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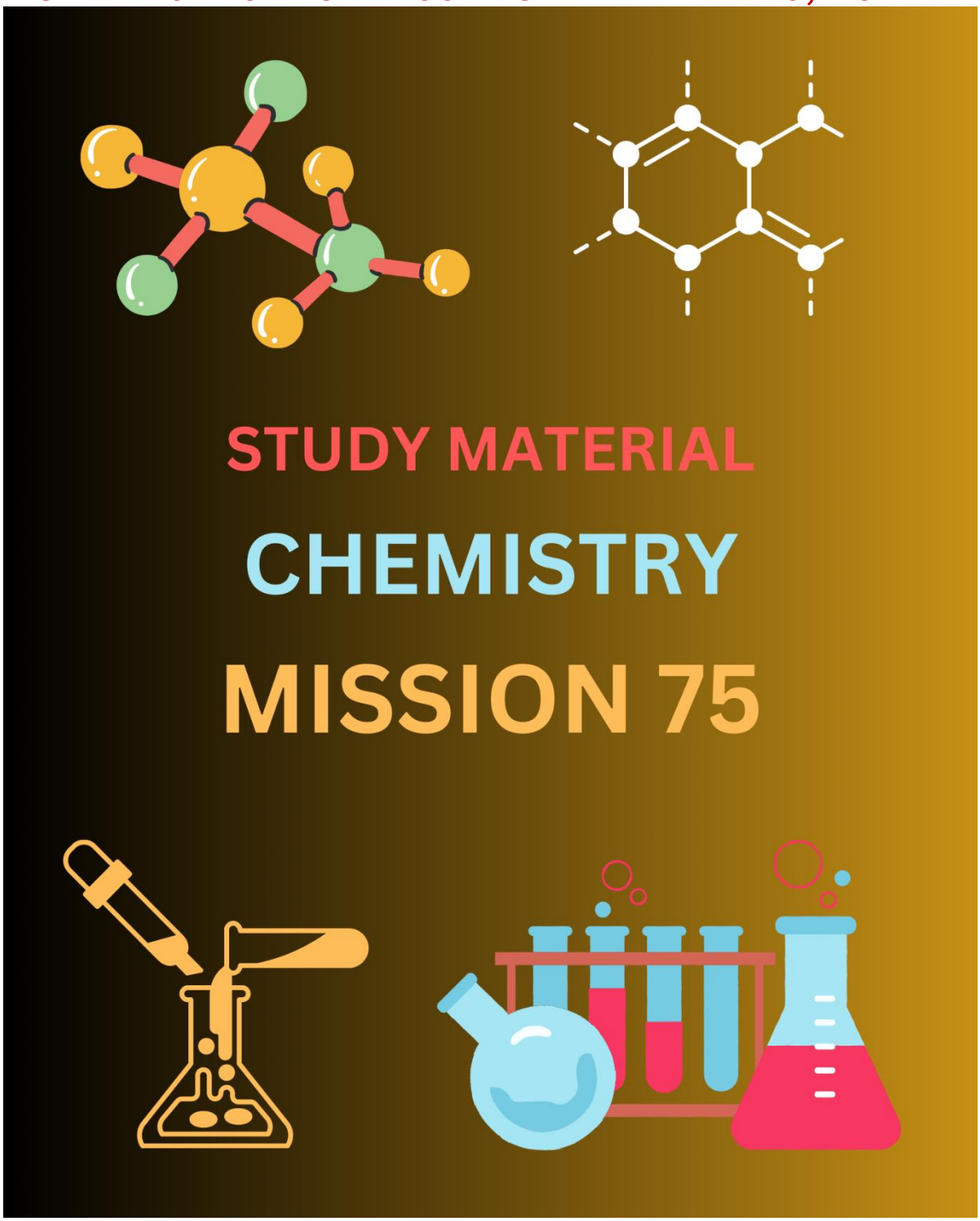


3-DAY ONLINE WORKSHOP ON CROSS-CURRICULAR APPROACH FOR PROJECT BASED LEARNING IN CHEMISTRY

CHEMISTRY STUDY MATERIAL PREPARED FOR CLASS XII STUDENTS DURING THE WORKSHOP FOR MISSION 75.

MISSION 75

The Material is prepared to enable students to achieve at least 45 marks out of 70 in Chemistry Theory Examinations.

Acknowledgement: NCERT Chemistry Class XII Text Book (Part I &II)

CHEMISTRY-XII (2023-24)

Note: In this Section there are the Topic & Chapter-wise Questions with answers are prepared.

There are Multiple Choice Questions (MCQ) followed by Assertion-Reasoning type Questions and sub-topic wise Competency Based Questions.

The Answers for the questions are also follows each Chapter.

1. SOLUTIONS

(WEIGHTAGE: 7 MARKS)

MULTIPLE CHOICE QUESTIONS

1. The boiling point of an azeotropic mixture of water and ethanol is less than that of water and ethanol. The mixture shows:
   (a) no deviation from Raoult's Law.
   (b) positive deviation from Raoult's Law.
   (c) negative deviation from Raoult's Law.
   (d) that the solution is unsaturated.

2. Which of the following best describes the difficulty in breathing as one climbs to higher altitudes?
   a) Henry's law
   b) Raoult's law
   c) Osmotic pressure
   d) Relative lowering of atmospheric pressure

3. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because -

   (a) it gains water due to osmosis.
   (b) it loses water due to reverse osmosis.
   (c) it gains water due to reverse osmosis.
   (d) it loses water due to osmosis.

4. The vapour pressure of the solution containing non-volatile solute is:
   (a) greater than vapour pressure of pure solvent
   (b) lesser than vapour pressure of pure solvent
   (c) equal to the vapour pressure of pure solvent
   (d) the sum of the vapour pressure of the solute and the solvent

5. The colligative property used for determination of molar mass of proteins and polymers
   (a) Relative lowering of vapour pressure
   (b) Depression in freezing point
   (c) Elevation in boiling point
   (d) Osmotic pressure of solution

ASSERTION & REASONING QUESTIONS

A statement of Assertion(A) followed by a statement of Reason® is given. Choose the correct answer out of the following choices

(a)Both A and R are true and R is correct explanation of A.
(b) Both A and R are true but R is not correct explanation of A.
® A is true but R is false.
(d) A is false but R is true.

1. **Assertion(A):**When NaCl is added to water a depression in freezing point is observed.
   Reason (R) : The lowering of vapour pressure of a solution causes depression in the freezing point.
2. **Assertion(A)**: When a solution is separated from pure solvent by a semi-permeable membrane, solvent molecules pass through it from solvent side to solution side.
   Reason(R): Diffusion is the movement of particles from an area of higher concentration to lower concentration.
3. **Assertion(A)**: 1M solution of KCl has less osmotic pressure than 1M solution of glucose
   Reason(R): in solution KCl dissociates into a greater number of particles.
4. **Assertion(A)**: Deep Sea divers often suffers from Bends
   Reason (R): Nitrogen gas has appreciable solubility at high pressure under water.
5. **Assertion(A)**: - When a cell is placed in hypertonic solution, it shrinks.
   Reason (R): - Reverse osmosis is used for desalination of water.

COMPETENCY BASED QUESTIONS

TYPES OF SOLUTIONS

Q1. What type of solution is formed on mixing camphor and nitrogen?
Q2. What type of solution is formed by sodium amalgam. Identify the solute and solvent in it.

EXPRESSING CONCENTRATION OF SOLUTION

(1) VERY SHORT ANSWER TYPE QUESTION

(a) **Which of the following factor(s) affect the solubility of a gaseous solute in the fixed volume of liquid solvent?**
(i) Nature of solute (ii) Temperature
(iii) Pressure
(b) **Which thing is responsible of low concentration of oxygen in the blood and tissues of people living at high altitude?**

(c) When will happen at equilibrium the rate of dissolution of a solid solute in a volatile liquid solvent with respect to concentration?

(2) SHORT ANSWER TYPE QUESTION

(a) Differentiate between molality and molarity of a solution. What is the effect of change in temperature of a solution on its molality and molarity?

(b) What are isotonic solutions?

(c) **Why do gases always tend to be less soluble in liquids as the temperature is raised?**

(3) NUMERICAL BASED QUESTION

(a) A 5 percent solution (by mass) of cane-sugar (M.W. 342) is isotonic with 0.877% solution of substance X. Find the molecular weight of X.

(b**) Concentrated nitric acid used in the laboratory work is 68% nitric acid by mass in aqueous solution. What should be the molarity of such a sample of acid if the density of the solution is 1·504 g mL^{-1}?**

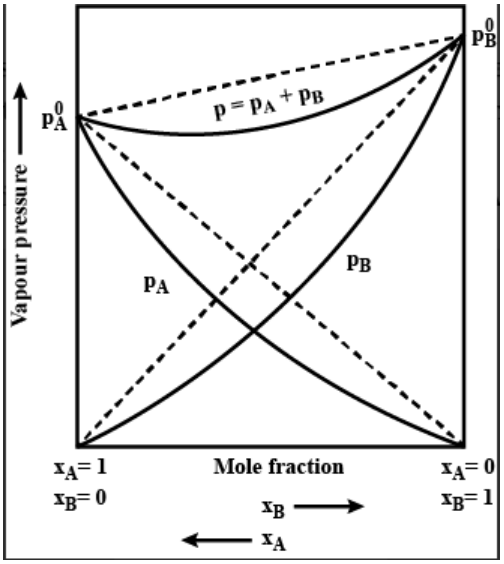
(c) A sample of drinking water was found to be severely contaminated with chloroform ($CHCl_3$), supposed to be a carcinogen. The level of contamination was 15 ppm (by mass).
(i) express this in percent by mass.
(ii) determine the molality of chloroform in the water sample.

HENRY'S LAW AND ITS APPLICATIONS

Q.1 State Henry's law.
Q.2 Which cold drink you prefer- one chilled or other one at room temperature and why?
Q.3 At the same temperature hydrogen is more soluble in water than Helium. Which of them will have higher value of K_H and why?
Q.4 What is the significance of Henry's Law constant K_H?
Q.5 If N_2 gas is bubbled through water at 293 K, how many millimoles of N_2 gas would dissolve in 1 litre of water? Assume that N_2 exerts a partial pressure of 0.987 bar. Given that Henry's law constant for N_2 at 293 K is 76.48 kbar.
Q.6 Write applications of Henry's law ?
Q.7 H_2S, a toxic gas with rotten egg like smell, is used for the qualitative analysis. If the solubility of H_2S in water at STP is 0.195 m, calculate Henry's law constant
Q.8 Henry's law constant for the molality of methane in benzene at 298 K is 4.27 x 10^5 mm Hg. Calculate the solubility of methane in benzene at 298 K under 760 mm Hg.
Q.9 Henry's law constant for CO_2 in water is 1.67 x 10^8 Pa at 298 K. Calculate the quantity of CO_2 in 500 mL of soda water when packed under 2.5 atm CO_2 pressure at 298 K.

RAOULT'S LAW AND ITS DEVIATION

1. State Raoult's law for the solution containing volatile components. How does Raoult's law become a special case of Henry's law? Write two differences between an ideal solution and a non-ideal solution.
2. What is meant by positive and negative deviations from Raoult's law and how is the sign of $\Delta_{mix}H$ related to positive and negative deviations from Raoult's law?
3. Define an ideal solution and write one of its characteristics.
4. On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution? What change in temperature would you observe after mixing liquids X and Y?
5. The vapour pressure of pure liquids A and B are 450 and 700 mm Hg respectively, at 350 K. Find out the composition of the liquid mixture if total vapour pressure is 600 mm Hg. Also find the composition of the vapour phase.
6. Why is an increase in temperature observed on mixing chloroform and acetone?
7. The graphical representation of vapour pressure of two components system as a function of composition is given alongside. By graphic inspection, answer the following questions:
   a. Name the type of deviation from raoult's law
   b. Predict the sign of ΔmixH for this system
   c. Are the A-B interactions stronger or weaker than A-A andB-B interactions.



AZEOTROPES

SHORT ANSWER QUESTIONS

Q.1Which kind of azeotropes exhibits negative deviation from raoults law?
Q.2 Which kind of Azeotrope has solute solvent interaction Weaker than solute solute and solvent solvent interactions?
Q.3 What are azeotropes explain with examples?
Q.4 What are maximum and minimum boiling azeotropes? Explain with examples?

COLLIGATIVE PROPERTIES

Reasoning based questions:

Q1. Explain why on addition of 1 mol glucose or NaCl to 1 litre water, the boiling point of water increases while on addition of 1 mol of methyl alcohol to 1 litre of water decreases its boiling point?
Q2. Why does measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers?
Q3. What happens if we place blood cells in a solution containingthe
(i) 0.5% NaCl solution (ii) 1.2% NaCl solution
Q4. Give reason for the following:
(i)An unripe mango is placed in a concentrated salt solution to prepare pickle.
(ii)Sprinkling of salt helps in clearing the snow-covered roads in hilly areas.
(iii) Doctors suggest gargles with NaCl solution for sore throat.

Numerical:

Q5. 18 g of glucose, $C_6H_{12}O_6$ (Molar mass – 180 g mol^{-1}) is dissolved in 1 kg of water in a sauce pan. At what temperature will this solution boil? (K_b for water = 0.52 K kg mol^{-1}, boiling point of pure water = 373.15 K)
Q6. Calculate the mass of a non-volatile solute (molecular mass 40) which should be dissolved in 114 g octane to reduce the vapour pressure to 80%.
Q7. Calculate the amount of $CaCl_2$(molar mass=111g/mol) which must be added to 500g of water to lower its freezing point by 2K, assuming $CaCl_2$ is completely dissociated.(K_f for water=1.86Kkgmol^{-1})
Q8. At 300 K, 36 g glucose present per litre in its solution has osmotic pressure of 4·98 bar. If the osmotic pressure of the solution is 1·52 bar at the same temperature, what would be its concentration?
Q9. 19.5g of CH_2FCOOH is dissolved in 500g of water. The depression in the freezing point of water observed is 1.0°C. Calculate the van's Hoff factor and dissociation constant of fluoroacetic acid.
Q10. Define the following terms:
(i) Osmotic Pressure
(ii) Reverse osmosis
(iii) Colligative properties

VAN'T HOFF FACTOR

1.What do you mean by van't Hoff factor? Calculate the values of van't Hoff factors for KCl and K_2SO_4.
2.What is the van't Hoff factor for a compound which undergoes tetramerisation in an organic solvent?
3.Predict the nature (or state) of the solute in the solution in the following situations :
(i) When 'i' is found to be 0.3 (ii) When 'i' is found to be 2.83
4. Calculate the value of van't Hoff factor 'i' for an aqueous solution of $AlCl_3$ which is 0.01molal.(Given : K_f for water = 1.86 K kg mol^{-1} , T_f of solution = -0.068 ^0C

ANSWERS

ANSWERS OF MCQ

Q	1	2	3	4	5
ANSWER	b	A	D	B	d

ANSWERS OF ASSERTION & REASIONING QUESTIONS

Questions	1	2	3	4	5
ANSWER	a	B	D	A	b

COMPETENCY BASED QUESTIONS

TYPES OF SOLUTIONS

1. Gaseous solution
2. Solid solution. Solute is sodium and solvent is Silver.

ANSWERS EXPRESSING CONCENTRATION OF SOLUTION

(1) VERY SHORT ANSWER TYPE QUESTION

(a) (I & ii) At constant temperature, the solubility of a gaseous solute in liquid depends on nature of solute and pressure. At constant pressure, solubility is dependent upon nature of solute and temperature.

(b) At high altitudes the atmospheric pressure is less but the body temperature remains same hence concentration of oxygen in the air as well as blood is less.

(c) At equilibrium the rate of dissolution of solid solute is equal to rate of crystallisation.

(2) SHORT ANSWER TYPE QUESTION

(a) Formulas for molarity and molality

Molality is independent of temperature, whereas molarity is a function of temperature because volume depends on temperature and mass does not

(b) An isotonic solution is a kind of solution with the same salt concentration as blood and cells. Those solutions which are exerting same osmotic pressure under similar conditions (For example 0.9% NaCl solution by mass volume is Isotonic with human blood).

(c) When gases are dissolved in water, it is accompanied by a release of heat energy, i.e., process is exothermic. When the temperature is increased, according to Lechatlier's Principle, the equilibrium shifts in backward direction, and thus gases becomes less soluble in liquids.

(3) NUMERCALS:

(a) Given: W (mass) of cane-sugar = 5% means 5 g
Molar mass of cane-sugar (M) = 342 g mol^{-1}
Mass of isotonic substance X
= 0.877% means 0.877 g
Molar mass of X = ?
Using formula,
W cane sugar M cane sugar =WXMX⇒5g342gmol−1=0.877gMX
or M_x = 0.877g×342gmol−15g⇒299.934gmol−15g
∴ M_x = 59.9 ≈ 60 g mol^{-1}

(b)

$$\text{Volume of solution} = \frac{\text{Mass of solution}}{\text{Density of solution}}$$

$$= \frac{(100\,\text{g})}{(1{\cdot}504\ \text{g mL}^{-1})} = 66{\cdot}5\ \text{mL} = 0{\cdot}0665\ \text{L}$$

$$\text{Molarity of solution (M)} = \frac{\text{Mass of } HNO_3 \text{ / Molar mass of } HNO_3}{\text{Volume of solution in Litres}}$$

$$= \frac{(68\,\text{g} / 63\,\text{g mol}^{-1})}{(0{\cdot}0665\,\text{L})} = 16{\cdot}23\ \text{mol L}^{-1} = \mathbf{16{\cdot}23\ M.}$$

(c) 15 ppm means 15 parts in million (10^6) by mass in the solution.

$$\therefore \text{Percentage by mass} = \frac{15}{10^6} \times 100 = 15 \times 10^{-4}\%$$

As only 15g of chloroform is present in 10^6g of the solution, mass of the solvent = 10^6 g

$$\text{Molar mass of } CHCl_3 = 12 + 1 + 3 \times 35{\cdot}5 = 119{\cdot}5\ \text{g mol}^{-1}$$

$$\text{Moles of } CHCl_3 = \frac{15}{119{\cdot}5}$$

$$\therefore \text{Molality} = \frac{15/119{\cdot}5 \times 1000}{10^6} = 1{\cdot}25 \times 10^{-4}\ \text{m}$$

HENRY'S LAW

1.Mole fraction of gas in the solution is directly proportional to partial pressure of gas in the vapour phase

2.Chilled as solubility of CO_2 is more at low temp.

3.Helium as greatertheK$_H$valuelower thesolubility

4.Henry's Law constant (K_H) helps in comparing the relative solubilities of different gases in the same solvent (e.g. water). In general, the lesser the value of K_H, the more the solubility of a gas.

5. The solubility of gas is related to the mole fraction in aqueous solution. The mole fraction of the gas in the solution is calculated by applying Henry's law. Thus:

x (Nitrogen) = p (nitrogen) / Kh

= 0.987bar /76,480 bar= 1.29×10^{-5}

As 1 litre of water contains 55.5 mol of it, therefore if n represents number of moles of N_2 in solution,

x (Nitrogen) = n mol /(n mol +55.5 mol)

= n/ 55.5 = 1.29×10^{-5}

(n in denominator is neglected as it is << 55.5)

Thus n = $1.29 \times 10^{-5} \times 55.5$ mol = 7.16×10^{-4}mol

=(7.16×10^{-4}mol × 1000 mmol)/1 mol = 0.716 mmol

6. Some applications of Henry's law –
-The solubility of CO2 in soft drinks and soda water is increased by sealing the bottles under high pressure.
-At high pressure underwater, scuba divers have to cope with high concentrations of dissolved gases while breathing air.
-At high altitudes, climbers become weak and are unable to think clearly, which are symptoms of a condition called anoxia

7.Solubility of H_2S gas = 0.195 m
= 0.195 mole in 1 kg of solvent
1 kg of solvent = 1000g

$$= \frac{1000}{18} = 55.55\ moles$$

$$\therefore x_{H_2S} = \frac{0.195}{0.195 + 55.55}$$

$$= \frac{0.195}{55.745} = 0.0035$$

Pressure at STP =0.987 bar

Applying Henry's law ,

$P_{H_2S} = K_H \, x \, X_{H_2S}$

$$K_H = \frac{P_{H_2S}}{x_{H_2S}} = \frac{0.987}{0.0035} = 282 \; bar$$

8. Here, p = 760 mm Hg, K_H = 4.27 × 10^5 mm Hg (at 298 K)
According to Henry's law, p = K_{Hx}
x = p / kH
= 760 mmHg / 4.27×105 mmHg
= 177.99 × 10^{-5}
= 178 × 10^{-5}

9. $K_H = 1.67 \, x \, 10^8 Pa$

$P_{CO_2} = 2.5 \; atm = 2.5 \; X \; 101325 \; Pa$

$\therefore X_{CO_2} = \frac{P_{CO_2}}{K_H} = \frac{2.5 \; X \; 101325}{1.67 \; X \; 10^8} = 1.517 X 10^{-3}$

For 500 Ml of soda water, water present ≈ 500 mL

=500 mg=$\frac{500}{18}$=27.78 moles

$\therefore n_{H_2O} = 27.78 \; moles$

$\frac{n_{CO_2}}{27.78}$=1.517 X 10^{-3}

$n_{CO_2} = 42.14 \; X \; 10^{-3}$

=42.14 m mol

42.14 x 10^{-3} x 44 g = 1.854 g

RAOULT'S LAW

1. Raoult's law: It states that partial vapour pressure of each component is directly proportional to their mole fraction if both solute and solvent are volatile.
   $P_1 = p_1^0 x_1$ and $p_2 = p_2^0 x_2$

According to Henry's law p = K_Hx , When K_H equals p_1^0 in Henry's law, Raoult's law becomes a special instance of Henry's law.

Ideal solution	Non-ideal solution
(*i*) It follows Raoult's law	(*i*) It does not follow Raoult's law.
(*ii*) $\Delta H_{mix} = 0, \Delta V_{mix} = 0$	(*ii*) $\Delta H_{mix} \neq 0, \Delta V_{mix} \neq 0$
(*iii*) They can be separated by fractional distillation.	(*iii*) They cannot be separated by fractional distillation.

2. Positive deviation from Raoult's law occurs when the total vapour pressure of the solution is more than corresponding vapour pressure in case of ideal solution.eg. Mixture of acetone and benzene solutions

$$P = P_A + P_B > P_A^o X_A + P_B^o X_B$$

Negative deviation from Raoult's law occurs when the total vapour pressure of the solution is less than corresponding vapour pressure in case of the ideal solution. eg. Mixture of CHCl3 and acetone.

$$P = P_A + P_B < P_A^o X_A + P_B^o X_B$$

For positive deviation from Raoult's law, $\Delta_{mix}H$ has a positive sign.
For negative deviation from Raoult's law, $\Delta_{mix}H$ has a negative sign.

3. Those solutions which are obeying Raoult's law are called ideal solutions. An ideal solution is a solution in which no volume change and no enthalpy change takes place on mixing the solute and the solvent in any proportion.Characteristic of an ideal solution :There will be no change in enthalpy ΔHmix = 0, ΔVmix = 0, ΔPmix = 0

4. Volume decreases by mixing X and Y. It shows negative deviations from Raoult's law. There will be rise in temperature. (ΔHmix < 0)

5. It is given that: p_A^0 = 450 mm of H p_B^0 = 700 mm of Hg p_{total} = 600 mm of Hg

From Raoult's law, we have:

$$p_A = p_A^0 x_A$$

$$p_B = p_B^0 x_B = p_B^0 (1 - x_A)$$

Therefore, total pressure

$$\Rightarrow p_{total} = p_A^0 x_A + p_B^0 (1 - x_A)$$

$$\Rightarrow p_{total} = p_A^0 x_A + p_B^0 - p_B^0 x_A$$

$$\Rightarrow p_{total} = (p_A^0 - p_B^0) x_A + p_B^0$$

$$\Rightarrow 600 = (450 - 700) x_A + 700$$

$$\Rightarrow -100 = -250 x_A$$

$$\Rightarrow x_A = 0.4$$

Therefore, $x_B = 1 - x_A$ = 1 − 0.4 = 0.6

Now, $p_A = p_A^0 x_A$ = 450 × 0.4 = 180 mm of Hg

$p_B = p_B^0 x_B$ = 700 × 0.6 = 420 mm of Hg

Now, in the vapour phase: Mole fraction of liquid A $= \dfrac{p_A}{p_A + p_B}$

$$= \frac{180}{180 + 420}$$

$$= \frac{180}{600} = 0.30$$

And, mole fraction of liquid B = 1 − 0.30 = 0.70

6. It is because force of attraction between chloroform and acetone is more than the force of attraction between $CHC1_3$—$CHC1_3$ or Acetone-Acetone. Therefore, AH = -ve,

i.e. exothermic process, therefore, there is increase in temperature.

7. a. Negative deviation
   b. Negative
   c. A-B interactions are stronger than A-A and B-B interactions.

AZEOTROPES

1.Maximum boiling azeotropes.

2.Minimum boiling Azeotropes.

3.Azeotropes are binary mixtures having the same composition in liquid and vapour phase and boils at constant temperature. Examples: alcohol-water mixture, nitric acid-water mixture.

4.**Maximum boiling azeotropes** : These are the binary mixtures whose boiling point is more than either of the two components. The solution that show large negative deviation from raoults law form maximum boiling azeotrope .Example: Mixture containing 68% HNO_3 and 32% H_2O.

Minimum boiling azeotropes : These are the binary mixtures whose boiling point is less than either of the two components. The solution that show positive deviation from raoults law form minimum boiling azeotrope .Example: Mixture containing 94.5% Ethanol and 4.5% H_2O.

COLLIGATIVE PROPERTIES

1.Glucose or NaCl is a non-volatile solute, therefore, addition of glucose to water lowers the vapour pressure of water as a result of which boiling point of water increases. On the other hand, methyl alcohol is more volatile than water, therefore its addition increases the total vapour pressure over the solution. As a result, boiling point of water decreases.

2. Because the magnitude of osmotic pressure is large even for very dilute solution and it can be measured at room temperature.

3.(i) Outer conc. is less than blood cell=> hypotonic solution => endosmosis => cell will swell. (ii) Outer conc. is more than blood cell=> hypertonic solution =>exosmosis => cell will shrink.

4(i) As it loses water due to exosmosis.

(ii) Salt decreases the freezing point of water. As a result, the snow starts melting from the surface and therefore, it helps in clearing the roads.

(iii) Due to osmosis, infected water comes out of the sores and they get cured.

5. Elevation of boiling point $\Delta T_b = W_B \times 100 \times K_b / M_B \times$ wt. of solvent
Given: $W_B = 18$ g
M_B (Formula of glucose is $C_6H_{12}O_6$) = 6 × 12 + 12 + 6 × 16 = 180
Wt. of solvent = 1 kg or 1000 g,
$K_b = 0.52$ K kg mol^{-1}
Hence, $\Delta T_b = 18 \times 1000 \times 0.52 / 180 \times 1000g = 0.52$ K
∴B.P of the solution = 373.15 + 0.052
= 373.202 K

6. $\Delta T_f = 0.48$ K, $W_1 = 75$g,
$M_2 = 256$ g mol^{-1} W_2 =?
Using formula, $W_2 = M_2 \times W_1 \times \Delta T_f / 1000 \times K_f$
$= 256 \times 75 \times 0.48 / 1000 \times 5.12 = 1.8$ g

$$\frac{p^0 - p}{p^0} = \frac{X_A}{X_B} \qquad \text{Let } p^0 = 100 \text{ mm Hg}$$

$$\frac{p^0 - p}{p^0} = \frac{W_B}{M_B} \times \frac{M_A}{W_A} \qquad p = 80 \text{ mm Hg}$$

$$\frac{20}{100} = \frac{W_B}{40 \text{ g mol}^{-1}} \times \frac{114 \text{ g mol}^{-1}}{114}$$

$$W_B = \frac{20}{100} \times 40 = 8\text{g}$$

7.

$$\underset{1-\alpha}{CaCl_2} \longrightarrow \underset{\alpha}{Ca^{+2}_{(aq)}} + \underset{2\alpha}{2Cl^-_{(aq)}}$$

$$i = 1 + 2\alpha = 3 \qquad (\because \ \alpha = 100\%)$$

$$\Delta T_f = i \times K_f \times M$$

$$2 = 3 \times 1.86 \times \frac{w/111}{0.5}$$

$$\Rightarrow \quad 2 = 3 \times 1.86 \times \frac{w}{55.5} \Rightarrow \quad w = 19.892\,g$$

8.

$$\pi = CRT = \frac{W_B \times R \times T}{M_B \times V}$$

For both the solutions, R, T and V are constants

Ist case : $$(4{\cdot}98 \text{ bar}) = \frac{(36 \text{ g}) \times R \times T}{(180 \text{ g mol}^{-1}) \times V}$$

IInd case : $(1{\cdot}52\ \text{bar}) = \dfrac{W_B \times R \times T}{M_B \times V}$ ...(ii)

Divide eqn. *(ii)* by eqn. *(i)*,

$$\frac{(1{\cdot}52\ \text{bar})}{(4{\cdot}98\ \text{bar})} = \frac{W_B}{M_B} \times (5\ \text{mol})$$

or $$\frac{W_B}{M_B} = \frac{1{\cdot}52}{4{\cdot}98} \times \frac{1}{(5\ \text{mol})} = 0{\cdot}0610\ \text{mol}^{-1}$$

9.Calculation of Van't Hoff factor (i)

Given, w_1 = 500 g = 0.5 kg, w_2 = 19.5 g, K_f = 1.86 K kg mol^{-1}, ΔT_f = 1 K

Molar mass of CH_2FCOOH (M_2)

= 2 × 12 + 3 × 1 + 1 × 19 + 2 × 16 = 24 + 3 + 19 + 32 = 78 g mol^{-1}

$\Delta T_f = iK_f\, m$

$$i = \frac{\Delta T_f}{K_f m} \quad \text{...(i)}$$

$$m = \frac{w_2}{M_2 \times w_1}$$

$$= \frac{19.5\ \text{g}}{(78\ \text{g mol}^{-1}) \times (0.5\ \text{kg})}$$

$$= 0.5\ \text{mol kg}^{-1} \quad \text{...(ii)}$$

From eq. (i), we get

$$i = \frac{1}{(1.86\ \text{K kg mol}^{-1}) \times (0.5\ \text{mol kg}^{-1})}$$

$$= 1.0753$$

Calculation of dissociation constant, K_a

Let α be the degree of dissociation of CH_2FCOOH then

$$CH_2FCOOH \rightleftharpoons CH_2FCOO^- + H^+$$

Initial conc.	C mol L^{-1}	0	0
At equilibrium	$C(1-\alpha)$	$C\alpha$	$C\alpha$

Total = $C(1+\alpha)$

$$\therefore \quad i = \frac{C(1+\alpha)}{C}$$

$$\Rightarrow \quad i = 1 + \alpha$$

$$\Rightarrow \quad \alpha = i - 1$$

$$= 1.0753 - 1$$
$$= 0.0753$$

Now, $$K_a = \frac{[CH_2FCOO^-][H^+]}{[CH_2FCOOH]}$$
$$= \frac{C\alpha . C\alpha}{C(1-\alpha)}$$
$$= \frac{C\alpha^2}{1-\alpha}$$

Taking the volume of the solution as 500 mL, we have the concentration :

$$C = \frac{\frac{19.5}{78}}{500} \times 1000 \text{ M}$$
$$= 0.5 \text{ M}$$

Therefore, $$K_a = \frac{C\alpha^2}{1-\alpha}$$
$$= \frac{0.5 \times (0.0753)^2}{1 - 0.0753}$$
$$= \frac{0.5 \times 0.00567}{0.9247}$$
$$= 0.00307$$
$$= 3.07 \times 10^{-3}$$

10. (i) It is the pressure which must be applied to the solution side (more concentrated solution) to just prevent the passage of pure solvent into it through a sernipermeable membrane.

(ii) The process of movement of solvent through a semipermeable membrane from the solution to the pure solvent by applying excess pressure on the solution side

(iii)Colligative properties of solutions are those properties which depend only upon the number of solute particles in the solution and not on their nature.

VAN'T HOFF FACTOR

1. Van't Hoff factor 'i' gives the extent of association or dissociation of the solute particles in the solution. It may be defined as the ratio of observed colligative property to calculated colligative property.

   i = Observed colligative property
   Calculated colligative property

   i = Number of moles of particles after association/dissociation
   Number of moles of particles before association/dissociation

   Value of 'i' for KCl :

   $KCl + water \rightarrow K^+(aq) + Cl^-(aq)$

   'i' = 1 +1 /1

'i' = 2

Value of 'i' for K_2SO_4:

K_2SO_4 + water $\rightarrow$ $2K^+(aq) + SO_4^{-2}(aq)$

'i' = 2 +1 /1

'i' = 3

2.Given : compound undergoes tetramerisation

Because ,i = Number of moles of compound after association

Number of moles of compound before association

Hence ,'i' = 1 /4

'i' = 0.25

3.(i) solute undergoes through association.

(ii) solute undergoes through dissociation.

4.Given: $\Delta T_f = 0.068$

K_f for water = 1.86 K kg mol^{-1}

Molality(m) = 0.01m

'i'= ?

We know that : $\Delta T_f = iK_fm$

$0.068 = i \times 1.86 \times 0.01$

$i = 3.65$

2. ELECTROCHEMISTRY

CBSE WEIGHTAGE: 7 Marks

MULTIPLE CHOICE QUESTIONS:

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 F

2. The cell reaction of the galvanic cell.
$Cu(s) / Cu^{2+}(aq) // Hg^{2+}(aq) / Hg(l)$ is
(*a*) $Hg + Cu^{2+} \longrightarrow Hg^{2+} + Cu$
(*b*) $Hg + Cu^{2+} \longrightarrow Cu^{+} + Hg^{+}$
(*c*) $Cu + Hg \longrightarrow CuHg$
(*d*) $Cu + Hg^{2+} \longrightarrow Cu^{2+} + Hg$

3. If limiting molar conductivity of Ca^{2+} and Cl^- are 119.0 and 76.3 S $cm^2\ mol^{-1}$, then the value of limiting molar conductivity of $CaCl_2$ will be
(a) 195.3 S $cm^2\ mol^{-1}$
(b) 271.6 S $cm^2\ mol^{-1}$
(c) 43.3 S $cm^2\ mol^{-1}$
(d) 314.3 S $cm^2\ mol^{-1}$.

4. Fused NaCl on electrolysis gives ..... on cathode.
(a) Chlroine (b) Sodium
(c) Sodium amalgam (d) Hydrogen

5. Rust is a mixture of
(a) FeO and $Fe(OH)_3$
(b) FeO and $Fe(OH)_2$
(c) Fe_2O_3 and $Fe(OH)_3$
(d) Fe_3O_4 and Fe (OH)

6. The standard reduction potentials of X, Y, Z metals are 0.52V, -3.03V, -1.18V respectively. The order of reducing power of the corresponding metals is:
(a) Y > Z > X
(b) X > Y > Z
(c) Z > Y > X
(d) Z > X > Y

7. For a spontaneous reaction, ΔG, equilibrium constant K and E^0cell will be respectively.

(a) – ve > 1, + ve
(b) + ve > 1 – ve
(c) -ve, < 1, -ve
(d) -ve, > 1, -ve

8. In fuel cell

a)chemical energy is converted to electrical energy

b) energy of combustion of fuel is converted to chemical energy

c) energy of combustion of fuel is converted to electrical energy

d)electrical energy is converted to chemical energy.

9. While charging the lead storage battery _____
(a) $PbSO_4$ anode is reduced to Pb.
(b) $PbSO_4$ cathode is reduced to Pb.
(c) $PbSO_4$ cathode is oxidised to Pb.
(d) $PbSO_4$ anode is oxidised to PbO_2.

10. The cell constant of a conductivity cell.....
(a) changes with change of electrolyte
(b) changes with change of concentration of electrolyte
(c) changes with temperature of electrolyte
(d) remains constant for a cell.

ASSERTION-REASON TYPE QUESTIONS

1. ASSERTION - Electrochemical cell is a device which is used to transform chemical energy into electrical energy.
   REASON – In electrochemical cells non-spontaneous redox reaction takes place.
   (a) A and R both statements are correct and R is the correct explanation of A.
   (b) A and R both statements are correct and R is not the correct explanation of A.
   (c) A is correct statement but R is not the correct statement.
   (d) A is incorrect statement but R is the correct statement.

2. ASSERTION - Copper sulphate cannot be stored in zinc vessel.
   REASON – Zn has lower electrode potential and can displace Cu from Copper sulphate solution.
   (a) A and R both statements are correct and R is the correct explanation of A.

(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

3. ASSERTION - An electrochemical cell stops working when Ecell becomes zero.
REASON – E^0cell of an electrochemical cell never becomes zero.
(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

4. ASSERTION - Molar conductivity increases, if concentration of weak electrolytic solution decreases.
REASON – On decreasing concentration of weak electrolytic solution, total number of ions increases due to increase of degree of ionisation.
(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

5. ASSERTION –2 F of charge is required to deposit 1 mol of silver at cathode during electrolysis of $AgNO_3$ solution.
REASON – 1 mol of electron carries 1 F of charge.
(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

COMPETENCY BASED QUESTIONS

QUESTIONS BASED ON NERNS'T EQUATION

1. Calculate electromotive force (E cell) at 298 K for the following cell takes place at 298K

   Co | Co^{2+} (1.0M) || Ni^{2+} (0.01 M) | Ni

   (E°cell = 0.03 volt)

2. In the button cells widely used in watches and other devices the following reaction takes place:

   $Zn(s)+Ag_2O(s)+H_2O(l)\rightarrow Zn^{2+}(aq)+2Ag(s)+2OH^-(aq)$

   Determine ΔrG^0 and E^0 for the reaction. (E^0_{Ag}= 0.344, E^0_{Zn}=−0.76)

3. E° (Cu^{2+}/Cu) and E° (Ag^+/Ag) is + 0.337 V and + 0.799 V respectively. Make a cell whose EMF is +ve. If the concentration of Cu^{2+} is 0.01M and E_{cell} at 25°C is zero, calculate the concentration of Ag^+.

4. Calculate △rG° and log Kc for the following reaction at 298 K.

   $2Cr(s) + 3Fe^{2+}(aq) \rightarrow 2Cr^{3+}(aq)+ 3Fe(s)$

   [(E°cell = 0.30 V), 1F = 96500C mol^{-1}]

5. Calculate the potential of the following cell

   Sn^{4+} (1.5 M) + Zn → Sn^{2+} (0.5 M) + Zn^{2+} (2M).

   Given: $E^0_{Sn4+/Sn2+}$= 0.13V, $E^0_{Zn2+/Zn}$ = − 0.76V

   Will the cell potential ↑ or ↓ if the concentration of Sn^{4+} is increased?

QUESTIONS BASED ON FARADAY'S LAW

Q. 1 (a) How much charge in terms of Faraday is required for the reduction of 1 mol of Cu^{2+} to Cu.

(b) In electrolysis of aqueous NaCl solution when Pt electrode is taken, then which gas is liberated at cathode?

Q. 2 Calculate the time to deposit 1.27 g of copper at cathode when a current of 2A was passed through the solution of $CuSO_4$.

(Molar mass of Cu = 63.5 g mol^{-1},1 F = 96500 C mol^{-1})

Q. 3 Three electrolytic cells A,B,C containing solutions of $ZnSO_4$, $AgNO_3$ and $CuSO_4$ respectively are connected in series. A steady current of 1.5 amperes was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow? What mass of copper and zinc were deposited?

Q. 4 Calculate the strength of the current required to deposit 1.2 g of magnesium from the molten $MgCl_2$ in 1 hour

Q. 5 State the following laws :
(i) Faraday first law of electrolysis
(ii) Faraday's second law of Electrolysis

Q. 6 A solution of $Ni(NO_3)_2$ is electrolyzed between platinum electrodes using a current of 5.0 ampere for 20 minutes. What mass of nickel will be deposited at the cathode? (Given : At. mass of Ni = 58.7 g mol^{-1}, 1F = 96500 C mol^{-1})

QUESTIONS BASED ON CONDUCTANCE OF ELECTROLYTIC SOLUTIONS

Q-1 The conductivity of 0.20 M solution of KCl at 298 K is 0.0248 S cm^{-1}. Calculate its molar conductivity.

Q-2 The resistance of a conductivity cell containing 0.001M KCl solution at 298K is 1500 ohm. What is the cell constant if conductivity of 0.001M KCl solution at 298 K is 0.146×10^{-3} S cm^{-1}.

Q-3 Write difference between Metallic & Electrolytic Conduction.

Q-4 Resistance of a conductivity cell filled with 0.1 mol L^{-1} KCl solution is 100 ohms. If the resistance of 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 solutions is 1.29 S/m.

Q-5(a) State Kohlrausch's law of independent migration of ions.
(b) Suggest a way to determine the limiting molar conductivity value of water.

Q-6 Conductivity of 0.00241M acetic acid is 7.896×10^{-5} S cm^{-1}. Calculate its molar conductivity and if $\Lambda^{\circ}m$ for acetic acid are 390.5 S cm^2 mol^{-1}, what is its dissociation constant?

Q-7 Why does the conductivity of a solution decrease with dilution?

Q-8 The molar conductivities of KCl, NaCl and KNO_3 are 152, 128 and 111 S cm^2 $mo1^{-1}$ respectively. What is the molar conductivity of $NaNO_3$? (in S $cm^2 mol^{-1}$)

Q-9 The molar conductivity of 0.025 mol L^{-1} Methanoic acid is 46.1 S cm^2 mol^{-1}. Calculate its degree of dissociation and dissociation constant. Given $\lambda^{\circ}(H^+) = 349.6$ S cm^2 mol^{-1} and $\lambda^{\circ}(HCOO^-) = 54.6$ S cm^2 mol^{-1}.

Q-10 How does molar conductivity of strong and weak electrolytes vary with concentration?

QUESTIONS BASED ON BATTERIES

1. Write the chemistry of lead storage battery when it is recharging.
2. Rusting of Iron is an electrochemical process. Justify.
3. Give electrode reactions of H2-O2 fuel cell. Give its two advantages.
4. The cell potential of a mercury cell remains constant. Give reason.
5. What is the major difference in between primary and secondary cells?

Solutions/Answers

MCQs - 1B, 2D, 3B, 4B , 5C, 6A, 7A, 8C, 9A, 10D
Assertion – Reason type questions – 1- (C), 2 – (A), 3-(B), 4-(A), 5-(D)

COMPETENCY BASED QUESTIONS

NERNS'T EQUATION NUMERICALS

Sol. 1

$Co\ (s) + Ni^{2+} \rightleftharpoons Co^{2+} + Ni$

From Nernst equation,

$$E°Cell = E°cell - \frac{0.0591}{n} \log 10 \frac{\{Co^{2+}\}}{\{Ni^{2+}\}}$$

Here, n = 2, E^{o}_{Cell} =0.03 volt,

$[Co^{2+}]$ =1.0M and $[Ni^{2+}]$ = 0.01 M

$$E_{cell} = 0.03 - \frac{0.0591}{2} \log \frac{1}{0.01}$$

$E_{cell} = 0.03 - 0.0591$

$E_{cell} = -0.0291$

The negative value of E shows that the cell reaction written above will go in the reverse direction it means

$Co^{2+} + Ni \rightarrow Co(s) + Ni^{2+}$

Sol. 2

$E^0_{cell} = E^0_{cathode} - E^0_{anode}$

$E^0_{cell} = E^0_{Ag} - E^0_{Zn}$

$E^0_{cell} = 0.344 - (-0.76)$

E^0_{cell} =1.104 V

$\Delta G^{0} = - nFE^0_{cell}$

$\Delta G^0 = -2 \times 96500 \times 1.104$

$\Delta G^0 = -213072$ J

$\Delta G^0 = -213$ kJ

Sol. 3

Cu is more reactive than silver, so that the cell is as Cu/Cu^{2+} (0.01M) || Ag^{+} (C)/Ag

or cell reaction $Cu + 2Ag^{+} \rightarrow Cu^{2+} + 2Ag$

$E_{cell} = E°cell - \frac{0.0591}{n} \log \frac{\{Cu^{2+}\}\{Ag\}^2}{\{Cu\}\{Ag+\}^2}$

$E_{cell} = 0 - \frac{0.0591}{2} \log \frac{(0.01)\times 1^2}{1\times\{Ag+\}^2}$

$(Ag^{+}) = 1.47 \times 10^{-9}$ M

Sol. 4

$\triangle rG° = nFE°cell$

n = 6

$=6\times96500$ C/mol×0.30V

$=-173700$ J/mol

$\triangle rG°$ = −173.7 KJ/mol

$E^0_{cell} = \frac{0.0591}{n} V \times \log K_c$

$\log K_c = 0.30V\times6/0.0591V$

$\log K_c = 30.5$

Sol. 5

From Nernst equation,

$E_{cell} = E°cell - \frac{0.0591}{n} \log 10 \frac{\{Sn^{2+}\}\{Zn^{2+}\}}{\{Sn^{4+}\}\{Zn\}}$

$E_{cell} = 0.89 - \frac{0.0591}{2} \log \frac{0.5\times2}{1.5\times1}$

$E_{cell} = 0.89 - \frac{0.0591}{2} \log \frac{1}{1.5}$

$E_{cell} = 0.895$ V

On increasing the concentration of Sn^{4+}, EMF of the cell will increase.

FARADAY'S LAW

1. Ans: (a) The quantity of charge required for reduction of 1 mol of Cu^{2+} = 2 faradays ($\because Cu^{2+} + 2e^{-} \rightarrow Cu$)

= 2 × 96500 C = 193000 C

(b) H_2 gas

2. Ans:

$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$

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

63.5 gram of copper is deposited = 2 × 96500 C

1.27 gram of Cu is deposited = $\frac{2 \times 96500}{63.5}$ x 1.27

= I × t (Q = I × t)

$t = \frac{2 \times 96500 \times 1.27}{63.5 \times 2} = 1930$ seconds

3. Ans

According to the reaction: $Ag^{+} + e^{-} \rightarrow Ag$

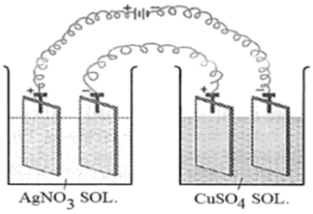
i.e., 108 g of Ag is deposited by 96487 C. $\frac{96500 \times 1.45}{108}$

Therefore, 1.45 g of Ag is deposited by =
= 1295.43 C
Given, Current = 1.5 A = $\frac{1295.43}{1.5}$
Therefore, Time
= 863.6 s= 864 s= 14.40 min
Again, Cu^{2+} + $2e^{-}$→ Cu
i.e., 2 x 96500C of charge deposit = 63.5 g of Cu $\frac{63.5\ x\ 1295.43}{2\ x\ 96500}$
Therefore, 1295.43 C of charge will deposit = = 0.426 g of Cu
Zn^{2+} + $2e^{-}$→ Zn
i.e., 2 x 96500 C of charge deposit = 65.4 g of Zn $\frac{65.4\ x\ 1295.43}{2\ x\ 96500}$
Therefore, 1295.43 C of charge will deposit == 0.439 g of Zn

4. Ans : Reaction of deposition of Mg from molten $MgCl_2$
$MgCl_2 \rightarrow Mg^{2+} + 2Cl^{-1}$
$Mg^{2+} + 2e^{-} \rightarrow Mg$
24 g of magnesium is deposited by 2x96500 C of electricity
1.2g of Mg will be deposited by $\frac{2x96500}{24}$x1.2 = 9650 C of electricity
Now Q = It , I = Q / t =9650/3600 = 2.68 A

5. Ans:
(i) Faraday first law of electrolysis : According to this law the mass of the substance deposited or liberated at any electrode during electrolysis is directly proportional to the quantity of charge passed through the electrolyte.
$\omega \propto Q$ ($\because Q = I \times t$)
ω = = ZIt

Faraday's second law of Electrolysis
This law states that when the same quantity of electricity is passed through solutions of different electrolytes taken in separate electrolytic cells which are connected in series, the weights of the substance produced at the electrodes are directly proportional to their equivalent weights.



Electrolytic cells (voltameters) connected in series

$\frac{weight\ of\ copper\ deposited}{weight\ of\ silver\ deposited} = \frac{Eq.wt.of\ Cu}{Eq.wt.of\ Ag}$

It is the amount of charge carried by one mole of electrons. This can be obtained by multiplying the charge on one electron by Avogadro's number.
i.e. 1.602×10^{-19} coulombs $\times 6.023 \times 10^{23}$ mol^{-1} = 96490 coulombs mol^{-1}

This quantity of electricity (i.e. 96490 coulombs), which is carried by one mole of electrons, is known as one.

CONDUCTANCE OF ELECTROLYTIC SOLUTION

ANS-1 m = K*1000/molarity
=0.0248*1000/0.20
= 124.5 cm^2/mole

ANS-2 R = 1500 ohm
k = 1.46 x 10^{-4} Scm^{-1}
T = 298K
Cell constant = Conductivity x Resistance
= 0.146 x 10^{-3} S cm^{-1} x 1500
= 0.219 cm^{-1}

ANS-3

METALLIC CONDUCTION	ELCTROLYTIC CONDUCTION
No Chemical change takes place in the conductor.	Chemical changes take place in electrolyte.
Only electrons move.	Matter moves in the form of ions.
At high temperature conductance decreases.	At high temperature conductivity increases.
Shows high conductance.	Have relatively smaller conductance.

ANS-4 Cell constant = k × R
= 0.0129 × 100
= 1.29 cm^{-1}

$$k = \frac{\text{Cell constant}}{\text{Resistance}}$$

$$= \frac{1.29}{520} = 2.48 \times 10^{-3}\ \text{S cm}^{-1}$$

$$\text{Molar conductivity } \wedge m = 10^3\ \text{k/m}$$

$$= \frac{10^3 \times 2.48 \times 10^{-3}}{0.02}$$

$$= 1245\ \text{cm}^2\ \text{mol}^{-1}$$

ANS-5 (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) Λ°_m value of water.

Consider the following chemical equations,

(i) $H2O(I) \rightarrow H^+(aq) + OH^-(aq)$

(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.

ANS-6 Concentration = 0.00241M

Conductivity = 7.896×10^{-5} S cm^{-1}

$\Lambda^\circ = K \times (1000/c)C$

390.5 = 0.00241

ANS-7 On dilution, the number of ions per unit volume decreases. Hence the conductivity decreases.

ANS-8

$$NaCl + KNO_3 \rightarrow NaNO_3 + KCl$$

According to kohlrausch's law, $\Lambda^\circ_m(NaNO_3)$ is given as,

$$\Lambda^\circ_m(NaNO_3) = \Lambda^\circ_m(NaCl) + \Lambda^\circ_m(KNO_3) - \Lambda^\circ_m(KCl)$$

$$= 128 + 111 - 152$$

$$\Lambda^\circ_m(NaNO_3) = 87\ Scm^2\ mol^{-1}$$

ANS-9 λ_0 for $(H^+) = 349.6$ S cm2/mol , λ_0 for $(HCOO^-) = 54.6$ S cm^2/mol

$\lambda m^0(HCOOH) = \lambda 0(H^+) + \lambda 0(HCOO^-) = 349.6 + 54.6 = 404.2$ S cm^2/mol

Degree of dissociation (α)= $\Lambda_c m / \Lambda_0 m = 46.1/404.2 = 0.114$

Calculation of dissociation constant :-

$HCOOH$	$\rightleftharpoons$	$HCOO^-$ +	H^+
C		0	0
C−α		Cα	Cα

$K = C\alpha^2 / 1-\alpha = 0.025 \times (0.114)^2 / 1-0.114 = 3.67 \times 10^{-4}$

ANS-10 Molar conductivity of a strong and weak electrolyte increases with dilution . The molar conductivity increases with decrease in concentration or on dilution. The molar conductivity of a weak electrolyte rises steeply at low concentration. The molar conductivity of a strong electrolyte decreases slightly with the increase in concentration.

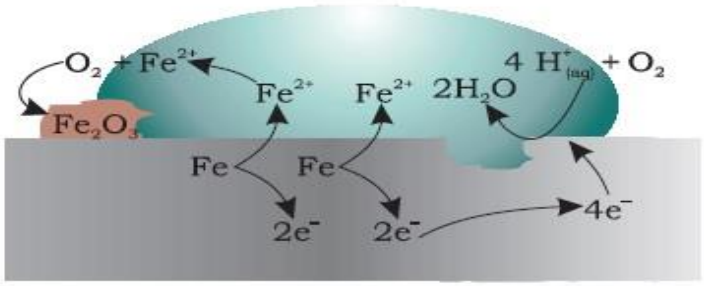
BATTERIES

ANS 1-

During Recharging of Lead Storage Battery following reactions take place at the two terminals:
Negative Terminal:
Act as Cathode- $PbSO_{4(s)} + 2\,e^- \rightarrow Pb_{(s)} + SO_4^{2-}$.
Positive Terminal:
Act as Anode- $PbSO_{4(s)} + 2H_2O \rightarrow PbO_{2(s)} + H_2SO_4(aq) + 2H^+ + 2\,e^-$

Net Reaction : $PbSO_{4(s)} + 2H_2O \rightarrow Pb_{(s)} + PbO_{2(s)} + 2H_2SO_4(aq)$

ANS 2-



Oxidation: $Fe\,(s) \rightarrow Fe^{2+}\,(aq) + 2e^-$
Reduction: $O_2\,(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$
Atomospheric oxidation: $2Fe^{2+}(aq) + 2H_2O(l) + \frac{1}{2}O_2(g) \rightarrow Fe_2O_3(s) + 4H^+(aq)$

With the help of this reaction it is proved that the rusting of iron is an electrochemical process.

Ans 3-
At Anode: $H_2 + 2\,OH^- \rightarrow 2\,H_2O + 2\,e^-$.
At Cathode: $O_2 + 2\,H_2O + 2\,e^- \rightarrow 4\,OH^-$

Advantages – 1. Pollution free and 2. Highly efficient

Ans 4- Cell potential of a mercury cell is constant because overall reaction does not involve any ion in solution whose concentration can change during its life time.

Ans 5- The major difference between the primary and secondary cell is that the primary cells are irreversible means do not charge again after using whereas secondary cells are rechargeable again and again.

3. CHEMICAL KINETICS

(CBSE WEIGHTAGE: 7 MARKS)

QUESTIONS BASED ON MCQ

1. What is the order of reaction decomposition of Ammonia on platinum surface is
(a) Zero order reaction
(b) First order reaction
(c) Second order reaction
(d) Fractional order reaction

2. In the rate equation, when the concentration of reactants is unity then the rate is equal to:
(a) Specific rate constant
(b) Average rate constant
(c) Instantaneous rate constant
(d) None of the above

3. The rate constant of zero-order reactions has the unit
(a) s^{-1}
(b) mol $L^{-1}s^{-1}$
(c) L^2 mol^{-2} s^{-1}
(d) L $mol^{-1}s^{-1}$

4. Radioactive disintegration is an example of
(a) first order reaction
(b) zero order reaction
(c) second order reaction
(d) third order reaction

5. A catalyst alters, which of the following in a chemical reaction?
(a) Entropy
(b) Enthalpy
(c) Internal energy
(d) Activation energy

QUESTIONS BASED ON ASSERTION /REASONING

Read the statements given as assertion & reason both and choose the correct option as per the following instructions.
(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 and R is true.

1. Assertion: The order and molecularity of a reaction are always the same.
Reason: Order is determined experimentally whereas molecularity by a balanced elementary reaction.

2. Assertion: Rate constant of a zero-order reaction has the same unit as the rate of a reaction.
Reason: Rate constant of a zero-order reaction does not depend upon the concentration of the reactant.

3. Assertion: In a first-order reaction, the concentration of the reactant is doubled, its half-life is also doubled.
Reason: The half-life of a reaction does not depend upon the initial concentration of the reactant in first-order reaction.

4. Assertion: All collision of reactant molecules lead to product formation.
Reason: Only those collisions in which molecules have correct orientation and sufficient kinetics energy lead to compound formation.

5. Assertion: In Bimolecular reaction if one of the reactant is in excess, it's called Pseudo first order reaction i.e order is one.
Reason: Rate of reaction does not depend on reactant in large concentration.

COMPETENCY BASED QUESTIONS

QUESTIONS BASED ON AVERAGE AND INSTANTANEOUS RATE OF REACTION

Q.1. Differentiate between average rate and instantaneous rate of reaction.

Q.2 For the reaction $2N_2O_5$ (g) → 4 NO_2 (g) + O_2 (g), the rate of formation of NO_2 (g) is $2{\cdot}8 \times 10^{-3}$ M s^{-1}. Calculate the rate of disappearance of N_2O_5 (g).

Q.3 For the hydrolysis of methyl acetate in aqueous solution, the following result are obtained:

t/s	0	10	20
$[CH_3COOCH_3]$/ $mol\ L^{-1}$	0.10	0.05	0.025

Calculate the average rate of reaction between the time intervals 10 to 20 seconds.
(**Given : Log 2** = 0.3010, **Log 4 = 0. 6021**).

Q.4 For the hydrolysis of methyl acetate in aqueous solution, the following result are obtained:

t/s	0	10	20
$[CH_3COOCH_3]$/ $mol\ L^{-1}$	0.60	0.30	0.15

Calculate the average rate of reaction between the time intervals 30 to 60 seconds.
(**Given : Log 2** = 0.3010, **Log 4 = 0. 6021**).

QUESTIONS BASED ON CONCENTRATION AND RATE LAW

Q 1. For the reaction A→B, the rate of reaction becomes three times when the concentration of A is increased by nine times. What is the order of reaction?

Q 2. Define the term, half-life of a reaction ($t_{1/2}$)

Q 3. A reaction is of second order with respect to a reactant.
How is its rate affected if the concentration of the reactant is (i) Doubled? (ii) Reduced to half?

Q 4. Discuss any three factors which affect the rate of a chemical reaction.

Q 5. 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?

Q 6. A reaction is first order in reactant A and of second order in reactant B.
How is the rate of this reaction affected when.
(i) the concentration of B alone is increased to three times?
(ii) the concentrations of A as well as B are doubled?

Q. 7. Observe the table given showing volume of CO_2 obtained by reaction of $CaCO_3$ and dilute HCl after every minute. Answer the questions that follow: Table showing volume of CO_2 at one minute interval by reaction of $CaCO_3$ with dilute HCl.

Time/mmm	Volume of CO_2/cm^3
0	0
1	24 cm^3
2	34 cm^3
3	38 cm^3
4	40 cm^3
5	40 cm^3
6	40 cm^3

(*a*) What happens to rate of reaction with time?
(*b*) Why does $CaCO_3$ powder react faster than marble chips?
(*c*) What happens to rate of reaction if concentrated HCl is used?
(*d*) In manufacture of NH_3,
$N_2(g) + 3H_2(g) \rightarrow 2NH_3$ + heat
What is effect of pressure on rate of reaction?
(*e*) Why does rate of reaction becomes almost double for energy 10° rise in temperature?

QUESTIONS BASED RATE LAW AND ORDER OF THE REACTION

Q 1. In a reaction between A and B, the initial rate of reaction (r_0) was measured for different initial concentrations of A and B as given below:

A/mol L^{-1}	0.20	0.20	0.40
B/mol L^{-1}	0.30	0.10	0.05
r_0/ mol $L^{-1}s^{-1}$	5.07×10^{-5}	5.07×10^{-5}	1.43×10^{-4}

What is the order of the reaction with respect to A and B?

Q2. The following results have been obtained during the kinetic studies of the reaction:

$2A + B \rightarrow C + D$

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}

Determine the rate law and the rate constant for the reaction.

Q3. The reaction between A and B is first order with respect to A and zero order with respect to B.

Fill in the blanks in the following table:

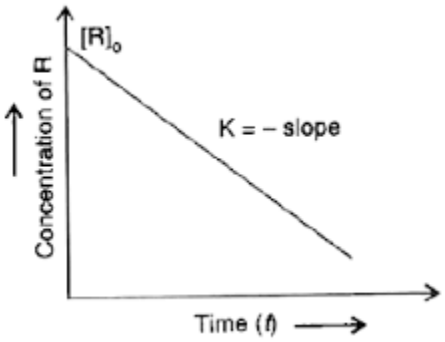
Experiment	[A] mol L^{-1}	[B] mol L^{-1}	Initial rate/mol $L^{-1}min^{-1}$
I	0.1	0.1	2.0×10^{-2}
II	-	0.2	4.0×10^{-2}
III	0.4	0.4	-
IV	-	0.2	2.0×10^{-2}

QUESTIONS BASED ON ZERO ORDER REACTION

1. The decomposition of NH_3 on the platinum surface is zero order reaction. Calculate the rates of production of N_2 and H_2 if k= 2.5 $\times$ 10^{-4} mol L^{-1} s^{-1}.

2. What is the rate equation for the reaction $2A+B \rightarrow C$ if the order of the reaction is zero ?
   Also give an example of zero order reaction.

3. Mention the order for which following curve has been drawn.
   Also draw rate Vs concentration curve for the same order of reaction.



4. If the zero order reaction takes 100 min for 50% completion, how much time will it take for the 75% completion of the reaction?

5. The rate constant value for a zero order reaction is 2 x 10^{-2} mol $L^{-1}s^{-1}$. If the concentration of the reactant after 25 seconds is 0.5 M, then find the initial concentration of the reaction.

QUESTIONS BASED ON FIRST ORDER REACTION

Q.1 What are the units of rate constant for first order reaction?

Q.2 **Time required to decompose SO_2Cl_2 to half of its initial amount is 60 minutes.**
If the decomposition is a first order reaction, calculate the rate constant of the reaction.

Q 3 A first order reaction has a rate constant 1.15 x 10^{-3} s^{-1}.
How long will 5 g of this reactant take to reduce to 3g?

Q 4 The half-life for radioactive decay of ^{14}C is 5730 years. An archaeological artefact containing wood had only 80% of the ^{14}C found in a living tree. Estimate the age of the sample.

Q.5 A first order reaction takes 40 min for 30% decomposition. Calculate its half-life period.

Q.6 For the decomposition of azo Isopropane to hexane and nitrogen at 543 K, the following data are obtained. Calculate rate constant.

t (sec)	*P*(mm of Hg)
0	35.0
360	54.0
720	63.0

Q.7 The following data were obtained during the first order thermal decomposition of SO_2Cl_2 at a constant volume. Calculate the rate of the reaction when total pressure is 0.65 atm.

$SO_2Cl_{2(g)} \rightarrow SO_{2(g)} + Cl_{2(g)}$

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

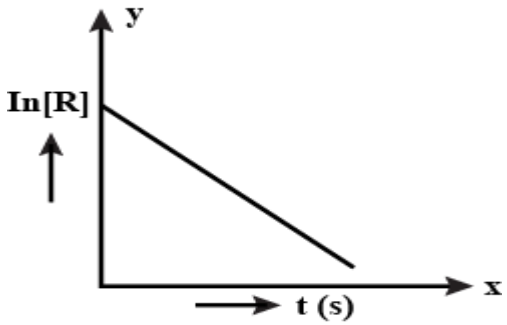
Q.8 During nuclear explosion, one of the products is ^{90}Sr with half-life of 28.1 years.

If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby instead of calcium, how much of it will remain after 10 years and 60 years if it is not lost metabolically?

Q 7. A first order reaction takes 10 minutes for 25% decomposition. Calculate $t_{1/2}$ for the reaction. (Given: log 2 = 0.3010, log 3 = 0.4771, log 4 = 0.6021).

Q.8 The rate constant for a first order reaction is 60 per second . How much time will it take to reduce the initial concentration of the reactant to 1/10 th of its initial value?

Q.9 For a certain chemical reaction variation in the concentration ln [R] vs. time plot is given alongside . For this reaction what is the slope of the curve ?



(i) Predict the order of the reaction.
(ii) What is the slope of the curve?

QUESTIONS BASED ON PSEUDO FIRST ORDER REACTION

1. Define pseudo first order reaction with two example.
2. Hydrolysis of methyl acetate in aqueous solution has been studied by titrating the liberated acetic acid against sodium hydroxide. The concentration of the ester at different times is given below.

t/min	0	30	60	90
C/mol L^{-1}	0.8500	0.8004	0.7538	0.7096

Show that it follows a pseudo first order reaction, as the concentration of water remains nearly constant (55 mol L^{-1}), during the course of the reaction.
What is the value of k′ in this equation? Rate = k′ $[CH_3COOCH_3][H_2O]$

QUESTIONS BASED ON HALF-LIFE

Q1. Show that in a first order reaction, time required for completion of 99.9% is 10 times of half-life ($t_{1/2}$) of the reaction.
Q2. For a first order reaction, show that time required for 75% completion is twice the time required for the completion of 50% of reaction.

QUESTIONS BASED ON EFFECT OF TEMPERATURE

1. Activation Energy E_a and 'A' (Arrhenius constant) are 104.4 kJ mol^{-1} and 6.0×10^{14} S^{-1} respectively. What is value of 'k' when T is ∞?
2. The rate constants of a reaction at 200 K and 500 K are 0.02s^{-1} and 0.20s^{-1}respectively.
   Calculate the value of E_a (Given 2.303R = 19.15 $JK^{-1}mol^{-1}$)

Answers

MCQ

1. a 2. a 3. b 4. a 5. d

ASSERTION REASON

1. D 2. A 3. D 4. D 5. A

(ANSWERS) AVERAGE AND INSTANTANEOUS RATE OF REACTION

Q. 1 Ans. The ratio of change of concentration of reactants to the time consumed in that change is called average rate of reaction.
The rate of reaction at a particular instant is called instantaneous rate of reaction.
Q.2 Ans. rate of disappearance of N_2O_5 = 1.4x 10^{-3} Ms^{-1}
Q.3 Ans. Average rate of reaction = 0.0025 mol $L^{-1}s^{-1}$
Q.4 Ans. Average rate of reaction = 0.005 mol $L^{-1}s^{-1}$

(ANSWERS) QUESTIONS BASED ON CONCENTRATION AND RATE LAW

1. Given that, rate of reaction becomes three times as the concentration of A is increased by 9 times
   $\Rightarrow 3r=k\,[9A]^{n}$
   $3=9^{n}$ or $3^{1}=3^{2n}$

⇒ 2n=1 or n=1/2

∴ Rate, r=k [A] $^{1/2}$ Order of the reaction is ½.

2. The half-life of a chemical reaction can be defined as the time taken for the concentration of a given reactant to reach 50% of its initial concentration (i.e. the time taken for the reactant concentration to reach half of its initial value).

3. a) 4 times b) ¼ times

4. Any three factors are
   a) Catalyst
   b) Concentration change
   c) Temperature

5. First order reaction

6. a) 9 times b) 8 times

7
(a) The rate of reaction first decreases with time then becomes constant.
(b) $CaCO_3$ powder has more surface area than marble chips therefore, more rate of reaction.
(c) The rate of reaction will increase because rate of reaction increases with the increase in concentration.
(d) The rate of reaction increases with increase in pressure.
(e) It is because number of molecules undergoing effective collisions become almost double, hence rate of reaction almost doubled.

(ANSWER) RATE LAW AND ORDER OF THE REACTION

Ans.1 Assume; the order of the reaction with respect to A is x and with respect to B is y. Therefore, the rate of reaction (r_0) = k $[A]^x$ $[B]^y$

5.07×10^{-5}= k $[0.20]^x$ $[0.30]^y$ (i)

5.07×10^{-5} = k $[0.20]^x$ $[0.10]^y$ (ii)

1.43×10^{-4} = k $[0.40]^x$ $[0.05]^y$ (iii)

Dividing equation (i) by (ii), we obtain

$$\frac{5.07x10^{-5}}{5.07x10^{-5}} = \frac{k[0.20]^x[0.30]^y}{k[[0.20]^x[0.10]^y}$$

$$1 = \frac{k[0.30]^y}{k[0.10]^y} = \left(\frac{0.30}{0.10}\right)^0 = \left(\frac{0.30}{0.10}\right)^y$$

y = 0

Dividing equation (iii) by (ii), we obtain

$$\frac{1.43 \times 10^{-4}}{5.07 \times 10^{-5}} = \frac{k[0.40]^x[0.05]^y}{k[[0.20]^x[0.30]^y}$$

$$\frac{1.43 \times 10^{-4}}{5.07 \times 10^{-5}} = \frac{k[0.40]^x}{k[[0.20]^x}$$ [Since y = 0 $[0.05]^y = [0.30]^y = 1$]

$2.821 = 2^x$

Log 2.821= x log 2

x = (log2.821)/ x log 2

= 1.496= 1.5 (approx)
From the above calculation, we get the order of the reaction with respect to A =1.5 and with respect to B = zero.

Ans.2 Rate law may be expressed as
Rate=k$[A]^x[B]^y$
$(Rate)_1=6.0\times10^{-3}=k(0.1)^x(0.1)^y$……(i)
$(Rate)_2=7.2\times10^{-2}=k\ (0.3)^x(0.2)^y$……(ii)
$(Rate)_3=2.88\times10^{-1}=k\ (0.3)^x(0.4)^y$……(iii)
$(Rate)_4=2.40\times10^{-2}=k\ (0.4)^x(0.1)^y$……(iv)

$$\frac{(Rate)1}{(Rate)4} = \frac{6.0\ x\ 10^{-3}}{2.40\ x\ 10^{-2}} \quad \frac{k(0.1)^x(0.1)^y}{k(0.4)^x(0.1)^y}$$

$$\frac{1}{4} = \frac{k(0.1)^x}{k(0.4)^x} = \left(\frac{1}{4}\right)^x$$

X = 1

$$\frac{(Rate)2}{(Rate)3} = \frac{7.2\ x\ 10^{-2}}{2.88\ x\ 10^{-1}} \quad \frac{k(0.3)^x(0.2)^y}{k(0.3)^x(0.4)^y}$$

$$\frac{1}{4} = \frac{k(0.2)^y}{k(0.4)^y} = \left(\frac{1}{2}\right)^y \Rightarrow\ y = 2$$

Rate law expression is given by
Rate=k$[A][B]^2$
Rate constant k can be determined by placing the values of A, B and rate of formation of D.
By taking the values from experiment II
Rate =k$[A][B]^2$

$$k = \frac{Rate}{[A][B]^2}$$

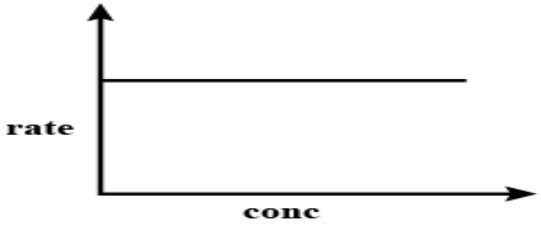
$$k = \frac{7.2\ x\ 10^{-2} mol\ L^{-1}\ \overset{-1}{\min}}{(0.3\ \text{mol}\ L^{-1})(0.2\ \text{mol}\ L^{-1})}$$

k = 6.0 $mol^{-2}\ L^2\ min^{-1}$

Ans 3. According to question the given reaction is of the first order with respect to A and of zero order with respect to B.
Therefore, the rate of the reaction is given by,
Rate = k $[A]^1\ [B]^0$
Rate = k [A]
From experiment I, we get
2.0×10^{-2}mol $L^{-1}min^{-1}$=k (0.1 mol L^{-1})
k = 0.2 min^{-1}
From experiment II, we get
4.0×10^{-2}mol $L^{-1}min^{-1}$ = 0.2 min^{-1} [A]
[A] = 0.2 mol L^{-1}
From experiment III, we get
Rate = 0.2 min^{-1} × 0.4 mol L^{-1} = 0.08 mol $L^{-1}min^{-1}$
From experiment IV, we get
2.0×10^{-2} mol $L^{-1}min^{-1}$ = 0.2min^{-1} [A]
[A] = 0.1 mol L^{-1}

(ANSWER) ZERO ORDER REACTION

1. Rate = k = -½ $d[NH_3]/dt$ = + $d[N_2]/dt$ = + ⅓ $d[H_2]/dt$
   Rate of production of N_2 = $d[N_2]/dt$ = k = 2.5×10^{-4} mol/L s
   Rate of production of H_2 = $d[H_2]/dt$ = 3×k = $3\times2.5\times10^{-4}$ = 7.5×10^{-4} mol/L s
2. $r = k[A]^0[B]^0 = k$
   $2\ NH_3\ (g) \rightarrow N_2(g) + 3H_2(g)$
3. Zero order reaction.



4. For a zero order reaction, $[A] = [A_O] - kt$
   For 50% completion, [A] = 50 M, $[A_O]$= 100 M, $t_{50\%}$= 100 min
   $[A] = [A_O] - kt$
   $50 = 100 - k\ (100)$
   $k = 0.5\ molL^{-1}min^{-1}$
   For 75% completion, [A] = 25 M, $[A_O]$= 100 M, $t_{75\%}$= ?
   $[A] = [A_O] - kt$
   $25 = 100 - 0.5t$
   t= 150 min
5. Concentration of reactant after 25 s,[A] = 0.5 M= 0.5 mol/L
   Rate constant, k = $2\times10^{-2}\ molL^{-1}\ s^{-1}$
   Concentration of reactant initially, $[A_O]$ = ?
   The expression for a zero order reaction is given by
   $[A] = [A_O] - kt$
   $0.5\ mol/L = [A_O] - [(2\times10^{-2}\ molL^{-1}\ s^{-1})\ (25s)]$
   $0.5\ mol/L = [A_O] - 5\times10^{-1}\ mol/L$
   $[A_O] = 1\ mol/L$

ANSWER- FIRST ORDER REACTION

Q.1 time $^{-1}$

Q.2

$$k = \frac{0.693}{t_{1/2}} = \frac{0.693}{60}$$
$$= 1.155\times10^{-2}\ min^{-1}$$
$$= 1.925\times10^{-4}\ s^{-1}$$

Q.3 For first order reaction

$[A]_0 = 5g$; $[A] = 3g$; $k = 1.15 \times 10^{-3}\ s^{-1}$

For 1st order reaction,

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

$$= \frac{2.303}{1.15 \times 10^{-3} s^{-1}} \log \frac{5}{3}$$

$$= 2.00 \times 10^3 (\log 1.667)$$

$$= 443.8\ s \simeq 444\ s$$

Q.4 For first order reaction

$$\text{Decay constant } (k) = \frac{0.693}{t_{1/2}} = \frac{0.693}{5730}\ \text{year}^{-1}$$

$$t = \frac{2.303}{k} \log \frac{[A_0]}{[A]}$$

$$= \frac{2.303}{(0.693/5730\ \text{years}^{-1})} \log \frac{100}{80}$$

$$= \frac{2.303 \times 5730}{0.693} \times 0.0969 = 1845\ \text{years.}$$

Q.5 For first order equation

30% decomposition means that $x = 30\%$ of $[R_0]$ or, $[R] = [R_0] - 0.3[R_0] = 0.7[R_0]$

For reaction of 1st order,

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]} = \frac{2.303}{40} \log \frac{[R_0]}{0.70[R_0]}$$

$$= \frac{2.303}{40} \log \frac{10}{7}\ \text{min}^{-1}$$

$$= \frac{2.303}{40} \times 0.1549\ \text{min}^{-1} = 8.918 \times 10^{-3}\ \text{min}^{-1}$$

For a 1st order reaction,

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693}{8.918 \times 10^{-3}\ \text{min}^{-1}} = 77.7\ \text{min}$$

Q.6

$$\underset{\text{Azoisopropane}}{(CH_3)_2CHN{=}NCH(CH_3)_{2(g)}} \longrightarrow N_{2(g)} + \underset{\text{Hexane}}{C_6H_{14(g)}}$$

Initial pressure	P_0	0	0
Pressure after time t	$P_0 - p$	p	p

Total pressure after time t (P_t)
$= (P_0 - p) + p + p = P_0 + p$ or $p = P_t - P_0$
$[R]_0 \propto P_0$ and $[R] \propto P_0 - p$
On substituting the value of p,
$[R] \propto P_0 - (P_t - P_0)$, *i.e.* $[R] \propto 2P_0 - P_t$
As decomposition of azoisopropane is a first order reaction

$$\therefore \quad k = \frac{2.303}{t}\log\frac{[R]_0}{[R]} = \frac{2.303}{t}\log\frac{P_0}{2P_0 - P_t}$$

When $t = 360$ sec,

$$k = \frac{2.303}{360}\log\frac{35.0}{2\times 35.0 - 54.0} = \frac{2.303}{360}\log\frac{35.0}{16}$$
$$= 2.175 \times 10^{-3}\ s^{-1}$$

When $t = 720$ sec,

$$k = \frac{2.303}{720}\log\frac{35.0}{2\times 35.0 - 63} = \frac{2.303}{720}\log 5$$
$$= 2.235 \times 10^{-3}\ s^{-1}$$

$\therefore$ Average value of k

$$= \frac{2.175 + 2.235}{2} \times 10^{-3}\ s^{-1}$$
$$= 2.20 \times 10^{-3}\ s^{-1}$$

Q.7

$$SO_2Cl_{2(g)} \longrightarrow SO_{2(g)} + Cl_{2(g)}$$

Let initial pressure	P_0	0	0
Pressure at time t	$P_0 - p$	p	p

Let initial pressure $P_0 \propto R_0$
Pressure at time t, $P_t = P_0 - p + p + p = P_0 + p$
$\therefore$ Pressure of reactant at time t

$$= P_0 - p = 2P_0 - P_t \propto R$$

Using formula, $k = \frac{2.303}{t}\log\frac{P_0}{2P_0 - P_t}$
When $t = 100$ s,

$$k = \frac{2.303}{100}\log\frac{0.5}{2\times 0.5 - 0.6} = \frac{2.303}{100}\log(1.25)$$
$$= \frac{2.303}{100}(0.0969) = 2.2316 \times 10^{-3}\ s^{-1}$$

When $P_t = 0.65$ atm,
$\therefore$ Pressure of SO_2Cl_2 at time t ($p_{SO_2Cl_2}$),
$R = 2P_0 - p_t = 2 \times 0.50 - 0.65$ atm $= 0.35$ atm
Rate at that time $= k \times p_{SO_2Cl_2}$
$= (2.2316 \times 10^{-3}) \times (0.35)$
$= 7.8 \times 10^{-4}$ atm s^{-1}

Q.8

As radioactive disintegration follows first order kinetics. Hence

Decay constant of ^{90}Sr, $(\lambda) = \frac{0.693}{t_{1/2}} = \frac{0.693}{28.1}$

$= 2.466 \times 10^{-2}\ yr^{-1}$

To calculate the amount left after 10 years

Given, $[R_0] = 1\ \mu g$, $t = 10$ years,

$k = 2.466 \times 10^{-2}\ yr^{-1}$, $[R] = ?$

Using formula, $\lambda = \frac{2.303}{t}\log\frac{[R_0]}{[R]}$

or $\quad 2.466 \times 10^{-2} = \frac{2.303}{10}\log\frac{1}{[R]}$

$$\frac{2.466 \times 10^{-2} \times 10}{2.303} = -\log[R]$$

or, $\quad \log [R] = -0.1071$

or, $\quad [R] = \text{Antilog}\ (-0.1071) = 0.7814\ \mu g$

To calculate the amount left after 60 years,

$t = 60$ years, $[R_0] = 1\ \mu g$, $[R] = ?$

or, $\quad 2.466 \times 10^{-2} = \frac{2.303}{60}\log\frac{1}{[R]}$

or, $\quad \frac{2.466 \times 10^{-2} \times 60}{2.303} = -\log [R]$

or, $\quad \log [R] = -0.6425$

or, $\quad [R] = \text{Antilog}\ (-0.6425) = 0.2278\ \mu g$

Q.9

$$t_{25\%} = \frac{2.303}{k}\log\frac{[R]_0}{\frac{3}{4}[R]_0}$$

[∵ 25% of reactants has been changed into products

$$[R] = [R]_0 - \frac{25}{100}[R]_0 = \frac{75}{100}[R]_0 = \frac{3}{4}[R]_0$$]

$$k = \frac{2.303}{10\ min}[\log 4 - \log 3]$$

$$\Rightarrow \quad k = \frac{2.303}{10} \times (0.6021 - 0.4771) = \frac{2.303}{10} \times 0.1250$$

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

$$\Rightarrow \quad t_{1/2} = \frac{2.303 \times 10}{2.303 \times 0.1250} \times 0.3010 = \frac{3.010}{0.1250} = 24.08\ min.$$

Q.10

$k = 60\ s^{-1}$

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

$t = \frac{2.303}{60} \log \frac{[R]_0}{\frac{1}{10}[R]_0} = \frac{2.303}{60} \log 10$

$t = \frac{2.303}{60\ s^{-1}} = 3.83 \times 10^{-2}\ s \qquad [\because \log 10 = 1]$

Q.11 Let the slope of the curve be −k

$\Rightarrow \ln[R] = -k$; t=0 R= R_0

$\Rightarrow R = R_0 e^{-kt}$, which is the equation of first order reaction.

Hence, the Order of the given reaction is First.

⇒k is rate constant of the reaction

therefore,Slope represents negative of the rate constant of reaction

ANSWER PSEUDO FIRST ORDER REACTION

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

Example – Hydrolysis of ester (acidic medium)

$CH_3COOC_2H_5 + H_2O \longrightarrow CH_3COOH + C_2H_5OH$

Inversion of sucrose

2. For pseudo first order reaction, the reaction should be first order with respect to ester when $[H_2O]$ is constant. The rate constant k for pseudo first order reaction is

t/min	C/ mol L^{-1}	k'/min^{-1}
0	0.8500	–
30	0.8004	2.004×10^{-3}
60	0.7538	2.002×10^{-3}
90	0.7096	2.005×10^{-3}

It can be seen that $k' [H_2O]$ is constant and equal to 2.004×10^{-3} min–1 and hence, it is pseudo first order reaction.

We can now determine k from $k' [H_2O] = 2.004 \times 10^{-3}\ min^{-1}$

$k' [55\ mol\ L^{-1}] = 2.004 \times 10^{-3}\ min^{-1}$ $k' = 3.64 \times 10^{-5}\ mol^{-1}\ L\ min^{-1}$

(ANSWER) HALF-LIFE

Ans 1. For a first order reaction, time required for 99.9% completions

$$t_{99.9\%} = \frac{2.303}{k}\log\frac{100}{100-99.9}$$

$$= \frac{2.303}{k}\log\frac{100}{0.1}$$

$$= \frac{2.303}{k}\log 1000$$

$$= \frac{2.303}{k} \times 3 \quad = \quad \frac{6.909}{k}$$

For a first order reaction, time required for 50% completions

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

$$\frac{t(99.9\%)}{t(50\%)} = \frac{6.909}{k} \times \frac{k}{0.693}$$

Therefore, $t_{99.9\%} = 10t_{1/2}$

Ans2. For a first order reaction, time required for 75% completions

$$t_{75\%} = \frac{2.303}{k}\log\frac{100}{100-75}$$

$$= \frac{2.303}{k}\log 4$$

$$= \frac{2.303}{k} \times 0.6020$$

For a first order reaction, time required for 50% completions

$$T_{50\%} = \frac{2.303}{k}\log\frac{100}{100-50}$$

$$= \frac{2.303}{k}\log 2$$

$$= \frac{2.303}{k} \times 0.3010$$

$$\frac{t\,(75\%)}{t(50\%)} = \frac{2.303 \times 0.6020}{k} \times \frac{k}{2.303 \times 0.3010} = \frac{0.6020}{0.3010} = 2$$

Therefore, $t_{75\%} = 2t_{50\%}$

ANSWER/ EFFECT OF TEMPERATURE

1.

Arrhenius equation $K = Ae^{-Ea/RT}$

As $T \longrightarrow \infty$, $RT \longrightarrow \infty$

$\frac{-Ea}{RT} \longrightarrow 0$ $e^{-Ea/RT} \longrightarrow 1$

Hence $K \longrightarrow A$ as $T \longrightarrow \infty$

$\therefore$ Value of K as $T \longrightarrow \infty = 6.0 \times 10^{14} S^{-1}$

2.

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

$$\log\frac{0.20}{0.02} = \frac{Ea}{2.303R}\left[\frac{1}{200} - \frac{1}{500}\right]$$

$$\log 10 = \frac{Ea}{19.15}\left(\frac{300}{200 \times 600}\right)$$

$$Ea = \frac{19.15 \times 200 \times 500}{300}$$

$$Ea = 6383\ J / mol$$

-----/////-----

4. d & f BLOCK ELEMENTS

(CBSE WEIGHTAGE: 7 MARKS)

1. MCQ BASED QUESTIONS

1. The property which is not a characteristic of transition metals is
   (a) variable oxidation states.
   (b) tendency to form complexes.
   (c) formation of coloured compounds.
   (d) natural radioactivity.

2. Zr and Hf have almost equal atomic and ionic radii because of
   (a) diagonal relationship
   (b) lanthanoid contraction
   (c) actinoid contraction
   (d) belonging to the same group

3. Which of the following is likely to form white salts?
   (a) Cu^{2+}
   (b) Ti^{3+}
   (c) Sc^{3+}
   (d) Fe^{3+}

4. Which one of the following characteristics of the transition metals is associated with higher catalytic activity?
   (a) High enthalpy of atomisation
   (b) Paramagnetic behaviour
   (c) Colour of hydrate ions
   (d) Variable oxidation states

5. When manganese dioxide is fused with KOH in air. It gives
   (a) potassium manganate
   (b) potassium permanganate
   (c) manganese hydroxide
   (d) Mn_3O_4.

2. ASSERTION AND REASON BASED QUESTIONS

Choose the correct answer from the following choices

a Both assertion and reason are correct statements and reason is correct explanation of assertion

b Both assertion and reason are correct statements but reason is not correct explanation of assertion

c Assertion is correct statement but reason is wrong statement

d Assertion is wrong statement but reason is correct statement

1. **Assertion:** Zn, Cd and Hg are normally not considered transition metals
   Reason: d-Orbitals in Zn, Cd and Hg elements are completely filled, hence these metals do not show the general characteristics properties of the transition elements

2. **Assertion:** The highest oxidation state of osmium is +8.
   Reason: Osmium is a 5d-block

3. **Assertion:** Cu cannot liberate hydrogen from dilute acids.
   Reason: Because it has negative standard electrode potential.

4. **Assertion:** Tungsten has very low enthalpy of atomization.
   Reason: Tungsten has maximum number of unpaired electrons.

5. **Assertion:** The oxides of lower transition metal are basic whereas the higher oxides are usually acidic.
   Reason: $Cr_2O_3$is amphoteric in nature.

COMPETENCY BASED QUESTIONS

3. REASONING BASED QUESTIONS

1. Account for the following regarding transition metals:
   (i) Transition metal shows variable oxidation state
   (ii) Transition metals have high enthalpy of atomization.
   (iii) Transition metals have tendency to form complex.
   (iv) Transition metal complexes are coloured.
   (v) Transition metals act as catalyst
   (vi) Transition metals form interstitial compound.
   (vii) Transition metals form alloy.
2. Zn, Cd, Hg are not regarded as transition metal but kept in transition series.
3. Mn shows the highest oxidation state of +7 with oxygen but with fluorine of +4
4. Cu^{2+} Salts are coloured but Zn^{2+} salts are colourless.
5. The radii of 2nd & 3rd transition series are almost same.
6. Of d^4 Configuration Mn^{3+} acts as an oxidizing agent but Cr^{2+} acts as reducing agent.
7. Cr^{2+} is a strong reducing agent.

8. Zn, Cd, Hg are soft metals.

9. Following are the transition metal ion of 3d Series Ti^{4+}, V^{2+}, Mn^{3+}, Cr^{3+}
(Ti=22, V=23, Cr=24, Mn=25)
Answer the following:
   i. Which ion is most stable in aqueous solution and why?
   ii. Which ion is strong oxidising agent and why?
   iii. Which ion is colourless & why ?

10. Why the m.p. of Mn in 1st transition series is abnormally low?

11. There is a general increase in the density from Titanium to Copper.

12. Colour of $KMnO_4$ disappear when oxalic and is added to its solution in acidic medium.

13. Why Cu^+ is unstable in aqueous solution.

14. (i) On what ground can you say that scandium (Z=21) is a transition element but zinc (Z=30) is not?
(ii) Density of d-block elements is quite high. Why?
(iii) Ni(II) compounds are thermodynamically more stable than Pt(II) compounds. Why?

15. Assign suitable reasons for the following:
(i) In the 3d series from Sc to Zn the enthalpy of atomization of Zn is the lowest.
(ii) The Mn^{2+} compounds are more stable than Fe^{2+} towards oxidation to their +3 state.
(iii) Sc^{3+} is colourless in aqueous solution, whereas Ti^{3+} is coloured.

16. Silver atom has completely filled d orbitals ($4d^{10}$) in its ground state. How can you say that it is a transition element?

17. Which of the 3d series of the transition metals exhibits the largest number of oxidation states and why?

18. The $E°(M^{2+}/M)$ value for copper is positive (+0.34 V). What is possible reason for this?

19. How would you account for the irregular variation of ionisation enthalpies (first and second) in the first series of the transition elements?

20. Why is the highest oxidation state of a metal exhibited in its oxide or fluoride only?

21. Actinoid contraction is greater from element to element than lanthanoid contraction. Why?

22. Why are Mn^{2+} compounds more stable than Fe^{2+} towards oxidation to their +3 state?

23. How would you account for the following?

(i) Cobalt (II) is stable in aqueous solution but in the presence of complexing reagents it is easily oxidised.

(ii) The d^1 configuration is very unstable in ions.

24. State reasons for the following observations:

(i) Ti^{4+} is colourless whereas V^{4+} is coloured in an aqueous solution.

(ii) There is a greater horizontal similarity in the properties of the transition elements than of the main group elements.

25. Explain the following observations giving an appropriate reason for each.

(i) There occurs much more frequent metal-metal bonding in compounds of heavy transition metals (i.e. 3rd series).

(ii) Mn^{2+} is much more resistant than Fe^{2+} towards oxidation.

4. POTASSIUM DICHROMATE & POTASSIUM PERMANGANATE

Q.1- What is the effect of pH on dichromate ion solution?

Q.2- Complete following reactions:-

(i) $MnO_4^- + H^+ + Fe^{2+} \rightarrow$

(ii) $MnO_4^- + C_2O_4^{2-} + H^+ \rightarrow$

(iii) $MnO_4^- + OH^- + I^- \rightarrow$

Q.3-(a) Write the equation involved in the preparation of potassium dichromate from iron chromite. What happens when potassium dichromate reacts with

(i) Hydrogen sulphide (ii) $FeSO_4$?

Q.4 Complete the following chemical equations :

(i) MnO_4^- (aq) + $S_2O_3^{2-}$ (aq) + H_2O (1) →

(ii) $Cr_2O_7^{2-}$ (aq) + Fe^{2+} (aq) + H^+ (aq) →

Q.5 Complete the following chemical equations :

(*i*) $Cr_2O_7^{2-} + H^+ + I^- \rightarrow$

(*ii*) $MnO_4^- + NO_2^- + H^+ \rightarrow$

Q.6 What is meant by 'disproportionation'? Give an example of a disproportionation reaction in aqueous solution.

Q.7. Describe the reaction involved in the preparation of potassium permanganate. How does the acidified permanganate solution react with oxalic acid? Write the ionic equations for the reactions.

Q.8. Describe the oxidising action of potassium dichromate and write the ionic equations
for its reaction with (i) iodine (ii) H_2S.

Q9. Complete the following chemical equations:

(i) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow$

(ii) $Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \rightarrow$

Q10. What happens when $(NH_4)_2Cr_2O_7$ is heated?

Q11. Complete the following chemical equations :

(i) $MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow$

(ii) $KMnO_4 \xrightarrow{\text{heated}}$

(iii) $Cr_2O_7^{2-} + H_2S + H^+ \longrightarrow$

Q12. Complete the following chemical equations:

(i) $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \longrightarrow$

(ii) $2CrO_4^{2-} + 2H^+ \longrightarrow$

(iii) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow$

Q13. Write balanced chemical equations for the two reactions showing oxidizing nature of potassium permanganate.

Q14. What is meant by "disproportionation"? Give one example of disproportionation reaction in aqueous solutions.

5. WORD PROBLEM

1. When a brown compound of Manganese (A) is treated with HCl it gives a gas (B). the gas taken in excess reacts with NH_3 to give an explosive compound (C). Identify (A), (B) and (C).

2. When an oxide of manganese (A) is fused with KOH in the presence of an oxidizing agent and dissolved in water it gives a dark solution of compound (B). Compound (B) disproportionates in neutral or acidic solution to give purple compound (C). An alkaline solution of (C) oxidises KI to a compound (D) and compound (A) is also formed. Identify (A) to (D).

3. A violet compound of manganese (A) decomposes on heating to liberate oxygen and compounds (B) and (C) of manganese are formed. Compound (C) reacts with KOH in the presence of KNO_3 to give compound (B). On heating compound (C) with conc. H_2SO_4 and NaCl, Cl_2 gas is liberated and compound (D) of manganese is formed. Identify A, B, C, D along with reactions involved.
4. When chromite ore $FeCr_2O_4$ is fused with NaOH in presence of air, a yellow coloured compound (A) is obtained which on acidification with dilute sulphuric acid gives a compound (B). Compound (B) on reaction with KC1 forms an orange coloured crystalline compound (C).
(i) Write the formulae of the compounds (A), (B) and (C).
(ii) Write one use of compound (C).

6. LANTHANOIDS AND ACTINOIDS

1. Answer the following:

(i) What is general electronic configuration of lanthanoids?
(ii) What are the common oxidation state of Ce(58) ?
(iii) Why do actinoids show a wide range of Oxidation states?

2. What is lanthanoid contraction? Write its one consequence.

3. Account for the following:

(i) Actinoid contraction is greater than lanthanoid contraction.
(ii) Chemistry of actinoids is complicated as compared to lanthanoids.
(iii) Zr and Hf have almost identical radii.

4. Write one similarity and one difference between lanthanoid and actionoid elements.

5. Name a member of the lanthanoid series which is well known to exhibit +2 oxidation state.

-ANSWER-

1. MCQ BASED QUESTIONS

1. (d)
2. (b)
3. (c)
5. (d)
6. (a)

2. ASSERTION AND REASON BASED QUESTIONS

1. (a)
2. (b)
3. (c)
4. (d)
5. (b)

COMPETENCY BASED QUESTIONS

3. REASONING BASED QUESTIONS

1. (i) Due to participation of ns and (n-1)d electrons which are of almost same energy.

   (ii)Due to strong metallic bond

   (iii) vacant d orbital and small size and high Charge.

   (iv)Due to d-d transition and presence of unpaired electron

   (v) Due to variable O.S

   provides suitable surface for the reactant to adsorb on it and form unstable intermediate which lower down the activation energy of the reaction to takes place.

   (vi) because Small size atom such as C, H,S etc occupy interstitial site of the lattice and are very hard, high m. p. shows conductivity & chemically inert

   (vii) Due to almost Similar radii they substitute from crystal lattice.
2. Because they have completely filled d-orbital & properties similar to d-block element.
3. Because oxygen has tendency to form multiple bond while fluorine is monovalent.
4. Cu^{2+} has unpaired electron in d-orbital Zn^{2+} have no unpaired electron in d-orbital
5. Due to lanthanoid contraction.
6. Mn^{3+} gain electron to attain $3d^5$ configuration so act as O.A. Cr^{2+} loose e to attain stable $3d^3$ (t_2g^3) configuration so act as R.A.
7. Cr^{2+} loose electron to attain stable $3d^3$(t_2g^3) configuration acts as R.A.
8. Due to weak metallic bond.
9.

i. Cr^{3+} due to half filled t_2g^3

ii. Mn^{3+} because it gain electron to attend the stable Mn^{2+} ($3d^5$) configuration

iii. Ti^{4+} have no unpaired electron .

10. Electrons are tightly held by the nucleus so that delocalization is less & metallic bond is much weaker.

11. Because mass increases and volume decreases.

12. $KMnO_4$ acts as oxidising agent it oxidises oxalic acid to CO_2 & self reduced to Mn^{2+} which is colourless.

13.Because it undergo disproportionation $2Cu^+ \rightarrow Cu(s) + Cu^{2+}$

14. **(i)** It is because Sc (21) has incompletely filled d-orbital, that is why it is transition element, whereas Zn(30) does not have incompletely filled d-orbitals, therefore, it is not regarded as transition element.

(ii) This is due to fact that their small atomic volume, high nuclear charge and mass.

(iii) This is because that sum of ionisation energies (E_1+E_2) is less in case of Ni than Pt.

15.(i) Zinc does not have unpaired electrons and larger in size, therefore, has weak metallic bonds. That is why it has least enthalpy of atomisation.

(ii) Mn^{2+} has $3d^5$ (stable electronic configuration), therefore, it does not get oxidised to Mn^{3+}, whereas Fe^{2+} has $3d^6$ which readily changes to Fe^{3+} ($3d^5$) which has stable electronic configuration.

(iii) Sc^{3+} is colourless as it does not have unpaired electron and cannot undergo d-d transition, whereas Ti^{3+} is coloured due to presence of unpaired electrons, and undergoes d-d transition by absorbing light from visible region and radiate complementary colour.

16.Silver is a transition metal because it can exhibit +2 oxidation state which has incompletely filled d-orbital.

17. Mn exhibits the largest number of oxidation states because it has 7 electrons in 's' as well as 'd' orbitals which can take part in bond formation.

18.It is because hydration energy of Cu^{2+} is low and not able to overcome enthalpy of atomisation and ionisation enthalpy.

19. The irregular variation is due to different stability of their (transition elements) electronic configuration and less variation in atomic size.

20. It is because both F_2 and O_2 are strong oxidising agents due to high electronegativity and high standard reduction potential.

21.It is because of poor shielding effect of 4f and 5f electrons in actinoids, whereas in lanthanoids, there is poor shielding effect of 4f electrons only. That is why effective nuclear charge increases more from element to element in actinoids than lanthanoids.

22. Mn^{2+} is more stable due to half-filled d-orbitals but Fe^{2+} is not stable because it does not have half-filled d-orbitals. Mn^{2+}: $3d^5\ 4s^0$, Fe^{2+}: $3d^6 4s^0$

23. (i) Co(II) gets oxidised to Co(III) in presence of complexing agent because Co(III) is more stable than Co(II). Most of the strong field ligands cause pairing of electrons forming diamagnetic octahedral complexes which are very stable due to very large crystal field stabilisation energy.

(ii) d^1 configuration is very unstable in ions because after losing one more electron, it will become stable. All elements with d^1 configuration are either reducing or undergo disproportionation,

24. (i) Ti^{4+} does not have unpaired electron, therefore can't absorb energy from visible region and rediate colour, V^{4+} has one unpaired electron, undergoes d-d transition by absorbing high from visible region and rediate violet colour.

(ii) It is due to similarity in atomic and ionic size, there is more horizontal similarity. Secondly, in transition elements incoming electron goes to inner shell (d-orbitals), whereas in main group elements, the incoming electron goes to outermost shell.

25. (i) Due to lanthanoid contraction, effective nuclear charge remains almost same therefore, metallic radii are nearly same, therefore, metal-metal bonding is more.

(ii) Mn^{2+} ($3d^5$) has stable electronic configuration, therefore, it does not get oxidised. Fe^{2+} ($3d^6$) gets oxidised to form Fe^{3+} ($3d^5$) which is more stable.

4. POTASSIUM DICHROMATE & POTASSIUM PERMANGANATE

1. Dichromate ion is orange in acidic solution (pH<7) and turns yellow in basic solution. It is due to interconversion of dichromate ion to chromate ion. Following reactions take place:-

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

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

2- (i) $MnO_4^- + 8H^+ + 5\ Fe^{2+} \rightarrow Mn^{2+} + 5\ Fe^{3+} + 4H_2O$

(ii) $2\ MnO_4^- + 5\ C_2O_4^{2-} + 16\ H^+ \rightarrow 2\ Mn^{2+} + 10\ CO_2 + 8H_2O$

(iii) $2\ MnO_4^- + H_2O + I^- \rightarrow 2MnO_2 + 2OH^- + IO_3^-$

Ans. 3 a) Preparation: - It takes place in three steps. Following reaction takes place:

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

$2Na_2CrO_4 + 2\ H^+ \longrightarrow Na_2Cr_2O_7 + 2\ Na^+ + H_2O$

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

Reactions: - (i) $Cr_2O_7^{2-} + 8\ H^+ + 3\ H_2S \rightarrow 2Cr^{3+} + 7\ H_2O + 3S$

(ii) $Cr_2O_7^{2-} + 14\ H^+ + 6\ Fe^{2+} \rightarrow 2Cr^{3+} + 7\ H_2O + 6\ Fe^{3+}$.

Answer : 4.

(*i*) $8MnO_4^-\ (aq) + 3S_2O_3^{2-}\ (aq) + H_2O\ (l) \rightarrow 8MnO_2\ (s) + 6SO_4^{2-}\ (aq) + 2OH^-\ (aq)$

(*ii*) $Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

Answer : 5.

(*i*) $Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

(*ii*) $2MnO_4^- + 5NO_2^- + 6H^+ \rightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$

Answer : 6. Disproportionation: In a disproportionation reaction an element undergoes self-oxidation as well as self-reduction forming two different compounds.

For example, $3\underset{(VI)}{MnO_4^{2-}} + 4H^{+1} \longrightarrow 2\underset{(VII)}{MnO_4^-} + \underset{(IV)}{MnO_2} + 2H_2O$

Answer : 7. Potassium Permangante (KMnO4) is prepared from pyrolusite ore (MnO2). The ore (MnO2) is fused with an alkali metal hydroxide like KOH in the presence of air or an oxidising agent like KNO3 to give dark

green potassium manganate (K2MnO4). K2MnO4 disproportionates in a neutral or acidic solution to give potassium permanganate.

$$2MnO_2 + 4KOH + O_2 \longrightarrow \underset{\text{(Green)}}{2K_2MnO_4} + 2H_2O$$

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

Oxidation or oxalic acid is Oxidised at 333 K:

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

Answer : 8.

(*i*) It oxidises iodide ion (I^-) to iodine (I_2)

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

(*ii*) It oxidises H_2S to S

$$Cr_2O_7^{2-} + 14\ H^+ + 6\ e^- \longrightarrow 2\ Cr^{3+} + 7\ H_2O$$
$$3\ H_2S \longrightarrow 3\ S + 6\ H^+ + 6\ e^-$$
$$\overline{Cr_2O_7^{2-} + 3\ H_2S + 8\ H^+ \longrightarrow 2\ Cr^{3+} + 3\ S + 7\ H_2O}$$

Answer 9:

(*i*) $$8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6(SO_4^{2-}) + 2OH^-$$

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

Answer 10:

(*i*) $$(NH_4)_2Cr_2O_7 \xrightarrow{\text{Heat}} \underset{\text{Nitrogen}}{N_2} + 4H_2O + \underset{\text{Chromic oxide}}{Cr_2O_3}$$

Answer 11:

(*i*) $$2\,MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$$

(*ii*) $$2KMnO_4 \xrightarrow[513\ K]{\text{heated}} \underset{\text{Pot. manganate}}{K_2MnO_4} + MnO_2 + O_2$$

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

Answer 12:

(*i*) $Cr_2O_7^{2-}(aq) + 6Fe^{2+} + 14H^+ \longrightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$

(*ii*) $2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$

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

Answer 13: Reactions showing oxidising nature of KMnO4

(i) 2KMnO4 + 5SO2 + 2H2O → K2SO4+ 2MnSO4 + 2H2SO4

(ii) 2KMnO4 + 3H2SO4 + 5H2O → K2SO4 + 2MnSO4 + 3H2O + 5S

Answer 14 : Disproportionation: When in a reaction, the oxidation of an element in a compound increases in one of the products and decreases in the other product, it is said to undergodisproportionation of oxidation state.

Example : In acidic solution Mn (VI) in MnO_4^{2-} changes to Mn (VII) in the product MnO_4^- and to Mn (IV) in the product MnO_2.

5. WORD PROBLEM

1: A → MnO_2

B → Cl_2

C → NCl_3

Reaction: $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$
(A) (B)

$NH_3 + 3\ Cl_2 \rightarrow NCl_3 + 3HCl$
(C)

NCl_3 is an explosive compound.

2: A → MnO_2
B → K_2MnO_4
C → $KMnO_4$
D → KIO_3

Reactions $2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$
(A) (B)

$3K_2MnO_4 + 4H^+ \rightarrow 2KMnO_4 + MnO_2 + 2H_2O + 4K^+$
(C)

$2MnO_4^- + H_2O + KI \rightarrow 2MnO_2 + 2OH^- + KIO_3$
(D)

3: A : $KMnO_4$ B : K_2MnO_4 C : MnO_2 D : $MnCl_2$

Reactions:

$$2\ KMnO_4 \xrightarrow{heat} K_2MnO_4 + MnO_2 + O_2$$
(A) (B) (C)

$$MnO_2 + 2KOH + KNO_3 \rightarrow K_2MnO_4 + H_2O + KNO_2$$
(C) (B)

$$MnO_2 + 4NaCl + 4H_2SO_4 \rightarrow MnCl_2 + 4NaHSO_4 + 2\ H_2O + Cl_2$$
(C) (D)

4: . The chromite ore $FeCr_2O_4$ on fusion with NaOH in presence of air, forms a yellow coloured compound (A) i.e. Sodium chromate.

$$4FeCr_2O_4 + 16NaOH + 7O_2 \xrightarrow{Fuse} \underset{\substack{\text{Sodium chromate}\\(A)\\\text{Yellow}}}{8Na_2CrO_4} + 2Fe_2O_3 + 8H_2O$$

Sodium chromate (A) upon acidification with dilute sulphuric acid gives Sodium dichromate (B).

$$2Na_2CrO_4 + H_2SO_4 \longrightarrow \underset{\substack{\text{Sodium dichromate}\\(B)}}{Na_2Cr_2O_7} + Na_2SO_4 + H_2O$$

Sodium dichromate (B) on reaction with KCl forms orange coloured compound Potassium dichromate (C).

$$Na_2Cr_2O_7 + 2KCl \rightarrow 2NaCl + K_2Cr_2O_7\ (C)$$

(i) Thus (A) → Sodium chromate Na_2CrO_4 (A) → Sodium dichromate $Na_2Cr_2O_7$ (B) → Potassium dichromate $K_2Cr_2O_7$

(ii) (C) is used as a strong oxidising agent in acidic medium in volumetric analysis.

6. LANTHANOIDS AND ACTINOIDS

1.

I. (n-2)$f^{1\ to\ 14}(n-1)d^{0\ or\ 1}ns^2$
II. +3 and +4
III. It is due to comparable energy of 7s, 6d and 5f orbitals , electrons from all of these orbitals take part in bond formation.

2. The regular decrease in atomic and ionic radii with increase in atomic number in lanthanoid is known as lanthanoid contraction.

Consequence- difficulty in separation of lanthanoids.

3(i) It is because 5f electrons in actinoids have poor shielding effect than 4f electrons in lanthanoids , therefore, effective nuclear charge is more in actinoids.

(ii) Because all actinoids are radioactive and show wide range of oxidation state.

(iii) Due to lanthanoid contraction.

4. Similarity- The most characteristic oxidation state of both lanthanoid and actinoid is +3.

Difference- Besides +3 oxidation state lanthanoids show +2 and +4 but actinoids show +4, +5, +6 and +7 oxidation state.

5. Europium(Eu).

5. COORDINATION COMPOUNDS

(CBSE WEIGHTAGE: 7 MARKS)

MULTIPLE CHOICE QUESTIONS:

1. Write the no. of ions produced from the complex $[Co(NH_3)_6]Cl_3$ in solution

(A) 1 (B) 2

(C) 3 (D) 4

2. The denticity of $EDTA^{4-}$ ligand is

(A) 6 (B) 3

(C) 4 (D) 2

3. Of the following complexes, which one will show ionisation isomerism?

(A) $[Cr(NH_3)_6][Co(en)_3]$ (B) $[Cr(NH_3)_6]Cl_3$

(C) $[Cr(en)_3]Cl_3$ (D) $[CoBr(NH_3)_5]SO_4$

4. The crystal field splitting energy for octahedral and tetrahedral complexes is related as

(A) $\Delta_t = 2/9\ \Delta_o$ (B) $\Delta_o = 2/9\ \Delta_t$

(C) $\Delta_t = 4/9\ \Delta_o$ (D) $\Delta_0 = 4/9\ \Delta_t$

5. Give the oxidation number and coordination number of the central metal atom in the complex compound $[Pt(en)_2]^{2+}$.

(A) 4, 2 (B) 2, 4

(C) 2, 2 (D) 1, 4

ASSERTION REASONING QUESTIONS:

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

(B) Both Assertion and Reason are correct statements, but Reason is not the correct explanation of the Assertion.

(C) Assertion is correct, but Reason is wrong statement.

(D) Assertion is wrong, but Reason is correct statement

1. **Assertion**: Linkage isomerism arises in coordination compounds containing ambidentate ligand.

Reason: Ambidentate ligand has two different donor atoms.

2. **Assertion**: Carbon monoxide forms low spin complexes with metals.

Reason: Carbon monoxide is neutral oxide.

3. **Assertion** :The complex $[Co(NH_3)_3Cl_3]$ gives no precipitate with $AgNO_3$ solution.

Reason : The given complex is non-ionisable .

4. **Assertion**: $[Ni(CO)_4]$ is tetrahedral in shape.

Reason : Ni atom is in zero oxidation state and undergoes sp^3 hybridisation in $[Ni(CO)_4]$

5**. Assertion** : $[Fe(CN)_6]^{3-}$ ion shows magnetic moment corresponding to two unpaired electrons.

Reason : Because it has d^2sp^3 type hybridisation.

COMPETENCY BASED QUESTIONS

QUESTIONS BASED ON WERNER'S THEORY

1.If one mole of $PdCl_2.4NH_3$ produces 2 moles of AgCl on reacting with excess of $AgNO_3$ in aqueous medium, find out the secondary valency of 'Pd' in the compound.

2.How many mole of AgCl will get precipitated when 3 mole of $[Ni(H_2O)_6]Cl_2$ reacts with excess of $AgNO_3$?

3.Write the IUPAC name of compound with formula $CoCl_3.4NH_3$, one mole of which gives one mole of AgCl precipitate on reaction with excess $AgNO_3$.

4.When a coordination compound $NiCl_2.6H_2O$ is mixed with $AgNO_3$, 2 mole of AgCl are precipitated per mole of the compound. Write IUPAC name of the complex

5.A co-ordination complex of cobalt has molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt

atom. One mole of this compound produces three mole ions in an aqueous solution. On reacting this solution with excess of silver nitrate solution two moles of AgCl get precipitated. Write the ionic formula and IUPAC name of this complex.

NOMENCLATURE BASED QUESTIONS:

1.Write the IUPAC names of the following coordination compounds:

(a) $[Pt\ (NH_3)_2\ Cl\ (NO_2)]$ (b) $K_3\ [Cr\ (C_2O_4)_3]$

(c) $[Co\ Cl_2\ (en)_2]Cl$ (d) $[Cr\ (NH_3)_3\ (H_2O)_3]\ Cl_3$

(e) $[Ag\ (NH_3)_2][Ag(CN)_2]$

2. Write the formulas for the following coordination compounds:

(a) Tetraammineaquachloridocobalt (III) chloride

(b) Potassium tetrahydroxidozincate (II)

(c) Potassium trioxalatoaluminate (III)

(d) Dichloridobis (ethane-1, 2-diamine) cobalt (III) ion

(e) Tetracarbonylnickel (0)

QUESTIONS BASED ON ISOMERISM:

1. What type of isomerism is shown by the following complex: $[Co(NH_3)_6][Cr(CN)_6]$

2. What type of isomerism is exhibited by the following complex: $[Co(NH_3)_5SO_4]Cl$

3. What type of isomerism is exhibited by the complex $[Co(NH_3)_5NO_2]^{2+}$?

4. Give an example of ionisation isomerism.

5: For the square coplanar complex $[Pt(NH_3)(NH_2OH)Cl(Py)]^+$, how many geometrical isomers are possible? Draw them.

6 : List various types of isomerism possible for coordination compounds, giving an example of each

7. How many geometrical isomers are possible in the following coordination entities?

A)$[Cr(C_2O_4)_3]^{3-}$ B)$[Co(NH_3)_3Cl_3]$

8. Draw the structures of optical isomers of:

(i) $[Cr(C_2O_4)_3]^{3-}$

(ii) $[PtCl_2(en)_2]^{2+}$

(iii) $[Cr(NH_3)_2Cl_2(en)]^{3+}$

QUESTIONS ON VALENCE BOND THEORY:

1.Describe the shape and magnetic behaviour of following complexes :
(i) $[Co(NH_3)_6]^{3+}$
(ii) $[Ni(CN)_4]^{2-}$ (At. No. Co = 27, Ni = 28)

2.$[Fe(H_2O)_6]^{3+}$ is strongly paramagnetic whereas $[Fe(CN)_6]^{3-}$ is weakly paramagnetic. Explain.(At. no. Fe = 26)

3.Explain why $[Co(NH_3)_6]^{3+}$ is an inner orbital complex whereas $[Ni(NH_3)_6]^{2+}$ is an outer orbital complex. (At. no. Co = 27, Ni = 28)

4.Compare the following complexes with respect to their shape, magnetic behaviour and the hybrid orbitals involved :
(i) $[CoF_4]^{2-}$ (ii) $[Cr(H_2O)_2(C_2O_4)_2]^-$
(iii) $[Ni(CO)_4]$ (Atomic number : (Cr = 24, Co = 27, Ni = 28)

5. Using Valence bond theory explain the geometry and magnetic behaviour by $[Cr(NH_3)_6]^{3+}$. (At. no. Cr = 24)

QUESTIONS ON CRYSTAL FIELD THEORY:

1. What is spectrochemical series? Explain the difference between a weak field ligand and a strong field ligand.

2. Draw figure to show the splitting of d-orbitals in an octahedral crystal field.

3. What is meant by crystal field splitting energy? On the basis of crystal field theory, write the electronic configuration of d^4 in terms of t_{2g} and e_g in an octahedral field when
(i) $\Delta_0 > P$
(ii) $\Delta_0 < P$

4. How synergic effect strengthens the bond between metal and the carbonyl group?

QUESTIONS ON APPLICATION OF COORDINATION COMPOUNDS:

1. How will you estimate Hardness of water ?

2 What are the uses of coordination compounds in pharma?

3. Explain the applications of coordination compounds in the field of metal purification giving an example

4. Discuss briefly giving an example in each case the role of coordination compounds in:

(i) biological systems (ii) medicinal chemistry and (iii) analytical chemistry (iv) extraction/metallurgy of metals.

ANSWERS

MULTIPLE-CHOICE QUESTIONS

1. (D) 2. (A) 3. (D) 4. (C) 5. (B)

ASSERTION REASONING QUESTIONS

1,(A) 2. (B) 3. (C) 4. (A) 5. (D)

COMPETENCY BASED QUESTIONS

QUESTIONS BASED ON WERNER'S THEORY

1.4

2. 6moles

3. Tetraamminedichloridocobalt(III) chloride, $[Co(NH_3)_4Cl_2]Cl$

4.Hexaaquanickel(II) chloride

5.$[Co(NH_3)_5(NO_2)]Cl_2$, Pentaamminenitrito-N-cobalt(III) chloride

NOMENCLATURE BASED QUESTIONS:

1.(a) Diamminechloridonitrito-N-platinum (II) (b) Potassium trioxalatochromate (III)

(c) Dichloridobis (ethane-1, 2-diamine)cobalt (III) chloride

(d) Triamminetriaquachromium (III) chloride (e) Diamminesilver (I) dicyanidoargentate (I)

2. (a) $[Co\ (NH_3)_4(H_2O)\ Cl]\ Cl_2$ (b) $K_2\ [Zn\ (OH)_4]$ (c) $K_3\ [Al\ (C_2O_4)_3]$

(d) $[Co\ Cl_2\ (en)_2]^+$ (e) $[Ni\ (CO)_4]$

QUESTIONS BASED ON ISOMERISM:

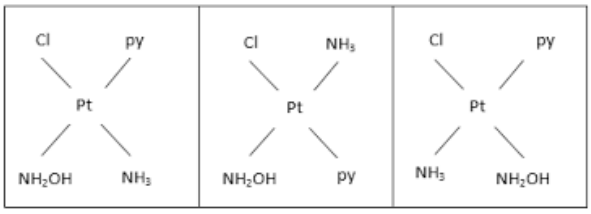
1. Coordination isomerism.

2 . Ionisation isomerism.

3. Linkage isomerism.

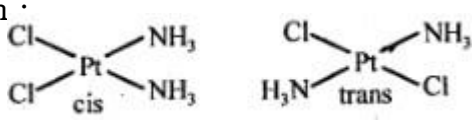
4 : $[Co(NH_3)_5Br]S0_4$ and $[Co(NH_3)_5S0_4)]Br$ is the example of ionisation isomerism.

5: The given complex in the question is a square planar complex and complex of type $[M_{ABCD}]$ where M is the metal ion and ABCD are the ligands can have 3 geometrical isomers

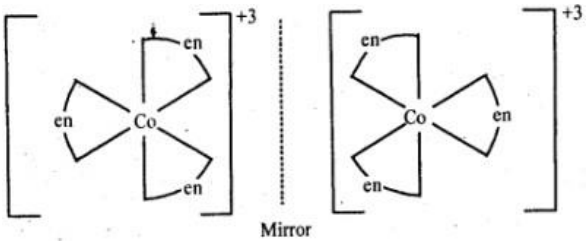


6 :The various types of isomerism present in coordination compounds are :

(i) Geometrical isomerism :



(ii) Optical isomerism :



(iii) Linkage isomerism : This is found in complexes that have ambidentate ligands.

For e.g. : $[Co(NH_3)_5(NO_2)]Cl_2$ and $[Co(NH_3)_5(ONO)]Cl_2$

(iv) Coordination isomerism :This kind of isomerism comes up when ligands are interchanged between anionic and cationic entities of different metal ions present in the complex.

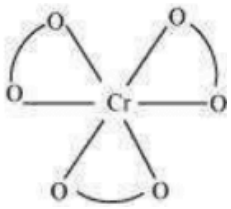
Example – $[Cr(NH_3)_6] [Co(CN)_6]$

(v) Ionisation isomerism : This is the kind of isomerism where a counter ion takes the place of a ligand inside the coordination sphere.. For e.g., $[Co(NH_3)_5Br]SO_4$ and $[Co(NH_3)_5SO_4]Br$

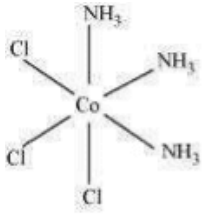
(vi) Solvate isomerism :

$[Cr(H_2O)_5Cl]Cl.H_2O$ and $[Cr(H_2O)_6]Cl_2$.

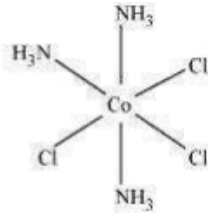
7: (A) In $[Cr(C_2O_4)_3]^{3-}$ no geometric isomers are present because it is a bidentate ligand



(B) In [$Co(NH_3)_3Cl_3$]two isomers are possible.

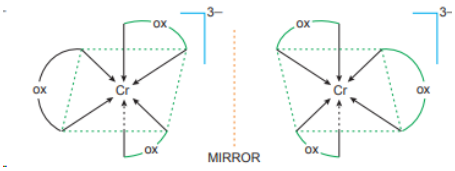


Facial

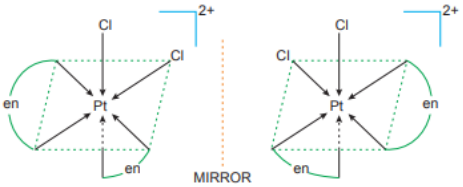


Meridional

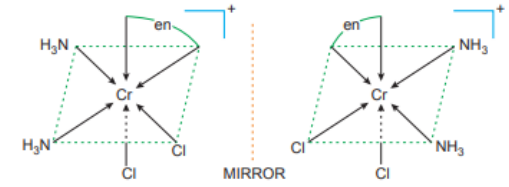
(i) $[Cr(C_2O_4)_3]^{3-}$



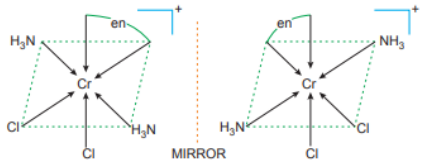
(ii)$[PtCl_2(en)_2]^{2+}$



(iii)cis $[Cr(NH_3)_2Cl_2(en)]^{+}$



(iv)trans $[Cr(NH_3)_2Cl_2(en)]^+$

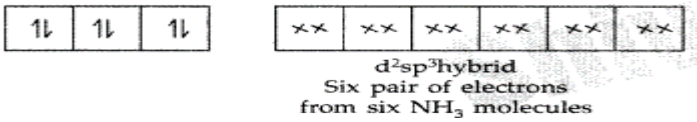


QUESTIONS ON VALENCE BOND THEORY:

1(i) $[CO(NH_3)_6]^{3+}$:

Orbitals of CO^{3+} ion :

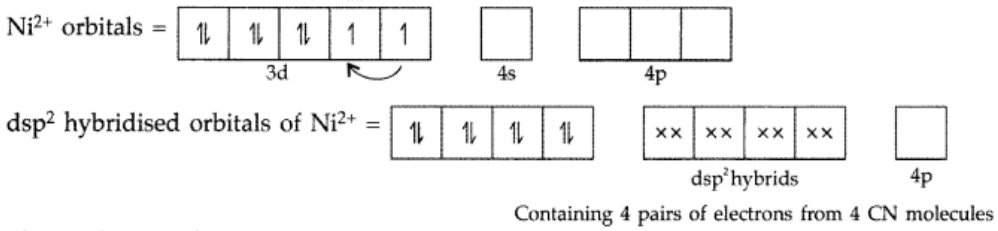
d^2sp^3 hybridised orbitals of CO^{3+} :



Hybridization : d^2sp^3 Shape : Octahedral

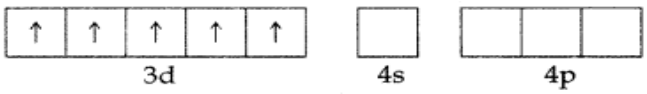
Magnetic behaviour : Diamagnetic (absence of unpaired electrons)

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



Shape : Square planar
Hybridisation : dsp^2
Magnetic behaviour : Diamagnetic (no unpaired electrons)

2.In both the cases, Fe is in oxidation state +3. Outer electronic configuration of $Fe^{3+}$is :



In the presence of CN^-, the 3d electrons pair up leaving only one unpaired electron. The hybridization involved is d^2sp^3 forming inner orbital complex which is weakly paramagnetic. In the presence of H_2O (a weak ligand), 3d electrons do not pair up. The hybridization involved is sp^3d^2 forming an outer orbital complex. As it contains five unpaired electrons so it is strongly paramagnetic.

3. .In $[Co(NH_3)_6]^{3+}$, the d-electrons of Co^{3+} ([Ar]$3d^6$ $4s^0$) get paired leaving behind two empty d- orbital and undergo d^2sp^3 hybridization and hence inner orbital complex, while in

$[Ni(NH_3)_6]^{2+}$ the d-electrons of Ni^{2+} ($[Ar]3d^8\ 4s^0$) do not pair up and use outer 4d subshell hence outer orbital complex.

4 (i) **$[CoF_4]^{2-}$** : Tetrafluorido cobalt (II) ion

Coordination number = 4 Shape = Tetrahedral Hybridisation = sp^3

$\therefore$ ***Magnetic moment*** $(\mu) = \sqrt{n(n+2)}$ BM $= \sqrt{3(3+2)} = \sqrt{15} =$ **3.87 BM**

(ii) **$[Cr(H_2O)_2(C_2O_4)_2]^-$** : Diaquadioxalato chromium (III) ion

Coordination number = 6 *Shape* = Octahedral *Hybridisation* = d^2sp^3

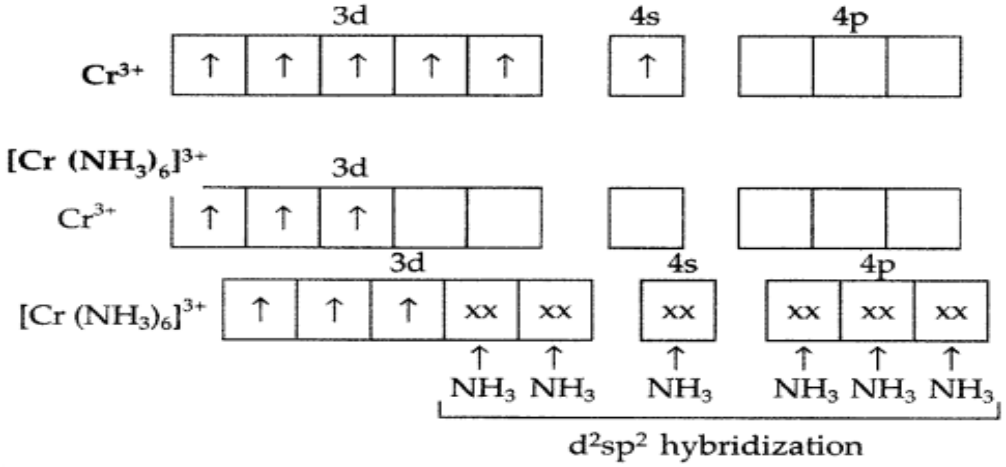
$\therefore$ ***Magnetic moment*** $(\mu) = \sqrt{n(n+2)}$ BM $= \sqrt{15} =$ **3.87 BM**

(iii) **$[Ni(CO)_4]$** : Tetracarbonyl nickel (O)

Coordination no. = 4 *Shape* = Tetrahedral *Hybridisation* = sp^3

$\therefore$ ***Magnetic moment*** $(\mu) = \sqrt{n(n+2)}$ BM $= \sqrt{0(0+2)} =$ **0**

5.Cr atom (Z = 24), Ground state = $[Ar]\ 3d^5\ 4s^1$



Geometry : Octahedral

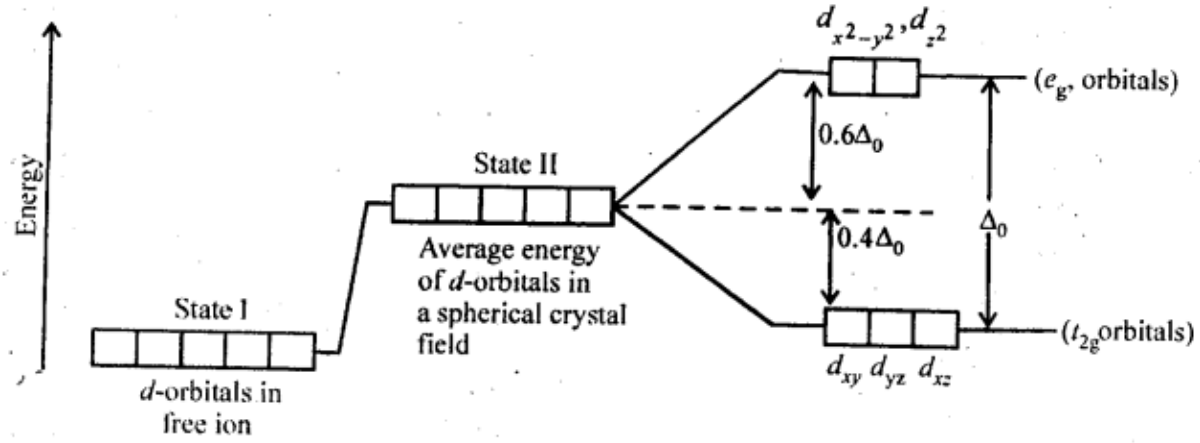
Magnetic property : Paramagnetic

QUESTIONS ON CRYSTAL FIELD THEORY:

1. The crystal field splitting, Δ_0, depends upon the field produced by the ligand and charge on the metal ion. Some ligands are able to produce strong fields in which, the splitting will be large whereas others produce weak fields and consequently result in small splitting of d-orbitals. In general, ligands can be arranged in a series in the order of increasing field strength as given below :

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} <$
$H_2O < NCS^- < edta^{4-} < NH_3 < en < CN^- < CO$

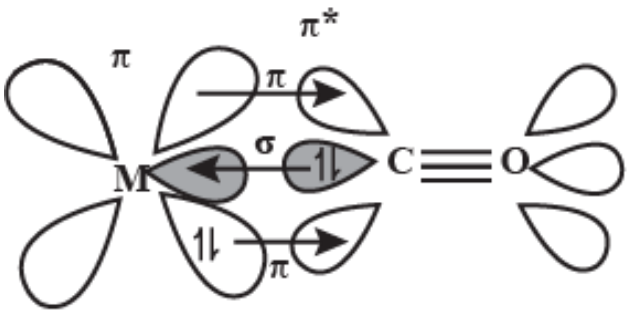
2.



3. Crystal field splitting energy : When ligands approach the central metal ion, the degenerate d-orbitals split into two sets, one with lower energy (t_{2g}) and the other with higher energy (e_g). The difference of energy between these two sets of orbitals is called crystal field splitting energy. (Δ0 for octahedral complexes).
The magnitude of Δ0 decides the actual configuration of d-orbitals by the help of mean pairing energy.

- If P > Δ_0 then pairing of electrons does not occur and electrons enter in the higher energy e orbitals and thus form high spin complexes due to weak field ligands.
- If P < Δ_0 then pairing of electrons occurs within the same set and form low spin complexes due to strong field ligands.

4.Synergic bonding interaction in a carbonyl complex is shown below. Carbonyl C donates lone pair of electrons to metal to form M−C σ bond. Filled d orbital of metal donates lone pair of electrons to vacant antibonding π orbital ofCO to form M−C π bond.



Synergic bonding in metal carbonyls

QUESTIONS ON APPLICATION OF COORDINATION COMPOUNDS:

1.Hardness of water is estimated by simple titration with Na_2EDTA.

The Ca^{2+} and Mg^{2+} ions form stable complexes with EDTA.

The selective estimation of these ions can be done due to difference in the stability constants of calcium and magnesium complexes.

2.Coordination compounds such as platinum, palladium and ruthenium complexes are anti-cancer drugs.

3.Mond process for refining nickel metal:Nickel is heated in a stream of CO to form nickel tetra carbonyl complex which is highly volatile. Nickel tetra carbonyl is heated at high temperature. It decomposes to give pure nickel.

$Ni + 4CO \xrightarrow{330-350K} Ni(CO)_4$

$Ni(CO)_4 \xrightarrow{450-470K} Ni + 4CO$

4.(i) Biological systems:Several naturally occurring biologically important compounds are coordination compounds.Thus, chlorophyll is a coordination compound containing Mg(II) ions. It is green pigment present in plants and is used in photosynthesis.

(ii) Medicinal chemistry:To remove metal poisoning, complexing agents are used, cis platin $[PtCl_2(NH_3)_2]$ is used in cancer chemotherapy.

(iii) Analytical chemistry:Complex formation is used in qualitative scheme of analysis. In group I analysis, silver ion is separated from the precipitate of AgCl, Hg_2Cl_2 and $PbCl_2$. Aqueous ammonia is added to the ppt. AgCl dissolves due to formation of soluble complex.

$AgCl + 2NH_3 \rightleftharpoons [Ag(NH_3)_2]Cl$

(iv) Extraction/metallurgy of metals: Metals such as gold and silver are extracted by complex formation technique. Cyanide process is used for extraction of silver and gold from its ore.

$Ag_2S + 4NaCN \rightarrow 2Na[Ag(CN)_2] + Na_2S$

$2Na[Ag(CN)_2] + Zn \rightarrow Na_2[Zn(CN)_4] + 2Ag$

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6. HALOALKANES AND HALOARENES
(CBSE WEIGHTAGE: 6 MARKS)

MULTIPLE -CHOICE QUESTIONS WITH ONE CORRECT ANSWER

1. Aryl halides are extremely less reactive towards nucleophilic substitution than alkyl halides. Which of the following accounts for this?

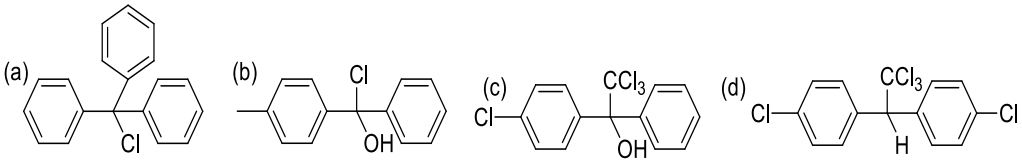
(i) Due to resonance in aryl halides.
(ii) In alkyl halides carbon atom in C–X bond is sp^2 hybridised whereas in aryl halides carbon atom in C–X bond is sp3 hybridized.
(iii) Due to stability of phenyl cation.
(iv) Due to possible repulsion, there are less chances of nucleophile to approach electron rich arenes.

(a) (i), (ii) and (iv)
(b) (i), (ii) and (iii)
(c) (i) and (iv)
(d) (ii), (iii) and (iv)

2. Haloarenes are ortho and para directing due to
(a) Resonance in aryl halide
(b) – I effect of halogen atom
(c) + I effect of halogen atom
(d) both (a) and (b)

3. Benzene reacts with n-propyl chloride in the presence of anhydrous $AlCl_3$ to give
(a) 3 – Propyl – 1 – chlorobenzene
(b) n-Propylbenzene
(c) No reaction
(d) Isopropylbenzene

4. Trichloroacetaldehyde, CCl_3CHO reacts with chlorobenzene in presence of sulphuric acid and produces:



5. Aryl halides cannot be prepared by the reaction of aryl alcohols with PCl_3, PCl_5 or $SOCl_2$ because
(a) Phenols are highly unstable compounds.
(b) carbon-oxygen bond in phenols has a partial double bond character.
(c) carbon-oxygen bond is non- polar
(d) all of these

ASSERTION-REASON TYPE QUESTION

Directions: In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

(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 and R is true.

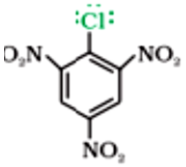
1. **Assertion (A):** When alkyl halides react with alcoholic KOH alkene is formed as a product.
   Reason (R): Alcoholic KOH act as a base and alkoxide ion attack on ß-hydrogen atom rather than partial positive charged carbon atom hence elimination reaction takes place.
2. **Assertion (A):** Presence of a nitro group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution.
   Reason (R): Nitro group, being an electron withdrawing group decreases the electron density over the benzene ring.
3. **Assertion (A):** In monohaloarenes, further electrophilic substitution occurs at ortho and para positions.
   Reason (R): Halogen atom is a ring deactivator.
4. **Assertion (A):** Aryl iodides can be prepared by reaction of arenes with iodine in the presence of an oxidising agent like HNO_3 and HIO_3.
   Reason (R): Oxidising agents like HNO_3 and HIO_3 oxidized HI into I_2 and increase yield of the reaction.
5. **Assertion (A):** When toluene reacts with chlorine gas in the presence of sunlight o-, p- chlorotoluene formed as a product.
   Reason (R): this reaction is an example of free radical halogenation mechanism.

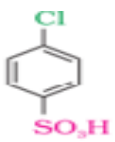
NOMENCLATURE TYPE QUESTIONS

1. Give the IUPAC Names of the following compounds

(i) $(CH_3)_2CHCH(Cl)CH_3$

(ii) $(CH_3)_3CCH_2CH(Br)\ C_6H_5$

(iii) 

(iv) 

(v) $CH_3CH{=}CHC(Br)(CH_3)_2$

2. Write the structure of the following Organic halogen compounds.
   (i) 2-Chloro-3-methylpentane
   (ii) 1-Chloro-4- ethyl cyclohaxane
   (iii) 1,4 dibromobut-2-ene
   (iv) 2-Bromo-2-methylpropane
   (v) 1-Bromo-2,2-dimethylpropane

COMPETENCY BASED QUESTIONS

REASONING TYPE QUESTIONS

1. The dipole moment of chlorobenzene is lower than that of cyclohexyl chloride.
2. Alkyl halides, though polar, are immiscible with water.
3. Grignard reagents should be prepared under anhydrous conditions.
4. Aryl halides are extremely less reactive towards Nucleophilic Substitution reactions.
5. The treatment of alkyl chlorides with aq. KOH leads to the formation of alcohols but in the presence of alc. KOH alkenes are major products.
6. Haloalkanes react with KCN to form alkyl cyanides as main product while AgCN forms isocyanides as main product.
7. On reaction of alkyl halides with potassium nitrite gives alkyl nitrites as major product but with silver nitrite, nitroalkanes are formed.
8. para-Dichlorobenzene has higher MP and lesser solubility than those of o- and m- isomers.
9. Chloroform is stored in closed dark coloured bottles.
10. Sulphuric acid is not used during the reaction of alcohols with KI.

CHEMICAL TEST TYPE QUESTIONS

1. Give chemical tests to distinguish between the following pairs of compounds:
   a) Ethylbromide and Bromobenzene
   b) Ethylchloride and Ethylbromide
   c) Chlorobenzene and Chlorocyclohexane
2. Give chemical tests to distinguish between the following pairs of compounds:
   a) Ethylchloride and Vinylchloride
   b) Chlorobenzene and n-hexylchloride
3. Give chemical tests to distinguish between the following pairs of compounds:
   a) Chlorobenzene and Benzylchloride
   b) p-chlorotoluene and Benzylchloride
   c) Chloroform and Carbon tetrachloride

NAME REACTION TYPE QUESTIONS

1. Write given naming reactions.

a. Finkelstein reaction
b. Sandmeyer's reaction
c. Wurtz-reaction

2. Identify and Write name reaction involved in below conversions.

a. Benzene to Diphenyl
b. Reaction between Alkyl halide and Aryl halide
c. (Freon 12) CCl_2F_2 from CCl_4

MECHANISM TYPE QUESTIONS

1. Explain the S_N1 & S_N2 mechanism with suitable examples
2. Arrange the compounds of each set in order of reactivity towards S_N2 displacement
   a) 2-Bromo-2-methylbutane, 1-Bromopentane , 2-Bromopentane
   b) 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 3-Bromo-2-methylbutane
   c) 1-Bromobutane, 1-Bromo-2,2-dimethylpropane, 1-Bromo-2-methylbutane, 1-Bromo-3-methylbutane

CONVERSION TYPE QUESTIONS

1. How the following conversions can be carried out?
   a. 1-Iodobutane from 1 – Butanol
   b. 2-Chlorobutane to 3,4-Dimethylhexane
   c. 2-Methylprop-1-ene to 2-Chloro-2-Methylpropane
2. How will you bring about the following conversions?
   a. Chlorobenzene to Benzyl chloride
   b. Methane to Ethane
   c. 1-Bromopropane to 2-Bromopropane
3. How will you bring about the following conversions?
   a. t-butylchloride to t-butyl ethyl ether
   b. Ethane to Bromoethene
   c. Bromomethane to Propanone
   d. Benzene to Biphenyl

COMPLETE THE REACTIONS TYPE QUESTIONS

1. Write the major products in each of the following:

a) $CH_3\text{-}CH{=}CH_2 \xrightarrow[\text{Markownikoff's addition}]{HBr} \mathbf{X} \xrightarrow[\text{Hydrolysis}]{\text{Aq. KOH}, \Delta} \mathbf{Y}$

b) $CH_3CH_2OH \xrightarrow{P/I_2, \Delta} X \xrightarrow[\text{(Nucleophilic substitution)}]{KCN, Et\text{-}OH\text{-}H_2O} Y$

c) $CH_3\text{-}CH(Cl)\text{-}CH_3 \xrightarrow{KOH(alc),\,\Delta} X \xrightarrow[\text{Anti-Mark. addition}]{HBr,\,Peroxide} Y \xrightarrow[\text{Hydrolysis}]{Aq.KOH,\,\Delta} \mathbf{Z}$

d) $C_6H_5ONa + C_2H_5Cl \rightarrow X$

e) $CH_3CH_2CH_2Cl + NaI \xrightarrow{\text{Acetone, heat}} X$

f) $CH_3CH_2Br \xrightarrow{AgCN} X$

ARRANGE IN CORRECT ORDER TYPE QUESTIONS

1. Arrange each set of compounds in order of increasing boiling points.
(i) 1-Chloropropane, Isopropyl chloride, 1-Chlorobutane.
(ii) Bromomethane, Bromoform, Chloromethane, Dibromomethane.
2. Arrange following compounds in order of increasing density :
n-C_3H_7Cl, n-C_3H_7Br, n-C_3H_7I

WORD PROBLEM TYPE QUESTIONS

1. 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.
   a) Write down the structural formula of both compounds 'A' and 'B'.
   b) Out of these two compounds, which one will be converted to the product with inverted configuration?
2. Primary alkyl halide C_4H_9Br (a) reacted with alcoholic KOH to give compound (b). Compound (b) is reacted with HBr to give (c) which is an isomer of (a). When (a) is reacted with Na metal, it gives a compound (d), C_8H_{18} which is different from the compound formed when n-butyl bromide is reacted with sodium. Give the structural formula of (a) and write the equations for all the reactions.
3. A haloalkane C_2H_5Br on treatment with boiling alcoholic KOH gives compound X. X is reacted with Br_2 to give a compound Y. Compound Y is treated with alcoholic KOH to give compound Z. Identify the compounds X, Y and Z. Write the equations for all the reactions.

ANSWERS

MULTIPLE -CHOICE QUESTIONS WITH ONE CORRECT ANSWER

1.c	**2. d**	**3. d**	**4. d**	**5. b**

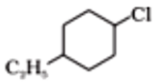
ASSERTION-REASON TYPE QUESTION

1.A	**2.A**	**3.B**	**4. A**	**5. D**

NOMENCLATURE TYPE QUESTIONS

(i) 2-Chloro-3-methylbutane
(ii) 1 Bromo 3,3 dimethyl 1 phenyl butane
(iii) 2,4,6 trinitro chlorobenzene
(iv) 4-chloro benzenesulphonic acid
(v) 4-Bromo-4methyl pent 2 ene

1. (i)$CH_3CH(Cl)CH(CH_3)CH_2CH_3$

(ii) 

(iii)$BrCH_2$-CH=CH-CH_2-Br
(iv)$(CH_3)_3CBr$
(v)$(CH_3)_3CCH_2Br$

COMPETENCY BASED QUESTIONS

REASONING TYPE QUESTIONS

1. This is mainly because of following two reasons:

a) The halogen atom of chlorobenzene is linked to sp^2-hybridized carbon atom whereas the halogen atom of cyclohexyl chloride is linked to sp^3-hybridized. The sp^2 hybridized carbon atom is more electronegative than sp^3 hybridized carbon atom.Thus C-Cl bond of chlorobenzene is less polar than C-Cl bond of cyclohexyl chloride.

b) There is resonance in chlorobenzene due to which the C- Cl bond acquires double bond character and so the bond length of C-Cl bond in chlorobenzene is shorter than the bond length of C-Cl bond in cyclohexyl chloride. So dipole moment of chlorobenzene is less than the dipole moment of cyclohexyl chloride.

2. The molecules of alkyl halide are held by dipole- dipole interactions and water molecules are held by strong hydrogen bonds. Alkyl halide are neither able to form H- bonds with water nor are able to break the H-bonding network of. Therefore alkyl halides are immiscible with water.

3. Grignard reagents are very reactive. They react with moisture immediately to form alkanes. Therefore Grignard reagent should be prepared under anhydrous condition.
4. Aryl halides are less reactive towards nucleophilic substitution reaction as compared to alkyl halides because of resonance in aryl halide the C- Cl bond acquires double character and so cannot be easily replaced by nucleophiles.
5. In aqueous medium KOH completely dissociates to give OH^- ions which act as strong nucleophiles and so bring about nucleophilic substitution reaction. Whereas alcoholic KOH gives alkoxide ion which act as strong base and so bring about elimination reaction forming alkene.
6. KCN is ionic in nature and provides cyanide ions in solution. CN- is ambidentate nucleophile and so both the sites are available for linking. Since C-C bond is stronger than C- N bond, the attack takes place mainly through carbon atom and not through nitrogen. Therefore alkyl cyanide is the major product. AgCN is covalent compound and electron donation is possible only through nitrogen therefore alkyl isocyanide is the major product formed.
7. Nitrite ion is an ambident nucleophile because it has two sites — oxygen and nitrogen— through which attack can take place. Potassium nitrite (KNO_2) is an ionic compound and one of the oxygen atoms has a negative charge ($O=N-O^-K^+$). Nucleophilic attack takes place through this oxygen atom as C-O bond is stronger than C-N bond. Therefore alkyl nitrite is the major product. Silver nitrite is a covalent compound and nucleophilic attack can only take place through nitrogen, therefore nitro alkanes are the major product.
8. The p-isomer is more symmetrical as compared to the ortho and meta isomers. This means that in the crystal lattice, molecules of the p-isomers are more closely packed as compared to the other isomers. As a result, p-isomer has a higher melting point and lower solubility as compared to ortho and meta isomers.
9. Chloroform is stored in dark coloured bottles to prevent the formation of poisonous phosgene by arial oxidation.
10. In the presence of sulphuric acid (H_2SO_4), KI produces HI Since is an oxidizing agent, it oxidizes HI (produced in the reaction to form I_2). As a result, the reaction between alcohol and HI to produce alkyl iodide cannot occur. Therefore, sulphuric acid is not used during the reaction of alcohols with KI.

CHEMICAL TEST TYPE QUESTIONS

1. (i) C_2H_5Br & C_6H_5Br ($AgNO_3$Test)

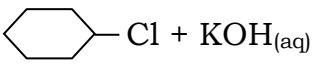
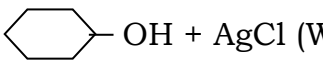
$C_2H_5Br + KOH_{(aq)} + AgNO_3 \rightarrow C_2H_5OH + AgBr$ (yellow ppt) $+ KNO_3$

$C_6H_5Br + KOH_{(aq)} + AgNO_3 \rightarrow$ No Reaction

(ii) C_2H_5Cl & C_2H_5Br ($AgNO_3$Test)

$C_2H_5Cl + KOH_{(aq)} + AgNO_3 \rightarrow C_2H_5OH + AgCl$ (white ppt) $+ KNO_3$

$C_2H_5Br + KOH_{(aq)} + AgNO_3 \rightarrow C_2H_5OH + AgBr$ (yellow ppt) $+ KNO_3$

(iii)  $+ KOH_{(aq)} + AgNO_3 \rightarrow$  $+ AgCl$ (White ppt) $+KNO_3$

$C_6H_5Cl + KOH_{(aq)} + AgNO_3 \rightarrow$ No Reaction

2. C_2H_5Cl & $CH_2=CHCl$ ($AgNO_3$ Test)

$C_2H_5Cl + KOH\ (aq) + AgNO_3 \rightarrow C_2H_5OH + AgCl$ (White ppt) $+ KNO_3$

$CH_2=CHCl + KOH_{(aq)} + AgNO_3 \rightarrow$ No Reaction

(ii) C_6H_5Cl & $CH_3(CH_2)_4CH_2Cl$:- ($AgNO_3$ Test)

$CH_3(CH_2)_4CH_2Cl + KOH_{(aq)} + AgNO_3 \rightarrow CH_3(CH_2)_4CH_2OH + AgCl$ (White ppt) $+ KNO_3$

$C_6H_5Cl + KOH_{(aq)} + AgNO_3 \rightarrow$ No Reaction

3. (i) C_6H_5Cl & $C_6H_5CH_2Cl$ ($AgNO_3$ Test)

$C_6H_5CH_2Cl + KOH_{(aq)} + AgNO_3 \rightarrow C_6H_5CH_2OH + AgCl$ (White ppt) $+ KNO_3$

$C_6H_5Cl + KOH_{(aq)} + AgNO_3 \rightarrow$ No Reaction

(ii) p-$ClC_6H_4CH_3$ & $C_6H_5CH_2Cl$ ($AgNO_3$ Test)

$C_6H_5CH_2Cl + KOH_{(aq)} + AgNO_3 \rightarrow C_6H_5CH_2OH + AgCl$ (White ppt) $+ KNO_3$

p-$ClC_6H_4CH_3 + KOH_{(aq)} + AgNO_3 \rightarrow$ No Reaction

(iii) CCl_4 & $CHCl_3$:- Carbylamine Test

$CHCl_3 + C_6H_5NH_2 + KOH \rightarrow C_6H_5NC$(Foul smell) $+ KCl + H_2O$

$CCl_4 + C_6H_5NH_2 + KOH \rightarrow$ No Reaction

NAME REACTION TYPE QUESTIONS

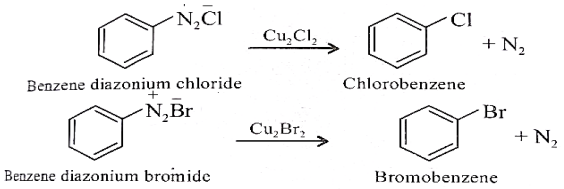
1. Finkelstein reaction

$$R\text{-}X + NaI \xrightarrow{\text{Acetone}} RI + NaX$$

X= Cl or Br)

Alkyl halide — Sodium iodide — Alkyl iodide — Sodium halide

(ii) Sandmeyer's reaction



(iii) Wurtz-reaction

$$R - X + 2Na + X - R' \xrightarrow{\text{dry ether}} R - R' + 2NaX$$

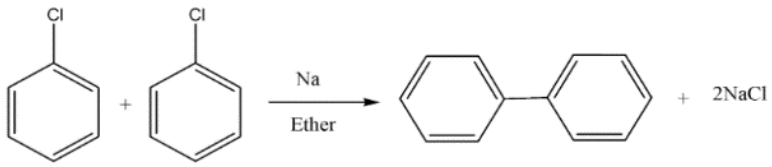
Alkane

Eg :

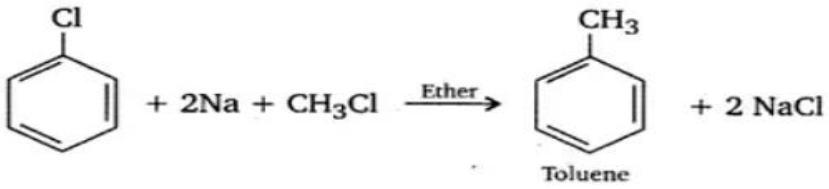
$$C_2H_5 - Cl + 2Na \xrightarrow{\text{dry ether}} C_4H_{10} + 2NaCl$$

n-Butane

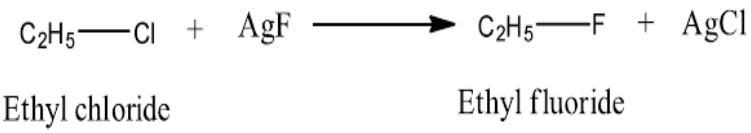
2. (i)Fitting Reaction



(ii) Wurtz fitting Reaction

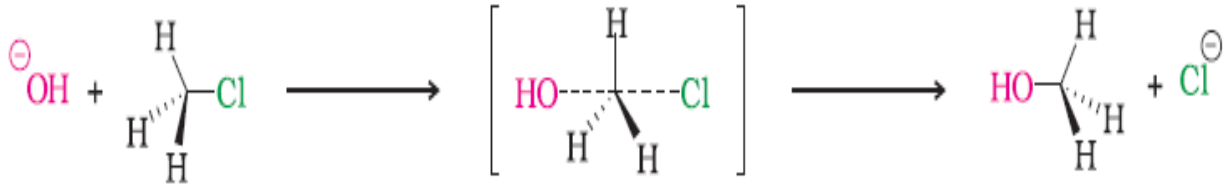


(iii) Swartz Reaction

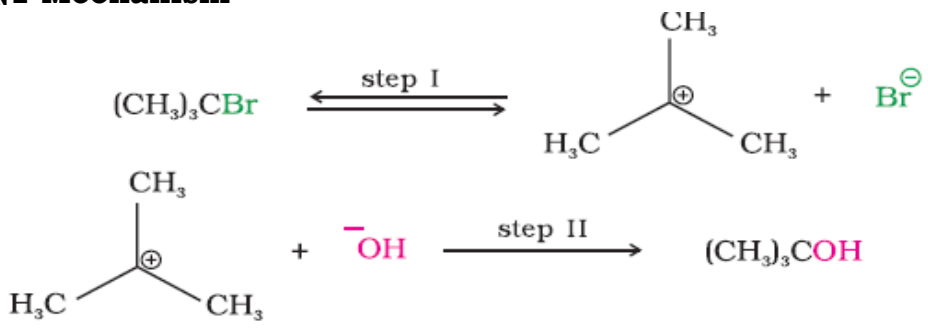


MECHANISM TYPE QUESTIONS

1. S_N2 Mechanism



S_N1 Mechanism

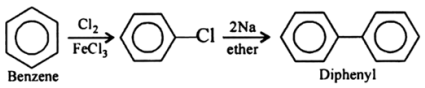


2.

a. 1-Bromopentane >2-Bromopentane>2-Bromo-2-methylbutane
b. 1-Bromo-3-methylbutane > 3-Bromo-2-methylbutane >2-Bromo-2-methylbutane
c. 1-Bromobutane>1-Bromo-3-methylbutane >1-Bromo-2-methylbutane>1-Bromo-2,2-dimethylpropane

CONVERSION TYPE QUESTIONS

1. The conversions are as follows -
   a. $CH_3CH_2CH_2CH_2OH \xrightarrow{\text{red phosporous/}I_2} CH_3CH_2CH_2CH_2I + H_2O$
   b. $2CH_3\text{-}CH(Cl)CH_2\text{-}CH_3 \xrightarrow{Na,\ \text{dry ether}} CH_3\text{-}CH_2\text{-}CH(CH_3)CH(CH_3)CH_2CH_3$
   c. $(CH_3)_2C{=}CH_2 \xrightarrow{HCl} (CH_3)_3CCl$
2. The conversions are as follows -
   a. $C_6H_5Cl + CH_3Cl + Na \xrightarrow{\text{dry ether}} C_6H_5CH_3 \xrightarrow{Cl_2,\ Fe/\text{dark}} C_6H_5CH_2Cl$
   b. $2CH_4 \xrightarrow{Cl_2,\ UV\ light} 2CH_3Cl \xrightarrow{Na,\ \text{dry ether}} CH_3\text{-}CH_3$
   c. $CH_3\text{-}CH_2\text{-}CH_2\text{-}Br \xrightarrow{\text{alc KOH}} CH_3\text{-}CH{=}CH_2 \xrightarrow{HBr} CH_3\text{-}CHBr\text{-}CH_3$
3. The conversions are as follows -
   a. $(CH_3)_3CCl + NaOH(aq) \rightarrow (CH_3)_3COH \xrightarrow{Na} (CH_3)_3CONa \xrightarrow{C_2H_5Cl} (CH_3)_3COC_2H_5$
   b. $CH_3\text{-}CH_3 + Br_2 \xrightarrow{hv} CH_3\text{-}CH_2Br \xrightarrow{\text{alc KOH}} CH_2{=}CH_2 \xrightarrow{Br_2/CCl_4} BrCH_2\text{-}CH_2Br \xrightarrow{\text{alc KOH}} CH_2{=}CH_2Br$
   c. $CH_3Br \xrightarrow{KCN} CH_3CN \xrightarrow{CH_3MgBr} (CH_3)_2C{=}NMgBr \xrightarrow{H3O+,\ \text{hydrolysis}} (CH_3)_2C{=}O$
   d.



COMPLETE THE REACTIONS TYPE QUESTIONS

a) X= $CH_3CH(Br)CH_3$ Y= $CH_3CH(OH)CH_3$
b) X= CH_3CH_2I Y= CH_3CH_2CN
c) X= $CH_3CH{=}CH_2$ Y= $CH_3CH_2CH_2Br$ Z= $CH_3CH_2CH_2OH$
d) X= $C_6H_5\text{-}O\text{-}C_2H_5$
e) X= $CH_3CH_2CH_2I$
f) X=CH_3CH_2NC

ARRANGE IN CORRECT ORDER TYPE QUESTIONS

1. (i)1-Chlorobutane >1-Chloropropane> Isopropyl chloride
   (In first two molecular mass increases b.p increases,in last two branching increases b.p decreases)
   (ii) Bromoform > Dibromomethane> Bromomethane > Chloromethane
   (Molecular mass increases B.P increases.)
2. n-C_3H_7I > n-C_3H_7Br > n-C_3H_7Cl (Molecular mass increases density increases)

WORD PROBLEM TYPE QUESTIONS

1. i) A= 2-Bromo-2- methyl propane(3^0) B= 2- bromo butane(2^0)
   ii) 2- bromo butane
2. (a) is isobutyl Bromide, (b) is 2-methyl-1-propene, (c) is tret-butyl Bromide and (d) is 2,5- dimethylhexane.
3. X= ethane Y = 1,2- dibromoethane Z = bromoethene

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7. ALCOHOL, PHENOL AND ETHERS
(CBSE WEIGHTAGE: 6 MARKS)

MULTIPLE CHOICE QUESTIONS (ONE CORRECT ANSWER)

1. Phenol reacts with Br_2 in CS_2 at low temperature to give
   (a) o-Bromophenol
   (b) o-and p-bromophenols
   (c) p-Bromophenol
   (d) 2, 4, 6Tribromophenol
2. The correct order of boiling points of alcohol of the same molecular mass :
   (a) 1° > 2° > 3°
   (b) 3° > 2° > 1°
   (c) 2° > 1° > 3°
   (d) 2° > 3° > 1°
3. When Phenol is distilled with zinc dust, it gives
   (a) Benzene
   (b) Toluene
   (c) Benzaldehyde
   (d) Benzoic acid
4. Which of the following cannot be made by using Williamson Synthesis:
   (a) Methoxybenzene
   (b) Benzyl p-nitrophenyl ether
   (c) tert. butyl methyl ether
   (d) Ditert. butyl ether
5. Dehydration of alcohol to ethers is catalysed by
   (a) cone. H_2SO_4 at 413 K
   (b) Hot NaOH
   (c) Hot HBr
   (d) Hot HNO_3

ASSERTION-REASON TYPE QUESTION

Each question consists of two statements,namely,Assertion (A) and Reason (R).For selecting the correct answer,use the following code:

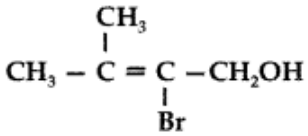
(a) Both Assertion (A) and Reason (R) are the true and Reason (R) is a correct explanation of Assertion (A).
(b) Both Assertion (A) and Reason (R) are the true but Reason (R) is not a correct explanation of Assertion (A).
(c) Assertion (A) is true and Reason (R) is false.
(d) Assertion (A) is false and Reason (R) is true.

1. Assertion (A): Phenol is more acidic than ethanol.
   Reason (R): Phenoxide ion is stabilized by resonance but ethoxide ion is not.
2. Assertion (A): Phenol gives o-and p- nitrophenol on nitration with conc. HNO_3 AND H_2SO_4 mixture.
   Reason (R): -OH group in phenol is O- and P-directing.
3. Assertion (A): Alcohols have higher boiling point than ethers.
   Reason (R): They can form intermolecular hydrogen bonding.
4. Assertion (A): O – nitrophenol is less volatile than P-nitrophenol.
   Reason (R):Intramolecular hydrogen bonding is present in O-nitrophenol while intermolecular hydrogen bonding is present in O-nitrphenol.
5. Assertion (A): Lucas test can be used to distinguish between 1-propanol and 2-propanol.
   Reason (R): Lucas test is based upon the difference in reactivity of primary ,secondary and tertiary alcohols with conc. HCl and anhydrous $ZnCl_2$.

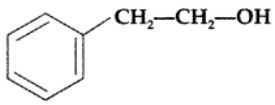
NOMENCLATURE TYPE QUESTIONS

1. Write the IUPAC name of the following compounds.

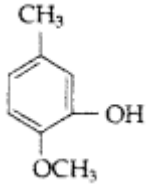
(a)



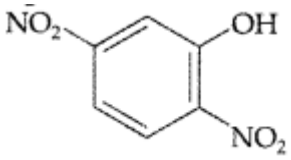
(b)



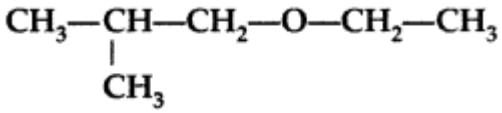
(c)



(d)



(e)



2. Write the structure of the following compound whose IUPAC name are as follows:

(a) 2-methylpropan- 2-ol molecule.
(b) Hex-l-en-3-ol
(c) Butane-1,3-diol
(d) 1-phenylpropan-2-ol
(e) 2-Methoxypropane

COMPETENCY BASED QUESTIONS

REASONING TYPE QUESTIONS

1. Ortho nitrophenol has lower boiling point than p-nitrophenol. Why?
2. Ortho-nitrophenol is more acidic than ortho-methoxyphenol. Why?
3. Of the two hydroxy organic compounds ROH and R'OH, the first one is basic and other is acidic in behaviour. How is R different from R'?
4. Which of the following isomers is more volatile : o-nitrophenol or p-nitrophenol?
5. Out of CH_3OH and C_6H_5OH which one is more acidic and why?
6. Alcohols are more soluble in water than the hydrocarbons of comparable molecular masses?
7. The boiling point of ethanol is higher than that of methoxymethane?
8. The C—O—H bond angle in alcohols is slightly less than the tetrahedral angle (190°28′)?
9. $(CH_3)_3C—O—CH_3$ on reaction with HI gives $(CH_3)_3C—I$ and $CH_3—OH$ as the main products and not $(CH_3)_3C—OH$ and $CH_3—I$?
10. $(CH_3)_3C—Br$ on reaction with sodium methoxide (Na+ _OCH_3) gives alkene as the main product and not an ether.

CHEMICAL TEST TYPE QUESTIONS

1. Give one chemical test to distinguish between : Propan-1-ol and Propan-2-ol
2. Give one chemical test to distinguish Phenol and Acetic acid.
3. Give one chemical test to distinguish Methanol and ethanol.

4. Give one chemical test each to distinguish between the following pair: (i)Phenol and Propan-1-ol (ii)Ethanol and di methyl ether (iii) propan-1-ol and 2-methyl propan -2-ol
5. Give one chemical test to distinguish (i) Ethanol and propan-1-ol (ii) Propan-2-ol and pentan-3-ol
6. Give one chemical test to distinguish
   (i) β – naphthol and ethanol
   (ii) diethyl ether and n-butane
   (iii) Di ethylether and but-1-ene

NAME REACTION TYPE QUESTIONS

1. Write the following name reaction:

a) Kolbe's reaction
b) Reimer-Tiemann reaction
c) Williamson synthesis
d) Hydroboration
e) Esterification

MECHANISM TYPE QUESTIONS

1. Write the mechanism of acid catalyzed hydration of alkenes.
2. Write the mechanism of acid catalyzed dehydration of ethanol to yield ethene at 443 K.
3. Write the mechanism of dehydration of Alcohol to form Ether at 413 K.

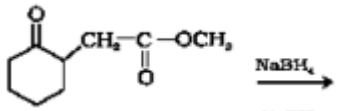
CONVERSION TYPE QUESTIONS

1. How are the following conversions carried out? (i) Propane to Propan-2-ol (ii) Phenol to acetophenone (iii) Propene to propan-1-ol
2. How will you bring about the following conversions? (i) Ethyl chloride to Ethanal (ii) Phenol to salicylic acid (ii) Benzyl chloride to Benzyl alcohol
3. Write the chemical reactions for the following conversions. (i) Phenol to anisole (ii) Ethyl magnesium chloride to Propan-1-ol (iii) Cumene to phenol (iv) Phenol to picric acid

COMPLETE THE REACTIONS TYPE QUESTIONS

1. Predict the products of the following reactions :

a) $CH_3 - CH_2 - CH_2 - CH_2 - OH + SOCl_2 \rightarrow$
b) $CH_3 - CH_2 - CH_2 - O - CH_3 + HBr \rightarrow$
c) $C_6H_5 - CH_2 - O - C_6H_5 + HI \xrightarrow{\text{heat}}$
d) $CH_3 - CH = CH_2 \xrightarrow{H_2O/H^+}$



ARRANGE IN CORRECT ORDER TYPE QUESTIONS

1. Arrange each set of compounds in the decreasing order of property indicated

a) Methanol ,ethanol , diethylether , ethylene glycol. (Boiling point)
b) Phenol , O- nitrophenol , p- methoxyphenol , p- nitrophenol.(K_a value)
c) Dimethyl ether , ethanol , phenol . (solubility in water)
d) 2-methylpropan-1-ol, n-Butanol, 2-methylpropan-2-ol (acidic nature)
e) Ethanol, n-butane , water, propane. (boling point)
f) Isobutane, n-butane , n- butanol , n-butyl chloride (boiling point)
g) Water , ethanol , phenol (acidity character)
h) Ethanol , isopropanol , tertiary butyl alcohol (reactivity towards lucas reagent)
i) Methanol, ethyl alcohol, ethylene glycol , glycerol. (solubility in water)
j) Phenol, o- nitrophenol , p-nitrophenol , m-nitrophenol (boiling point order)

WORD PROBLEM TYPE QUESTIONS

1. An organic compound A with molecular formula $C_8H_{16}O_2$ was hydrolysed with sulphuric acid to give a carboxylic acid B and alcohol C. Oxidation of C with chromic acid produced B. C on dehydration gives but-1-ene.Write reactions involved.
2. When an aromatic organic compound with molecular formula C_6H_6O is treated with bromine water, white precipitate of compound Y is obtained. Give the structure and the name of X and Y and write the chemical reaction involved. .
3. 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 .
4. An organic compound A (C_6H_6O) gives a characteristic colour with aq.$FeCl_3$ solution. (A) On reacting with CO_2 and NaOH at 400 K under pressure gives (B) which on acidification gives a compound (C) .The compound (C) reacts with acetyl chloride to give (D) which is a popular pain killer. Deduce the structure of A,B,C& D.
5. An organic compound (X) when dissolved in ether and treated with magnesium metal forms a compound Y. The compound, Y, on treatment with acetaldehyde and the product on acid hydrolysis gives isopropyl alcohol. Identify the compound X. What is the general name of the compounds of the type Y.

ANSWERS

MULTIPLE CHOICE QUESTIONS (ONE CORRECT ANSWER)

1. (b)o-and p-bromophenols
2. (a) 1° > 2° > 3°
3. (a) Benzene
4. (d) Ditert. butyl ether
5. (a) conc. H_2S0_4 at 413 K

ASSERTION-REASON TYPE QUESTION

1. a 2 .d 3. c 4. d 5. a

NOMENCLATURE TYPE QUESTIONS

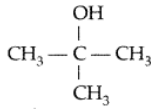
1.

(a) 2-bromo-3-methylbut-2-en-1-ol (b)2. 2-Phenylethanol (c)2-Methoxy-5-methyl phenol

(d)2, 5-dinitrophenol (e)1-Ethoxy-2-methylpropane

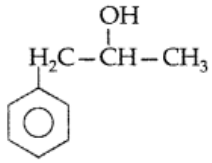
2

(a)



(b) $CH_2 = CH - CH(OH) - CH_2 - CH_2 - CH_3$ (c) CH_3-CH (OH)-CH_2-CH_2OH

(d)



(e)CH_3-O-CH $(CH_3)_2$

REASONING TYPE QUESTIONS

1. Intermolecular hydrogen bonding
2. $-NO_2$ is EWG while OCH_3 is EDG so H^+ release is easy from o-nitrophenol.
3. Where R=alkyl, ROH behaves as *Bronsted* base and where R=aryl, R'OH behaves as a Bronsted acid.
4. o-nitrophenol due to intramolecular H-bonding.
5. Phenol, phenoxide ion is resonance stabilized.
6. Alcohols can form H-bonds with water.
7. intermolecular H-bonding.
8. Repulsion between lone pair of electrons of oxygen of alcohols.
9. $(CH_3)_3$ is tert. Carbocation which is more stable for S_N1 reaction.
10. Tert. Alkyl halide undergo elimination in the presence of strong nucleophile and form alkene.

CHEMICAL TEST TYPE QUESTIONS

1. Propan-2-ol (2*) alcohol takes 5 minutes to give turbidity with lucas reagent($HCl/ZnCl_2$)
   Wherease propan-1-ol(1*) does not give test
   $CH_3CH(OH)CH_3 + HCl/ZnCl_2 \rightarrow CH_3CH(Cl)CH_3$ (five minutes)

2. Add $NaHCO_3$to each. Phenol will not react, whereas acetic acid will give brisk effervescence due to CO_2.(comparison of acidic nature)
   $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$ (brisk effervescence)

3. Add I_2 and NaOH to each one. Ethanol will give yellow ppt. of iodoform (iodoform test), whereas methanol will not give yellow ppt.

CH_3CH_2OH ---- I_2/NaOH →CHI_3 (YELLOW PPT)

4. (i) Phenol gives violet colouration with neutral $FeCl_3$ where prop-1-ol does not

6 $C_6H_5OH + FeCl_3 \rightarrow [Fe(O\ C_6H_5)_6]^{-3} + 3H^+ + 3HCl$

(ii) Ethanol gives yellow ppt in Iodo form test where di methyl ether does not

$CH_3CH_2OH + I_2/NaOH \rightarrow CHI_3$ (YELLOW PPT)

(iii)2-methylpropan-2-ol gives turbidity immediately with lucas reagent while propan-1-ol does not.

5. (i)Both the alcohols are primary alcohols so can be distinguished by Iodoform test

$CH_3CH_2OH + I_2/NaOH \rightarrow CHI_3$ (YELLOW PPT) Prop-1-ol does not perform Iodo form test

(ii) Propan-2-ol gives yellow ppt in Iodoform test where Pentan-3-ol does not

$CH_3CH(OH)CH_3 + I_2/NaOH \rightarrow CHI_3$ (yellow ppt)

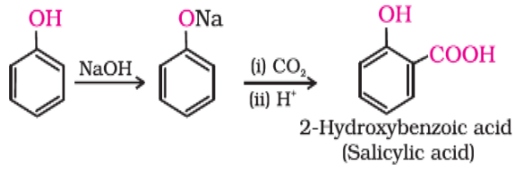
6.(i) β – naphthol gives violet colouration with neutral $FeCl_3$ where Ethenol does not

(ii)Di ethyl ether dissolves in con. H_2SO_4 where n-butane does not

(iii)But-1-ene decolourises potassium per mengnate solution where di ethyl ether does not.

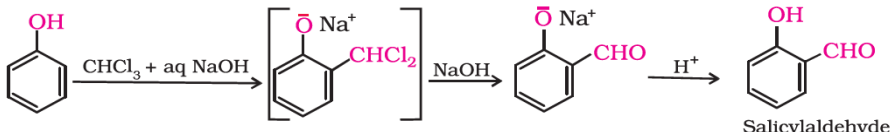
NAME REACTION TYPE QUESTIONS

a. Kolbe's reaction



2-Hydroxybenzoic acid
(Salicylic acid)

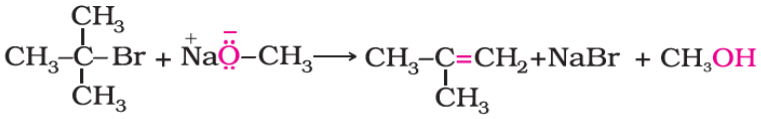
b. Reimer-Tiemann reaction



Intermediate

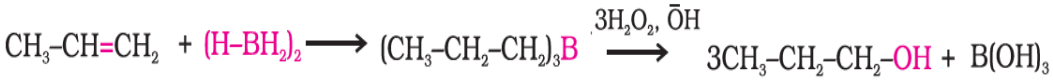
Salicylaldehyde

c. Williamson synthesis



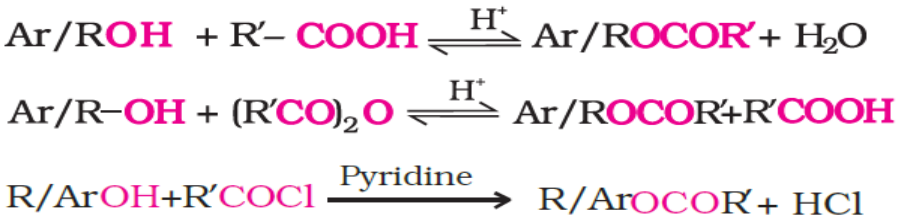
2-Methylpropene

d. Hydroboration



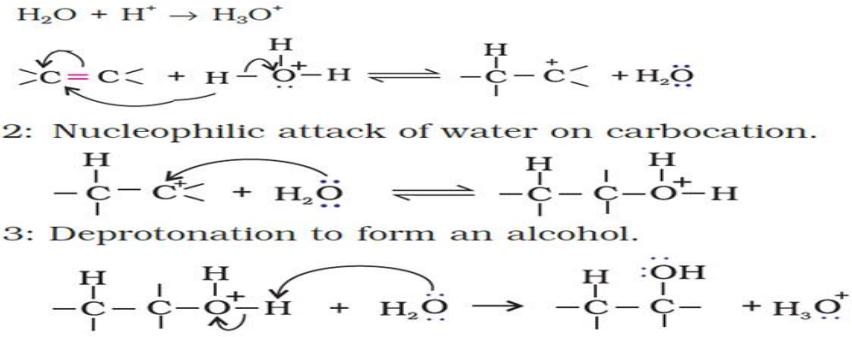
Propan-1-ol

e. Esterification



MECHANISM TYPE QUESTIONS

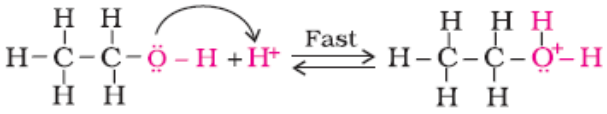
1. Step 1: Protonation of alkene to form carbocation by electrophilic attack of H_3O^+ *or* H^+.



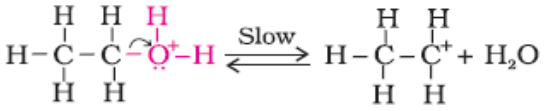
2.

Mechanism

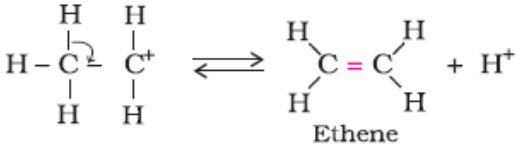
Step 1: Formation of protonated alcohol.



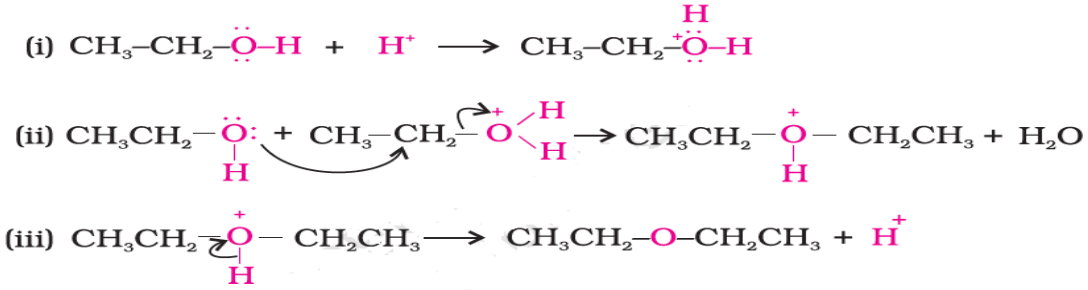
Step 2: Formation of carbocation: It is the slowest step and hence, the rate determining step of the reaction.



Step 3: Formation of ethene by elimination of a proton.

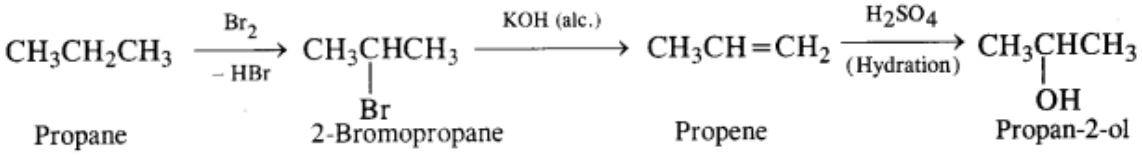


3. **Mechanism**

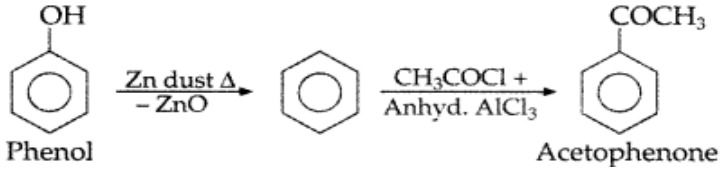


CONVERSION TYPE QUESTIONS

1 (i)

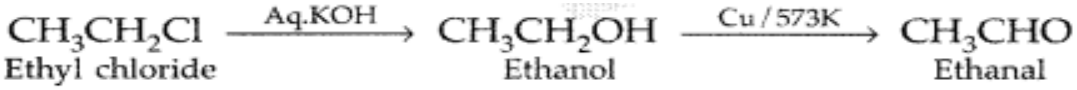


(ii)

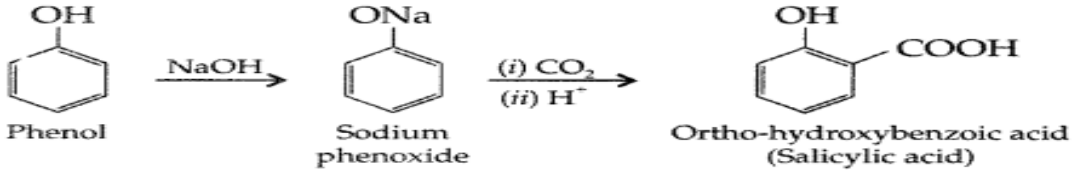


(iii)

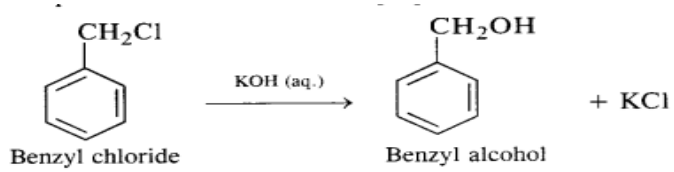
2 (i)



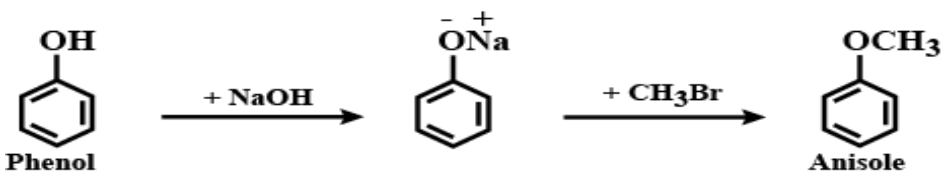
(ii)



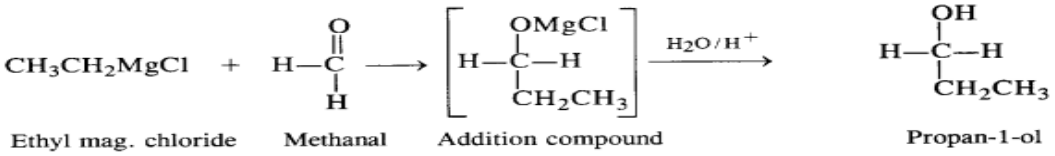
(iii)



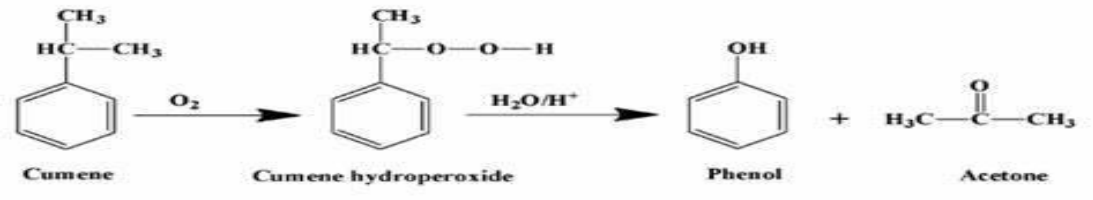
3 (i)



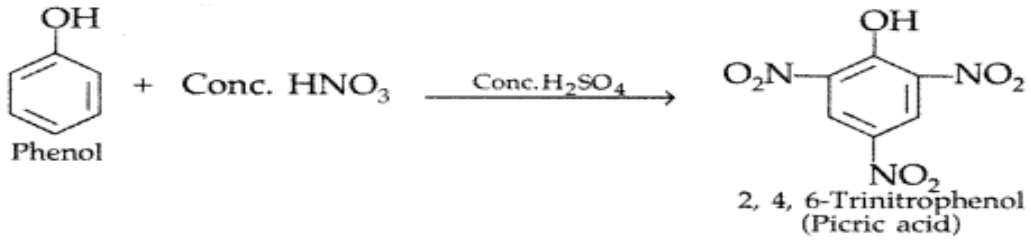
(ii)



(iii)



(iv)



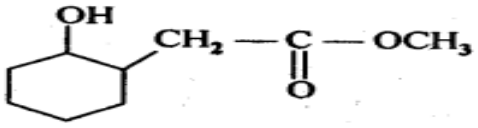
COMPLETE THE REACTIONS TYPE QUESTIONS

a) $CH_3 - CH_2 - CH_2 - CH_2 - Cl + SO_2 + HCl$

b) $CH_3 - CH_2 - CH_2 - OH + CH_3\ Br$

c) $C_6H_5 - CH_2\text{ -I } + C_6H_5 - OH$

d) d.CH_2 - CH (OH) - CH_3

e) 

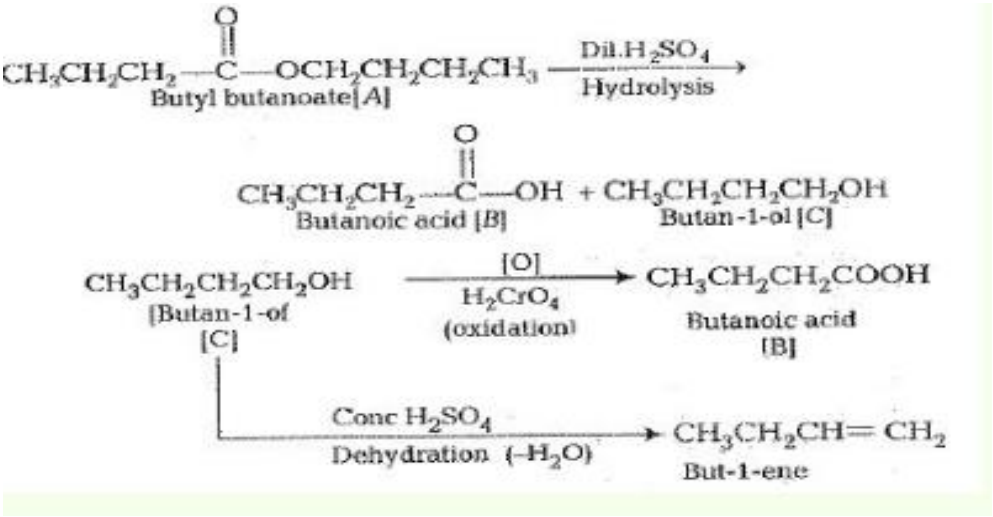
ARRANGE IN CORRECT ORDER TYPE QUESTIONS

1.

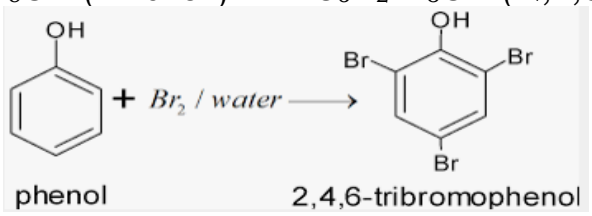
a) Ethylene glycol > diethyl ether > ethanol > Methanol .
b) O- nitrophenol>, p- nitrophenol> Phenol > p- methoxyphenol.
c) Ethanol > phenol > Dimethyl ether .
d) n-Butanol> 2-methylpropan-1-ol > 2-methylpropan-2-ol.
e) Water > Ethanol > n-butane > propane.
f) n- butanol> n-butyl chloride > n-butane >Isobutane .
g) phenol> Water > ethanol .
h) tertiary butyl alcohol > isopropanol > Ethanol.
i) glycerol> ethylene glycol > methanol > ethyl alcohol .
j) p-nitrophenol> o- nitrophenol> phenol

WORD PROBLEM TYPE QUESTIONS

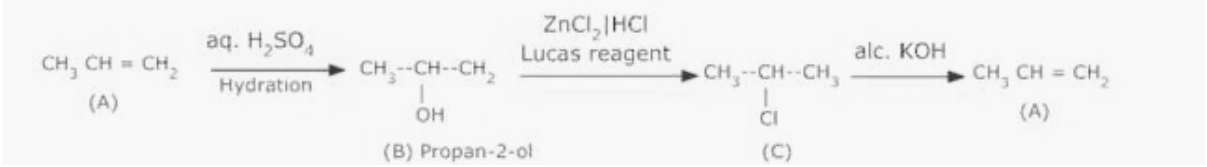
1. A - Butylbutanoate , B - Butanoic acid , C - Butan-1-ol



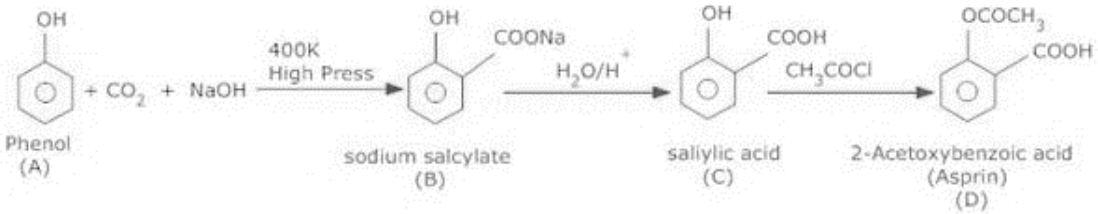
2.X - C_6H_5OH (Phenol) Y- $C_6H_2Br_3OH$ (2,4,6-tribromophenol)



3. A- Propene B- Propan-2-ol C - 2-chloropropane



4. A- Phenol B - Sodium salicylate C- Salicylic acid D- Aspirin



5.The compound X is CH_3Br (bromomethane) and Y is CH_3MgBr (Methylmagnesium bromide) The compounds of the type 'Y' are called Grignard reagent. Y has one C atom and acetaldehyde has 2 C atoms so 3 C containing isopropyl alcohol is produced on acid hydrolysis.

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8. ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

(CBSE WEIGHTAGE: 8 MARKS)

MULTIPLE -CHOICE QUESTIONS (ONE CORRECT ANSWER)

1. The reagent(s) which can be used to distinguish acetophenone from benzophenone is (are)
   (a) 2,4dinitrophenyl hydrazine
   (b) Aqueous solution of $NaHSO_3$
   (c) Benedict's reagent
   (d) I_2& NaOH
2. Carboxylic acid group doesn't give the usual addition reactions of aldehydes & ketones because
   (a) O-H bond is more polar than C=O group.
   (b) Carboxylate ion gets ionized.
   (c) Carboxylate ion gets stabilized by resonance.
   (d) It exists as –COOH & there is no carbonyl group.
3. The reagent with which both acetaldehyde and acetone will react is
   (a) I_2/NaOH
   (b) Fehling's solution
   (c) Carbonic acid
   (d) Tollen's reagent
4. Phenol & benzoic acid can be distinguished by reaction with.
   (a) Aqueous NaOH
   (b) Aqueous $NaHCO_3$
   (c) Neutral $AlCl_3$
   (d) Aqueous NH_3
5. The weakest acid amongst the following is
   (a) $ClCH_2COOH$
   (b) CCl_3COOH
   (c) CH_3COOH
   (d) $Cl_2CHCOOH$

ASSERTION-REASON TYPE QUESTION

Directions: In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

(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 and R is true.

1. **Assertion** - Aldehydes and ketones both react with Tollen's reagent to form a silver mirror.

   Reason – Both aldehydes and ketones contain a carbonyl group.

2. **Assertion –** Formaldehyde is a planar molecule.

   Reason – It contains sp^2 hybridised carbon atom.

3. **Assertion –** The α- hydrogen in carbonyl group is less acidic.

Reason – The anion formed after loss of α-H atom is resonance stabilised.

4. **Assertion –** Acetaldehyde and acetone cannot be distinguished with iodoform test.

Reason – Both give yellow ppt with NaOH and I_2 mixture.

5. **Assertion –** Aldol condensation may be catalyzed by acid as well as base.

Reason – Aldehydes are easily attacked by all nucleophiles.

NOMENCLATURE TYPE QUESTIONS

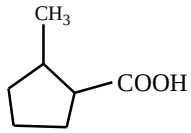
1. Write the structures of the following compounds:

(i) α-Methoxy propionaldehyde
(ii) 3-Hydroxybutanal
(iii) 2-Hydroxycyclopentane carbaldehyde
(iv) 4-oxopentanal
(v) Di-sec. butyl ketone
(vi) 4-Fluoroacetophenone

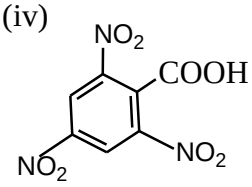
2. Name the following compounds according to the IUPAC system of nomenclature:

(i) $PhCH_2CH_2COOH$ (ii) $(CH_3)_2C{=}{=}CHCOOH$

(iii)



(iv)



COMPETENCY BASED QUESTION

REASONING TYPE QUESTIONS

1. Aldehydes are more reactive than ketones towards nucleophilic reagents. Give reasons.
2. Aldehydes and Ketones have lower boiling points than corresponding alcohols. Why?
3. Formaldehyde does not take part in Aldol condensation. Why?
4. Carboxylic acids do not give characteristic reactions of carbonyl group. Explain why?
5. Although phenoxide ion has more number of resonating structures than carboxylate ion, carboxylic acid is a stronger acid than phenol. Give two reasons.
6. Cl – CH_2COOH is a stronger acid than CH_3COOH. Explain why?
7. Why is 4-nitrobenzoic acid is more acidic than benzoic acid.

8. Carboxylic acids are higher boiling liquids than aldehydes, ketones and alcohols of comparable molecular masses. Give reason.
9. Why is there a significant difference in the boiling points of butanal and butanol?
10. Explain why electrophilic substitution in benzoic acid takes place at meta position ?

CHEMICAL TEST TYPE QUESTIONS

1. Give simple chemical test to distinguish between :
   (i) Ethanal and Propanal
   (ii) Propanal and propanone
   (iii) Pentan-2-one and Pentan-3-one.
2. Give chemical tests to distinguish between the following pairs of compounds :
   (a) Phenol and Benzoic acid
   (b) Benzaldehyde and Acetophenone
   (c) Acetophenone and Benzophenone
3. Write a chemical test to distinguish between CH_3COOH and HCOOH
4. A and B are two functional isomers of compound C_2H_6O. On heating with NaOH and I_2, isomer B forms yellow precipitate of iodoform whereas isomer A does not form any precipitate. Write the formulae of A and B.

NAME REACTION TYPE QUESTIONS

1. Illustrate the following reactions giving suitable example in each case:
(i) Rosenmund reduction
(ii) Etard reaction
(iii) Stephen reaction
(iv) Clemmensen reduction
(v) Wolff-Kishner reduction
2. Write the equation involved in the following reactions:
(i) Aldol Condensation
(ii) Cross Aldol Condensation
(iii) Cannizzaro reaction
(iv) Hell- Volhard –Zelinsky reaction (HVZ reaction)

MECHANISM TYPE QUESTIONS

1. Explain the mechanism of a nucleophilic attack on the carbonyl group of an aldehyde or a ketone.

CONVERSION TYPE QUESTIONS

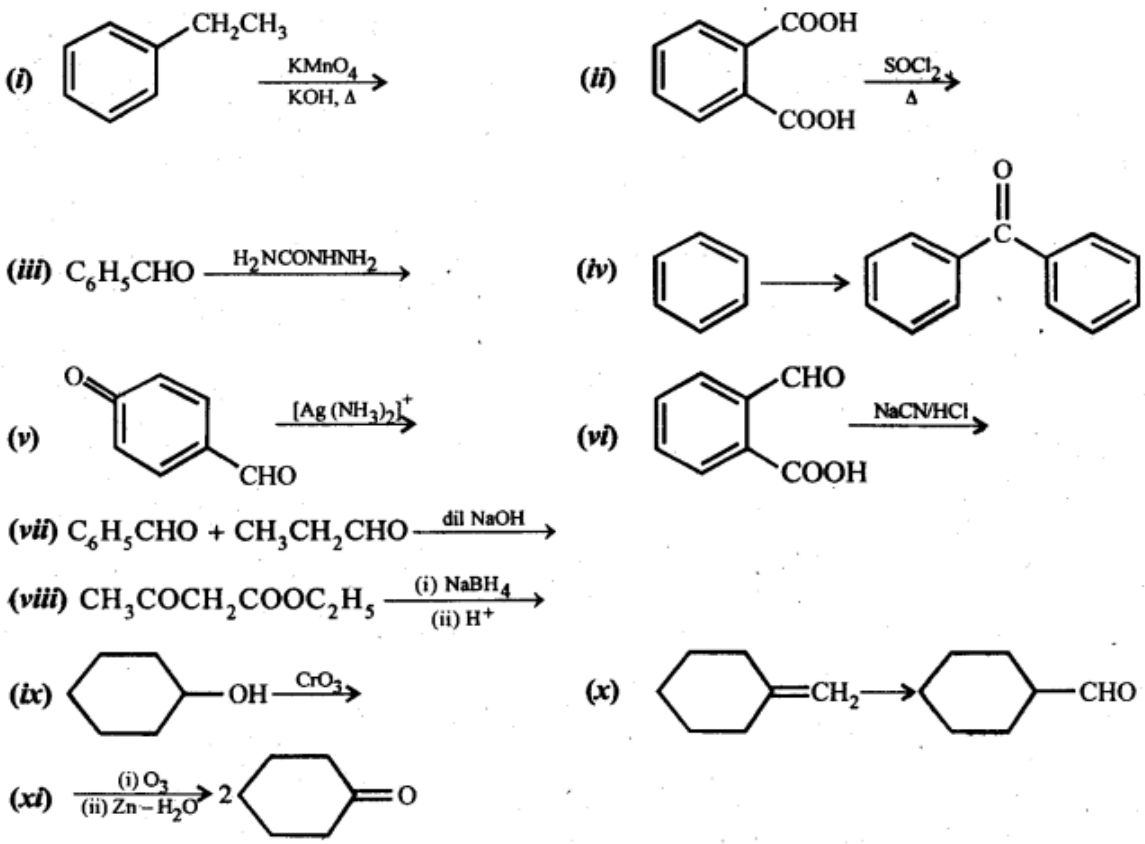
1. **How will you convert**
   i) Ethyl benzene to benzoic acid.
   ii) Acetophenone to benzoic acid.

iii) Bromobenzene to benzoic acid.
iv) Phenylethene (styrene) to benzoic acid.

2. **How will you bring about the following conversions in not more than two steps?**
i) Propanone to Propene
(ii) Benzoic acid to Benzaldehyde
(iii) Ethanol to 3-Hydroxybutanal
(iv) Benzene to m-Nitroacetophenone
(v) Benzaldehyde to Benzophenone

COMPLETE THE REACTIONS TYPE QUESTIONS

Complete each of the following reactions by giving the missing reactants, reagents or products:



ARRANGE IN CORRECT ORDER TYPE QUESTIONS

Arrange the following compounds in order of property indicated :-

1. FCH_2COOH, $O_2N\text{-}CH_2\text{-}COOH$, CH_3COOH, HCOOH **(in decreasing order of acid character)**

2. Acetone, Acetaldehyde, Benzaldehyde, Acetophenone **(in increasing order of reactivity towards addition of HCN)**
3. CH_3CHO, CH_3CH_2OH, CH_3OCH_3, $CH_3CH_2CH_3$ **(in increasing order of boiling point)**
4. $(CH_3)_2CHCOOH$, $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$ **(in increasing order of acid strength)**
5. Benzoic acid, 4-Nitrobenzoic acid, 3,4-Dinitrobenzoic acid, 4-Methoxybenzoic acid **(in increasing order of acid strength)**
6. Ethanal, Propanal, Propanone, Butanone **(in increasing order of reactivity towards nucleophilic addition reaction)**
7. Benzaldehyde, p-Tolualdehyde, p-Nitrobenzaldehyde, Acetophenone **(in increasing order of reactivity towards nucleophilic addition reaction)**
8. CH_3COOCH_3, CH_3COCl, CH_3CONH_2, $(CH_3CO)_2O$ **(in increasing order of reactivity towards hydrolysis)**
9. CH_3CH_2OH, CH_3COOH, $ClCH_2COOH$, FCH_2COOH, $C_6H_5CH_2COOH$ **(in decreasing order of acid character)**
10. Acetaldehyde, Acetone, Di-tert-butyl ketone, Methyl tert-butyl **ketone (in decreasing order of reactivity towards HCN)**

WORD PROBLEM TYPE QUESTIONS

1. 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.

2. An aromatic compound "A' (Molecular formula C_8H_8O) gives a 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 severe oxidation with potassium permanganate forms a carboxylic acid 'C' (Molecular formula $C_7H_60_2$), which is also formed along with the yellow compound in the above reaction. Identify A, B and C and write all the reactions involved.

3. Write down functional isomers of a carbonyl compound with molecular formula C_3H_6O. Which isomer will react faster with HCN and why? Explain the mechanism of the reaction also. Will the reaction lead to the completion with the conversion of the whole reactant into product reaction conditions? If a strong acid is added to the reaction mixture, what will be the effect on the concentration of the product and why?

4. When liquid 'A' is treated with a freshly prepared ammonical silver nitrate solution, it gives a bright silver mirror. The liquid forms a white crystalline solid on treatment with sodium hydrogen sulphite. Liquid 'B' also forms a

white crystalline solid with sodium hydrogen sulphite, but it does not give a test with ammoniacal silver nitrate. Which of the two liquids is aldehyde? Write the chemical equations of these reactions also.

5. Two moles of organic compound 'A' on treatment with a strong base gives two compounds 'B' and 'C'. Compound 'B' on dehydrogenation with Cu gives 'A' while acidification of 'C' yields carboxylic acid 'D' with molecular formula of CH_2O_2. Identify the compounds A, B, C and D and write all chemical reactions involved.

ANSWERS

MULTIPLE -CHOICE QUESTIONS WITH ONE CORRECT ANSWER

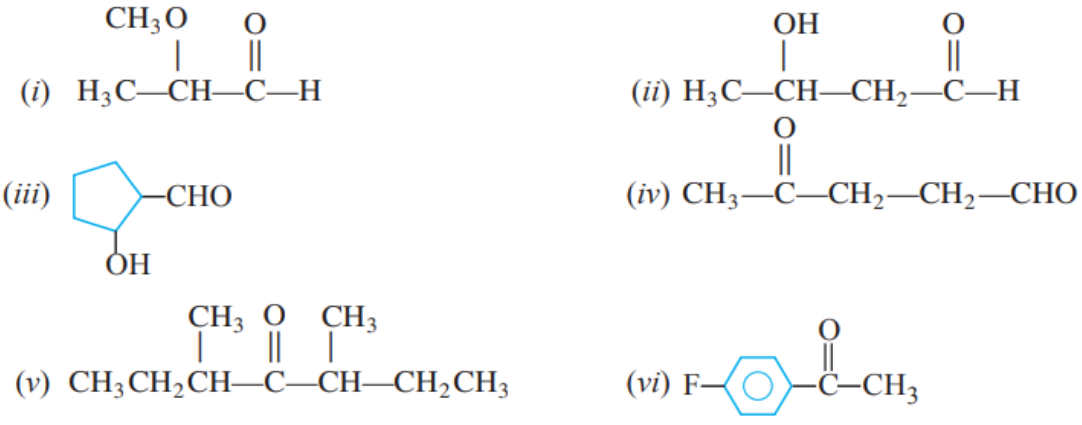
1. (d) I_2& NaOH
2. (c) Carboxylate ion gets stabilized by resonance
3. (a) I_2/NaOH
4. (b) Aqueous $NaHCO_3$
5. (c) CH_3COOH

ASSERTION-REASON TYPE QUESTION

1. (D) 2.(A) 3.(D) 4.(A) 5.(C)

NOMENCLATURE TYPE QUESTIONS

1.



2.

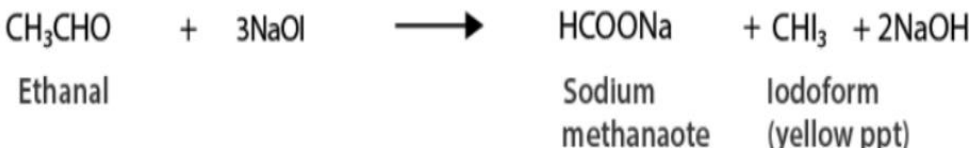
(i) 3-Phenylpropanoic acid
(ii) 3-Methylbut-2-enoic acid
(iii) 2-Methylcyclopentanecarboxylic acid
(iv) 2, 4, 6-Trinitrobenzoic acid.

REASONING TYPE QUESTIONS:

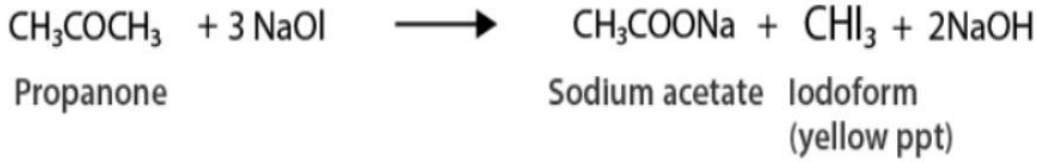
1. Aldehydes are more reactive than ketones due to the following two reasons :
2. Due to smaller +1 effect of one alkyl group in aldehydes as compared to larger +1 effect of two alkyl groups, the magnitude of positive charge on the carbonyl carbon is more in aldehydes than in ketones. As a result nucleophilic addition reactions occur more readily in aldehydes than in ketones.
3. Due to presence of a H-atom on the carbonyl group, aldehydes can be more easily oxidised than ketones.
4. It is due to weak molecular association in aldehydes and ketones arising out of the dipole- dipole interactions. In alcohols, stronger H bonds are formed.
5. Formaldehyde does not contain a-hydrogen atom. Therefore it does not take part in aldol condensation.
6. The carboxylic carbon is less electrophilic than carbonyl carbon because of the possible resonance structure.
7. 5.In the resonating structure of phenol and carboxylic acid, the negative charge on the carboxylate ion is delocalised over two oxygen atoms while they are localized on carbon atoms in phenol.
8. In case of caboxylate ion two equivalent resonance structures are obtained whereas in phenol non-equivalent resonance structures are obtained.
9. Because – I effect of Cl decreases the electron density in the O-H bond thereby making the release of a proton easier.
10. Because of electron withdrawing nature of -NO2 group
11. Because -COOH group of carboxylic acids is capable to do intermolecular hydrogen bonding forming a dimer while alcohols, aldehydes and ketones cannot
12. Butanol has a higher boiling point than butanal because butanol has a polar O-H bond, due to which it forms intermolecular hydrogen bonding, which is absent in butanal. Thus leading to a higher boiling point of Butanol.
13. 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.

CHEMICAL TEST TYPE QUESTIONS

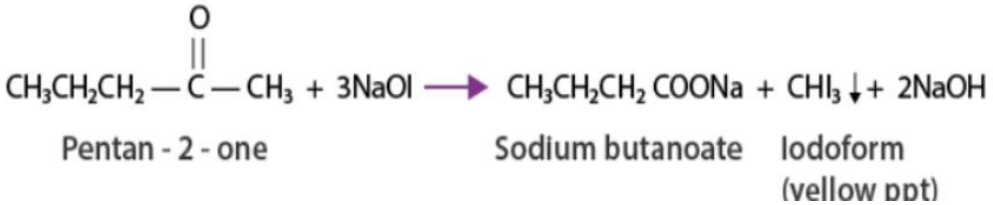
1.(i) Ethanal and propanal can be distinguished by iodoform test. Yellow precipitate of iodoform will be formed from Ethanal on heating with iodine and sodium hydroxide solution.



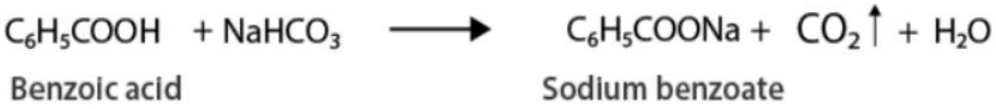
(ii) Propanal and propanone can be distinguished by iodoform test. Yellow precipitate of iodoform will be formed from Propanone on heating with iodine and sodium hydroxide solution.



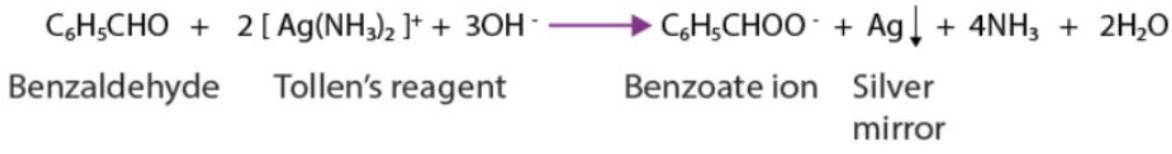
(ii) Pentan-2-one and Pentan-3-one can be distinguished by iodoform test. Yellow precipitate of iodoform will be formed from Pentan-2-one on heating with iodine and sodium hydroxide solution.



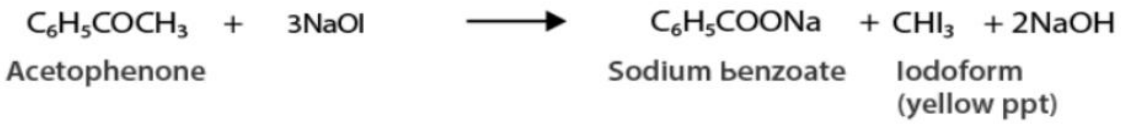
2. (a)Phenol and benzoic acid can be distinguished by their reactions with sodium bicarbonate solution. Benzoic acid will give effervescence with $NaHCO_3$ but phenol will not react.



(b) Benzaldehyde and acetophenone can be distinguished by Tollens test. Benzaldehyde will form silver mirror, on treatment with Tollens reagent whereas acetophenone will not show Tollens Test.

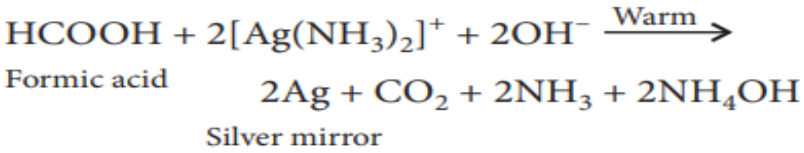


(c) Acetophenone and benzophenone can be distinguished by iodoform test. Acetophenone will give the yellow precipitate of iodoform, but benzophenone will not react.



3. Add Tollens' reagent to formic acid and warm. Silver mirror is formed.

Acetic acid does not give this test.



4.Molecular Formula of compounds A and B is C_3H_6O

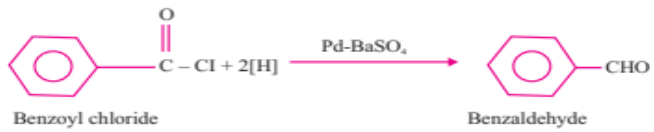
B forms yellow precipitate of iodoform. Hence, B must contain -COCH3 group.

The compound B is CH_3COCH_3

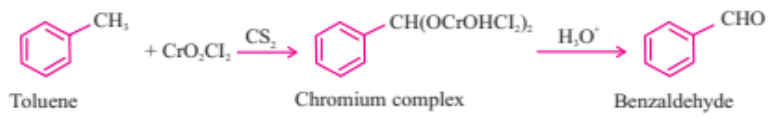
A does not give iodoform test and it is functional isomer of B thus, A is CH_3CH_2CHO.

NAME REACTION TYPE QUESTIONS

1.(i) Acyl chlorides when hydrogenated over catalyst palladium on barium sulphate yield aldehydes.

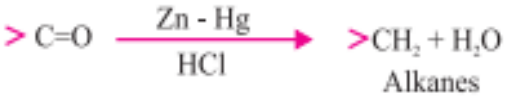


(ii) On treating toluene with chromyl chloride CrO_2Cl_2, the methyl group is oxidized to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.

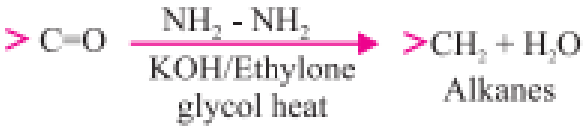


(iii) Nitriles are reduced to corresponding imines with stannous chloride in the presence of Hydrochloric acid, which on hydrolysis gives corresponding aldehyde.

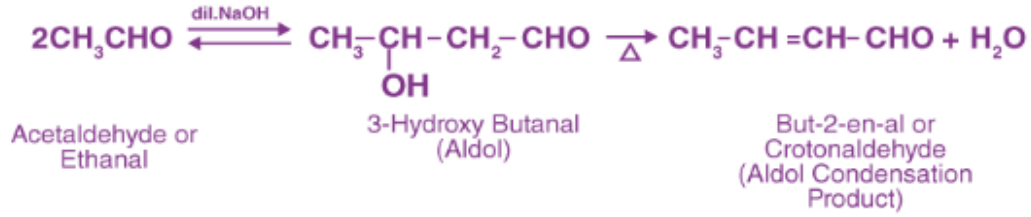
(iv) The carbonyl group of aldehydes and ketone is reduced to $-CH_2$ group on treatment with zinc amalgam and conc. HCl.



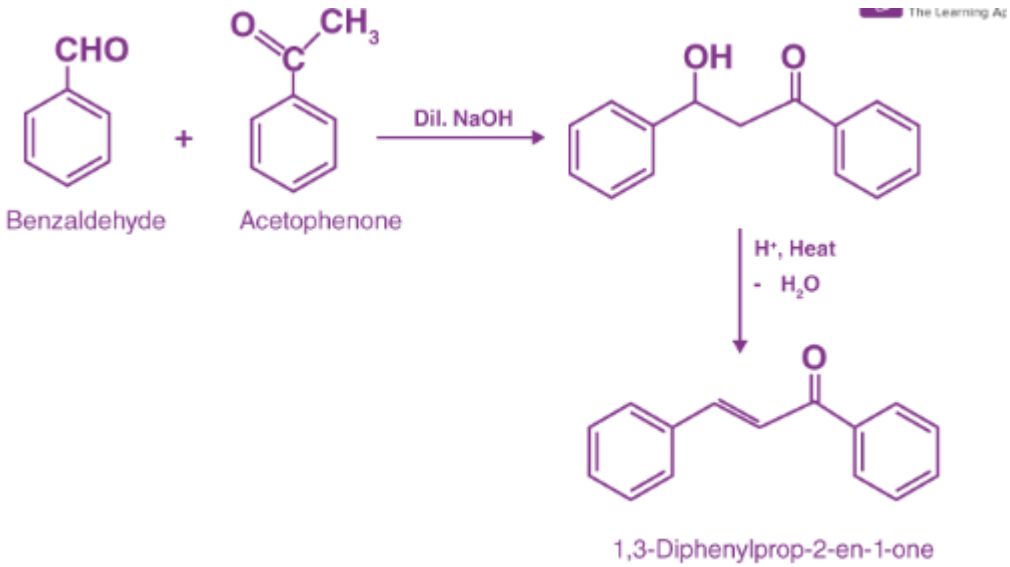
(v) Condensation of the carbonyl compound with hydrazine forms the hydrazone, and treatment with base induces the reduction of the carbon coupled with oxidation of the hydrazine to gaseous nitrogen, to yield the corresponding alkane.



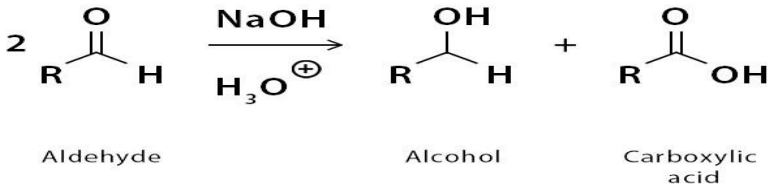
2.(i) Aldehydes and ketones having at least one α-hydrogen condense in the presence of dilute alkali as catalyst to form β-hydroxy aldehydes (aldol) or β-hydroxy ketones (ketol).



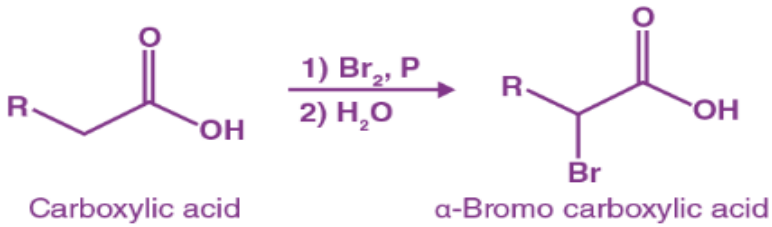
(ii) When aldol condensation is carried out between two different aldehydes and/or ketones, a mixture of self and cross-aldol products are obtained.

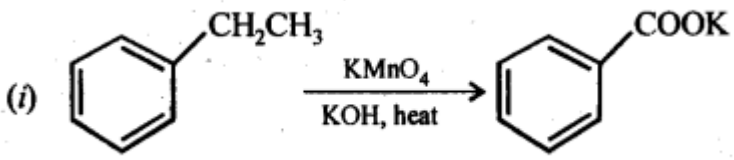


(iii) Aldehydes which do not have α-hydrogen atom, undergo self oxidation and reduction (disproportionation) reaction on treatment with concentrated alkali, to yield carboxylic acid salt and an alcohol respectively.



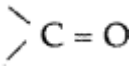
(iv) Carboxylic acids having an α-hydrogen are halogenated at the α-position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give α-halocarboxylic acid.

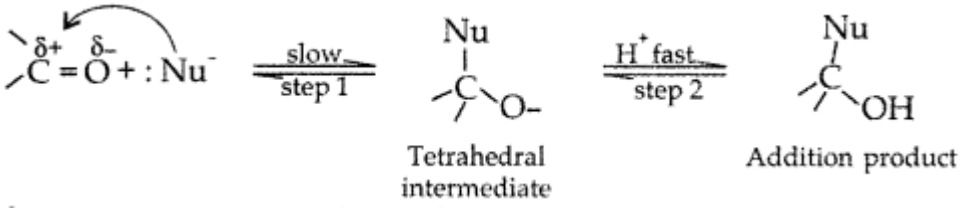




MECHANISM TYPE QUESTIONS

A1) Mechanism of a nucleophilic attack on the carbonyl group

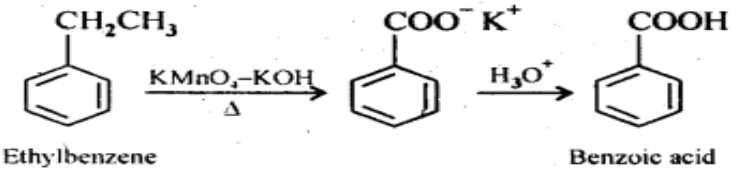
 is a polar group in which carbon acquires positive charge and O acquires negative charge due to more electronegativity of oxygen. The Nu~ attacks on carbon and forms a tetrahedral intermediate and then electrophile attacks on oxygen and forms a compound.



CONVERSION TYPE QUESTIONS

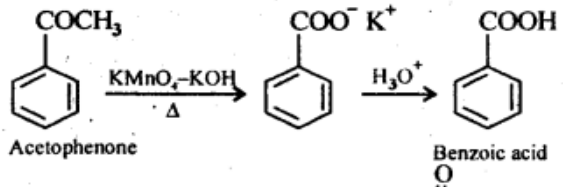
Q1

(i)



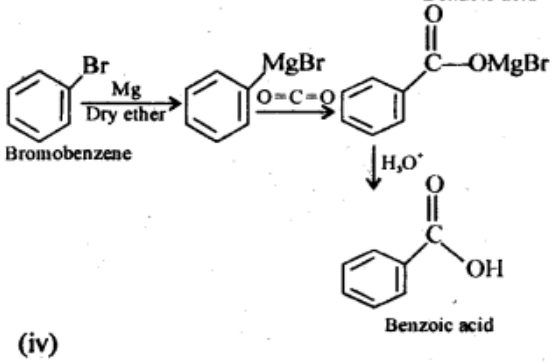
Ethylbenzene Benzoic acid

(ii)



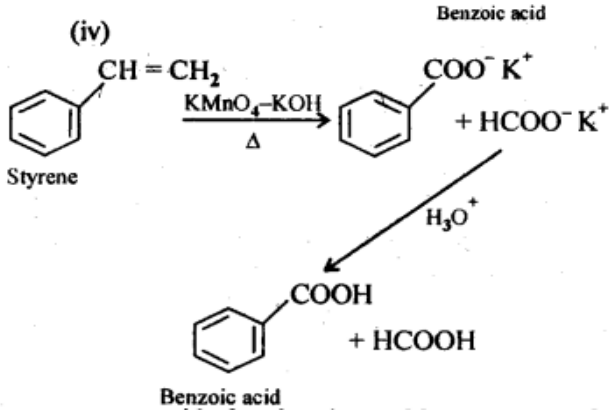
Acetophenone Benzoic acid

(iii)



Bromobenzene Benzoic acid

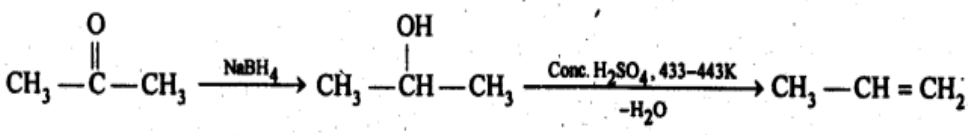
(iv)



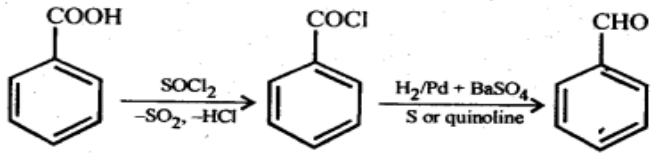
Styrene Benzoic acid

Q2.

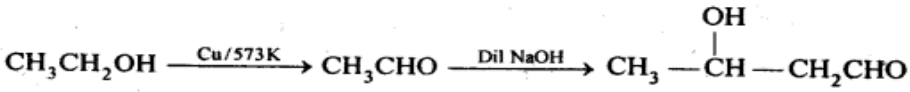
(*i*) **Propanone to propene:**



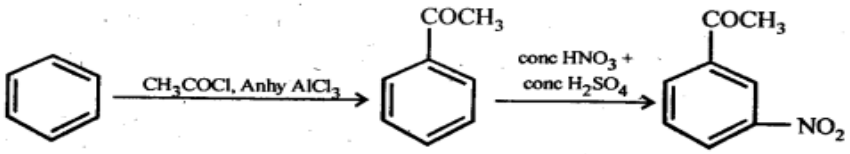
(*ii*) Benzoic acid to benzaldehyde:



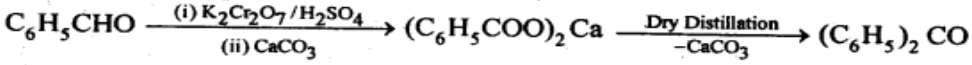
(*iii*) Ethanol to 3-hydroxy butanal:



(*iv*) Benzene to *m*-nitroacetophenone:

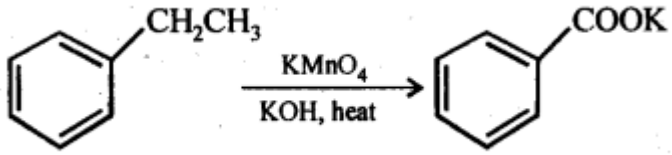


(*v*) Benzaldehyde to benzophenone:

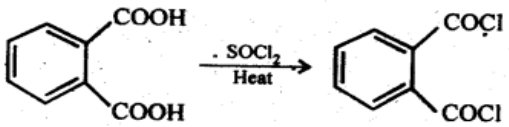


COMPLETE THE REACTIONS TYPE QUESTIONS

(*i*)

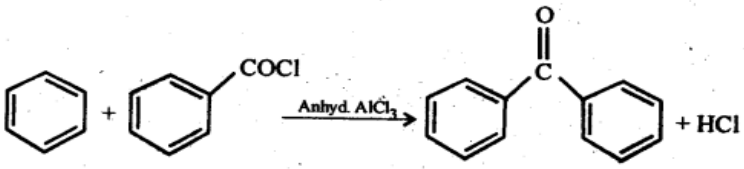


(*ii*)

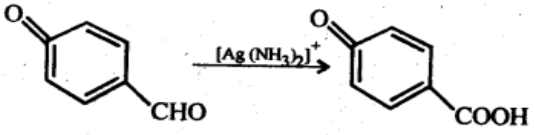


(*iii*) $C_6H_5CHO \xrightarrow{H_2NCONHNH_2} C_6H_5CH = NNHCONH_2 + H_2O$

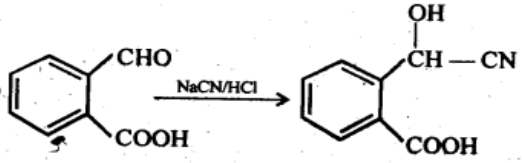
(*iv*)



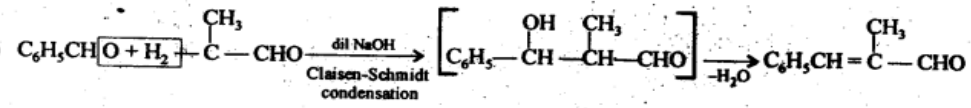
(*v*)

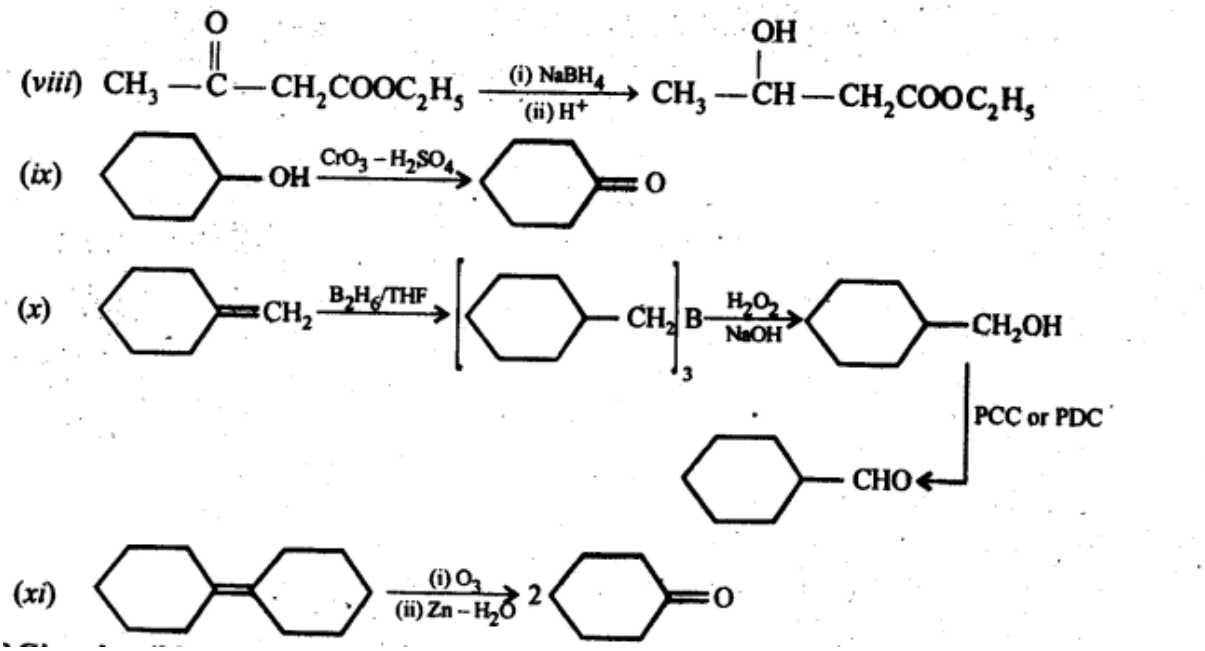


(*vi*)



(*vii*)





ARRANGE IN CORRECT ORDER TYPE QUESTIONS

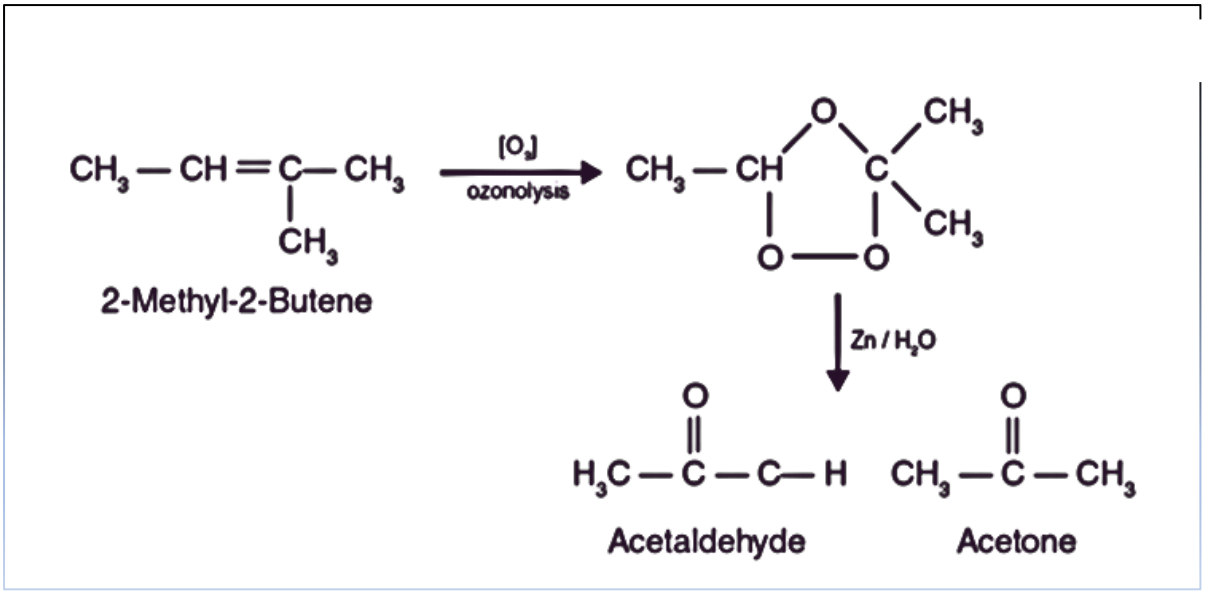
1. O_2N-CH_2-COOH > FCH_2COOH > CH_3COOH > HCOOH
2. Acetophenone < Acetone < Benzaldehyde < Acetaldehyde
3. $CH_3CH_2CH_3$ < CH_3OCH_3 < CH_3CHO < CH_3CH_2OH
4. $(CH_3)_2CHCOOH$ < $CH_3CH(Br)CH_2COOH$ < $CH_3CH_2CH(Br)COOH$
5. 4-Methoxybenzoic acid < Benzoic acid < 4-Nitrobenzoic acid < 3,4-Dinitrobenzoic acid
6. Butanone < Propanone < Propanal < Ethanal
7. Acetophenone < p-Tolualdehyde < Benzaldehyde < p-Nitrobenzaldehyde
8. CH_3CONH_2 < CH_3COOCH_3 < $(CH_3CO)_2O$ < CH_3COCl
9. FCH_2COOH > $ClCH_2COOH$ > $C_6H_5CH_2COOH$ > CH_3COOH > CH_3CH_2OH
10. Acetaldehyde > Acetone > Methyl tert-butyl ketone > Di-tert-butyl ketone

WORD PROBLEM TYPE QUESTIONS

1. (i) Compound B gives Fehling's test, which means it is aldehyde also. It forms an iodoform, so compound B is acetaldehyde, among aldehydes.

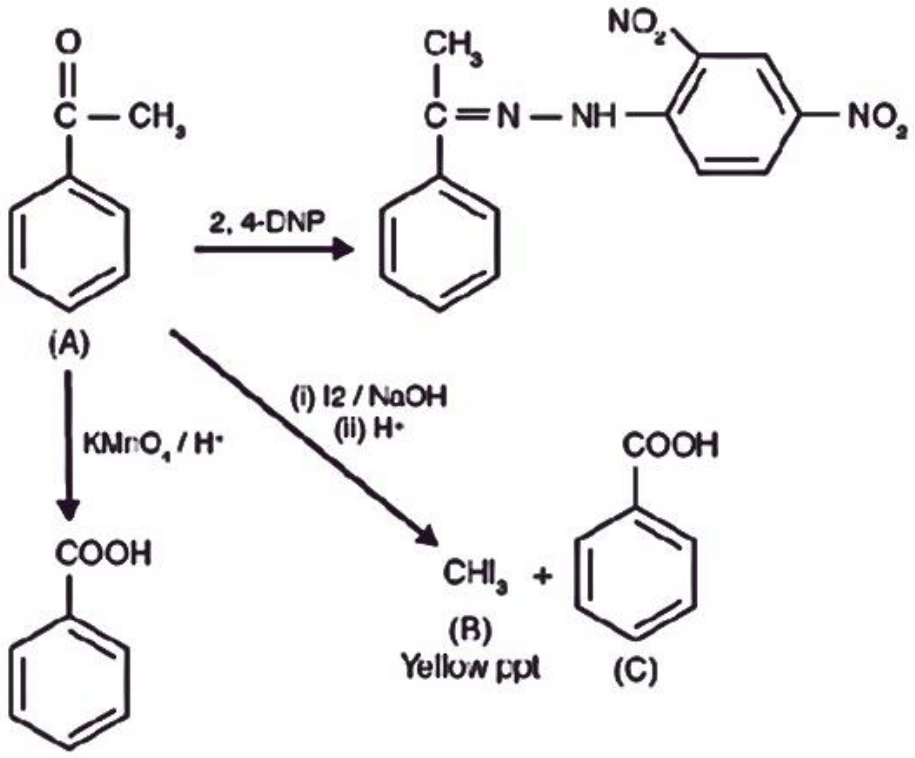
(ii) Compound C does not give Fehling's test but gives iodoform, so ketone must have a methyl group attached to carbonyl.

Reactions for ozonolysis and formation of iodoform from B and C are



2. Since the aromatic compound, 'A' does not give Tollen's reagent test or Fehling's test, it is not an aromatic aldehyde. It responds to the iodoform test, indicating a methyl ketone.

The series of reactions involved are listed.



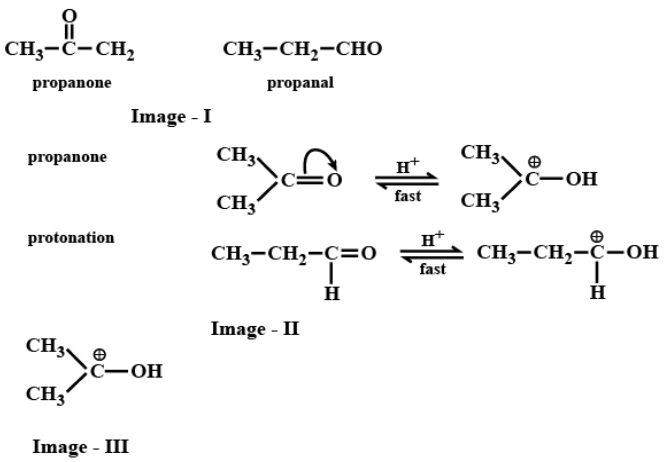
3 Functional isomers of C_3H_6O containing carbonyl group are CH_3CH_2CHO (Propanal) and CH_3COCH_3 (Propanone).

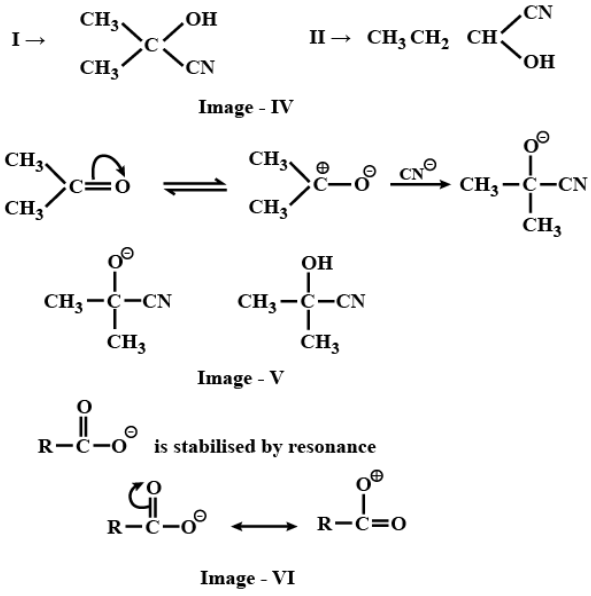
(a) Propanal CH_3CH_2CHO will react faster with HCN because less steric hindrance and electronic factors increase its electrophilicity.

Mechanism - step-1) ionisation of weak acid in presence of base

$$OH^- + HCN \rightarrow H_2O + CN^-$$

step-2) nucleophilic addition of CN^- on carbonyl compound



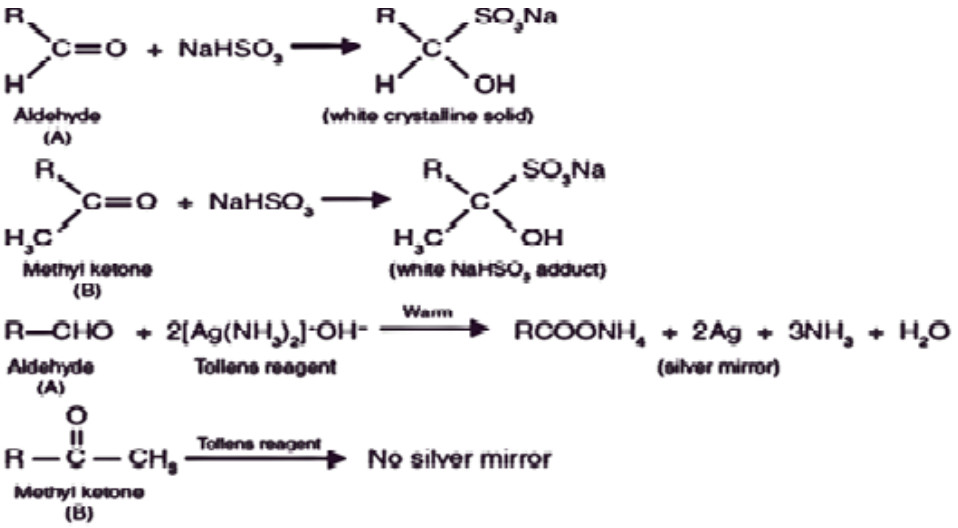


(b) It does not lead to completion because it is a reversible reaction. Equilibrium is established,

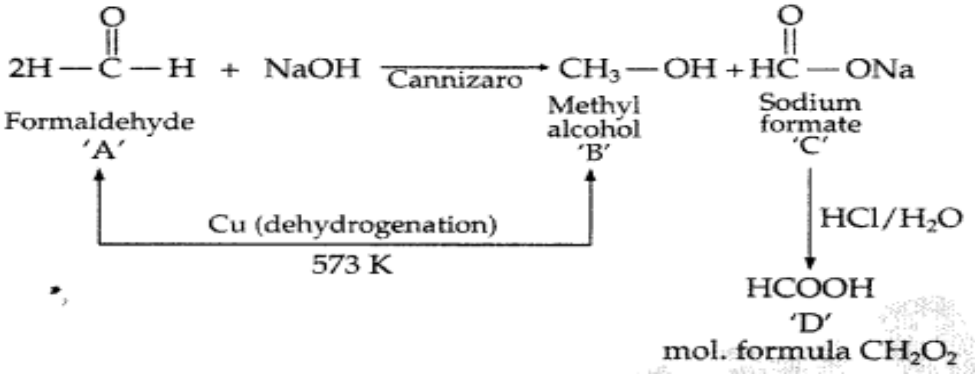
(c) If A strong acid is added to the reaction mixture, the reaction is inhibited because the production of CN^- ions is prevented.

4. Liquid 'A' must be Aldehyde because it reacts with both NaHSO3 and ammonical silver nitrate.

Liquid 'B' must be ketone because it does not react with ammonical silver nitrate but react with NaHSO3.


Aldehyde
(A)
(white crystalline solid)
Methyl ketone
(B)
(white NaHSO3 adduct)
Warm
Aldehyde
(A)
Tollens reagent
(silver mirror)
Tollens reagent
Methyl ketone
(B)
No silver mirror

5.


Cannizaro
Formaldehyde
'A'
Methyl
alcohol
'B'
Sodium
formate
'C'
Cu (dehydrogenation)
573 K
HCl/H2O
HCOOH
'D'
mol. formula CH2O2

9. AMINES

(CBSE WEIGHTAGE: 6 MARKS)

MULTIPLE -CHOICE QUESTIONS WITH ONE CORRECT ANSWER

1. Which of the following is formed when an alkyl primary amine reacts with nitrous acid?
(a) Alkyl nitrite (b) Secondary amine
(c) Nitroalkane (d) Alcohol
2. Which of the following amines are insoluble in water?
(a) Methanamine (b) Aniline
(c) Propanamine (d) Ethanamine
3. Which of the following statements about primary amines is 'false'?
(a) Alkylamines are stronger bases than arylamines.
(b) Alkylamines are stronger bases than ammonia.
(c) Alkylamines react with nitrous acid to produce alcohols.
(d) Arylamines react with nitrous acid to produce phenols
4. Amongst the following, the strongest base in aqueous medium is:
(a) CH_3NH_2 (b) $NCCH_2NH_2$
(c) $(CH_3)_2NH$ (d) $C_6H_5NHCH_3$
5. The best reagent for converting 2-phenylpropanamide into 2-phenylpropanamine is:
(a) $LiAlH_4$ (b) Br_2 in aqueous NaOH
(c) iodine in the presence of red phosphorus (d) excess H_2

ASSERTION-REASON TYPE QUESTION

Directions: In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:
(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 and R is true.

1. **Assertion:** Gabriel phthalimide reaction can be used to prepare aryl and alkyl amines
   Reason: Aryl halides have same reactivity as alkyl halides towards nucleophilic substitution reaction.
2. **Assertion:** Aniline does not undergo Friedel -Crafts reaction
   Reason: Friedel-Crafts reaction is electrophilic substitution reaction
3. **Assertion:** Aniline reacts with bromine water to form 2,4,6-tribromoaniline
   Reason: Aniline is resonance stabilized
4. **Assertion:** The order of basicity of amines in gaseous state is different than those in aqueous solution

Reason: In aqueous solution solvation is also to be takes in to account.

5. **Assertion:** Hinsberg's reagent does not react with tertiary amines
   Reason: No hydrogen atom is attached to nitrogen of amino group

NOMENCLATURE TYPE QUESTIONS

1. Write IUPAC names of the following compounds.

   (i) $(CH_3)_2CHNH_2$ (ii) $CH_3(CH_2)_2NH_2$ (iii) $CH_3NHCH(CH_3)_2$

   (iv) $(CH_3)_3CNH_2$ (v) $C_6H_5NHCH_3$

2. Write the formula of the following compounds.

   a.) 2, 4, 6-Tribromoaniline b) N-Ethyl-N-methylethanamine

   c) ethane-1, 2-diamine. d) benzenamine. e) N, N diethylethanamine.

REASONING TYPE QUESTIONS

A. Accounts for the following

1. Pk_b of aniline is more than that of methyl amine.
2. Aniline gets coloured on standing in air for a long time.
3. $MeNH_2$ is more basic than MeOH.
4. Acylation of aniline is carried out in the present of Pyridine.
5. Aniline can not be prepared by the ammonolysis of chlorobenzene under normal condition.
6. N-ethylethanamine boils at 329.3k and butanamine boil at 350.8 k although both are isomeric in nature.
7. Aniline on nitration gives good amount of m-nitroaniline through $-NH_2$ group is o/p directing in electrophilic substitution reaction.
8. $(CH_3)_2$ NH is more basic than $(CH_3)_3N$ in aquous solution.
9. Ammonoslysis of alkyl halide is not a good method to prepare pure primary amines.
10. Aniline does not undergo Friedel crafts reaction.
11. Ethylamine is soluble in winter whereas aniline is insolible.
12. Methylamine in water reacts with ferric chloride to precipitate hydrated ferric oxide.
13. Diazorium salt of aromatic amine are more stable than aliphatic amine.
14. Gabriel Phthalimide synthesis is preferred for Primary amine.

CHEMICAL TEST TYPE QUESTIONS

1. Give One Chemical test to distinguish between the following pairs of compounds.

i. Methylamine and dimethyl amine
ii. Secondary and tertiary amines
iii. Ethyl amine and aniline
iv. Aniline and N-methyl aniline

v. Aniline and Benzyl amine
vi. Primary, secondary and tertiary amines

NAME REACTION TYPE QUESTIONS

Write short notes on the following:

1. Sandmeyers reaction
2. Gabriel pthalimide synthesis
3. **Carbylamine reaction**
4. **Hofmann's bromamide reaction**
5. **Coupling reaction**

CONVERSION TYPE QUESTIONS

1. How will you bring about following conversions?

(i) Ethanoic acid to methanamine.
(ii) Methanamine to ethanamine.
(iii) Nitromethane to methyl isocyanides.

2. How are the following conversions carried out?

(i) Ethanamine to ethanoic acid.
(ii) Chloromethane to ethanamine .

3. Write chemical equations for the following conversations:

(i) Aniline to benzenenitrile
(ii) Benzene diazonium chloride to benzylamine
(iii) Aniline to Phenol

4. How will you convert:

(i) Nitrobenzene into aniline.
(ii) Benzyl chloride into 2-Phenylethamine.

COMPLETE THE REACTIONS TYPE QUESTIONS

1. Complete the following reactions:

1) $C_6H_5N_2Cl + H_3PO_2 + H_2O \rightarrow$
2) $C_6H_5NH_2 + CH_3COCl \rightarrow$
3) $C_2H_5NH_2 + C_6H_5SO_2Cl \rightarrow$
4) $C_2H_5NH_2 + HNO_2 \rightarrow$
5) $CH_3CH_2NH_2 + CHCl_3 + KOH$ (Alcoholic) $\rightarrow$

ARRANGE IN CORRECT ORDER TYPE QUESTIONS

Arrange the following in their given order:

(a) in decreasing order of the pK_b values:
$C_2H_5NH_2$, $C_6H_5NHCH_3$, $(C_2H_5)_2NH$, and $C_6H_5NH_2$

(b) In increasing order of basic strength:
(i) Aniline, p-nitroaniline and p-toluidine
(ii) $C_6H_5NH_2$, $C_6H_5NHCH_3$, $C_6H_5CH_2NH_2$

(c) Decreasing order of the basic strength in gas phase
$C_2H_5NH_2$, $(C_2H_5)_2NH$, $(C_2H_5)_3N$, NH_3

(d) In increasing order of boiling point:
C_2H_5OH, $(CH_3)_2NH$, $C_2H_5NH_2$

(e) In increasing order of solubility in water:
$C_6H_5NH_2$, $(C_2H_5)_2NH$, $C_2H_5NH_2$

(f) In increasing order of dipole moment :
$CH_3CH_2CH_3$, $CH_3CH_2NH_2$, CH_3CH_2OH

WORD PROBLEM TYPE QUESTIONS

1. An aromatic compound 'A' on treatment with aqueous ammonia and heating, forms compound 'B' which on heating with Br_2 and KOH forms a compound 'C' of molecular formula C_6H_7N. Write the structures and IUPAC names of compound A, B and C.
2. A compound 'X' having molecular formula C_3H_7NO, reacts with Br_2 in presence of KOH to give another Compound 'Y'. The compound Y reacts with HNO_2 to form ethanol and N_2 gas. Identify the compound X and Y and write the reactions involved.
3. An organic compound 'A' having molecular formula C_3H_5N on hydrolysis give another compound 'B'. The compound 'B' on treatment with HNO_2 gave ethyl alcohol. 'B' on warming with $CHCl_3$ and alcoholic caustic potash gave an offensive smelling substance 'C'. Identify A, B & C.
4. An aliphatic compound 'A' with molecular formula C_2H_3Cl on treatment with AgCN gives two isomeric compounds of unequal amounts with the molecular formula C_3H_3N. The minor of these two products on complete reduction with H_2 in presence of Ni gives a compound B with molecular formula C_3H_9N. Identify the compounds 'A','B', and write the reaction involved.
5. Iodomethane reacts with KCN to form a major product 'A'. Compound 'A' on reduction in presence of $LiAlH_4$ forms a higher amine 'B'. Compound 'B' on treatment with $CuCl_2$ form a blue colour complex 'C'. Identify the compounds 'A', 'B' and 'c':

ANSWER KEY

MULTIPLE CHOICE QUESTIONS (ONE CORRECT ANSWER)

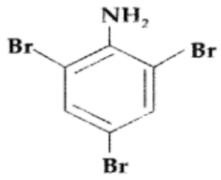
1. d
2. b
3. d
4. c
5. a

ASSERTION-REASON TYPE QUESTION

1. d
2. b
3. b
4. a
5. a

NOMENCLATURE TYPE QUESTIONS

1. (i) Propane-2-amine
   (ii) Propane-1-amine
   (iii) N-methylpropan-2-amine
   (iv) 2-methylpropan-2-amine
   (v) N-methyl benzenamine
2. a)



b) $(CH_3CH_2)_2NCH_3$

c) $H_2N–CH_2–CH_2–NH_2$

d) $C_6H5–NH_2$

e) $(CH_3CH_2)_3N$

COMPETENCY BASED QUESTION

REASONING TYPE QUESTIONS

Accounts for the following:

1. In aniline due to resonance the lone pair of electrons on N-atom get delocalized in benzene ring. So electron density over N decreases. On the other hand in melhy animine due to +I fect electron density increases. So aniline is less basic & have higher pk_b value.
2. Due to +R effect of $-NH_2$ group the electron density on benzene ring increases . So oxidized easily or standing for a long time.
3. Nitroogen is less electronegative than oxygen therefore lone pair of electrons on Nitrogen is readily available for donation. Hence $MeNH_2$ is more basic.
4. This is done to remove the HCL so formed during the reaction & shift the equilibrium to the right hand side.
5. Due to double bond character in cholorobenzene due to conjugation.
6. N-ethylamine is secondary amine but butanamine is Primary amine both have tendency to form intermolecular H bond but in primary amine more intermolecular H-bond is present so have high B.P.
7. Aniline in strong acidic medium accepts proton and form anilinium ion which act as metadirecting group.
8. $(CH_3)_2$ NH is more basic than $(CH_3)_3$ N is aquous solution due to all three favorable factors: (i)+ I effect (ii) Hydration effect (iii) Steric effect
9.It gives mixture of Primary, secondary and tertiary amine along with some quaternary ammoniumsalt which is difficult to separate.
10. Due to formation of salt with catalyst $AlCl_3$ used in fridel craft reaction.
11. Because ethyl amine has tendency to form intermolecular H bond with water, Amiline has no such tendency .
12. Methylamine being more basic than water accepts proton from water give OH^- ion which combines with Fe^{3+} ion present in water and form brown precipitate of hydrated ferric oxide.
13. Due to dispersal of +ve charge on benzene ring.
14. Because it gives pure Primary amine without any contamination of secondary and tertiary.

CHEMICAL TEST TYPE QUESTIONS

Ans.(i) Methyl amines gives offensive smelling compound. (Methyl isocyanide) on treatment with CHCl3 & KOH while dimethyl amine does not react.

Ans.(ii) On adding HNO2, secondary amine will form yellow oily compound whereas tertiary amine will form salt, soluble in water.

Ans.(iii) on adding $NaNO_2$ and HCl and cooling it to 0 add alkaline solution of phenol. Aniline willgive orange red dye whereas no such dye is formed in case of ethyl amine.

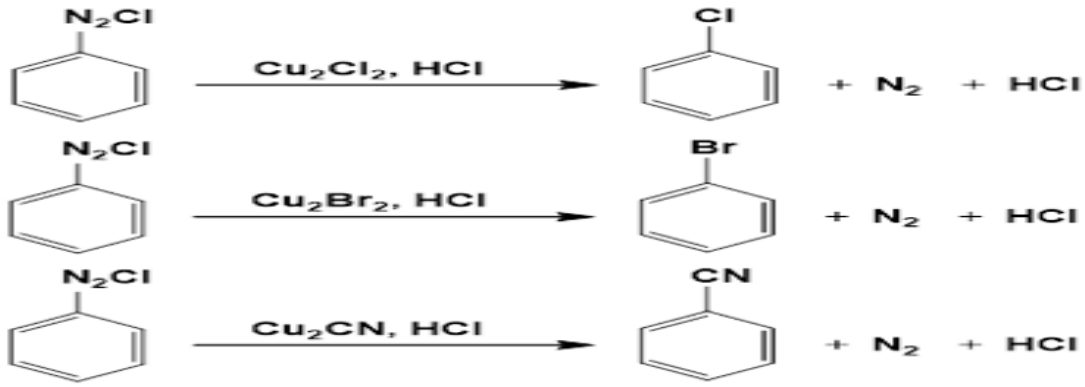
Ans.(iv) Add $CHCl_3$ & KOH, Aniline will give offensive smell formation of phenyl Isocyanide, whereasN-methyl aniline will not react."

Ans.(v) Add Bromine water, Aniline & will form white ppt. whereas benzyl amine will not form whiteppt.

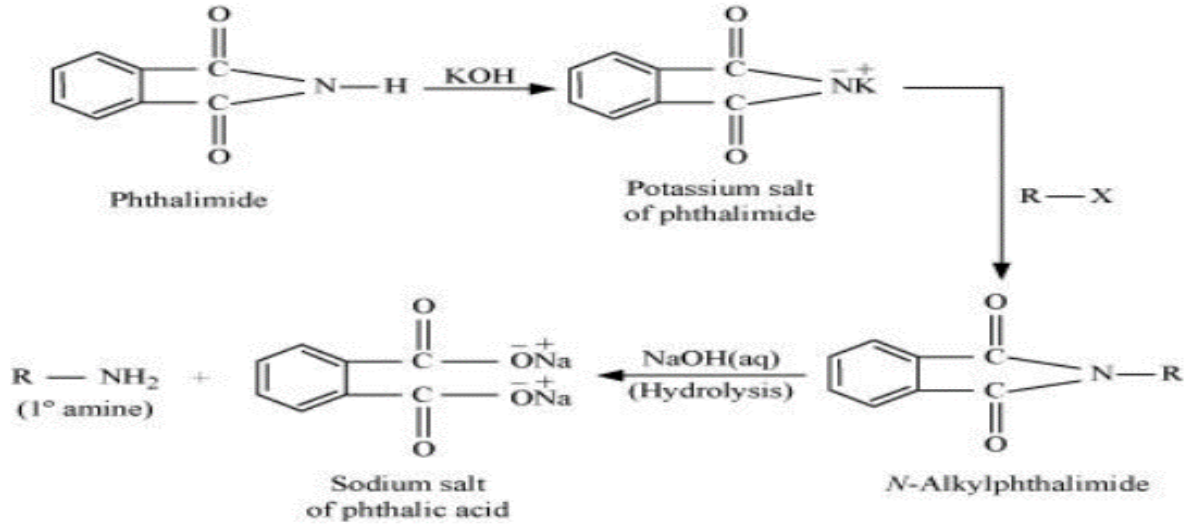
Ans.(vi) On adding Hensberg's reagent, primary amine forms N-alkyl benzene salphonamide which is soluble in alkali secondary amine forms N, N-Dialkyl benzene salphonamide which is insoluble in alkaliTertiary amine does not respond to this test.

NAME REACTION TYPE QUESTIONS

(1). Sandmeyer's Reaction - Benzene diazonium chloride is converted to chlorobenzene, bromobenzene, cyanobenzene on treatment with CuCl/HCl, CuBr/HBr and CuCN/KCN, respectively.



(2). Gabriel phthalimide synthesis - It is a very useful method for the preparation of aliphatic primary amines. It involves the treatment of phthalimide with ethanolic potassium hydroxide to form potassium salt of phthalimide. This salt is further heated with alkyl halide, followed by alkaline hydrolysis to yield the corresponding primary amine.



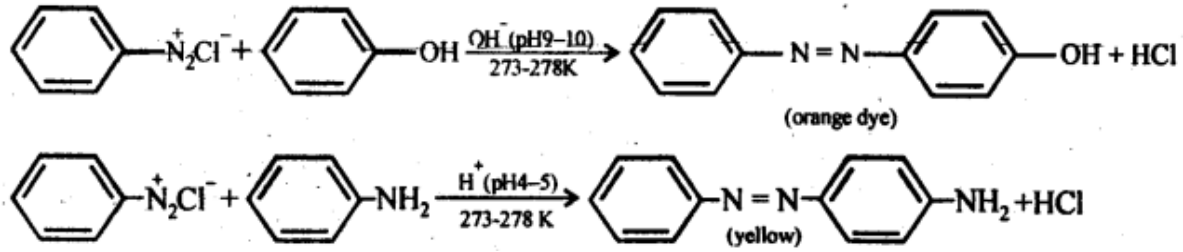
(3) Carbylamine reaction: Both aliphatic and aromatic primary amines when warmed with chloroform and an alcoholic solution of KOH, produces isocyanides or carbylamines which have very unpleasant odours. This reaction is called carbylamine reaction.

$$R—NH_2 + CHCl_3 + 3KOH\,(alc) \longrightarrow R—N\equiv C + 3KCl + 3H_2O$$

(4).Hoffmann's bromamide reaction: When an amide is treated with bromine in alkali solution, it is converted to a primary amine that has one carbon atom less than the starting amide. This reaction is known as Hoffinann's bromamide degradation reaction.

$$C_6H_5CONH_2 \xrightarrow{Br_2 + NaOH} C_6H_5NH_2$$

(5) Coupling reaction: In this reaction, arene diazonium salt reacts with aromatic amino compound (in acidic medium) or a phenol (in alkaline medium) to form brightly coloured azo compounds. The reaction generally takes place at para position to the hydroxy or amino group.



CONVERSION TYPE QUESTIONS

1.

(i) $CH_3COOH \xrightarrow{NH_3} CH_3CONH_2 \xrightarrow{Br_2+KOH} CH_3NH_2$

(ii) $CH_3NH_2 \xrightarrow{HNO_2} CH_3OH \xrightarrow{Pcl_5} CH_3Cl \xrightarrow{KCN} CH_3CN \xrightarrow{[H]} CH_3CH_2NH_2$

(iii) $CH_3NO_2 \xrightarrow{Sn/Hcl} CH_3NH_2 \xrightarrow{CHCl_3/KOH} CH_3NC$

2.

(i) $CH_3CH_2NH_2 \xrightarrow{HNO_2} CH_3CH_2OH \xrightarrow[H_2SO_4]{KMnO_4} CH_3COOH$

(ii) $CH_3Cl \xrightarrow{KCN} CH_3CN \xrightarrow{Na/C_{2H_5OH}} CH_3CH_2NH_2$

3.

(i) $C_6H_5NH_2 \xrightarrow[273-278K]{NaNO_2+HCl} C_6H_5N_2Cl \xrightarrow{CuCN/KCN}$

(ii) $C_6H_5N_2Cl \xrightarrow{CuCN/KCN} C_6H_5CN \xrightarrow{Na/C_{2H_5OH}} C_6H_5CH_2NH_2$

(iii) $C_6H_5NH_2 \xrightarrow[273-278K]{NaNO_2+HCl} C_6H_5N_2Cl \xrightarrow[boil]{H2_o} C_6H_5OH$

4.

(i) $C_6H_5NO_2 \xrightarrow{Sn/HCL} C_6H_5NH_2$

(ii) $C_6H_5CH_2Cl \xrightarrow{KCN} C_6H_5CH_2CN \xrightarrow{Na/C_{2H_5OH}} C_6H_5CH_2CH_2NH_2$

COMPLETE THE REACTIONS TYPE QUESTIONS

1. $C_6H_5N_2Cl + H_3PO_2 + H_2O \rightarrow C_6H_6 + N_2 + H_3PO_3 + HCl$
2. $C_6H_5NH_2 + CH_3COCl \rightarrow C_6H_5NHCOCH_3 + HCl$
3. $C_2H_5NH_2 + C_6H_5SO_2Cl \rightarrow C_6H_5SO_2NHC_2H_5 + HCl$
4. $C_2H_5NH_2 + HNO_2 \rightarrow C_2H_5OH + N_2 + HCl$
5. $CH_3CH_2NH_2 + CHCl_3 + 3KOH\ (Alcoholic) \xrightarrow{\Delta} CH_3CH_2{-}N{\equiv}C + 3KCl + 3H_2O$

ARRANGE IN CORRECT ORDER TYPE QUESTIONS

a) $C_2H_5NH_2 > C_6H_5NHCH_3 > (C_2H_5)_2NH > C_6H_5NH_2$

b) (i) p-nitroaniline < Aniline < p-toluidine

(ii) $C_6H_5NH_2 < C_6H_5NHCH_3 < C_6H_5CH_2NH_2$

c) $(C_2H_5)_3N > (C_2H_5)_2NH > C_2H_5NH_2 > NH_3$

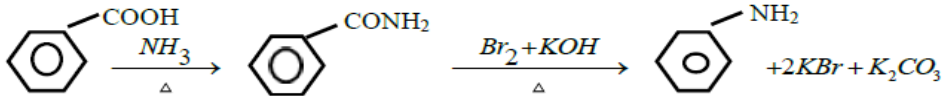
d) $(CH_3)_2NH < C_2H_5NH_2 < C_2H_5OH$

(e) $C_6H_5NH_2, < (C_2H_5)_2NH, < C_2H_5NH_2$

(f) $CH_3CH_2CH_3 < CH_3CH_2NH_2 < CH_3CH_2OH$

WORD PROBLEM TYPE QUESTIONS

Q1.Ans.



(A) Benzonic Acid (Phenyl Mechatronic Acid) — (B) Benzane-amide (Phenyl Methanamide) — (C) Aniline (Benzamine)

Q2. Ans. $C_2H_5-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[\Delta]{Br_2/KOH} C_2H_5-NH_2 \xrightarrow{HNO_2} C_2H_5OH + N_2 + H_2O$

(X) Propanamide — (Y) Ethane amine

Q3. Ans. $C_2H_5NC + 2H_2O \xrightarrow{H^+} C_2H_5 - NH_2 \xrightarrow{HNO_2} C_2H_5OH + N_2 + H_2O$

(A) Ethyl isocyanides (Rthyl Carbyl amine

(B) Ethane amine

$C_2H_5NH_2 + CHCl_3 + 3KOH \rightarrow C_2H_5NC + 3KCl + 3H_2O$

B Chloroform (Ethyl isocyanide)

Q4. Ans. $H_2C = CH - Cl + AgCN \rightarrow H_2C = CH - C \equiv N + H_2C = CH - NC$

(A) Chloroethene (Minor) (Major)

$H_2C = CH - CN \xrightarrow[Ni]{H_2} H_3C - CH_2 - NH_2$

Propene nitrile Proanamine(B)

Q5. Ans. $H_3C - I + KCN \rightarrow H_3C - CN \xrightarrow{LiAlH_4} CH_3 - CH_2 - NH_2$

Iodomethane (A) Ethane nitrile (B) Ethan amine

$CH_3 - CH_2 - NH_2 \xrightarrow{CuCl_2} \left[Cu(CH_3CH_2NH_2)_4\right]Cl_2$

Blue complex

10. BIOMOLECULES
(CBSE WEIGHTAGE: 7 MARKS)

MULTIPLE CHOICE QUESTIONS (ONE CORRECT ANSWER)

1. α−D (+)-glucose and β−D (+)-glucose are-
(A) Anomers (B) Epimers (C) Enantiomers (D) Geometrical isomers
2. Which of the following statements about maltose is incorrect?
(A) It consists of two glucopyranose units
(B) It is a disaccharide
(C) Glycosidic bond between C1 of one unit and C4 of the other unit
(D) It is a non-reducing sugar
3. Which of the following acids is a vitamin?
(A) Aspartic acid (B) Ascorbic acid (C) Adipic acid (D) Saccharic acid
4. Which of the following statements is not true about glucose?
(A) It is an aldohexose (B) On heating with HI it forms n-hexane
(C) It is present in Pyranose form (D) It does not give 2,4-DNP test
5. The helical structure of protein is stabilized by:
(A) Peptide bond (B) Dipeptide bond (C) Hydrogen bonds (D) vander Waal's forces
6. The symbols D and L in the name of Carbohydrate represents
(A) Dextro rotatory nature (B) Laevo rotatory nature (C) The relative configuration of a particular isomer (D) The optical activity of compounds
7. DNA and RNA compose of similar-
(A) Sugar (B) Purines bases (C) Pyrimidines bases (D) Both (A) and (B)
8. Which of the following is/are example(s) of denaturation of protein?
(A) Coagulation of egg white (B) Curding of milk
(C) Clotting of blood (D) Both (A) and (B)
9. What are the hydrolysis products of lactose?
(A) β–D-galactose and β –D-Glucose (B) α –D-Galactose and α –D-Glucose (C) α –D-Glucose and β –D-Fructose (D) None of these
10. Dinucleotide is obtained by joining two nucleotides together by phosphodiester linkage. Between which carbon atoms of pentose sugars of nucleotides are these linkages present?
(A) 5' and 3' (B) 1' and 5' (C) 5' and 5' (D) 3' and 3'

ASSERTION-REASON TYPE QUESTION

1. Two statements are given below- one labeled Assertion (A) and the other labeled Reason (R).
ASSERTION – Vitamin C can't be stored in our body.

REASON – Vitamin C is water soluble and is excreted from the body through urine.

(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

2. Two statements are given below- one labeled Assertion (A) and the other labeled Reason (R).
ASSERTION – Proteins are polymers of alpha amino acids connected by peptide bonds.
REASON – A tripeptide contains 3 amino acids linked by 3 peptide bonds.
(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

3. Two statements are given below- one labeled Assertion (A) and the other labeled Reason (R).
ASSERTION – Change in pH and heating leads to denaturation of proteins.
REASON – Change in pH and heating cause loss of biological activity of proteins.
(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.
(d) A is incorrect statement but R is the correct statement.

4. Two statements are given below- one labeled Assertion (A) and the other labeled Reason (R).
ASSERTION – Adenine and Guanine are the purines present in both nucleic acids.
REASON – Thiamine and Uracil are the pyrimidine present in DNA.
(a) A and R both statements are correct and R is the correct explanation of A.
(b) A and R both statements are correct and R is not the correct explanation of A.
(c) A is correct statement but R is not the correct statement.

(d) A is incorrect statement but R is the correct statement.

5. Two statements are given below- one labeled Assertion (A) and the other labeled Reason (R).
   ASSERTION – Amylopectin is water soluble and contributes 15-20% of starch.
   REASON – Amylopectin has C_1-C_4 & C_1-C_6 glycosidic linkages.
   (a) A and R both statements are correct and R is the correct explanation of A.
   (b) A and R both statements are correct and R is not the correct explanation of A.
   (c) A is correct statement but R is not the correct statement.
   (d) A is incorrect statement but R is the correct statement.

COMPETENCY BASED QUESTION

QUESTIONS BASED ON CARBOHYDRATES

1. Write any two functions of carbohydrates in plants.
2. Define the following terms:
   (i) Glycosidic linkage
   (ii) Invert sugar
   (iii) Oligosaccharides
3. What are the hydrolysis products of (i) sucrose, and (ii) lactose & (iii) maltose?
4. What happens when D-glucose is treated with. the following reagents.
   (i) HI (ii) Bromine water (iii) HNO_3
5. Give any two evidence to justify that glucose has ring structure.
6. (a) What is the basic structural difference between starch and cellulose?
   (b) What is essentially the difference between a-glucose and β -glucose?
7. What is meant by reducing sugars?
8. Compare the amylose and amylopectin components of starch.

QUESTIONS BASED ON PROTEINS

1. Explain the concept of protein denaturation and provide examples of factors that can lead to protein denaturation. Why is protein structure crucial for its function?
2. Discuss the role of hydrogen bonds in maintaining the secondary structure of proteins.
3. Mention the type of linkage responsible for the formation of the following:
   (i) Primary structure of proteins
   (ii) Cross-linkage of polypeptide chains
   (iii) α-helix formation
   (iv) β-sheet structure

4. What are essential and non-essential amino acids? Name one of each type.
5. (a) What type of bonding helps in stabilizing of a-helix structure of proteins?
   (b) Differentiate between globular and fibrous proteins.
6. Amino acids are amphoteric in nature. Explain.

QUESTIONS BASED ON VITAMINS

1. How are vitamins classified? Name the vitamin responsible for the coagulation of blood.
2. Why are vitamin A and vitamin C essential to us? Give their important sources.
3. Name the only vitamin which can be synthesized in our body. Name one disease that is caused due to the deficiency of this vitamin.
4. Why Vitamin C cannot be stored in our body?
5. i) Deficiency of which vitamin causes Beriberi?
   ii) Which vitamin is also known as cobalamin?
   iii) Deficiency of which vitamin causes night-blindness?

QUESTIONS BASED ON NUCEIC ACIDS

1. What are the nitrogenous base present in DNA and RNA?
2. Define the term a nucleoside and a nucleotide.
3. (a)Two nucleotides are connected through a linkage and form dinucleotide. Name the linkage.
   (b) A DNA sample has more number of G=C pair as compared to A=T pair. What you think that its boiling point will be higher or not?
4. What are the types of RNA? Give names only.
5. What are the structural differences in between DNA and RNA?

ANSWERS

MULTIPLE CHOICE QUESTIONS (ONE CORRECT ANSWER)

1-(A) 2-(D) 3-(B) 4-(D)5-(C) 6-(C) 7-(B) 8(D),9(A)10(A)

ASSERTION-REASON TYPE QUESTION :

1 (A), 2- (B), 3- (A), 4- (C), 5- (D)

COMPETENCY BASED QUESTION

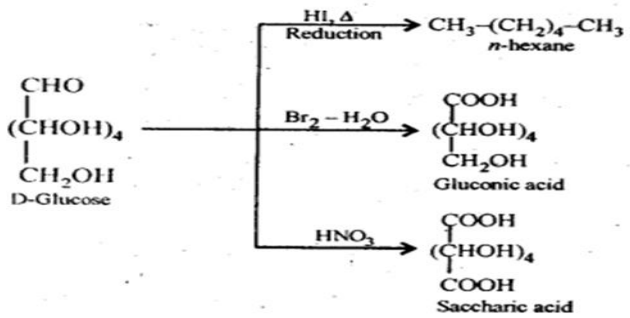
CARBOHYDRATES –

1. Two major functions of carbohydrates in plants are following
   (a) Structural material for plant cell walls: The polysaccharide cellulose acts as the chief structural material of the plant cell walls.
   (b)Reserve food material:

2. (i) Glycosidic linkage: The two monosaccharide units are joined together through an ethereal or oxide linkage formed by loss of a molecule of water. Such a linkage between two monosaccharide units through oxygen atom is called glycosidic linkage
   (ii) Invert sugar: An equimolar mixture of glucose and fructose obtained by hydrolysis of sucrose in presence of an acid such as dil. HC1 or the enzyme invertase or sucrase is called invert sugar.
   (iii) Oligosaccharides: Those carbohydrates which on hydrolysis give 2-10 molecules of monosaccharides are called oligosaccharides.
   Example: sucrose, maltose.

3. Both sucrose and lactose are disaccharides. Sucrose on hydrolysis gives one molecule each of glucose and fructose but lactose on hydrolysis gives one molecule each of D-(+) – glucose and D-(+)-Galactose.
   Maltose on hydrolysis gives two molecules of glucose.

4.



5. (a) Glucose does not form addition product with $NaHSO_3$.
   (b) Pentaacetate of glucose does not react with hydroxyl amine.
6. (a) Starch consists of amylose and amylopectin. Amylose is a linear polymer of α-D-glucose while cellulose is a linear polymer of β -D-glucose.
   In amylose, C -1 of one glucose unit is connected to C – 4 of the other through α-glycosidic linkage. However in cellulose, C – 1 of one glucose unit is connected to C-4 of the other through β – glycosidic linkage. Amylopectin on the other hand has highly branched structure.

(b) The two cyclic hemiacetal forms of glucose differ only in the configuration of the hydroxyl group on the first carbon atom called anomeric carbon. Such isomers i.e, α-form and β-form are called anomers. α-glucose is the monomer unit of starch and β-glucose is the monomer unit of cellulose. The six membered cyclic structure of glucose is called Pyranose structure. Pyranose structure of glucose: The six membered ring containing 5 carbon atoms and one oxygen atom because of its resemblance with pyron is called the pyranose form.

PROTEINS-

1. Protein denaturation is a process in which a protein loses its three-dimensional structure and, as a result, it's biological activity. The native, functional structure of a protein is determined by its unique sequence of amino acids and the specific folding and interactions between these amino acids. Denaturation disrupts these interactions, causing the protein to lose its original shape and, often, its function.
Factors Leading to Denaturation: heat, chemicals, or mechanical forces.
Protein structure crucial for its function because it underlies the functioning of enzymes, receptors, antibodies, and many other biologically important molecules.
2. Hydrogen bonds play a vital role in maintaining the secondary structure of proteins by stabilizing α-helices and β-sheets. These secondary structures, in turn, contribute to the overall three-dimensional structure of proteins, which is critical for their biological functions, including enzymatic activity, binding to other molecules, and maintaining structural integrity.
3.

(i)	Primary structure of proteins	peptide bond	A peptide bond forms through a condensation reaction between the amino group (-NH2) of one amino acid and the carboxyl group (-COOH) of another amino acid.
(ii)	Cross-linkage of polypeptide chains	covalent bonds, specifically disulfide bonds	These bonds help stabilize the three-dimensional structure of proteins
(iii)	α-helix formation	Hydrogen bond	hydrogen bonds between the carbonyl group (-C=O) of one amino acid and the amino group (-NH) of an amino acid
(iv)	β-sheet structure	Intermolecular hydrogen bonds	hydrogen bonds form between adjacent polypeptide strands

4. Essential amino acids are amino acids that the human body cannot synthesize on its own and must obtain from the diet. There are nine essential amino acids, one of them is Leucine: Leucine is an essential amino acid and is important for protein synthesis, muscle growth.
Non-essential amino acids are amino acids that the human body can synthesize on its own, so they do not need to be obtained directly from the

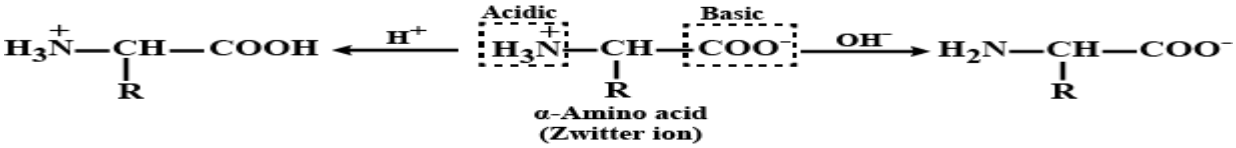
diet. There are eleven non-essential amino acids. One of them is Glutamine: Glutamine is a non-essential amino acid that plays a crucial role in various metabolic processes

5. (a) The type of bonding that helps in stabilizing the α-helix structure of proteins is hydrogen bonding. In α-helix, hydrogen bonds form between the carbonyl group (C=O) of one amino acid and the amino group (N-H) of an amino acid located four positions down the chain. These hydrogen bonds create a repeating pattern that stabilizes the helical structure.

(b) Characteristic differences between globular and fibrous proteins can be given as :

S.No.	globular proteins	fibrous proteins
1	These are cross-linked proteins and are condensation product of acidic and basic amino acids.	These are linear condensation polymer.
2	These are soluble in water, mineral acids and bases.	These are insoluble in water but soluble in strong acids and bases.
3	These proteins have three dimensional folded structure. These are stabilized by internal hydrogen bonding.	These are linear polymers held together by intermolecular hydrogen bonds.
4	Examples : Hemoglobin, insulin, and enzymes like amylase and trypsin	Examples : Collagen, keratin, and elastin

6. Amino acid contains amino ($-NH_2$) and carboxyl (-COOH) functional groups. In an aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton which gives rise to a dipolar ion called as Zwitter ion. As this dipolar ion can react with base (due to presence of deprotonated carboxyl group) and with base (due to presence of protonated amino group) it shows "Amphoteric behavior".



VITAMINS-

1. **Answer**:

On the basis of their solubility in water or fat, vitamins are classified into two groups.

(i) Fat-soluble vitamins: Vitamins that are soluble in fat and oils, but not in water, belong to this group. For example: Vitamins A, D, E, and K

(ii) Water-soluble vitamins: Vitamins that are soluble in water belong to this group. For example: B group vitamins (B1, B2, B6, B12, etc.) and vitamin C

However, biotin or vitamin H is neither soluble in water nor in fat.

Vitamin K is responsible for the coagulation of blood.

2. **Answer**: The deficiency of vitamin A leads to xerophthalmia (hardening of the cornea of the eye) and night blindness. The deficiency of vitamin C leads to scurvy (bleeding gums).
   The sources of vitamin A are fish liver oil, carrots, butter, and milk.
   The sources of vitamin C are citrus fruits, amla, and green leafy vegetables.
3. **Ans**: Vitamin that can be synthesized '.Vitamin B12

Disease due to the deficiency of Vitamin B12: Pernicious anemia.

4. **Ans**: Vitamin C is mainly ascorbic acid which is water soluble and is readily excreted through urine and thus cannot be stored in the body

5 Ans i) **Vitamin B1** ii) **Vitamin B12** iii) **Vitamin A**

NUCEIC ACIDS-

Ans 1- There are two types of nitrogenous base present –
Purines – Adenine and Guanine
Pyrimidines – Cytosine, Thymine and Uracil

Ans 2- Nucleoside – Pentose sugar + Nitrogenous base = Nucleoside
Nucleotide – Nucleoside + Phosphate group = Nucleotide

Ans 3- (a) Phosphodiester linkage
(b) The sample of DNA has higher boiling point because Guanine and Cytosine forms triple hydrogen bonds between them.

Ans 4- There are three types of RNA – messenger RNA (m-RNA), ribosomal RNA (r-RNA) & transfer RNA (t-RNA)

Ans 5 -

DNA	RNA
1. Double strand helical structure.	1. Single strand structure.
2. Deoxy ribose sugar is present.	2. Ribose sugar is present.
3. Uracil is not present in it.	3. Cytosine is not present in it.

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