Class XII Session 2024-25
Subject - Chemistry
Sample Question Paper - 10

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. Chlorobenzene is formed by the reaction of chlorine with benzene in the presence of $AlCl_3$. Which of the following species attacks the benzene ring in this reaction? **[1]**

a) $AlCl_3$
b) $[AlCl_4]^-$
c) Cl^+
d) Cl^-

2. Which of the following reactions of glucose can be explained only by its cyclic structure? **[1]**

a) Glucose is oxidised by nitric acid to gluconic acid.
b) Pentaacetate of glucose does not react with hydroxylamine.
c) Glucose reacts with hydroxylamine to form an oxime.
d) Glucose forms pentaacetate.

3. CH_3CONH_2 on reaction with NaOH and Br_2 in alcoholic medium gives: **[1]**

a) CH_3NH_2
b) $CH_3CH_2NH_2$
c) CH_3COONa
d) CH_3CH_2Br

4. The compound which forms acetaldehyde when heated with dilute NaOH is: **[1]**

a) 1, 2 dichloroethane
b) 1, 1, 1 trichloroethane
c) 1 chloroethane
d) 1, 1 dichloroethane

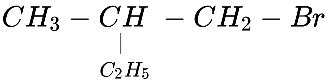
5. The reaction $A \rightarrow B$ is a second order process when the initial concentration of A is 0.50 M, the half life is 8.0 minutes. What is the half life if the initial concentration of A is 0.10 M? **[1]**

a) 40.0 minutes
b) 1.6 minutes
c) 8.0 minutes
d) 16.0 minutes

6. Match the items given in column I with that in column II: **[1]**

Column I	Column II
(a) Urea	(i) i < 1
(b) $FeCl_3$	(ii) i = 1
(c) Benzoic acid in Benzene	(iii) i = 2
(d) $MgSO_4$	(iv) i = 4

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

7. Which is the correct IUPAC name for  $CH_3 - \underset{\underset{C_2H_5}{|}}{CH} - CH_2 - Br$? **[1]**

a) 1-Bromo-2-ethyl-2-methylethane
b) 1-Bromo-2-methylbutane
c) 2-Methyl-1-bromobutane
d) 1-Bromo-2-ethylpropane

8. Silver ornaments turn black by the presence of which gas in the atmosphere? **[1]**

a) H_2S
b) O_2
c) Cl_2
d) N_2

9. The following experimental rate data were obtained for a reaction carried out at 25°C: **[1]**

$A_{(g)} + B_{(g)} \rightarrow C_{(g)} + D_{(g)}$

Initial $[A_{(g)}]$/mol dm^{-3}	Initial $[B_{(g)}]$/mol dm^{-3}	Initial rate/mol $dm^{-3}s^{-1}$
3.0×10^{-2}	2.0×10^{-2}	1.89×10^{-4}
3.0×10^{-2}	4.0×10^{-2}	1.89×10^{-4}
6.0×10^{-2}	4.0×10^{-2}	7.56×10^{-4}

What are the orders with respect to $A_{(g)}$ and $B_{(g)}$?

a) Order with respect to $A_{(g)}$ - Second
Order with respect to $B_{(g)}$ - First

b) Order with respect to $A_{(g)}$ - Zero
Order with respect to $B_{(g)}$ - Second

c) Order with respect to $A_{(g)}$ - First
Order with respect to $B_{(g)}$ - Zero

d) Order with respect to $A_{(g)}$ - Second
Order with respect to $B_{(g)}$ - Zero

10. The reduction of ethanenitrile with sodium and alcohol gives: **[1]**

a) 1-aminoethane
b) Ethanamide
c) 1-aminopropane
d) Ethanoic acid

11. Williamson's synthesis is used for the preparation of **[1]**

a) aldehydes
b) ethers
c) alkyl halides
d) alcohols

12. Aniline does not undergo Friedel – Crafts reaction because: **[1]**

a) Anilium ion deactivates any further reaction
b) Aluminium chloride reacts with Aniline
c) All of these
d) $AlCl_3$ act as a catalyst

13. **Assertion (A):** Cellulose can be easily converted into fibres. **[1]**

Reason (R): Cotton contains about 90% cellulose.

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):** Aldehydes and ketones show condensation reactions. **[1]**

Reason (R): The hydrogen atoms attached to α-carbon of aldehydes and ketones are reactive.

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):** Ammonolysis of alkyl halides is not a suitable method for the preparation of pure primary amines. **[1]**

Reason (R): Ammonolysis of alkyl halides yields mainly secondary amines.

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

16. **Assertion (A):** Dehydration of glycerol with $KHSO_4$ gives acrolein. **[1]**

Reason (R): Acrolein is an α, β-unsaturated aldehyde.

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. Name the type of isomerism when ambidentate ligands are attached to the central metal ion. Give two examples of ambidentate ligands. **[2]**

18. Transition elements show high melting points. Why? **[2]**

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

(a) A reaction is 50% complete in 2 hours and 75% complete in 4 hours. What is the order of the reaction? **[1]**

(b) For which type of reactions, order and molecularity have the same value? **[1]**

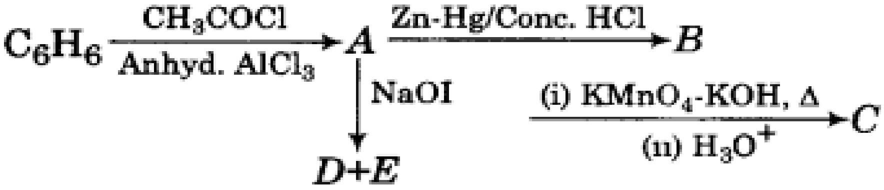
20. Based on solute-solvent interactions, arrange the following in order of increasing solubility in n-octane and explain. Cyclohexane, KCl, CH_3OH, CH_3CN. **[2]**

OR

What happens when

i. a pressure greater than osmotic pressure is applied on the solution side separated from solvent by a semipermeable membrane?
ii. acetone is added to pure ethanol?

21. Write the structures of A, B, C, D and E in the following reactions. **[2]**



Section C

22. Zinc rod is dipped in 0.1 M solution of $ZnSO_4$ **[3]**

The salt is 95% dissociated at is dilution at 298 K . Calculate the electrode potential. Given:

$E^0(Zn^{2+}/Zn) = -0.76$

23. The following results have been obtained during the kinetic studies of the reaction. **[3]**

$2A + B \rightarrow C + D$

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.

24. Give structures of the products you would except when each of the following alcohols **[3]**

i. Butan-1-ol
ii. 2-Methylbutan-2-ol react with
   a. HCl - $ZnCl_2$
   b. HBr and
   c. $SOCl_2$

OR

Explain how does the - OH group attached to a carbon of benzene ring activate it towards electrophilic substitution?

25. Draw structures of the following derivatives: **[3]**

i. 2,4-Dinitrophenylhydrazone of benzaldehyde
ii. Cyclopropanone oxime
iii. Acetaldehydedimethylacetal

26. Calculate the e.m.f at 25°c for the following cell: **[3]**

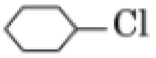
$Ni(s)|Ni^{2+}\left(0.01M\right)||Cu^{2+}\left(0.1M\right)|Cu(s)$

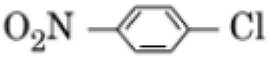
Given: $E^0_{Ni^{+2}/Ni} = -0.25$ V

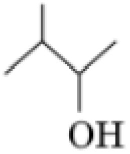
$E^0_{Cu^{2+}/Cu} = +0.34V$

[1F = 96,500 $Cmol^{-1}$]. Calculate the maximum work that can be accomplished by the operation of this cell

[3]

27. a. Out of  and , which one is more reactive towards S_N2 reaction and why?

b. Out of  and , which one is more reactive towards nucleophilic substitution reaction and why?

c. Out of  and , which one is optically active and why?

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

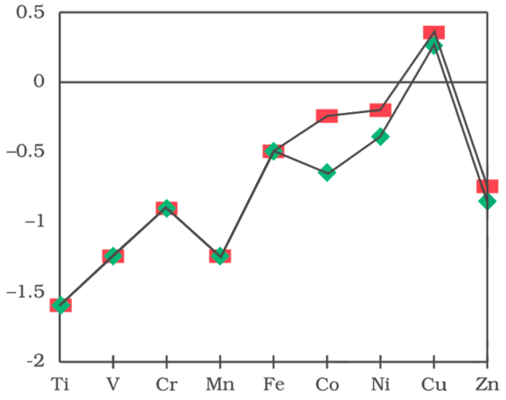
$2Cr(s) + 3Fe^{2+}(0.1M) \rightarrow 2Cr^{3+}(0.01M) + 3Fe(s)$

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

Section D

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

The unique behaviour of Cu, having a positive E° accounts for its inability to liberate H_2 from acids. Only oxidising acids (nitric and hot concentrated sulphuric) react with Cu, the acids being reduced. The stability of the half-filled d sub-shell in Mn^{2+} and the completely filled d^{10} configuration in Zn^{2+} are related to their E° values, whereas E° for Ni is related to the highest negative $\Delta_{hyd}H°$. An examination of the $E^o_{(M^{3+}/M^{2+})}$ values the low value for Sc reflects the stability of Sc^{3+} which has a noble gas configuration. The comparatively high value for Mn shows that $Mn^{2+}(d^5)$ is particularly stable, whereas a comparatively low value for Fe shows the extra stability of Fe^{3+} (d^5). The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level).



i. Why Zn has high value for M^{3+}/M^{2+} Standard Electrode Potentials? (1)

ii. Transition metals, despite high E° oxidation, are poor reducing agents. Justify. (1)

iii. Why is Cr^{2+} reducing and Mn^{3+} oxidising when both Cr and Mn have d^4 configuration? (2)

OR

Why Cu^{2+} is more stable than Cu^+? (2)

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

Vapour pressure of a liquid or a solution is the pressure exerted by the vapour in equilibrium with the liquid or solution at a particular temperature. It depends upon the nature of the liquid and temperature. The non-volatile solute in solution reduces the escaping tendency of the solvent molecules in the vapour phase because some of the solute particles occupy the positions of the solvent molecules on the liquid surface. The relative lowering of the vapour pressure of a solution containing a non-volatile solute is equal to the mole fraction of the solute in the solution. This is also known as Raoult's law. However, for solutions of volatile solutes, the vapour pressure of a component in a solution at a given temperature is equal to the mole fraction of that component in the solution multiplied by the vapour pressure of that pure component. The solutions in which each component obeys Raoult's law is called an ideal solution. For ideal solutions ΔH_{mixing} and ΔV_{mixing} are also zero. Practically no solution is ideal. A non-ideal solution is that solution in which solute and solvent molecules interact with one another with a different force than the forces of interaction between the molecules of the pure components. There are two types of non-ideal solutions, showing positive deviations and negative deviations from ideal behaviour. If for the two components A and B, the forces of interaction between A and B molecules are less than the A-A and B-B interactions, the non-ideal solutions have positive deviations. On the other hand, if the forces of interaction between A and B molecules are more than the A-A and B-B interactions, the non-ideal solutions have negative deviations.

i. What is the mole fraction of A in solution obeying result's low if the vapour pressure of a pure liquid A is 40 mm of Hg at 300 K. The vapour pressure of this liquid in solution with liquid B is 32 mm of Hg? (1)

ii. Vapour pressure of a solution of heptane & octane is given by the equation: (1)
P(sol.)(mm Hg) = 35 + 65x, where x is the mole fraction of heptane. Calculate the vapour pressure of pure octane. (2)

iii. What is the value of ΔV_{mixing} and ΔH_{mixing} for non-ideal solution showing negative deviation?

OR

Acetic acid + pyridine, the mixture is an example of which type of solution? (2)

Section E

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

(a) Which sugar is present in milk ? **[1]**

(b) Why must vitamin C be supplied regularly in diet? **[1]**

(c) What type of substance is phenylanine hydroxylate? Write its importance. **[1]**

(d) Define denaturation of protein. What is the effect of denaturation on the structure of protein? **[1]**

(e) Name the linkage connecting monosaccharide units in polysaccharides. **[1]**

(f) How do you explain the presence of all six carbon atoms in glucose in a straight chain? **[1]**

(g) Write the reactions showing the presence of following in the open structure of glucose: **[1]**

i. a carbonyl group
ii. chain with six carbon atoms

32. a. Amongst the following, the most stable complex is: **[5]**

i. $[Fe(H_2O)_6]^{3+}$
ii. $[Fe(NH_3)_6]^{3+}$
iii. $[Fe(C_2O_4)_3]^{3-}$
iv. $[FeCl_6]^{3+}$

b. What will be the correct order for the wavelength of absorption in the visible region for the following:
$[Ni(NO_2)_6]^{4-}$, $[Ni(NH_3)_6]^{2+}$, $[Ni(H_2O)_6]^{2+}$

OR

$FeSO_4$ solution mixed with $(NH_4)_2SO_4$ solution in 1:1 molar ratio gives the test of Fe^{2+} ion but $CuSO_4$ solution mixed with aqueous ammonia in 1:4 molar ratio does not give the test of Cu^{2+} ion. Explain why?

33. State the reactions and reaction conditions for the following conversions : **[5]**

i. Benzene diazonium chloride to nitrobenzene.
ii. Aniline to benzene diazonium chloride.
iii. Ethylamine to methylamine.

OR

i. Tert-Butylamine cannot be prepared by the action of NH_3 on tert-butyl bromic. Explain why?
ii. Suggest a convenient method for the preparation of tert-butylamine.

Solution

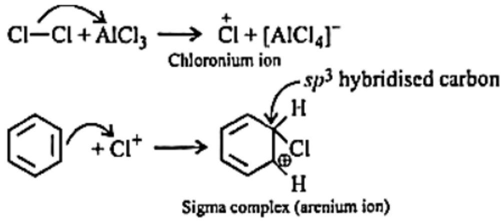
Section A

1.

(c) Cl^+

Explanation:

Aluminum chloride ($AlCl_3$) is a Lewis acid catalyst and works in the same way as $FeCl_3$ does. Benzene(C_6H_6)is converted into chlorobenzene by chlorination of benzene in the presence of $AlCl_3$. The reaction occurs by an electrophilic substitution reaction. Cl_2 forms a coordination complex with $AlCl_3$, forming $Cl^+AlCl_4^-$ complex, which gives a slight positive charge to Cl, and $AlCl_4^-$ is negatively charged. This Cl^+ then reacts with the aromatic double bond of the benzene ring to form an additional product, followed by deprotonation to form chlorobenzene and $AlCl_3$ and HCl as the side products.



2.

(b) Pentaacetate of glucose does not react with hydroxylamine.

Explanation: The pentaacetate of glucose does not react with the hydroxylamine indicating the absence of free -CHO group. This property of the glucose can be explained only by its own cyclic structure.

3. **(a)** CH_3NH_2

Explanation: Product formed is CH_3NH_2

4.

(d) 1, 1 dichloroethane

Explanation: $CH_3CHCl_2 + OH^- \rightarrow CH_3CH(OH)_2 \rightarrow CH_3CHO + H_2O$

Gem diols like ($CH_3CH(OH)_2$) are generally not stable. The 2 -OH group attached to the same C removes H_2O and forms carbonyl compounds.

5. **(a)** 40.0 minutes

Explanation: For second-order reaction:

$$t_{1/2} = \frac{2k}{[R]} \Rightarrow k = \frac{t_{1/2}[R]}{2}$$

Applying this equation,

$$\frac{t_{1/2}[R]}{2} = \frac{t'_{1/2}[R']}{2}$$

$$\frac{8.0 \times 0.50}{2} = \frac{t'_{1/2} \times 0.10}{2}$$

$$t'_{1/2} = \frac{8 \times 0.50}{0.10} = 40$$

6.

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

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

7.

(b) 1-Bromo-2-methylbutane

Explanation: First, we need to identify the longest carbon chain. Once we do that, the actual structure should read CH_3—CH_2—$CH(CH_3)$—CH_2—Br. –Br, the functional halide group is attached to the first carbon atom (1- Bromo), so we start the numbering from that position. The methyl group branch is bond to the second carbon atom in the chain(2-methyl). The number of carbons in the unbranched parent chain is four, thus giving the name butane. The IUPAC is named 1-Bromo-2-methylbutane.

8. **(a)** H_2S

Explanation: Silver ornaments turns black coming in contact with H_2S due to formation of Ag_2S. The chemical equation for this change can be represented as given below:

$2Ag(s) + H_2S(g) \rightarrow Ag_2S(s) + H_2(g)$

9.

(d) Order with respect to $A_{(g)}$ - Second

Order with respect to $B_{(g)}$ - Zero

Explanation: Order with respect to $A_{(g)}$ - Second

Order with respect to $B_{(g)}$ - Zero

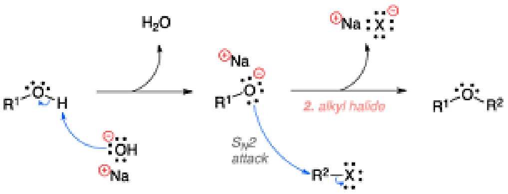
10. **(a)** 1-aminoethane

Explanation: 1-aminoethane

11.

(b) ethers

Explanation: The Williamson ether synthesis is an organic reaction, forming an ether from an organohalide and deprotonated alcohol (alkoxide). This reaction was developed by Alexander Williamson in 1850. Typically it involves the reaction of an alkoxide ion with a primary alkyl halide via an S_N2 reaction.



12.

(b) Aluminium chloride reacts with Aniline

Explanation: $AlCl_3$ being a lewis acid reacts with the lone pair of $-NH_2$ group of aniline forming an adduct ($C_6H_5NH_2^+AlCl_3$) which deactivates the benzene system hence no friedal craft reaction occurs.

13.

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

Explanation: Cellulose is a linear condensation polymer of β-glucose. Because of linear structure, cellulose can be easily converted into fibres.

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

Explanation: The release of hydrogen from α-carbon of aldehydes or ketones results in the formation of carbanion which is resonance stabilised. It is called enolate. Enolate ion can act as as a nucleophile and can attack the carbonyl group of the other molecule, i.e. giving condensation reactions.

15.

(c) Assertion (A) is true, but Reason (R) is false.

Explanation: The amine formed reacts further with more of alkyl halide to give $2\circ$ and $3\circ$ amines and finally quaternary salt

16.

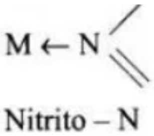
(b) Both A and R are true but R is not the correct explanation of A.

Explanation: Removal of two molecules of water gives a product which tautomerises to yield acrolein -an α, β-unsaturated aldehyde.

Section B

17. Linkage isomerism- arises in a coordinated compound containing ambidentate ligand

Examples:

i. 
Nitrito – N

$M \leftarrow O-N=O$
Nitrito — O

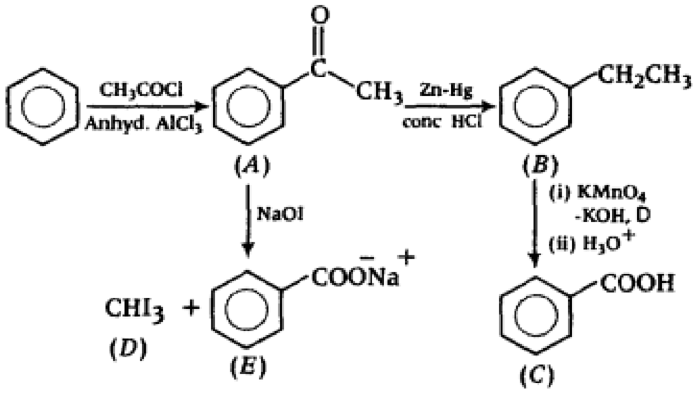
ii. $M \leftarrow SCN$
Thiocvanato

$M \leftarrow NCS$
Isothiocyanato

18. The high melting points of transition metals are due to strong metallic bonds between the atoms of these elements This is because of involvements of a greater number of electrons in the interatomic metallic bonding from (n - 1)d orbitals in addition to ns electrons in the interatomic molecular bonding.
19. Answer the following:
    (i) First order.
    (ii) Elementary reactions have the same value of order and molecularity because the elementary reaction proceeds in a single step.
20. n-octane is a non-polar solvent. Therefore, the solubility of a non-polar solute is more than that of a polar solute in the n-octane.
    The order of increasing polarity is:
    Cyclohexane < $CH_3CN < CH_3OH$ < KCl
    Therefore, the order of increasing solubility is:
    KCl < CH_3OH < CH_3CN < Cyclohexane

OR

i. Reverse osmosis (direction of osmosis is reversed) occurs i.e. net flow of the solvent is from solution to solvent. Hence greater pressure is applied to the solvent molecules from the solution side would move into the pure solvent through a semipermeable membrane.
ii. When acetone is added to the ethanol, molecules of acetone get in between the molecules of ethanol and break some of the hydrogen bond, which weakens the intermolecular attractive forces resulting in an increase in vapor pressure of the mixture than ethanol in a pure state.

21. 

Section C

22. $\left[Zn^{2+}\right] = 0.1 \times \frac{95}{100} = 0.095M$
    $Zn^{2+} + 2e^- \rightarrow Zn$
    $E_{(Zn^+/Zn)} = E^0_{(Zn^+/Zn)} - \frac{0.0591}{2}\log\frac{1}{\left[Zn^{2+}\right]}$
    $= -0.76V - \frac{0.0591}{2}\log\frac{1}{0.095}$
    $= -0.76V - \frac{0.0591}{2}[\log 1000 - \log 95]$
    $= -0.76 - \frac{0.0591}{2}[3.000 - 1.9777]$
    $= -0.76V - \frac{0.0591}{2} \times 1.0223$
    $= -0.76V - \frac{0.0604}{2} = 0.76 - 0.0302$
    = - 0.7902 V
23. From experiments I and IV, it may be noted that [B] is same but [A] has been made four times, the rate of reaction has also becomes four times. This means w.r.t A
    Rate $\propto [A]$
    From experiments II and III it may be noted that [A] is kept same an [B] has been doubled, the rate of reaction has become four times. This means w.r.t B,
    Rate $\propto [B]^2$
    Combining (i) and (ii), we get the rate law for the given reaction as:

Rate $= k\,[A]\,[B]^2$

Thus order w.r.t A = 1

Order w.r.t B = 2

The overall order of the reaction

= 1 + 2 = 3

The rate constant and its units can be calculated from the data of each experiment using the expression.

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

$= \frac{mol\,L^{-1}\min^{-1}}{\left(mol\,L^{-1}\right)\left(mol\,L^{-1}\right)^2}$

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

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

i. $\frac{6.0\times10^{-3}}{0.1\times(0.1)^2} = 6.0$

ii. $\frac{7.2\times10^{-2}}{0.3\times(0.2)^2} = 6.0$

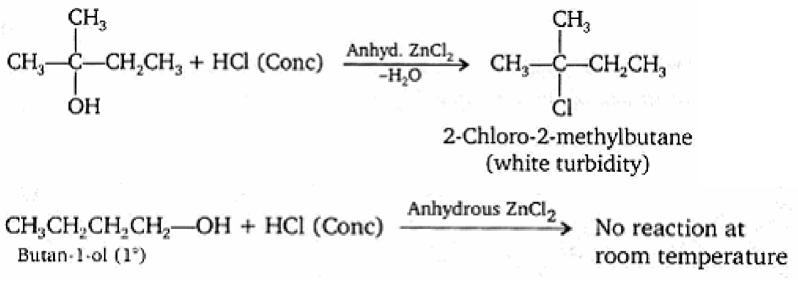
iii. $\frac{2.88\times10^{-1}}{0.3\times(0.4)^2} = 6.0$

iv. $\frac{2.4\times10^{-2}}{0.4\times(0.1)^2} = 6.0$

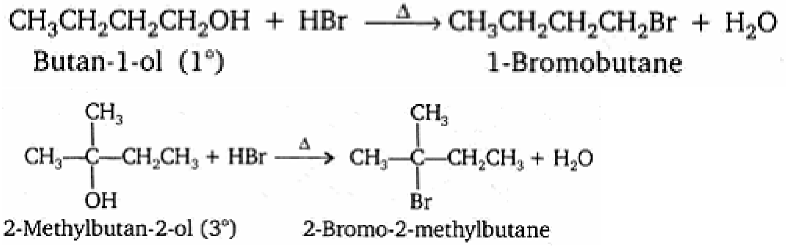
Rate constant $k = 6.0\,mol^{-2}L^{-2}\min^{-1}$

24. i. a. With HCl - $ZnCl_2$ (lucas reagent) 2-Methylbutane-2-ol

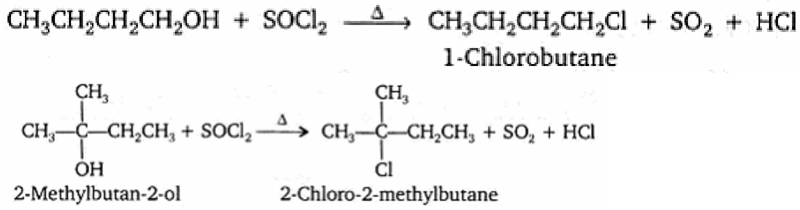
ii. Being a 3° alcohol, reacts with Lucas reagent to produce turbidity immediately due to the formation of insoluble tert-alkyl chloride while butane-l-ol (i) being a 1°alcohol does not react with Lucas reagent at room temperature.



a. Both the alcohols react to produce the corresponding alkyl bromides.

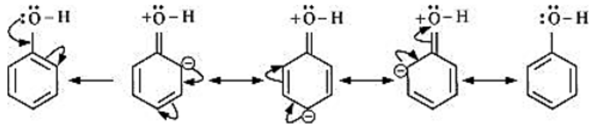


b. Both the alcohols react to form the corresponding alkyl chlorides.



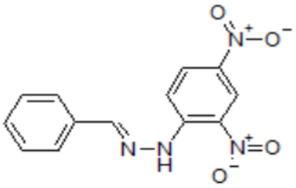
OR

The -OH group is an electron-donating group. Thus, it increases the electron density in the benzene ring as shown in the given resonance structure of phenol.

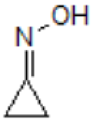


As a result, the benzene ring is activated towards electrophilic substitution.

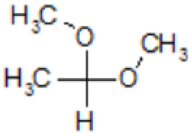
25. i.



ii.



iii.



26. Cell reaction is

$Ni(s)|Ni^{2+}\,(0.01M)\,||Cu^{2+}\,(0.1M)\,|Cu(s)$

At anode : $Ni(s) \rightarrow Ni^{2+}(aq) + 2e^{-}$

At cathode: $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$

Net cell reaction

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

$E_{cell} = E^{0}_{cell} - \frac{0.0591}{2}\log\frac{[Ni^{2+}]}{[Cu^{2+}]}$

$= [+0.34V - (-0.25V)] - \frac{0.0591}{2}\log\frac{1}{10}$

$= 0.59V - \frac{0.0591}{2} \times -1$

= 0.59 + 0.0295

= 0.6195V

$\Delta G = -nEF$

$= -2 \times 0.6195V \times 96500C/mol$

= -119563.5J/mol

$\Delta G = -119.5635KJ/mol$

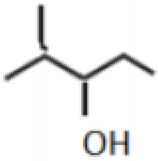
$-\Delta G = W_{\max} = 119.5635KJ/mol$

27. a.

is more reactive towards S_N2 because it is a primary halide.

b.

is more reactive towards nucleophilic substitution reaction because it is more reactive due to the presence of electron with drawing - NO_2 group.

c.  It is optically active due to chiral carbon.

28. 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

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

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

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

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

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

$= 0.309 \approx 0.31$

Section D

29. i. Due to the removal of an electron from the stable d^{10} configuration of Zn^{2+}.
    ii. Transition metals despite having high E° oxidation, are poor reducing agents because of their high heat of vaporization, high ionisation energies and low heats of hydration.
    iii. Cr^{2+} is reducing as its configuration changes from d_4 to d_3, the having a half-filled t_{2g} level. On the other hand, the change from Mn^{3+} to Mn^{2+} results in the half-filled (d_5) configuration which has extra stability.

    OR

    The Stability of Cu^{2+} is more than Cu^+ as stability depends on the hydration energy of the ions when they bond to the water molecules. The Cu^{2+} ion has a greater charge density than Cu^+ ion and thus forms much stronger bonds releasing more energy.

30. i. $P_A = x_A \times P_A^\circ$

    $32 = x_A \times 40$

    $x_A = \frac{32}{40}$

    $x_A = 0.8$

    ii. For pure octane, x = 0

    $\therefore$ p(sol.)(mm Hg) = P (octane) = 35 + 65 $\times$ 0 = 35 mm of Hg

    iii. The value of ΔV_{mixing} and ΔH_{mixing} is negative.

    iv. It is an example of Non-ideal solution.

Section E

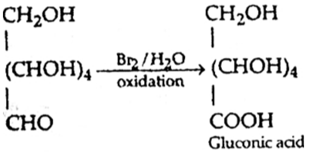
31. Attempt any five of the following:
    (i) Lactose is the type of sugar that occurs naturally in milk. It is found in the milk of animals such as cows and goats, as well as human breast milk.
    (ii) Vitamin 'C' is water soluble vitamin and hence excess of it is readily excreted in the urine so, it cannot be stored in our body and hence, it should be regularly supplied in the diet.
    (iii) It is an enzyme whose deficiency causes mental redardation.
    (iv) When a protein is subjected to a change in temperature or chemical change then it loses its biological activity.

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

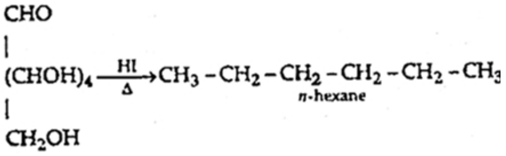
    (v) The monosaccharide units are linked through the glycosidic linkage in the polysaccharide.
    (vi) Glucose on prolonged heating with HI and red phosphorus gives n-hexane HI (excess) suggest that all six carbon atom are in straight chain.

    $\underset{\text{Glucose}}{C_6H_{12}O_6}\xrightarrow[\Delta]{H1(excess)}\underset{n-Hexane\ (straight\ chain)}{CH_3CH_2CH_2CH_2CH_2CH_3}$

    (vii) i. Reaction of glucose (a carbonyl group)



    ii. Straight chain with six carbon atoms



32. a. Complexes containing didentate or polydentate ligands are more stable than those containing monodentate ligands. In each of the given complex, Fe is in +3 state.

As $C_2O_4^{2-}$ is didentate chelating ligand, hence is the most stable complex.

b. As metal ion is fixed, the wavelength of absorption will decided by the field strengths (CFSE values) of the ligands. From the spectrochemical series, the order of CFSE is: $H_2O < NH_3 < NO_2$

Thus, the energies absorbed for excitation will be in the order:

$[Ni(NH_3)_6]^{2+} < [Ni(H_2O)_6]^{2+} < [Ni(NO_2)_6]^{4-}$

As wavelength and energy are inversely related.The wavelengths absorbed will be in the opposite order:

$[Ni(NH_3)_6]^{2+} > [Ni(H_2O)_6]^{2+} > [Ni(NO_2)_6]^{4-}$

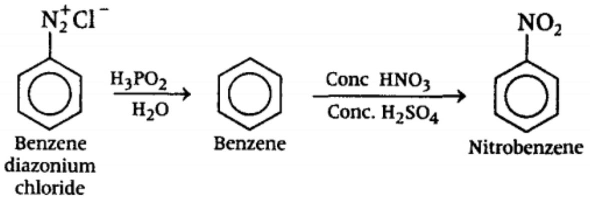
OR

$(NH_4)_2SO_4 + FeSO_4 + 6H_2O \rightarrow FeSO_4.(NH_4)_2SO_4.6H_2O$ (Mohr's Salt)

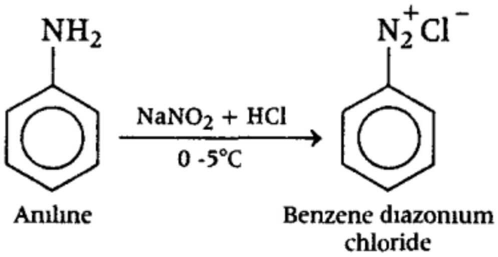
$CuSO_4 + 4NH_3 + 5H_2O \rightarrow [Cu(NH_3)_4]SO_4.5H_2O$ (tetramminocopper(ii) sulphate)

Both the compounds i.e., $FeSO_4.(NH_4)_2SO_4.6H_2O$ and $[Cu(NH_3)_4]SO_4.5H_2O$ fall under the category of addition compounds with only one major difference i.e., the former is an example of a double salt, while the latter is a coordination compound. A double salt is an addition compound that is stable in the solid state but that which breaks up into its constituent ions in the dissolved state. These compounds exhibit individual properties of their constituents. For e.g. $FeSO_4.(NH_4)_2SO_4.6H_2O$ breaks into Fe^{2+}, NH^{4+} and SO_4^{2-} ions. Hence, it gives a positive test for Fe^{2+} ions.A coordination compound is an addition compound which retains its identity in the solid as well as in the dissolved state. However, the individual properties of the constituents are lost. This happens because $[Cu(NH_3)_4]SO_4.5H_2O$ does not show the test for Cu^{2+}.The ions present in the solution of $[Cu(NH_3)_4]SO_4.5H_2O$ are $[Cu(NH_3)_4]^{2+}$ and SO_4^{2-}.

33. i.



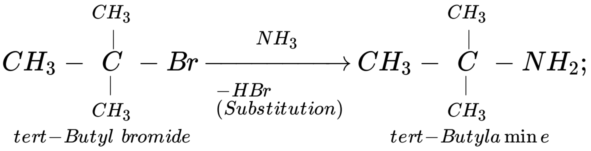
ii.



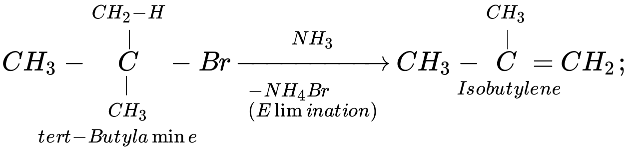
iii. $\underset{Ethyla\min e}{C_2H_5CH_2NH_2} \xrightarrow{HNO_2} CH_3CH_2OH \xrightarrow[K_2Cr_2O_7/H_2SO_4]{\hspace{3cm}} CH_3CHOOH \xrightarrow[\Delta]{NH_3} CH_3CH_2NOH_2 \xrightarrow{Br_2/KOH} \underset{\text{Methylamine}}{CH_3NH_2}$

OR

i. Tert.-Butyl bromide being a 3° alkyl halide on treatment with a base (i.e., NH_3) prefers to undergo elimination rather than substitution. Therefore, the product is isobutylene rather than tert-butylamine.

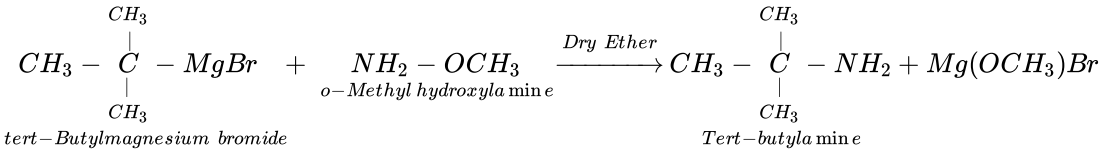


$$\underset{tert-Butyl\ bromide}{CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-Br} \xrightarrow[\substack{-HBr\\(Substitution)}]{NH_3} \underset{tert-Butyla\min e}{CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-NH_2};$$



$$\underset{tert-Butyla\min e}{CH_3-\overset{\overset{CH_2-H}{|}}{\underset{\underset{CH_3}{|}}{C}}-Br} \xrightarrow[\substack{-NH_4Br\\(E\lim ination)}]{NH_3} CH_3-\underset{Isobutylene}{\overset{\overset{CH_3}{|}}{C}}=CH_2;$$

ii. 1° amines containing tert-alkyl groups can be prepared by action of suitable Grignard reagents and o-methylhydroxylamine. For example,



$$\underset{tert-Butylmagnesium\ bromide}{CH_3-\underset{CH_3}{\overset{CH_3}{C}}-MgBr} + \underset{o-Methyl\ hydroxylamine}{NH_2-OCH_3} \xrightarrow{Dry\ Ether} \underset{Tert-butylamine}{CH_3-\underset{CH_3}{\overset{CH_3}{C}}-NH_2} + Mg(OCH_3)Br$$