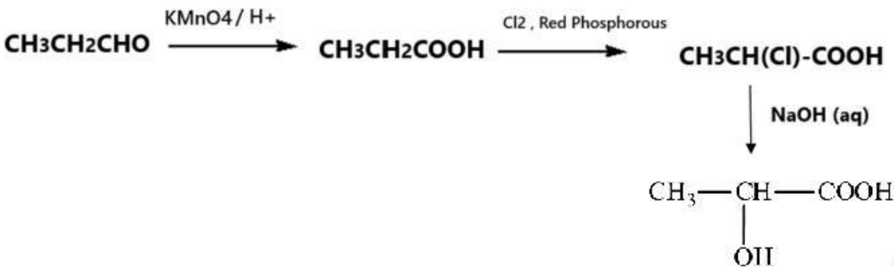
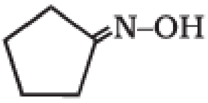
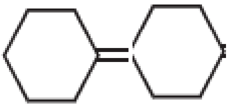
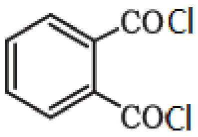
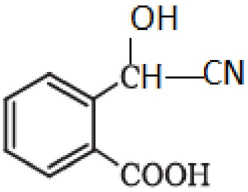
QP CODE 56/2/1 MM: 70

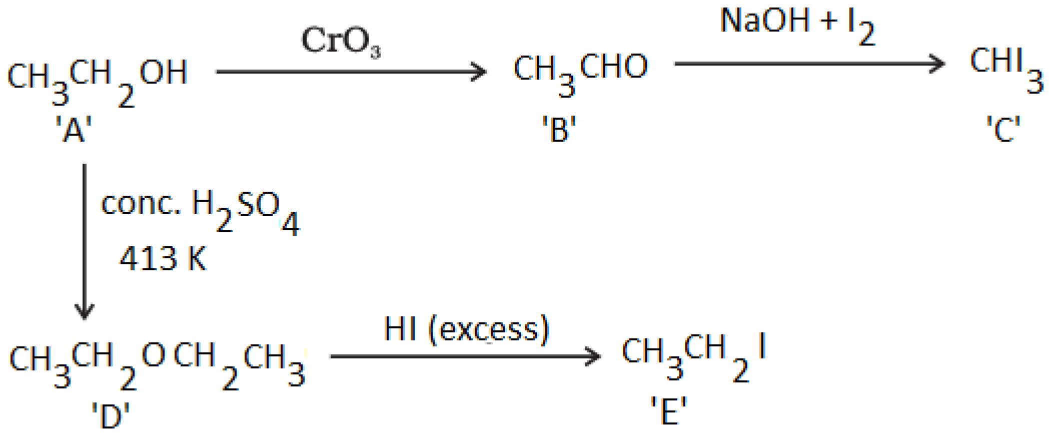
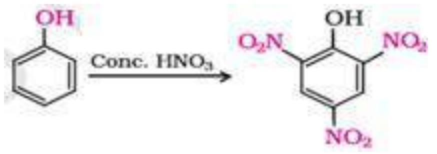
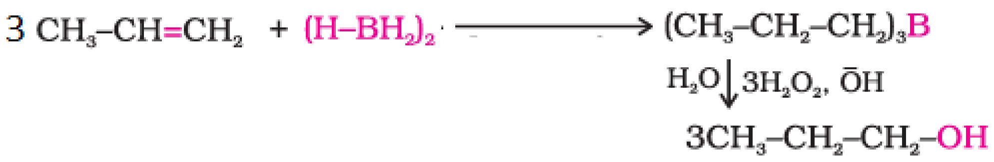
Q. No.	Value points	Mark
	SECTION A	
1	**(B)**	**1**
2	**(C)**	**1**
3	**(C)**	**1**
4	**(A)**	**1**
5	**(B)**	**1**
6	**(A)**	**1**
7	**(C)**	**1**
8	**(B)**	**1**
9	**(C)**	**1**
10	**(D)**	**1**
11	**(D)**	**1**
12	**(C)**	**1**
13	**(D)**	**1**
14	**(A)**	**1**
15	**(A)**	**1**
16	**(D)**	**1**
	SECTION B	
17	$k = \frac{[R]_0 - [R]}{t}$ $t = \frac{0.10 - 0.075}{0.0030}$ $t = \frac{0.025}{0.0030}$ $t = 8.33\ s$	½ 1 ½
	OR	
17	$\text{Rate} = \frac{-1}{2}\frac{\Delta[NH3]}{\Delta t} = \frac{\Delta[N2]}{\Delta t} = \frac{+1}{3}\frac{\Delta[H2]}{\Delta t}$ $\frac{-1}{2}\frac{\Delta[NH3]}{\Delta t} = \frac{\Delta[N2]}{\Delta t} = \frac{+1}{3}\frac{\Delta[H2]}{\Delta t} = k$ $\frac{\Delta[N2]}{\Delta t} = 2.5 \times 10^{-4}\ mol\ L^{-1}\ s^{-1}$ $\frac{\Delta[H2]}{\Delta t} = 3 \times 2.5 \times 10^{-4}$ $= 7.5 \times 10^{-4}\ mol\ L^{-1}\ s^{-1}$	½ ½ ½ ½
18	(a) The reaction that seems to be of higher order but under certain conditions is of first order. (b) The time in which the concentration of a reactant is reduced to one half of its initial concentration / The time in which half of the reaction is completed.	1 1
19	(a) Due to the presence of unpaired electron in d sub shell/ due to d-d transition. (b) Due to the presence of fully filled d- subshell in ground state and oxidized state.	1 1
20	(a) Tetraammineaquachloridocobalt(III) chloride (b) Dichloridobis(ethane-1,2-diamine)chromium(III) chloride	1 1

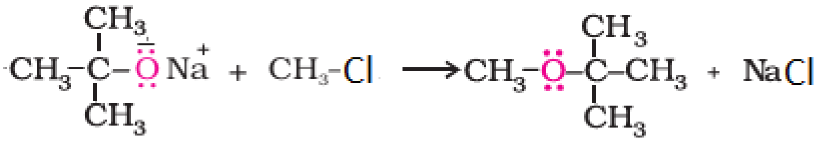
21	(a)  , due to the formation of more stable tertiary carbocation. (b) 2-Bromo-2-methylbutane < 2-Bromopentane < 1-Bromopentane.	½ , ½ 1
	SECTION C	
22	$\frac{p_1^0 - p_1}{p_1^0} = \frac{w_2 \times M_1}{M_2 \times w_1}$ $\frac{24 - p_1}{24} = \frac{5 \times 18}{60 \times 95}$ $\frac{24 - p_1}{24} = \frac{3}{190}$ $24 - p_1 = \frac{3 \times 24}{190}$ $p_1 = 23.62$ mm Hg / 23.64 mm Hg (Deduct ½ mark for no or incorrect unit).	1 1 1
23	$\rho = \frac{RA}{l}$ $= \frac{5\times10^3 \times 0.8}{40}$ $= 100\ \Omega$ cm $\kappa = \frac{1}{\rho}$ $= \frac{1}{100}$ $= 10^{-2}$ S cm^{-1} $\Lambda_m = \frac{\kappa \times 1000}{C}$ $= \frac{10^{-2}\times 1000}{0.05}$ $= 2 \times 10^2$ S cm^2 mol^{-1}	½ ½ ½ ½ ½ ½
24	(a) $5C_2O_4^{2-} + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{2+} + 8H_2O + 10CO_2$ (b) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$ (c) $Cr_2O_7^{2-} + 8H^+ + 3H_2S \rightarrow 2Cr^{3+} + 3S + 7H_2O$	1 1 1

25	(a)	
		½
	Hybridization: d^2sp^3	½
	Magnetic character: Diamagnetic.	½
	(b)	
		½
	Hybridization: sp^3	½
	Magnetic character: Diamagnetic.	½
26.	(a) (i) The stereoisomers related to each other as non-superimposable mirror images.	1
	(ii) A mixture containing dextro and laevo enantiomers in equal proportions.	1
	(b) C—Cl bond acquires a partial double bond character due to resonance / the carbon atom of benzene attached to halogen is sp^2-hybridised / Explanation through resonating structures.	1
27	(A)	
	(a) The carbonyl group of aldehydes and ketones is reduced to CH_2 group on treatment with hydrazine followed by heating with sodium or potassium hydroxide in high boiling solvent such as ethylene glycol	½
		½
	(b) Chromyl chloride oxidises methyl group of toluene to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.	½
		½
	(c) Aldehydes which do not have α-hydrogen atom, undergo self-oxidation and reduction reaction on heating with concentrated alkali gives salt of carboxylic acid and alcohol	½
		½
	(Or any other example)	
	OR	
27	(B)	
	(a) A = CH_3COCl (b) CH_3CHO (c) $CH_3CH=NNH_2$	½ x 3

	(b) A = CH_3CHO (b) $CH_3CH(OH)CH_2CHO$ (c) $CH_3CH=CHCHO$	½ x 3
28	(a) The oxide linkage between two monosaccharides. (b) Hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (–) and the product is named as invert sugar. (c) Carbohydrates that yield two to ten monosaccharide units, on hydrolysis.	1 1 1
	SECTION D	
29	(a) • When external pressure is larger than the osmotic pressure, then the movement of solvent is from solution to solvent side through semi permeable membrane. / The direction of osmosis can be reversed if a pressure larger than the osmotic pressure is applied to the solution side. • Cellulose acetate / Or any other suitable example. (b) (i) RBC swells up / Cells swell and may even burst due to endo-osmosis. **OR** (ii) 1 M KCl, i = 2 / KCl dissociates into ions, whereas urea does not dissociate. (c) It depends upon the number of solute particles in the solution.	1 1 1 ½ ½ 1
30	(a)  / Award full marks if attempted because of printing error. (b) Due to resonance in aniline the lone pair of electrons are less available while they are easily available in methyl amine. (c) (i) $NH_3 < (CH_3)_3N < CH_3NH_2 < (CH_3)_2NH$ OR (ii) A mixture of primary, secondary and tertiary amines and also a quaternary ammonium salt is formed.	2 1 1
	SECTION E	
31	(a) But-2-enal (b) On heating with NaOH + I_2, propanone gives yellow ppt. Of iodoform (CHI_3) whereas propanal does not. (Or any other suitable chemical test) (c) (i)  (ii) $CH_3CH_2OH \xrightarrow{PCC} CH_3CHO \xrightarrow[2.\ H_3O^+]{1.\ CH_3MgBr} CH_3CH(OH)CH_3$	1 1 1 1

	(iii)  (Or any other correct method)	1
	OR	
31	(B) (a)  (b)  (c)  (d)  (e) CH_3COCl / Anhy. $AlCl_3$ or $(CH_3CO)_2O$/ Anhy. $AlCl_3$	1 × 5= 5
32	(A) (a) $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ $= -2.87 - 1.5$ V $=$ **- 4.37 V**	 ½
	$\Delta G^0 = -nF E^oc_{ell}$	½
	$= -6 \times 96500 \times (-4.37)$ $= 2530.230$ kJ/mol	 1
	Reaction is non-spontaneous.	1
	(b) Yes, the tarnish can be removed.	1
	Aluminium has more negative standard electrode potential than silver so will reduce silver sulphide to silver, tarnish will be removed. **/** $3\,Ag^+ + Al \longrightarrow 3\,Ag + Al^{3+}$ $E^oc_{ell} = E^o_{cathode} - E^o_{anode}$ $= -0.71 - (-1.66)$ V $= 0.95$ V This indicates that the reaction is feasible and tarnish can be removed.	1

	OR	
32	(B) (a) (i) Potential difference between two electrodes of a galvanic cell. (ii) The galvanic cell in which combustion energy of fuels is directly converted into electrical energy. b) n =2 $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ $= -0.40 - (-0.76)$ V $=$ **0.36 V** $E_{Cell} = E^o_{celi} - \frac{0{\cdot}059}{2} \log [\frac{Zn^{2+}}{Cd^{2+}}]$ $= [0.36] - \frac{0{\cdot}059}{2} \log \frac{0{\cdot}1}{0{\cdot}01}$ $= (0 \cdot 36 - 0 \cdot 0295)$ = **0·3305 V** (Deduct ½ mark for no or incorrect unit)	 1 1 1 1 1
33	**(A) A =** CH_3CH_2OH / Ethanol / Ethyl alcohol, B = CH_3CHO / Ethanal / Acetaldehyde, C = CHI_3 / Iodoform / Triiodomethane, D = $CH_3CH_2O\ CH_2\ CH_3$ / Ethoxyethane / Diethyl ether, E = CH_3CH_2I / Ethyl iodide / Iodoethane. 	½ x 5 ½ x 5
	OR	
33	(B) (a) (i)  (ii)  (iii)	 1 1 1

	 $CH_3-C(CH_3)_2-\ddot{\underset{\cdot\cdot}{O}}^{-}\,Na^+ + CH_3-Cl \longrightarrow CH_3-\ddot{\underset{\cdot\cdot}{O}}-C(CH_3)_2-CH_3 + NaCl$ (b) On heating with NaOH + I_2, Butan-2-ol gives yellow ppt. Of iodoform (CHI_3) whereas Butan-1-ol does not. (Or any other suitable chemical test) (c) Ethanol < Water < Phenol.	1 1