Class XII Session 2023-24
Subject - Chemistry
Sample Question Paper - 6

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. To prepare alkanes containing odd number of carbon atoms, Wurtz reaction is not preferred because: **[1]**

a) a lot of reaction mixture goes wasted.

b) a mixture of three different alkyl halides has to be used.

c) a mixture of four different alkyl halides has to be used.

d) a mixture of two different alkyl halides has to be used.

2. DNA and RNA contain four bases each. Which of the following bases is not present in RNA? **[1]**

a) Thymine

b) Cytosine

c) Guanine

d) Adenine

3. An organic compound containing oxygen, upon oxidation forms a carboxylic acid as the only organic product with its molecular mass higher by 14 units. The organic compound is ________. **[1]**

a) a ketone

b) a primary alcohol

c) an aldehyde

d) a secondary alcohol

4. Compounds A and C in the following reaction are ________. **[1]**

$$CH_3CHO \xrightarrow[(ii)\ H_2O]{(i)\ CH_3MgBr} (A) \xrightarrow{H_2SO_4, \Delta} (B) \xrightarrow{\overset{Hydorboration}{oxidation}} (C)$$

a) optical isomers

b) identical

c) functional isomers

d) positional isomers

5. Activation energy of a reaction is **[1]**

a) The energy released during the reaction

b) Energy evolved when activated complex is formed

c) The minimum amount of energy required to overcome the barrier

d) The energy absorbed during a reaction

6. Match the items of column I with appropriate entries of column II. **[1]**

Column I	Column II
(a) $\frac{\triangle P}{P^o_A}$	(i) $\frac{\triangle T_b}{m}$
(b) K_b	(ii) mol fraction of solute
(c) i	(iii) $\frac{\triangle T_f}{m}$
(d) K_f	(iv) Ratio of observed molar mass to actual molar mass

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

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

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

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

7. IUPAC name of neo-Pentylbromide is: **[1]**

a) 1-Bromo-3-methylbutane

b) 1-Bromo-2,2-dimethylpropane.

c) 1-Bromo-1,2-dimethylpropane

d) 1-Bromo-2-methylbutane

8. Which of the following is amphoteric oxide? **[1]**
Mn_2O_7, CrO_3, Cr_2O_3, CrO, V_2O_5, V_2O_4.

a) V_2O_5 and Cr_2O_3

b) V_2O_5, V_2O_4

c) CrO, V_2O_5

d) Mn_2O_7, CrO_3

9. The slope of the line in the plot of concentration [A] Vs. time (s) indicate **[1]**

a) +k

b) -k

c) $\frac{+k}{2.303}$

d) $\frac{-k}{2.303}$

10. Which of the following will undergo aldol condensation? **[1]**

a) CH_3CH_2CHO

b) CH = CCHO

c) C_6H_5CHO

d) CH_2 = CHCHO

11. The conversion of an alkyl halide into alcohol by aqueous NaOH is classified as **[1]**

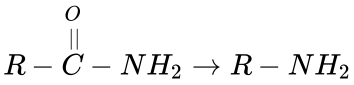
a) a dehydrohalogenation reaction

b) a substitution reaction

c) an addition reaction

d) a dehydration reaction

12. Which one of the following reagents is most suitable in completing the following synthesis? **[1]**



$$R - \overset{\overset{O}{||}}{C} - NH_2 \rightarrow R - NH_2$$

a) $LiAlH_4$

b) Br_2+ NaOH

c) Sn

d) H_2 + Ni

13. **Assertion (A):** Maltose is a reducing sugar that gives two moles of D-glucose on hydrolysis. **[1]**

Reason (R): Maltose has a 1, 4-β-glycosidic linkage.

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):** Reactivity of ketones is more than aldehydes. **[1]**

Reason (R): The carbonyl carbon of ketones is less electrophilic as compared to 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):** The rate of hydrolysis of methyl chloride to methanol is higher in DMF than in water. **[1]**

Reason (R): Hydrolysis of methyl chloride follows second order kinetics.

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):** Phenol forms 2,4,6-tribromophenol on treatment with Br_2 in carbon disulphide at 273K. **[1]**

Reason (R): Bromine polarises in carbon disulphide.

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. Describe briefly the nature of bonding in metal carbonyl. **[2]**

18. In what way is the electronic configuration of the transition elements different from that of the non transition elements? **[2]**

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

(i) What is the unit of rate of reaction? **[1]**

(ii) What is the order of reaction if the rate of reaction is independent of concentration of all the reactants? **[1]**

20. State Henry's law correlating the pressure of a gas and its solution in a solvent and mention two applications for the law. **[2]**

OR

If the density of some lake water is 1.25 g mL^{-1} and contains 92 g of Na^+ ions per kg of water, calculate the molarity of Na^+ ions in the lake.

21. Give reasons: **[2]**

i. chloroacetic acid is stronger than acetic acid.

ii. pH of reaction should be carefully controlled while preparing ammonia derivatives of carbonyl compounds.

Section C

22. Calculate the emf of the following cell at 298 K. **[3]**

$2Cr(s) + 3Fe^{2+}(0.1M) \rightarrow 2Cr^{3+}(0.01M) + 3Fe(s)$

Given, $E^o_{cr^{3+}/cr}$ =-0.74V, $E^o_{Fe^{2+}/Fe}$ = -0.44 V

23. The decomposition of N_2O_5 in CCl_4 at 318K has been studied by monitoring the concentration of N_2O_5 in the solution. Initially the concentration of N_2O_5 is 2.33 mol L^{-1} and after 184 minutes, it is reduced to 2.08 mol L^{-1}. The reaction takes place according to the equation. **[3]**

$2\ N_2O_5\ (g) \rightarrow 4NO_2\ (g) + O_2\ (g)$.

Calculate the average rate of this reaction in terms of hours, minutes, and seconds. What is the rate of production of NO_2 during this period?

24. 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 . **[3]**

$$A(C_3H_6) \xrightarrow{aq.\ H_2SO_4} B \xrightarrow{\substack{Lucas \\ reagent}} C \xrightarrow{alc. KOH} A$$

OR

Give equations of the following reactions:

i. Oxidation of propan-1-ol with alkaline $KMnO_4$solution.

ii. Bromine in $CS_2$with phenol.

iii. Dilute $HNO_3$with phenol.

iv. Treating phenol with chloroform in presence of aqueous NaOH.

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. Mention the reactions occurring at **[3]**

i. anode

ii. cathode, during working of a mercury cell.

Why does the voltage of a mercury cell remain constant during its operation?

27. Haloarenes are less reactive than haloalkanes and haloalkenes. Explain. **[3]**

28. What is a Galvanic cell? Give the symbolic representation of the Daniell cell. **[3]**

Section D

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

$KMnO_4$ and $K_2Cr_2O_7$ are most important chemicals which are used as oxidising agents and disinfectants. K_2MnO_4 is prepared by fusing MnO_2 with KOH in presence of O_2. $K2MnO_4$ is electrolysed to get purple coloured $KMnO_4$. Na_2CrO_4 is prepared by heating chromite ore with Na_2CO_3 in presence of O_2. Na_2CrO_4 is converted into $Na_2Cr_2O_7$ by reacting with concentrated H_2SO_4. $Na_2Cr_2O_7$ is reacted with KCl to get $K_2Cr_2O_7$, orange coloured solid, soluble in water, changes to yellow coloured CrO_4^{2-} in basic medium, $KMnO_4$ acts as oxidising agent in acidic, neutral as well basic medium. In acidic medium, it converts Fe^{2+} to Fe^{3+}, Sn^{2+} to Sn^{4+}, COO^- to CO^2. In basic medium it converts I^- to IO^{3-}. $K_2Cr_2O_7$ acts as oxidising agent only in acidic medium, converts H_2S to S, SO_2 to $SO4^{2-}$, I^- to I_2. Lanthanoids and actinoids belong to f-block elements with general electronic configuration (n - 2) $f^{1\ to\ 14}$ (n - 1) d^{0-2} ns^2. All actinoids are radioactive. Both show contraction in atomic and ionic radii but actinoid contraction is more than lanthanoid contraction. Lanthanoid show +3 oxidation state, few elements show +2 and +4 oxidation states also. Actinoids show +3, +4, +5, +6, +7 oxidation states.

(i) Which lanthanoid shows +4 oxidation state and why?

OR

Convert sodium chromate to sodium dichromate. Give chemical equation.

$2Na_2CrO_4 + H_2SO_4$ (conc.) $\rightarrow$?

(ii) Give two similarities between lanthanoids and actinoids.

(iii) Complete the equation and balance:

$Cr_2O_7^{2-} + Fe^{2+} + H^+ \rightarrow ?$

30. **Read the text carefully and answer the questions:** **[4]**

The boiling point elevation and the freezing point depression of solutions have a number of practical applications. Ethylene glycol ($CH_2OH \cdot CH_2OH$) is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has a low vapour pressure. We can also use glycerol as an antifreeze. In order for boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol (CH_3OH), a fairly volatile liquid that boils only at 65^oC is sometimes used as antifreeze in automobile radiators.

(i) Out of the CH_3OH and $C_6H_{12}O_6$, which is a better reagent for depression in freezing point but not for elevation in boiling point?

(ii) Will the depression in freezing point be same or different, if 0.1 moles of sugar or 0.1 moles of glucose is dissolved in 1 L of water?

(iii) 124 g each of the two reagents glycerol and glycol are added in 5 kg water of the radiators in the two cars. Which one is better for a car? Justify your answer.

OR

If the cost of glycerol, glycol and methanol are the same, then what would be the sequence of the economy to use these compounds as antifreeze?

Section E

31. **Attempt any five of the following:** **[5]**

(i) What are the three components of nucleic acids? **[1]**

(ii) Name the bases present in RNA. Which one of these is not present in DNA? **[1]**

(iii) During curdling of milk, what happens to sugar present in it? **[1]**

(iv) Amino acids can be classified as $\alpha-, \beta-, \gamma-, \delta-$ and so on depending upon the relative position of the amino group with respect to the carboxyl group. Which type of amino acids forms a polypeptide chain in proteins? **[1]**

(v) α-Helix is a secondary structure of proteins formed by twisting of the polypeptide chain into right-handed screw like structures. Which type of interactions is responsible for making the α-helix structure stable? **[1]**

(vi) Some enzymes are named after the reaction, where they are used. What name is given to the class of enzymes which catalyse the oxidation of one substrate with simultaneous reduction of another substrate? **[1]**

(vii) Of the two bases named below, which one is present in RNA and which one is present in DNA? **[1]**

i. Thymine
ii. Uracil

32. Specify the oxidation numbers of the metals in the following coordination entities: **[5]**

i. $[Co(H_2O)(CN)(en)_2]^{2+}$
ii. $[Pt(Cl)_4]^{2-}$
iii. $K_3[Fe(CN)_6]$
iv. $[Cr(NH_3)_3Cl_3]$

OR

What is crystal field splitting energy? How does the magnitude of Δ_0 decide the actual configuration of d-orbitals in a coordination entity?

33. How will you convert **[5]**

i. Ethanoic acid into methanamine
ii. Hexanenitrile into 1-aminopentane
iii. Ethanamine into methanamine
iv. Nitromethane into dimethylamine
v. Propanoic acid into ethanoic acid

OR

Give one chemical test to distinguish between the following pairs of compounds.

i. Methylamine and dimethylamine
ii. Secondary and tertiary amines
iii. Ethylamine and aniline
iv. Aniline and benzylamine
v. Aniline and N-methylaniline.

Solution

Section A

1. **(d)** a mixture of two different alkyl halides has to be used.

   Explanation: Alkyl halides on treatment with sodium metal in dry ethereal (free from moisture) solution give higher alkanes. This reaction is known as the Wurtz reaction and is used for the preparation of higher alkanes containing even a number of carbon atoms. Many side products are formed when two different alkyl halides are used. So this method is not preferred to prepare alkanes having an odd number of C atoms.

2. **(a)** Thymine

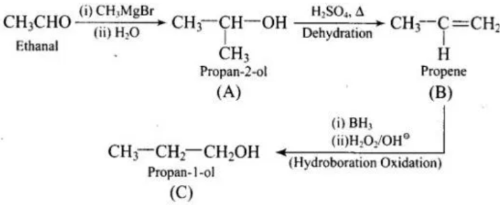
   Explanation: DNA contains four bases viz. adenine (A), guanine (G), cytosine (C) and thymine (T). RNA also contains four bases, the first three bases are same as in DNA but the fourth one is uracil (U).

3. **(b)** a primary alcohol

   Explanation: When –CH_2OH group is replaced by –COOH group then only molecular weight will increase by 14units.

4. **(d)** positional isomers

   Explanation:

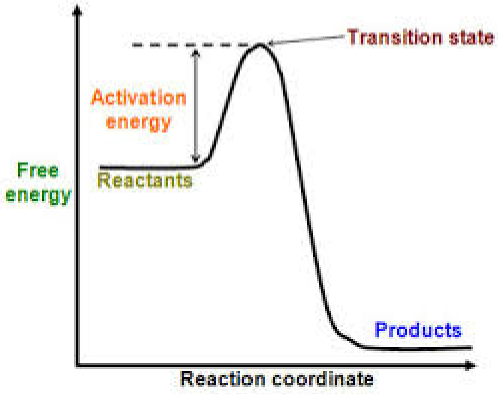


   Thus, $CH_3\underset{\underset{CH_3}{|}}{C}H-OH$ and CH_3-CH_2-CH_2OH are positional isomers(differs in position of functional group).

5. **(c)** The minimum amount of energy required to overcome the barrier

   Explanation: The minimum extra amount of energy required by the reactants to form the activated complex is known as activation energy.

   In terms of the transition-state theory, the activation energy is the difference in energy content between atoms or molecules in an activated or transition-state configuration and the corresponding atoms.



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

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

7. **(b)** 1-Bromo-2,2-dimethylpropane.

Explanation: neo-Pentyl bromide is $(CH_3)_3CCH_2Br$. C attached to Br is given position 1, so 2 $-CH_3$ groups are placed on 2nd C of the propane (parent chain).
Therefore, the IUPAC name of neo-Pentyl bromide **1-Bromo-2,2-dimethylpropane.**

8. **(a)** V_2O_5 and Cr_2O_3

Explanation: V_2O_5, Cr_2O_3 are amphoteric oxides because both react with alkalies as well as acids.

Remember: In lower oxides, the basic character is predominant while in higher oxides, the acidic character is predominant.

9.

(b) -k

Explanation: Slop of the line indicates = -k while the intercept represents $[R]_0$.

10. **(a)** CH_3CH_2CHO

Explanation: CH_3CH_2CHO will give aldol reaction because of the presence of alpha hydrogen in it.

11.

(b) a substitution reaction

Explanation: Alkyl halides on alkaline hydrolysis (aqueous NaOH) get converted into alcohol. This takes place by a nucleophilic substitution reaction where the −X atom is substituted by a nucleophile i.e −OH group. The primary alkyl halides undergo nucleophilic substitution reaction by S_N2 substitution mechanism, while tertiary alkyl halides follow S_N1 substitution mechanism.

12.

(b) Br_2+ NaOH

Explanation: Conversion of amide to amine having one carbon less is known as Hoffmann bromide reaction.
$RCONH_2 + Br_2 + 4NaOH \rightarrow RNH_2 + Na_2CO_3 + 2NaBr + 2H_2O$

13.

(c) A is true but R is false.

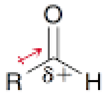
Explanation: Maltose, a disaccharide ($C_{12}H_{22}O_{11}$) is a reducing sugar, which upon hydrolysis yields 2 moles of D (+) glucose. In it, the two D-glucose units are linked through the α-glycosidic linkage between C-1 of one glucose unit and C-4 of the other.

14.

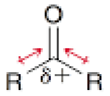
(d) A is false but R is true.

Explanation:

The carbonyl carbon in aldehydes generally has a more partial positive charge than in ketones due to the electron-donating nature of alkyl groups. Aldehydes only have one e-donor group while ketones have two.



An aldehyde
has only one electron-donating alkyl group
that stabilizes the partial positive charge



A ketone
has two electron-donating alkyl groups
that stabilize the partial positive charge

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

Explanation: Hydrolysis of methyl chloride to methanol follows a S_N2 reaction. The rates of many S_N2 reactions are affected by the solvent. Protic solvents are those that contain -OH or $-NH_2$ group, are generally the worst solvents for $-NH_2$ Polar protic solvents, (like water, alcohols, and carboxylic acids), which have strong dipoles but don't have OH, or $-NH_2$ groups are the best. In contrast to protic solvents, which decrease the rates of S_N2 reactants by lowering the ground state energy of nucleophile, polar aprotic solvents (DMF) increase the rates of S_N2 reactions by raising the ground state energy of nucleophile.

16.

(d) A is false but R is true.

Explanation: Phenol forms 2,4,6-tribromophenol on treatment with Br_2 in water.

Phenol forms a mixture of ortho and para bromophenol on treatment with Br_2 in carbon disulphide.

Bromine does not polarise in carbon disulphide.

Both Assertion and Reason are incorrect.

Section B

17. The metal carbon bond in metal carbonyls possess both S & P character. The M-C σ bond is formed by the donation of lone pair of electrons on the carbonyl carbon into a vacant orbital of the metal. M-C π bond is formed by the donation of a pair of electrons from a filled d-orbital of metal into the antibonding πorbital of carbon monoxide.
18. Transition elements contain incompletely filled d-subshell in pen-ultimate shell i.e. their electronic configuration is $(n-1)d^{1-10}ns^{1-2}$ whereas non transition elements have no d-subshell or their d-subshell is completely filled and have ns^{1-2} or ns^2np^{1-6} in their outermost shell.
19. Answer the following:
    (i) Unit of rate of reaction is mol L^{-1} s^{-1}.
    (ii) Zero order reaction.
20. Henry's law: It states that at a given temperature, the mass of the gas dissolved per unit volume of the solvent is proportional to the pressure of the gas in equilibrium with the solution.

    m = K.p where m is the mass of the gas dissolved per unit volume of solvent and p is pressure of the gas in equilibrium with solution, K is proportionality constant.

    Applications : It is used:

    i. in the production of carbonated beverages.
    ii. in the deep sea diving
    iii. in the function of lungs

OR

Molar mass of $Na = 23\ g\ mol^{-1}$

No. of moles of $Na^+ = \frac{92g}{23\text{gmol}^{-1}} = 4\text{mole}$

As $92\ g\ Na^+$ are present in one kg of water. So by definition of molality, its molality is 4 m.

$m = W_2 \times 1000$ W_2- mas of solute = 92g, M_2 - molar mass of Na = 23g/mol, W_1 - mass of solvent = 1000g

$M_2 \times W_1$

$= 92 \times \frac{1000}{23} \times 1000 = 4m$

21. i. Cl is an electron-withdrawing group, thus, increases the acidity of a carboxylic acid by stabilising the conjugate base through delocalisation of the negative charge by the inductive effect. While in acetic acid no such group is present which stabilises the conjugate base. That's why, chloroacetic acid because of the presence of an electron withdrawing group is more acidic than acetic acid (where no such group is present).
    ii. If the medium is too acidic, the ammonia derivatives being basic in nature will form their respective ammonium salts and hence, the reaction will not occur. However, if the medium is slightly acidic, the protonation of the carbonyl group will not occur and hence, the reaction will not occur. Therefore, to carry out such reactions, an optimum value of pH is needed. Hence, pH should be controlled in such reactions.

Section C

22. Since oxidation of Cr is taking place in the given reaction, the chromium electrode is anode and as Fe is reduced in the reaction, Fe electrode is the cathode. The half-cell reactions are as follows.

    At anode $Cr \rightarrow Cr^{3+} + 3e^-] \times 2$

    At cathode $Fe^{2+} + 2e^- \rightarrow Fe] \times 3$

    Overall reaction

    $2Cr + 3Fe^{2+} \rightarrow 2Cr^{3+} + 3Fe$

    $Eo = E_{cathode} - E_{anode} = -0.44 - (-0.74) = 0.3V$

    $E = E^o - \frac{0.0591}{n} \log \frac{[Cr^{3+}]^2}{[Fe^{2+}]^3}$

    Here, n = number of electrons transferred, i.e. equal to 6.

    $= 0.3 - \frac{0.0591}{6} \log \frac{[0.01]^2}{[0.1]^3}$

    $= 0.309 \approx 0.31$

23. Average Rate of reaction $= \frac{1}{2}\left\{-\frac{\triangle[\mathrm{N_2O_5}]}{\triangle t}\right\} = -\frac{1}{2}\left[\frac{(2.08-2.33)\mathrm{molL^{-1}}}{184\mathrm{min}}\right]$

$= 6.79 \times 10^{-4}$ mol L^{-1}/min = (6.79 × 10-4 mol L^{-1} min^{-1}) × (60 min/1h)

The average rate of this reaction in terms of hours = 4.07 × 10^{-2} mol L^{-1}/

The average rate of this reaction in terms of minutes = 6.79 × 10^{-4} mol L^{-1} × 1min/60s

The average rate of this reaction in terms of seconds = 1.13 × 10-5 mol L^{-1} s^{-1}

It may be remembered that

Rate $= \frac{1}{4}\left\{\frac{\triangle[\mathrm{NO_2}]}{\triangle t}\right\}$

$\frac{\triangle[\mathrm{NO_2}]}{\triangle t}$ = 6.79 × 10^{-4} × 4 mol L^{-1} min^{-1} = 2.72 × 10^{-3} mol L^{-1} min^{-1}

24. $CH_2CH = CH_2 \xrightarrow[Hydration]{aq.H_2SO_4} \underset{\text{(B)Propan - 2 - ol}}{CH_3 - - \underset{OH}{\underset{|}{CH}} - - CH_2}$

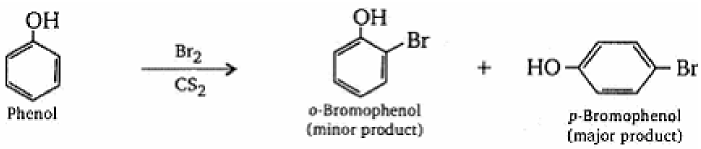
$\xrightarrow[Lucas\ reagent]{ZnCl_2|HCl} \underset{(C)}{CH_3 - - \underset{Cl}{\underset{|}{CH}} - - CH_3} \xrightarrow{alc.KOH} \underset{(A)}{CH_3CH = CH_2}$

OR

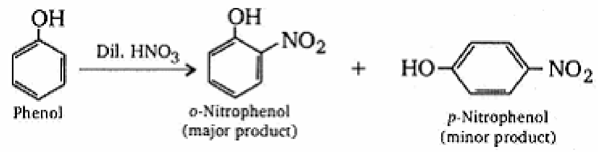
i.

$$\underset{\text{Propan - 1 - ol}}{\mathrm{CH_3CH_2CH_2OH}} + 2(0) \xrightarrow[\text{Oxidisation}]{\text{Alk. KMnO}_4} \underset{\text{Propanoic acid}}{\mathrm{CH_3CH_2CH_3COOH}} + \mathrm{H_2O}$$

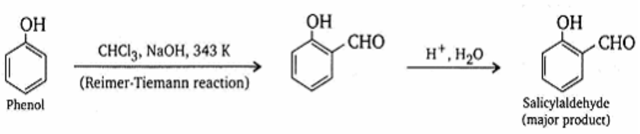
ii.



iii.



iv.



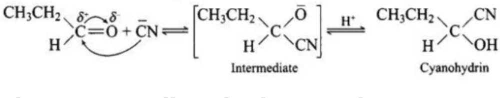
25. C_3H_6O will have the following functional isomer i.e Propanal and Propan-2-one

$\underset{\Pr opanal(I)}{CH_3CH_2CHO}\ \ \underset{\Pr opan-2-one(II)}{CH_3 - \overset{\overset{O}{||}}{C} - CH_3}$

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. **Mercury cell**

Anode Zinc-mercury amalgam

Cathode Paste of HgO and carbon

Electrolyte Paste of KOH and ZnO

Electrode reactions are as follows

At anode

$\mathrm{Zn(Hg)} + 2\mathrm{OH}^- \longrightarrow \mathrm{ZnO(s)} + \mathrm{H_2O} + 2e^-$

At cathode

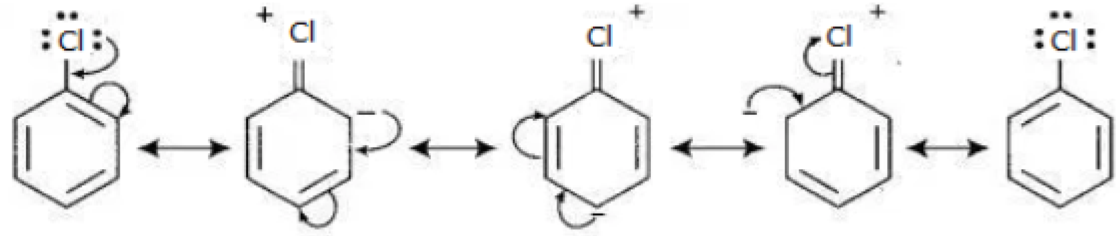
$HgO + H_2O + 2e^- \longrightarrow Hg(l) + 2OH^-$

Overall reaction

$Zn(Hg) + HgO(s) \longrightarrow ZnO(s) + Hg(l)$

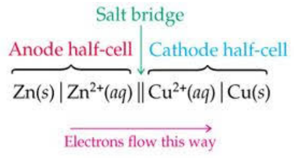
The voltage of a mercury cell remains constant during its life as the overall reaction does not involve any ion m solution whose concentration can change during its life-time.

27. The major reason haloarenes are less reactive than haloalkanes and haloalkenes is the resonance stabilization of the aryl ring. For example, in C_6H_5-Cl, the electron pairs on the halogen atom are in conjugation with π-electrons of the ring. Due to resonance, the C—Cl bond acquires a partial double bond character 169pm hence it is difficult to break the shorter bond, making it less reactive to nucleophilic substitution than haloalkanes and haloalkanes.



28. **Galvanic cell:** A galvanic cell is an electrochemical cell that converts the chemical energy of a spontaneous redox reaction into electrical energy. In this device, the Gibbs energy of the spontaneous redox reaction is converted into electrical work.

Symbolic representation of a Daniell cell:



Section D

29. **Read the text carefully and answer the questions:**

KMnO$_4$ and $K_2Cr_2O_7$ are most important chemicals which are used as oxidising agents and disinfectants. K_2MnO_4 is prepared by fusing MnO_2 with KOH in presence of O_2. K2MnO$_4$ is electrolysed to get purple coloured $KMnO_4$. Na_2CrO_4 is prepared by heating chromite ore with Na_2CO_3 in presence of O_2. Na_2CrO_4 is converted into $Na_2Cr_2O_7$ by reacting with concentrated H_2SO_4. $Na_2Cr_2O_7$ is reacted with KCl to get $K_2Cr_2O_7$, orange coloured solid, soluble in water, changes to yellow coloured CrO_4^{2-} in basic medium, $KMnO_4$ acts as oxidising agent in acidic, neutral as well basic medium. In acidic medium, it converts Fe^{2+} to Fe^{3+}, Sn^{2+} to Sn^{4+}, COO^- to CO^2. In basic medium it converts I^- to IO^{3-}. $K_2Cr_2O_7$ acts as oxidising agent only in acidic medium, converts H_2S to S, SO_2 to $SO4^{2-}$, I^- to I_2. Lanthanoids and actinoids belong to f-block elements with general electronic configuration (n - 2) $f^{1 \text{ to } 14}$ (n - 1) d^{0-2} ns^2. All actinoids are radioactive. Both show contraction in atomic and ionic radii but actinoid contraction is more than lanthanoid contraction. Lanthanoid show +3 oxidation state, few elements show +2 and +4 oxidation states also. Actinoids show +3, +4, +5, +6, +7 oxidation states.

(i) 'Ce' shows +4 oxidation state because it has stable noble gas electronic configuration.

OR

$2Na_2CrO_4 + H_2SO_4 \text{ (conc.)} \rightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$

(ii) i. Both show contraction, lanthanoid and actinoid contraction.
ii. Both form-coloured ions and undergo f-f transition.

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

30. **Read the text carefully and answer the questions:**

The boiling point elevation and the freezing point depression of solutions have a number of practical applications. Ethylene glycol ($CH_2OH \cdot CH_2OH$) is used in automobile radiators as an antifreeze because it lowers the freezing point of the coolant. The same substance also helps to prevent the radiator coolant from boiling away by elevating the boiling point. Ethylene glycol has a low vapour pressure. We can also use glycerol as an antifreeze. In order for boiling point elevation to occur, the solute must be non-volatile, but no such restriction applies to freezing point depression. For example, methanol (CH_3OH), a fairly volatile liquid that boils only at 65^oC is sometimes used as antifreeze in automobile radiators.

(i) CH_3OH is a better reagent for depression in freezing point but not for elevation in boiling point.

(ii) The depression in freezing point will be the same in both the solutions because both are non-electrolytes and gives the same number of solutes.

(iii) Glycol will be better than glycerol because it is more volatile than glycerol.

OR

The sequence of the economy to use these compounds as antifreeze is Methanol > Glycol > Glycerol.

Section E

31. Attempt any five of the following:

(i) The three components of nucleic acid are base, sugar and phosphate group..

(ii) Uracil, cytosine, guanine and adenine are present in RNA. Among these, uracil is not present in DNA.

(iii) The milk sugar lactose is converted into lactic acid by the bacteria during curdling of milk.

(iv) α-Amino acid, $R-\underset{NH_2}{\underset{|}{\dot{C}H}}-COOH$ forms a polypeptide chain in the proteins.

(v) In α-helix structure of the protein, a polypeptide chain is stabilized by the formation of intramolecular H-bonding by twisting into right-handed screw with -NH- group of amino acids in one turn with the >C = O groups of amino acids belonging to adjacent turn.

(vi) Enzyme oxidoreductase, the ending of name of an enzyme is -ase.

(vii) i. Thymine is present in DNA.

ii. Uracil is present in RNA.

32. i. $[Co(H_2O)(CN)(en)_2]^{2+}$ Let the oxidation number of Co be x. The charge on the complex is +2.

$$\begin{array}{cccc} [Co & (H_2O) & (CN) & (en)_2]^{2+} \\ \downarrow & \downarrow & \downarrow & \downarrow \\ x\ + & 0\ + & (-1)\ + & 2(0) = +2 \end{array}$$

x -1 = +2

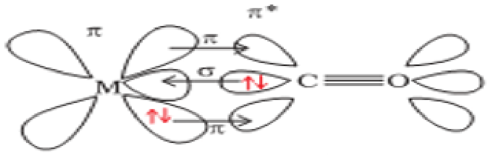
x = +3

ii. $[Pt(Cl)_4]^{2-}$ Let the oxidation number of Pt be x. The charge on the complex is –2.

$$\begin{array}{cc} [Pt & (Cl)_4]^{2-} \\ \downarrow & \downarrow \end{array}$$

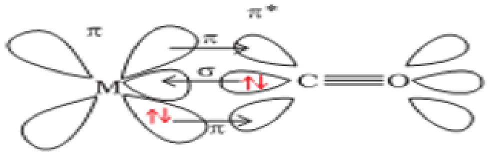
$$x + 4(-1) = -2$$

x = +2



Synergic bonding

iii. $K_3[Fe(CN)_6]$



Synergic bonding

iv.

$$\begin{array}{ccc} [Cr & (NH_3)_3 & Cl_3] \\ \downarrow & \downarrow & \downarrow \\ x\ + & 3(0)\ + & 3(-1) = 0 \end{array}$$

x - 3 = 0

x = +3

OR

The degenerate d-orbitals (in a spherical field environment) split into two levels i.e., $e_g and, t_{2g}$ in the presence of ligands. The splitting of the degenerate levels due to the presence of ligands is called the crystal-field splitting while the energy difference between the two levels ($e_g$andt_{2g}) is called the crystal-field splitting energy. It is denoted by Δ_0 After the orbitals have split, the filling of the electrons takes place. After 1 electron (each) has been filled in the three t_{2g}orbitals, the filling of the fourth electron takes place in two ways. It can enter the e_g orbital (giving rise to $t_{2g}^3 e_g^1$ like electronic configuration) or the pairing of the electrons can take place in the t_{2g} orbitals (giving rise to $t_{2g}^4 e_g^0$like electronic configuration). If the Δ_0 value of a ligand is less than the pairing energy (P), then the electrons enter the $e_g$orbital. On the other hand, if the $\Delta_0$value of a ligand is more than the pairing energy (P), then the electrons enter the t_{2g}orbital.

33. i. $\underset{Ethanoic\ acid}{CH_3COOH} \xrightarrow[-SO_2,\ -HCl]{SOCl_2} CH_3COCl \xrightarrow{NH_3(excess)} CH_3CONH_2 \xrightarrow[\substack{Hoffmann\\ bromamide\\ reaction}]{Br_2,\ KOH} \underset{Methanamine}{CH_3NH_2}$

ii. $\underset{Hexanenitrile}{CH_3(CH_2)_4CN} \xrightarrow[Hydrolysis]{H_3O^+} CH_3(CH_2)_4COOH \xrightarrow{SOCl_2} CH_3(CH_2)_4COCl \xrightarrow{NH_3(excess)} CH_3(CH2)_4CONH_2$
$\xrightarrow[\substack{Hoffmann\\ bromamide\\ reaction}]{Br_2,\ KOH} \underset{1-Aminopen\tan e}{CH_3(CH_2)_4NH_2}$

iii. $\underset{Ethanamine}{CH_3CH_2NH_2} \xrightarrow{HONO} CH_3CH_2OH \xrightarrow[Oxidation]{K_2Cr_2O_7,\ H^+} CH_3CHO \xrightarrow[Oxidation]{K_2Cr_2O_7,\ H^+} CH_3COOH$

iv. $\underset{Nitromethane}{CH_3NO_2} \xrightarrow[Reduction]{Sn,\ HCl} CH_3NH_2 \xrightarrow[\triangle]{CHCl_3,\ KOH} CH_3NC \xrightarrow[Reduction]{Na,\ C_2H_5OH} \underset{Dimethylamine}{CH_3NHCH_3}$

v. $\underset{Propanoic\ acid}{CH_3CH_2COOH} \xrightarrow{NH_3} CH_3CH_2COONH_4 \xrightarrow{\triangle} CH_3CH_2CONH_2 \xrightarrow[\substack{Hoffmann\\ bromamide\\ reaction}]{Br_2,\ KOH} CH_3CH_2NH_2 \xrightarrow{HONO} CH_3CH_2OH$

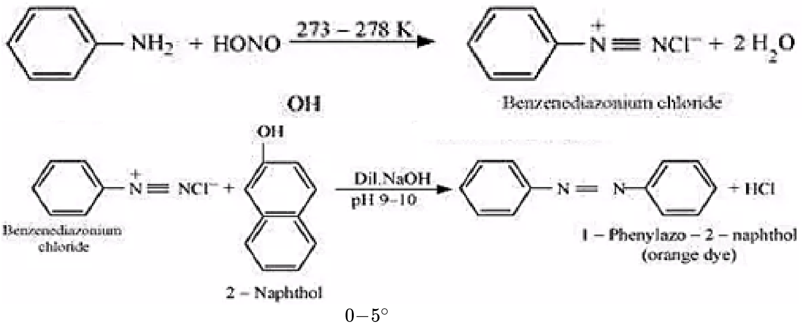
$\xrightarrow[Oxidation]{K_2Cr_2O_7,\ H^+} \underset{Ethanoic\ acid}{CH_3CHO} \xrightarrow[Oxidation]{K_2Cr_2O_7,\ H^+} \underset{Ethanoic\ acid}{CH_3COOH}$

OR

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.

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

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.