Class XII Session 2026-27
Subject - Chemistry
Sample Question Paper - 4

Time Allowed: 3 hours **Maximum Marks: 70**

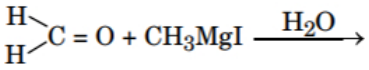
General Instructions:

Read the following instructions carefully.

1. There are **33** questions in this question paper with internal choice.
2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.
3. SECTION B consists of 5 very short answer questions carrying 2 marks each.
4. SECTION C consists of 7 short answer questions carrying 3 marks each.
5. SECTION D consists of 2 case-based questions carrying 4 marks each.
6. SECTION E consists of 3 long answer questions carrying 5 marks each.
7. **All questions are compulsory.**
8. **Use of log tables and calculators is not allowed.**

Section A

1. What would be the major product of the given reaction? **[1]**



a) Propanal b) Propanol

c) Ethanal d) Ethanol

2. Nucleic acids are the polymers of **[1]**

a) nucleosides b) nucleotides

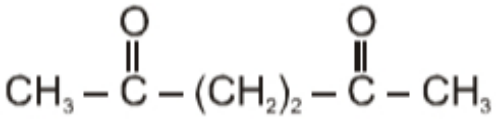
c) bases d) sugars

3. Aspirin is obtained by the acetylation of which of the following compounds? **[1]**

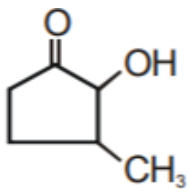
a) Phenol b) Acetyl salicylic acid

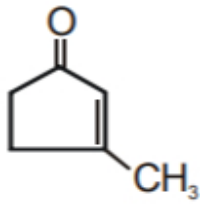
c) Salicylaldehyde d) Salicylic acid

4. The diketone **[1]**

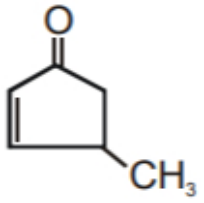


on intramolecular aldol condensation gives the final product :

a) 

b) 

c) 

d) 

5. Half-life period of a first order reaction is 1386 seconds. The rate constant (k) of the reaction is: **[1]**

a) $0.5 \times 10^{-2}\ s^{-1}$ b) $5 \times 10^{-2}\ s^{-1}$

c) $5.0 \times 10^{-3}\ s^{-1}$ d) $0.5 \times 10^{-3}\ s^{-1}$

6. Match the item given in Column I with expression given in Column II. **[1]**

Column I	Column II
(a) Osmotic Pressure	(i) $p = K_H . \chi_B$
(b) Relative lowering of vapour pressure	(ii) $\frac{\triangle P}{P^o_A} = \chi_B$
(c) Henry Law	(iii) $\triangle T_b = K_b . m$
(d) Elevation in boiling point	(iv) p = iCRT

a) (a) - (ii), (b) - (iii), (c) - (iv), (d) - (i). b) (a) - (iii), (b) - (i), (c) - (ii), (d) - (iv).

c) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i). d) (a) - (iv), (b) - (ii), (c) - (i), (d) - (iii).

7. Which of the following has the highest melting point? **[1]**

a) All have the same melting point b) o-Dichlorobenzene

c) m-Dichlorobenzene d) p-Dichlorobenzene

8. Ag^+ ion is isoelectronic with: **[1]**

a) Zn^{2+} b) Cu^+

c) Cd^{2+} d) Pd^{2+}

9. The unit of the rate of reaction is the same as that of the rate constant for a: **[1]**

a) it cannot be same b) second order reaction

c) zero order reaction d) first order reaction

10. In Clemmensen reduction, carbonyl compound is treated with _____. **[1]**

a) sodium amalgam + HNO_3 b) zinc amalgam + HCl

c) sodium amalgam + HCl d) zinc amalgam + nitric acid

11. Alkenes react with water in the presence of acid as catalyst to form alcohols. **[1]**

a) Deprotonation to form alcohol
b) nucleophilic attack of water on carbocation
c) Protonation of alkene and carbocation
d) All of these

12. The gas evolved when methylamine reacts with nitrous acid is _____. **[1]**

a) C_2H_6
b) H_2
c) NH_3
d) N_2

13. **Assertion (A):** Haemoglobin is an oxygen carrier. **[1]**
Reason (R): Oxygen binds as O_2 of haemoglobin.

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

14. **Assertion (A):** Oxidation of ketones is easier than aldehydes. **[1]**
Reason (R): C-C bond of ketones is stronger than C-H bond of aldehydes.

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

15. **Assertion (A):** Aryl halogen undergoes nucleophilic substitution reactions with ease. **[1]**
Reason (R): The carbon halogen bond in aryl halides has partial double bond character.

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

16. **Assertion (A):** The boiling point of diethyl ether is much less than that of ethanol. **[1]**
Reason (R): In ethanol, the molecules are associated by the formation of intermolecular hydrogen bonding whereas in diethyl ether, it is not possible.

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

Section B

17. 45 g of ethylene glycol ($C_2H_6O_2$) is mixed with 600 g of water. Calculate **[2]**

i. the freezing point depression and
ii. the freezing point of the solution.

OR

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

18. Amongest the following the most stable complex is: **[2]**

a. $[Fe(H_2O)_6]^{3+}$

b. $[Fe(NH_3)_6]^{3+}$

c. $[Fe(C_2O_4)_3]^{3-}$

d. $[FeCl_6]^{3-}$

Give a reason for the explanation.

19. What do you mean by inert pair effect? **[2]**

20. **Answer the following:** **[2]**

i. What is molecularity? **[1]**

ii. Why can't the molecularity of any reaction be equal to zero? **[1]**

21. a. How can acetaldehyde be prepared from acetyl chloride? **[2]**

b. Propanal is more reactive than propanone towards nucleophilic addition reaction. Give reason.

Section C

22. State and explain Kohlrausch's law of independent migration of ions. Write an expression for the molar conductivity of acetic acid at infinite dilution according to Kohlrausch's law. **[3]**

23. For the following reactions, write the rate of reaction expression in terms of reactants and products? **[3]**

i. $4NH_3\,(g) + 5O_2\,(g) \rightarrow 4NO\,(g) + 6H_2O\,(g)$

ii. $2N_2O_5 \rightarrow 2NO_2 + O_2$

24. Name the reagents used in the following reactions: **[3]**

i. Oxidation of a primary alcohol to carboxylic acid.

ii. Oxidation of a primary alcohol to aldehyde.

iii. Bromination of phenol to 2,4,6-tribromophenol.

iv. Benzyl alcohol to benzoic acid.

v. Dehydration of propan-2-ol to propene.

vi. Butan-2-one to butan-2-ol.

25. 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 the product at 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? **[3]**

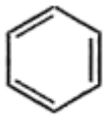
26. a. The standard Gibbs energy (ΔrG°) for the following cell reaction is -300 kJ mol^{-1}: **[3]**

$Zn(s) + 2Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$

Calculate E°_{cell} for the reaction. (Given: 1F = 96500 mol^{-1})

b. Calculate λ_m^o for $MgCl_2$ if λ^o values for Mg^{2+} ion and Cl^- ion are 106 S cm^2mol^{-1} and 76.3 S cm^2mol^{-1} respectively.

27. Complete the following: **[3]**

i.  $+ Cl_2 \xrightarrow{FeCl_3}$

ii. $CH_3COCH_3 + I_2 + NaOH \longrightarrow$

iii. $CH_3CH_2CH_2Cl + NaI \xrightarrow[heat]{Acetone}$

28. The electrical resistance of a column of 0.05 M NaOH solution of cell constant $50cm^{-1}$ is 4.5×10^3 ohm. Calculate its resistivity, conductivity and molar conductivity. **[3]**

Section D

29. **Read the following text carefully and answer the questions that follow:** **[4]**

Transition metals have incomplete d-subshell either in neutral atom or in their ions. The presence of partly filled d-orbitals in their atoms makes transition elements different from that of the non-transition elements. With partly filled d-orbitals, these elements exhibit certain characteristic properties such as display of a variety of oxidation states, formation of coloured ions and entering into complex formation with a variety of ligands. The transition metals and their compounds also exhibit catalytic properties and paramagnetic behaviour. The transition metals are very hard and have low volatility. An examination of the $E^o_{\frac{M^{2+}}{M}}$ values shows the varying trends:

$E^o_{\frac{M^{2+}}{M}}$	
V	-1.18
Cr	-0.91
Mn	-1.18
Fe	-0.44
Co	-0.28
Ni	-0.25
Cu	+0.34
Zn	-0.76

Answer the following questions:

a. On what basis can we say that Cu is a transition element but Zn is not? (Atomic number: Cu = 29, Zn = 30) **(1)**

b. Why do transition elements show variety of oxidation states? **(1)**

c. i. Why do $\frac{E^{o}_{M^{2+}}}{M}$ values show irregular trend from Vanadium to Zinc?

ii. How is the variability in oxidation states of transition metals different from that of the non-transition elements? **(2×1 = 2)**

OR

i. Of the d^4 species, Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidizing. Why? (Atomic number: Cr = 24, Mn = 25)

ii. Complete the following ionic equation: **(2×1 = 2)**

$2MnO_4^- + H_2O + I^- \longrightarrow$

30. The cause for deviation from Raoult's law in the colligative properties of non-ideal solutions lie in the nature of interactions at the molecular level. These properties show deviations from Raoult's law due to difference in interactions between solute - solvent, solute - solute and solvent - solvent. Some liquids on mixing, form azeotropes which are binary mixtures having the same composition in liquid and vapour phase and boil at a constant temperature. In such cases, it is not possible to separate the components by fractional distillation. There are two types of azeotropes called minimum boiling azeotrope and maximum boiling azeotrope. **[4]**

Based on the above passage, answer the following questions:

a. Pure ethanol cannot be prepared by fractional distillation of ethanol - water mixture. Comment. **(1)**

b. Why does a mixture of chloroform and acetone show deviation from ideal behaviour? **(1)**

c. i. The vapour pressure of pure benzene at a certain temperature is 1.25 atm. When 1.2 g of non-volatile, non-electrolyte solute is added to 60 g of benzene ($M = 78\ g\ mol^{-1}$), the vapour pressure of the solution becomes 1.237 atm. Calculate the molar mass of the non-volatile solute. **(2)**

OR

ii. The boiling point of benzene is 353.23 K. When 1.80 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point is raised to 354.11 K. Calculate the molar mass of the solute. K_b for benzene is $2.53\ K\ kg\ mol^{-1}$. **(2)**

Section E

31. **Attempt either A or B** **[5]**

i. **Answer the following questions:** **[1]**

i. Give one example of each- Monosaccharide, disaccharide and polysaccharide.

ii. What type of bonds hold a DNA double helix together?

iii. Give one example each for water-soluble vitamins and fat-soluble vitamins.

iv. Name the disaccharide which on hydrolysis gives glucose and galactose.

v. The two strands in DNA are not identical but are complementary. Explain.

ii. **Answer the following questions:** **[1]**

i. Write the products obtained after hydrolysis of lactose.

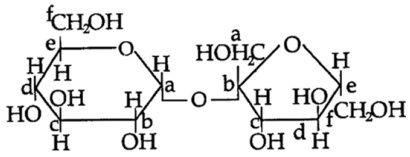
ii. Name the disaccharide which on hydrolysis gives two molecules of glucose.

iii. Which monosaccharide units are present in starch, cellulose and glycogen and which linkages link these units?

iv. Define denaturation of protein. What is the effect of denaturation on the structure of protein?

v. i. What is an anomer?

ii. Structure of a disaccharide formed by glucose and fructose is given below. Identify anomeric carbon atoms in monosaccharide units.



32. **Attempt either A or B** **[5]**

i. **Answer the following questions:** **[1]**

i. Write IUPAC name of given compound : $[Fe(C_2O_4)_3]^{3-}$.

ii. Write the IUPAC name of $[Cu(NH_3)_4]SO_4$.

iii. Arrange following complex ions in increasing order of crystal field splitting energy (Δ_O):

$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$.

iv. Indicate the types of isomerisms shown by the complex : $K[Fe(H_2O)_2(en)_2Cl_2]$?

v. Write IUPAC names of the following coordination entities:

a. $[Cr(NH_3)_3(H_2O)_3]Cl_3$

b. $K_3[Al(C_2O_4)_3]$

ii. **Answer the following questions:** **[1]**

i. What is the IUPAC name of $[Pt(NH_3)_4Cl_2]^{2+}$?

ii. A coordination compound with molecular formula $CrCl_3.\ 4H_2O$ precipitates one mole of AgCl with $AgNO_3$ solution. Its molar conductivity is found to be equivalent to two ions. What is the structural formula and name of the compound?

iii. Out of $[CoF_6]^{3-}$ and $[Co(C_2O_4)_3]^{3-}$, which one complex is

i. diamagnetic

ii. more stable

iii. outer orbital complex and

iv. low spin complex?

(Atomic no. of Co = 27)

iv. i. Write the IUPAC name of the following complex:

$[Co(NH_3)_4CI(NO_2)]CI$

ii. Write the formula for the following:

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

v. For the coordination compound on the basis of crystal field theory, write the electronic configuration for d^4 ion if $\Delta_0 < P$. Is the coordination compound a high spin or low spin complex?

33. Give one chemical test to distinguish between the following pairs of compounds. **[5]**

i. Methylamine and dimethylamine

ii. Secondary and tertiary amines

iii. Ethylamine and aniline

iv. Aniline and benzylamine

v. Aniline and N-methylaniline.

OR

I. Show how p-aminoazobenzene can be obtained from aniline.

II. Write structures for the following compounds:

a. Benzene diazonium chloride

b. p-Nitrotoluene

c. SuIphanilic acid

Solution

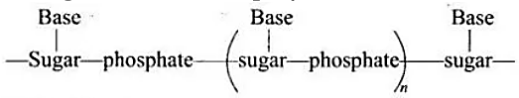
Section A

1.

(d) Ethanol
Explanation:
Ethanol

2.

(b) nucleotides
Explanation:
Nucleic acids are polymers of nucleotides in which nucleic acids are linked together by a phosphodiester linkage also called a polynucleotide.



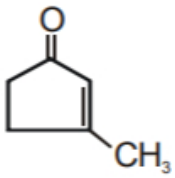
e.g., DNA, RNA, etc.

3.

(d) Salicylic acid
Explanation:
Salicylic acid

4.

(b)



Explanation:
The solution identifies option as the correct product of the intramolecular aldol condensation of the diketone. In an intramolecular aldol reaction, the diketone undergoes deprotonation to form an enolate, which then attacks the carbonyl carbon of another ketone group within the same molecule. This leads to the formation of a β-hydroxy ketone intermediate, which subsequently undergoes dehydration to yield a conjugated enone. Option represents the structure that results from this process, showing the correct connectivity and functional groups that arise from the aldol condensation. The other options do not match the expected product structure, either due to incorrect bonding or the presence of additional or missing functional groups.

5.

(d) $0.5 \times 10^{-3}\ s^{-1}$
Explanation:

$$\text{Half-life of a first-order reaction} = \frac{0.693}{K}$$

where,

K is the rate constant or the specific rate constant.

Given half-life = 1386 sec.

$$\frac{0.693}{K} = 1386$$

$$\Rightarrow K = \frac{693}{1386} \times 10^{-3} \Rightarrow 0.5 \times 10^{-3} s^{-1}$$

$0.5 \times 10^{-3}\ s^{-1}$

6.

(d) (a) - (iv), (b) - (ii), (c) - (i), (d) - (iii).
Explanation:
(a) - (iv), (b) - (ii), (c) - (i), (d) - (iii).

7.

(d) p-Dichlorobenzene
Explanation:
p-dichlorobenzene has a higher melting point than its ortho and meta isomers because of its symmetrical structure, which allows for better packing within the crystal lattice, leading to stronger intermolecular forces.

8.

(c) Cd^{2+}
Explanation:
The atomic number of Ag is 47 with an electronic configuration of [Kr] $4d^{10}$ $5s^1$ whereas for Cd, the atomic number is 48 and electronic configuration is [Kr] $4d^{10}$ $5s^2$. Ag^+ is isoelectronic with Cd^{2+}, since the electronic configuration of both of them is [Kr] $4d^{10}$.

9.

(c) zero order reaction

Explanation:

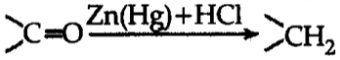
Therefore, for a zero order reaction the units of rate of reaction and rate constants are same.

10.

(b) zinc amalgam + HCl

Explanation:

Clemmensen reduction is used to convert carbonyl group to CH_2 group as follows:



11.

(d) All of these

Explanation:

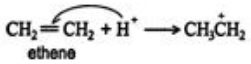
The addition of water to an alkene in the presence of a catalytic amount of strong acid leads to the formation of alcohols (hydroxy-alkanes).

$$CH_2 = CH_2 + H_2O \xrightarrow{H^+} CH_3CH_2OH$$

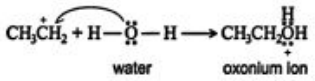
This reaction proceeds via a standard carbocation mechanism and follows the Markovnikov rule.

The mechanism for the addition of water to ethene follows.

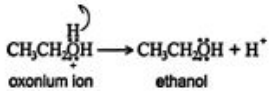
1. The hydrogen ion is attracted to the π bond, which breaks to form a σ bond with one of the double-bonded carbons. The second carbon of the original double-bonded carbons becomes a carbocation.



2. An acid-base reaction occurs between the water molecule and the carbocation, forming an oxonium ion.



3. The oxonium ion stabilizes by losing a hydrogen ion, with the resulting formation of an alcohol.

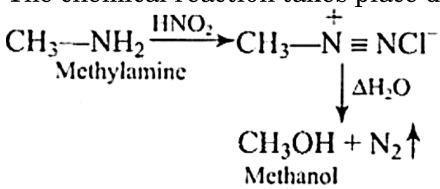


12.

(d) N_2

Explanation:

The chemical reaction takes place during the reaction of methylamine with nitrous acid is as follows



13.

(c) A is true but R is false.

Explanation:

The assertion is correct that haemoglobin is an oxygen carrier, but the reason that oxygen binds an O_2^- to Fe is false because oxygen binds O_2 to Fe of heme part to form oxyhaemoglobin. One molecule of Hb bind with 4 molecules of O_2.

14.

(d) A is false but R is true.

Explanation:

Oxidation of aldehyde is easier than ketones.

The difference between an aldehyde and ketone is the presence of a hydrogen atom attached to the carbon-oxygen double bond in the aldehyde. Ketone doesn't have that hydrogen attached.

$$\underset{Aldehyde}{R-\overset{O}{\overset{\|}{C}}-H} \quad \underset{Ketone}{R-\overset{O}{\overset{\|}{C}}-R'}$$

Due to the electron-withdrawing nature of the C=O group, the C–H bond in aldehyde is weak and thus it can be easily oxidised to corresponding Carboxylic acid.
C-C bond ketone is stronger than the C-H bond of aldehydes.

15.

(d) A is false but R is true.
Explanation:
Aryl halides are less reactive towards nucleophilic substitution reactions because of the carbon halogen bond in aryl halides has partial double bond character.

16. **(a)** Both A and R are true and R is the correct explanation of A.
Explanation:
Both A and R are true and R is the correct explanation of A.

Section B

17. Given, W_1 = 600 g, K_f = 1.86 K kg mol^{-1}

W_2 = 45 g, M_2 = 62.0 g mol^{-1}

T_f^o (water) = 273 k

i. $\Delta T_f = \frac{K_f \times W_2 \times 1000}{M_2 \times W_1}$

$= \frac{1.86 Kkgmol^{-1} \times 45g \times 1000}{62gmol^{-1} \times 600g}$

ΔT_f = 2.25 K

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

T_f = 273 K - 2.25 K = 270.75 K

OR

Moles of glucose = $\frac{18\ g}{180\ gmol^{-1}}$ = 0.1 mol

Number of kilograms of solvent = 1 kg

Thus molality of glucose solution = 0.1 mol kg^{-1} For water, change in boiling point
The elevation (T_b) in boiling point is

$\Delta T_b = K_b \times m$ = 0.52 K kg mol^{-1} × 0.1 mol kg^{-1} = 0.052 k
Since water boils at 373.15 K at 1.013 bar pressure, therefore, the boiling point of the solution will be 373.15 + 0.052 = 373.202 K.

18. In each of the given complex Fe is in +3 state. As $C_2O_4^{2-}$ is a didentate chelating ligand, it forms chelate rings and hence $[Fe(C_2O_4)_3]^{3-}$ is the most stable complex.

19. The trend of having the oxidation state two units less than the group oxidation state is called inert pair effect and becomes more prominent as we move down the group.

20. Answer the following:
    (a) The number of reacting species (atoms, ions or molecules) taking part in an elementary reaction, which must collide simultaneously in order to bring about a chemical reaction is called molecularity of a reaction.
    (b) Molecularity of a reaction means the number of molecules of the reactants taking place in an elementary reaction. Since at least one molecule must be present, so that molecularity will be at least one.

21. a. Acetyl chloride is hydrogenated over catalyst, palladium-barium sulphate to prepare acetaldehyde/

$$CH_3COCl \xrightarrow[Pd-BaSO_4]{H_2} CH_3CHO$$

    b. Due to less steric hinderance and greater electrophilicity of carbonyl carbon in propanal than propanone./ Due to more steric hinderance and less electrophilicity of carbonyl carbon in propanone than propanal

Section C

22. Kohlrausch's law of independent migration of ions states that the limiting molar conductivity of an electrolyte can be expressed as the sum of the individual contributions of the anion and the cation of the electrolyte, e.g.
$\Lambda_m^\circ\ (CH_3cooH) = \lambda^\circ_{CH_3COO^-} + \lambda^\circ_{H^+}$
The conductivity of a solution is related to the number of ions present per unit volume of the solution. When the

solution is diluted, the number of ions per unit volume decreases. Hence, conductivity or specific conductance of the solution decreases.

23. i)

In terms of reactant	In terms of products
i) $R_1 = \frac{-1}{4}\frac{\Delta[NH_3]}{\Delta t}$	i) $R_3 = \frac{1}{4}\frac{\Delta[NO]}{\Delta t}$
ii) $R_2 = \frac{-1}{5}\frac{\Delta[O_2]}{\Delta t}$	ii) $R_4 = \frac{1}{6}\frac{\Delta[H_2O]}{\Delta t}$

$$Rate = -\frac{1}{4}\frac{\Delta[NH_3]}{\Delta t} = -\frac{1}{5}\frac{\Delta[O_2]}{\Delta t} = \frac{1}{4}\frac{\Delta[NO]}{\Delta t} = \frac{1}{6}\frac{\Delta[H_2O]}{\Delta t}$$

ii)

In terms of reactant	In terms of product
$R_1 = -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t}$	$R_2 = \frac{1}{2}\frac{\Delta[NO_2]}{\Delta t}$
	$R_3 = \frac{\Delta[O_2]}{\Delta t}$

$$Rate = -\frac{1}{2}\frac{\Delta[N_2O_5]}{\Delta t} = \frac{1}{2}\frac{\Delta[NO_2]}{\Delta t} = \frac{\Delta[O_2]}{\Delta t}$$

24. i. Acidified potassium permanganate
ii. Pyridinium chlorochromate (PCC)
iii. Bromine water
iv. Acidified potassium permanganate
v. 85% phosphoric acid
vi. $NaBH_4$ or $LiAlH_4$

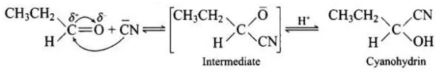
25. C_3H_6O will have the following functional isomer i.e Propanal and Propan-2-one

$$\underset{\text{Propanal (I)}}{CH_3CH_2CHO} \quad \underset{\text{Propan-2-one (II)}}{CH_3-\overset{O}{\overset{\|}{C}}-CH_3}$$

Compound I will react faster with HCN than compound II due to less steric hindrance and a greater positive charge on the carbon atom of the carbonyl group.

Mechanism of the reaction:

$HCN + OH^- \longrightarrow CN^- + H_2O$



The reaction will not lead to completion since it is a reversible reaction, hence equilibrium is established. If a strong acid is added to the reaction mixture, the addition is inhibited because the formation of CN^- ions from HCN is prevented.

26. a. $Zn(s) + 2Ag^+(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$

The number of moles of electrons transferred (n) is 2, as two moles of electrons are involved in the reduction of two moles of $Ag^{\wedge}$ + ions.

Now, you are given ΔG° = -300 $\frac{kJ}{mol}$, but you need to convert it to joules (J) by multiplying by 1000 (since 1 kJ = 1000 J):

ΔG° = -300 $\frac{kJ}{mol}$ $\times 1000$ $\frac{J}{kJ}$ = -300,000 $\frac{J}{mol}$

$$\Delta G^\circ = -nFE^\circ$$

Now, plug in the values into the equation and solve for E^o:

-300,000 $\frac{\text{J}}{\text{mol}}$ = -(2 mol $\times$ 96500 $\frac{\text{C}}{\text{mol}}$) $\times$ E^o

Given the cell reaction:

Let's calculate E^o:

$$E^o = \frac{-300{,}000\,\frac{\text{J}}{\text{mol}}}{-(2\text{ mol}\times 96500\,\frac{\text{C}}{\text{mol}})} \approx 3.11\text{ V}$$

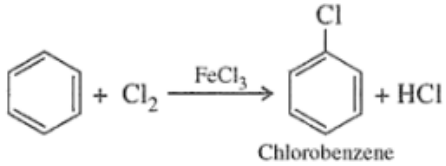
So, the standard cell potential E^o for the given cell reaction is approximately 3.11 V.

b. $MgCl_2 \longrightarrow Mg^{2+} + 2Cl^-$

$$\Lambda_m^0\left(MgCl_2\right) = \lambda_m^0\left(Mg^{2+}\right) + 2\lambda_m^0\left(Cl^-\right)$$

$\Lambda_m^0(MgCl_2) = 106S \cdot \frac{cm^2}{mol} + 2 \times 76.3S \cdot \frac{cm^2}{mol} = 258.6S \cdot \frac{cm^2}{mol}$

The limiting molar conductivity of $MgCl_2$ is $258.6\ S \cdot \frac{cm^2}{mol}$

27. i. 

Chlorobenzene

ii. $CH_3COCH_3 + I_2 + NaOH \longrightarrow \underset{Iodoform}{CHI_3} + CH_3COONa + 3NaI + 3H_2O$

iii. $CH_3CH_2CH_2Cl + NaI \xrightarrow[heat]{Acetone} CH_3CH_2CH_2I + NaCl$

28. **Resistivity**:

$\rho = R\frac{A}{l}$

$\rho = \frac{4.5 \times 10^3}{50}$

$\rho = 0.09 \times 10^3 \Omega\ cm$ or $90\Omega\ cm$

Conductivity:

$k = 1/\rho$

$= 1/90$

$k = 0.011\Omega^{-1}\ cm^{-1}$ or $0.011\ S\ cm^{-1}$

Molar Conductivity

$\Lambda_m = \frac{k}{c} \times 1000\ S\ cm^2\ mol^{-1}$

$= \frac{0.011}{0.05} \times 1000$

$= 220\Omega^{-1}\ cm^2\ mol^{-1}$ or $220\ Scm^2\ mol^{-1}$

Section D

29. a. Cu has incomplete d-orbital in +2 oxidation state whereas Zn has fully filled d-orbital in ground state as well as in +2 oxidation state.

b. Because both (n-1)d and ns subshell electrons take part in the bond formation due to their comparable energies/ due to the presence of unpaired electrons in d-orbitals.

c. i. Because of irregular values of $(\triangle_i H_1 + \triangle_i H_2)$ and sublimation enthalpies.

ii. In transition metals, oxidation states differ by +1 whereas in non-transition metals differ by +2.

OR

i. Because Cr^{2+} will be converted to Cr^{3+} which has more stable half filled t_{2g} configuration while Mn^{3+} changes to Mn^{2+} which has more stable half-filled d^5 configuration.

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

30. a. Ethanol-water forms azeotropic mixture.

b. Due to the formation of hydrogen bond between chloroform and acetone.

c. i. $\frac{P^0 - P}{P^0} = x_2 = \frac{w_2}{M_2} \times \frac{M_1}{w_1}$

$\frac{1.25 - 1.237}{1.25} = \frac{1.2}{M_2} \times \frac{78}{60}$

$M_2 = \frac{1.2}{M_2} \times \frac{78}{60} \times \frac{1.25}{0.013}$

$M_2 = 150\ g\ mol^{-1}$

OR

ii. The elevation (ΔT_b) in the boiling point $= 354.11\ K - 353.23\ K = 0.88\ K$

$M_2 = \frac{2.53\ K\ kg\ mol^{-1} \times 1.8\ g \times 1000\ g\ kg^{-1}}{0.88\ K \times 90\ g}$

$M_2 = 57.5\ g\ mol^{-1} \approx 58\ g\ mol^{-1}$

Section E

31. Attempt either A or B

(a) Answer the following questions:

i. Monosaccharide - Glucose, Fructose etc.
Disaccharide - Sucrose, maltose etc.

Polysaccharide - Cellulose, starch etc.

ii. Hydrogen bonding

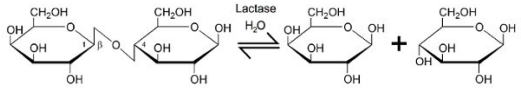
iii. Water soluble - Vitamin B / C
Fat soluble - A, D, E, K (Any one)

iv. Lactose

v. In the helical structure of DNA, the two strands are held together by hydrogen bonds between specific pairs of bases. Cytosine forms hydrogen bond with guanine, while adenine forms hydrogen bond with thymine. As a result, the two strands are complementary to each other.

(b) Answer the following questions:

i. Hydrolysis of Lactose gives D-galactose and D-glucose.



Lactose D-galactose D-glucose

ii. The disaccharide which gives two molecules of glucose on hydrolysis is maltose.

iii. In starch α-glucose units are present, in cellulose β -D glucose units are present. In starch and glycogen glycosidic α-linkage is present between C1-C4 and in cellulose glycosidic β -linkage is present between glucose units.

iv. When a protein is subjected to a change in temperature or chemical change then it loses its biological activity.

2° and 3° structures are destroyed but 1° structure remains intact.

v. i. The isomers which differ only in the configuration of the hydroxyl group at C-1 are called anomers and are referred to as α- and β-forms.

ii. 'a' carbon of glucose and 'b' carbon of fructose are the anomeric carbon atoms in the monosaccharide units.

32. Attempt either A or B

(a) Answer the following questions:

i. Trioxalatoferrate (III) ion

ii. Tetraamine copper II sulphate

iii. Crystal field splitting energy increases in following complex ion in the order :
$[Cr(Cl)_6]^{3-}$, $[Cr(CN)_6]^{3-}$, $[Cr(NH_3)_6]^{3+}$

iv. Both geometrical and optical isomerisms will be present.

v. a. Triamminetriaquachromium (III) chloride
b. Potassium trioxalatoaluminate (III)

(b) Answer the following questions:

i. Tetraamminedichlidooroplatinum (IV) ion

ii. $[Cr(H_2O)_4Cl_2]CI$

Tetraaquadichloridochromium (III) chloride.

iii. i. Diamagnetic complex - $[Co(C_2O_4)_3]^{3-}$

ii. More Stable Complex - $[Co(C_2O_4)_3]^{3-}$

iii. Outer orbital complex - $[CoF_6]^{3-}$

iv. Low spin complex - $[Co(C_2O_4)_3]^{3-}$

iv. i. Tetraaminechloridonitrito- N-cobalt (III) chloride.

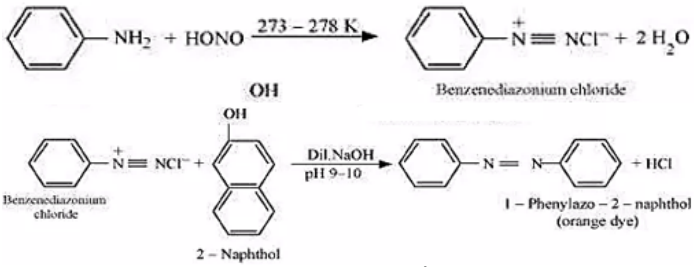
ii. $[CoCI_2(en)_2]CI$

v. $t_{2g}^3 e_g^1$, high spin

33. i. Methylamine and dimethylamine can be distinguished by the carbylamine test. Carbylamine test: Aliphatic and aromatic primary amines on heating with chloroform and ethanolic potassium hydroxide form foul-smelling isocyanides or carbylamines. Methylamine (being an aliphatic primary amine) gives a positive carbylamine test, but dimethylamine does not.

ii. Secondary and tertiary amines can be distinguished by allowing them to react with Hinsberg's reagent (benzenesulphonyl chloride, $C_6H_5SO_2Cl$).
Secondary amines react with Hinsberg's reagent to form a product that is insoluble in an alkali. For example, N, N - diethylamine reacts with Hinsberg's reagent to form N, N - diethylbenzenesulphonamide, which is insoluble in an alkali. Tertiary amines, however, do not react with Hinsberg's reagent.

iii. Ethylamine and aniline can be distinguished using the azo-dye test. A dye is obtained when aromatic amines react with $HNO_2\ (NaNO_2 + dil.\ HCl)$ at $0-5^\circ C$ followed by a reaction with the alkaline solution of 2-naphthol. The dye is usually yellow, red, or orange in colour. Aliphatic amines give a brisk effervescence due to the evolution of N_2 gas under similar conditions.



$$CH_3CH_2 - NH_2 + HONO \xrightarrow{0-5^\circ} C_2H_5OH + N_2 \uparrow + H_2O$$

iv. Aniline and benzylamine can be distinguished by their reactions with the help of nitrous acid, which is prepared in situ from a mineral acid and sodium nitrite. Benzylamine reacts with nitrous acid to form unstable diazonium salt, which in turn gives alcohol with the evolution of nitrogen gas.

$$\underset{Benzyla\ \min e}{C_6H_5CH_2 - NH_2} + HNO_2 \xrightarrow{NaNO_2+HCl} \underset{Unstable}{[C_6H_5CH_2 - N_2^+Cl^-]} \xrightarrow{H_2O} N_2 \uparrow + \underset{Benzyl\ alcohol}{C_6H5_6CH_2 - OH} + HCl$$

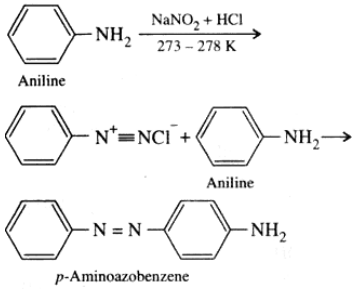
On the other hand, aniline reacts with HNO_2 at a low temperature to form stable diazonium salt. Thus, nitrogen gas is not evolved.

$$C_6H_5NH_2 \xrightarrow[273-278K]{NaNO_2+HCl} C_6H_5 - \overset{+}{N}_2\bar{Cl} + NaCl + 2H_2O$$

v. Aniline and N-ethylaniline can be distinguished using the Carbylamine test. Primary amines, on heating with chloroform and ethanolic potassium hydroxide form foul-smelling isocyanides or carbylamines. Aniline, being an aromatic primary amine, gives positive carbylamine test. However, N-methylaniline, being a secondary amine does not.

OR

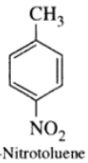
I. Steps involved in the conversion are given below:



II. a.



b.



c.

