Class XII Session 2023-24
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. The best method for the conversion of an alcohol into an alkyl chloride is by treating the alcohol with: **[1]**

a) $SOCl_2$ in presence of pyridine
b) PCl_3
c) Dry HCl in the presence of anhydrous $ZnCl_2$
d) PCl_5

2. Amino acid is. **[1]**

a) $H_2N.CH_2.COOH$
b) $Cl - CH_2. COOH$
c) $HO. CH_2COOH$
d) CH_3COONH_4

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

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

4. Acetone is treated with excess of ethanol in the presence of hydrochloric acid. The product obtained is: **[1]**

a) $(CH_3)_2C(OH)(OC_2H_5)$
b) $(CH_3)_2C(OC_2H_5)(OC_2H_5)$
c) CH_3COOH
d) $(CH_3)_2CH(OH)$

5. Which among the following is an example of pseudo first order reaction? **[1]**

a) Decomposition of nitrogen pentoxide
b) Acid catalysed hydrolysis of ethyl acetate
c) Dehydration of oxalic acid
d) Decomposition of hydrogen peroxide

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

Column I	Column II
(a) K_b	(i) Elevation in boiling point
(b) K_f	(ii) Van't Hoff factor
(c) i	(iii) Cryoscopic constant
(d) $\triangle T_b$	(iv) Ebullioscopic constant

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

7. Which one of the following forms propane nitrile as the major product? **[1]**

a) Propyl bromide + alcoholic KCN
b) Ethyl bromide + alcoholic KCN
c) Propyl bromide + alcoholic AgCN
d) Ethyl bromide + alcoholic AgCN

8. On addition of small amount of $KMnO_4$ to concentrated H_2SO_4, a green oily compound is obtained which is highly explosive in nature. Identify the compound from the following. **[1]**

a) MnO_2
b) Mn_2O_7
c) $MnSO_4$
d) Mn_2O_3

9. Which among the following is an example of photochemistry used in our daily life? **[1]**

a) In photography
b) In inversion of cane sugar
c) All of these
d) In decomposition of hydrogen peroxide

10. Give the products of the reaction **[1]**

$PhC \equiv CMe \xrightarrow{H_3O^+, Hg^{2+}} ?$

a) $PhCH_2CH_2CHO$
b) $PhCOCH_2CH_3$
c) PhCOCOMe
d) $PhCH_2COCH_3$

11. How many alcohols with molecular formula $C_4H_{10}O$ are chiral in nature? **[1]**

a) 1
b) 4
c) 3
d) 2

12. Which of the following amines can be resolved into enantiomers? **[1]**

a) 4 – (dimethylamino) pyridine
b) 2 – pentanamine
c) 3 – pentanamine
d) Trimethylamine

13. **Assertion (A)**: Mg is not present in the enamel of human teeth. **[1]**
Reason (R): Mg is an essential element for the biological functions of humans.

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):** The boiling points of aldehydes and ketones are higher than hydrocarbons and ethers of **[1]**

comparable molecular masses.

Reason (R): There is a weak molecular association in aldehydes and ketones arising out of the dipole-dipole interactions.

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):** Boiling points of alkyl halides decrease in the order R-I > R-Br > R-Cl > R-F. **[1]**

Reason (R): Van der Waals forces decrease with an increase in the size of the halogen atom.

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):** 2-Butanol on heating with H_2SO_4 gives 1-butene and 2-butene. **[1]**

Reason (R): Dehydration of 2-butanol follows Saytzeff's rule.

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. Using the valence bond approach, predict the shape and magnetic behaviour of $[CoCl_4]^{2-}$ Given, atomic number of Co = 27] **[2]**

18. Describe giving reason **[2]**

i. Why Fe has higher melting point than Cu?
ii. Why Co^{2+} have higher magnetic moment than Ni^{2+}?

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

(i) Write the slope value obtained in the plot of $\frac{log[R_o]}{[R_o]}$ Vs. time for a first-order reaction. **[1]**

(ii) For the homogeneous decomposition of N_2O_5 into NO_2 and O_2; $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$ **[1]**

Rate = k $[N_2O_5]$

Find out the order of reaction with respect to N_2O_5.

20. What role does the molecular interaction play in a solution of alcohol and water? **[2]**

OR

The vapour pressure of pure benzene at a certain temperature is 0.850 bar. A non-volatile, non-electrolyte solid weighing 0.5 g when added to 39.0 g of benzene (molar mass 78 g mol^{-1}). Vapour pressure of the solution, then, is 0.845 bar. What is the molar mass of the solid substance?

21. Write the names of the reagents and equations in the conversion of **[2]**

i. phenol to salicylaldehyde.
ii. anisole to p-methoxyacetophenone.

Section C

22. A strip of nickel metal is placed in a 1 molar solution of $Ni(NO_3)_2$ and a strip of silver metal is placed in a one molar solution of $AgNO_3$. An electrochemical cell is created when the two solutions are connected by a salt **[3]**

bridge and the two strips are connected by wires to a voltmeter.

i. Write the balanced equations for the overall reaction occurring in the cell and calculate the cell potential.

ii. Calculate the cell potential (E_{cell}) at 25^0 C for the cell, if the initial concentration of $Ni(NO_3)_2$ is 0.100 molar and the initial concentration of $AgNO_3$ is 1.00 molar.

$[E^\circ_{N_2^{2+}/N_1} = -0.25$ V, $E^\circ_{Ag^+/Ag} = 0.80$ V, $\log 10^{-1} = -1]$.

23. For hydrolysis of ester in water follows a pseudo first order kinetics. The obtained results are as given below: **[3]**

t(in seconds)	**0**	**30**	**60**	**90**
[Ester] M	0.55	0.31	0.17	0.085

i. Calculate the average rate of reaction between the time interval 30 to 60 s.

ii. Calculate the pseudo first order rate constant for the hydrolysis of ester.

24. Write the mechanism of hydration of ethene to yield ethanol. **[3]**

OR

How the following conversions can be carried out?

i. 2-Chloropropane to 1-propanol

ii. Isopropyl alcohol to iodoform

iii. Chlorobenzene to p-nitrophenol

25. Two moles of compound (A) on treatment with a strong base gives two compounds (B) and (C). The compound (B) on dehydrogenation with Cu gives (A) while acidification of (C) gives carboxylic acid (D) having molecular formula CH_2O_2. Identify (A) to (D). **[3]**

26. Write the chemical equation for all the steps involved in the rusting of iron. Give any one method to prevent rusting of iron. **[3]**

27. What happens when **[3]**

i. ethyl chloride is treated with aqueous KOH,

ii. methyl bromide is treated with sodium in the presence of dry ether,

iii. methyl chloride is treated with KCN?

28. Depict the galvanic cell in which the reaction: **[3]**

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

takes place. Further show:

i. Which of the electrodes is negatively charged?

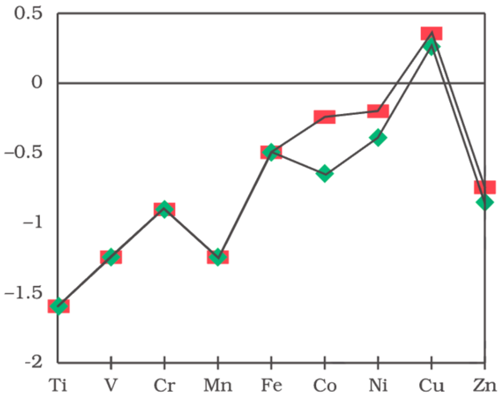
ii. The carries of current in the cell.

iii. Individual reaction at each electrode.

Section D

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

OR

Transition metals, despite high E° oxidation, are poor reducing agents. Justify.

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

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

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°C 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) Which of the two components of starch is water soluble? **[1]**

(ii) What is the information given by primary structure of proteins? **[1]**

(iii) Name the deficiency disease resulting from lack of vitamin A and E in the diet. **[1]**

(iv) What are the products of hydrolysis of sucrose? **[1]**

(v) Name the sugar present in milk. How many monosaccharide units are present in it? What are such oligosaccharides called? **[1]**

(vi) What is the difference between a glycosidic linkage and a peptide linkage? **[1]**

(vii) Give one example of each- Monosaccharide, disaccharide and polysaccharide. **[1]**

32. Draw the structures of optical isomers of: **[5]**

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

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

iii. $[Cr(NH_3)_2Cl_2(en)]^+$

OR

Explain on the basis of valence bond theory that $[Ni(CN)_4]^{2-}$ ion with square planar structure is diamagnetic and the $[NiCl_4]^{2-}$ ion with tetrahedral geometry is paramagnetic.

33. A. For the following conversion reactions write the chemical equations: **[5]**

i. Ethyl isocyanide to ethylamine
ii. Aniline to N-phenylethanamide

B. Two isomeric compounds A and B having molecular formula $C_4H_{11}N$, both lose N_2 on treatment with HNO_2 and gives compound C and D, respectively. C is resistant to oxidation but immediately responds to Lucas reagent, whereas 'D' responds to Lucas reagent after 5 minutes and gives a positive iodoform test. Identify A and B.

OR

a. Give reasons for the following :

i. Acetylation of aniline reduces its activation effect.
ii. CH_3NH_2 is more basic than $C_6H_5NH_2$.
iii. Although $-NH_2$ is o/p-directing group, yet aniline on nitration gives a significant amount of m-nitroaniline.

b. Explain the following reactions:

i. Coupling reaction
ii. Gabriel phthalimide reaction

Solution

Section A

1. **(a)** $SOCl_2$ in presence of pyridine

   Explanation: The hydroxyl group of an alcohol is replaced by halogen on reaction with concentrated halogen acids, phosphorus halides, or thionyl chloride. Thionyl chloride ($SOCl_2$) is preferred because the other two products SO_2 and HCl are escapable gases. Hence, the reaction gives pure alkyl halides.

   $ROH + SOCl_2 \rightarrow RCl + SO_2\,(g) + HCl\,(g)$

2. **(a)** $H_2N.CH_2.COOH$

   Explanation: Amino acids contain amino ($–NH_2$) and carboxyl (–COOH) functional groups.

3.

   (d) All of these

   Explanation:

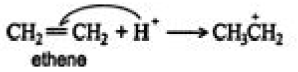
   The addition of water to an alkene in the presence of a catalytic amount of strong acid leads to the formation of alcohols (hydroxy-alkanes).

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

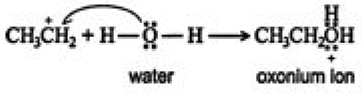
   This reaction proceeds via a standard carbocation mechanism and follows the Markovnikov rule.

   The mechanism for the addition of water to ethene follows.

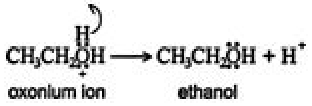
   1. The hydrogen ion is attracted to the π bond, which breaks to form a σ bond with one of the double-bonded carbons. The second carbon of the original double-bonded carbons becomes a carbocation.

   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.

4.

   (b) $(CH_3)_2C(OC_2H_5)(OC_2H_5)$

   Explanation: Ketones or aldehydes react with alcohols to form acetals. This reaction of alcohol on aldehydes or ketones is catalyzed in the presence of acid and is a reversible reaction. Firstly a hemiacetal $(CH_3)_2C(OH)(OC_2H_5)$ is formed which further reacts with alcohol to give acetal.

   $(CH_3)_2C(OC_2H_5)(OC_2H_5)$ $CH_3COCH_3 + 2C_2H_5OH \overset{H^+}{\rightleftarrows} (CH_3)_2C(OC_2H_5)(OC_2H_5)$

5.

   (b) Acid catalysed hydrolysis of ethyl acetate

   Explanation: In acid catalysed the hydrolysis of ethyl acetate the water is in excess so it is pseudo 1st order reaction, as the does not change.

6.

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

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

7.

(b) Ethyl bromide + alcoholic KCN

Explanation: $CH_3CH_2Br + KCN \rightarrow CH_3CH_2CN + KBr$

8.

(b) Mn_2O_7

Explanation: $2KMnO_4 + 2H_2SO_4(\text{Conc}) \longrightarrow Mn_2O_7 + 2KHSO_4 + H_2O$

9. **(a)** In photography

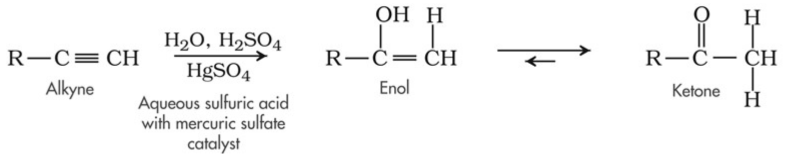
Explanation: Photography is an example of photochemistry used in our daily life. Reaction takes place in the presence of light

10.

(b) $PhCOCH_2CH_3$

Explanation: Hydration of given alkyne will occur according to Markovnikoff's rule leading to the formation of enol which will tautomerise to give keto form.

The general reaction of alkyne hydrations shown below:



Same reaction will occur with

$$PhC \equiv CMe \xrightarrow{H_3O^+, Hg^{2+}} ?\ PhC(OH) = CHCH_3 \Leftrightarrow PhCOCH_2CH_3 \ .$$

11. **(a)** 1

Explanation: A chiral molecule is one that is not superimposable on its mirror image.

2-Butanol is a small molecule with a chirality center. It is the simplest alcohol containing an asymmetric carbon. For a better illustration, the four different substituents are shown in different colours.

Carbon atom C-2 of 2-butanol carries four different substituents H, CH_3, OH, and CH_2CH_3. Exchange of any two of these substituents would yield the opposite enantiomer. However, such an exchange does not occur spontaneously because it requires a bond breakage. Therefore, enantiomers are different, stable, coexisting compounds.

12.

(b) 2 – pentanamine

Explanation: 2-pentamine will have a chiral centre, therefore it can be resolved into enantiomers.

$CH_3CH_2CH_2C^*HCH_3NH_2$

The C* in 2-pentan amine is the chiral center.

13.

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

Explanation: Enamel is the hardest substance in the human body and contains the highest percentage of minerals, with water and organic material composing the rest. The primary mineral is hydroxyapatite, which is crystalline calcium phosphate. Magnesium is not present in human enamel. However, magnesium is an essential mineral for human health. Magnesium is a cofactor for more than 300 enzyme systems and is involved in both aerobic and anaerobic energy generation and in glycolysis, either directly as an enzyme activator or as part of the magnesium-ATP complex. Magnesium is required for mitochondria to carry out oxidative phosphorylation. It plays a role in regulating potassium fluxes and in the metabolism of calcium.

14. **(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.

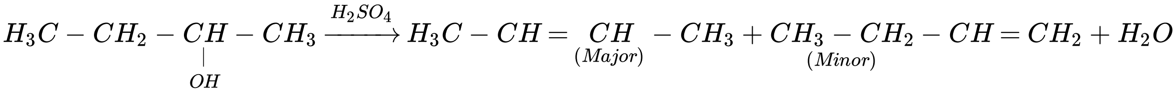
15.

(c) A is true but R is false.

Explanation: For the same alkyl group, the boiling point of haloalkanes decreases in the order RI > RBr > RCl > RF. This is due to the increase in van der Waals forces when the size and mass of the halogen atom increases. For isomeric haloalkanes, the boiling point decrease with an increase in branching.

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

Explanation: Saytzeff's rule: The alkene formed in the greatest amount is the one that corresponds to the removal of the hydrogen from the β-carbon having the fewest hydrogen substituent. In the case of 2^o and 3^o alcohols, Saytzeff's rule is followed.

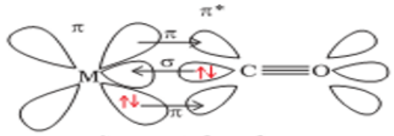


$$H_3C-CH_2-\underset{\underset{OH}{|}}{CH}-CH_3 \xrightarrow{H_2SO_4} H_3C-CH=\underset{(Major)}{CH}-CH_3+\underset{(Minor)}{CH_3-CH_2-CH=CH_2}+H_2O$$

Section B

17. Electronic configuration of Co: $[Ar]4s^2 3d^7$

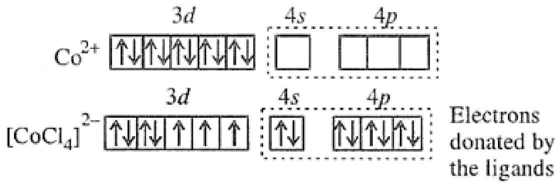
Electronic configuration of Co^{2+} : $[Ar]4s^0 3d^7$



Synergic bonding

Cl^- Cl⁻ does not cause pairing of electrons because it is weak field ligand.

Hence,



18. a. Fe has higher melting point than Cu. This is because Fe ($3d^6 4s^2$) has four unpaired electrons in 3d-subshell while Cu ($3d^{10}4s^1$) has only one electron in the 4s-subshell. Hence, metallic bonds in Fe are much stronger than those in Cu.

b. Co^{2+} has a configuration as $[Ar]3d^7$, thus, Co^{2+} has 3 unpaired electron in d orbital while Ni^{2+} has a configuration as $[Ar]3d^8$, Ni^{2+} has 2 unpaired electron. Thus, Ni^{2+} has lower magnetic moment than Co^{2+}.

19. Answer the following:

(i) The slope value obtained in the plot of $\frac{log[R_o]}{[R_o]}$ Vs. time for a first-order reaction is $\frac{k}{2.303}$.

(ii) It is first order with respect to N_2O_5.

20. In pure alcohol and water, the molecules are held tightly by a strong hydrogen bonding. The interaction between the molecules of alcohol and water is weaker than alcohol-alcohol and water-water interactions. As a result, when alcohol and water are mixed, the inter-molecular interactions become weaker and the molecules can easily escape. This increases the vapour pressure of the solution, which in turn lowers the boiling point of the resulting solution.

OR

The various quantities known to us are as follows:

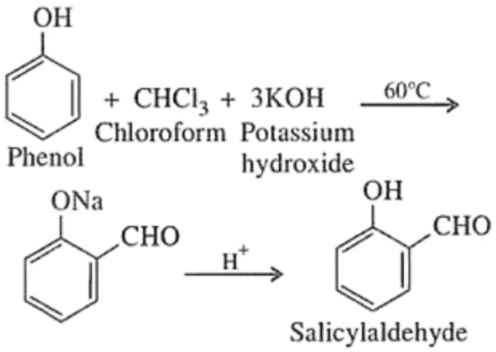
$p_1^0 = 0.850$ bar; $p = 0.845$ bar; $M_1 = 78g\ mol^{-1}$; $w_2 = 0.5$ g; $w_1 = 39$ g

Substituting these values in equation of relative lowering of vapour pressure, we get

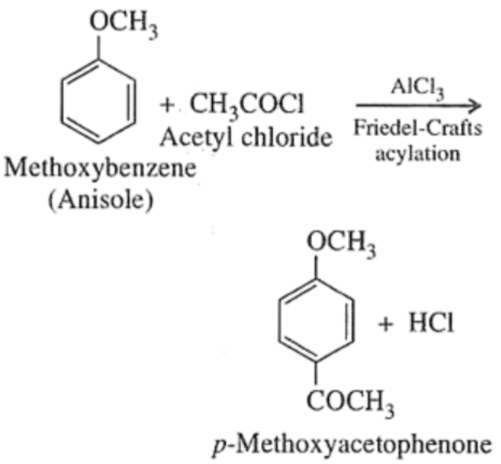
$$\frac{0.850\text{ bar} - 0.845\text{ bar}}{0.850\text{ bar}} = \frac{0.5g \times 78gmol^{-1}}{M_2 \times 39g}$$

Therefore, $M_2 = 170\ g\ mol^{-1}$

21. i.



ii.



Section C

22. i. **Oxidation half cell reaction;** Ni(s) $\rightarrow$ Ni^{2+} (aq) + $2e^-$ (**At anode**)

Reduction half cell reaction; $2Ag^+$(aq) + $2e^-$ $\rightarrow$ + 2Ag(s) (**At cathode**)

Overall cell reaction; Ni (s) + $2Ag^+$ (aq)$\rightarrow$ Ni^{2+} (aq) + 2Ag (s); Therefore, $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$ = +0.80 V - (-0.25 V) = 1.05 V

ii. By applying Nernst equation, we have;

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

$= E^\circ_{\text{cell}} - \frac{0.0591}{2}\log\frac{(0.1)}{(1)^2}$

$= 1.05 - \frac{0.0591}{2} \times (-1)$

= 1.05 + 0.0295 = 1.0795 V.

23. i. $R_{av} = -\frac{\Delta[Ester]}{\Delta t} = -\frac{(0.17-0.31)}{60-30}$

$= 4.67 \times 10^{-3}\ s^{-1}$

ii. At t = 30 s, [R]=0.31 M, $[R]_0$=0.55 M

$k = \frac{2.303}{t}\log\frac{[R]_0}{[R]} = \frac{2.303}{30}\log\left(\frac{0.55}{0.31}\right)$

$k = \frac{2.303}{30}\log(1.774) = \frac{2.303}{30} \times 0.2490$

$k = 1.91 \times 10^{-2} s^{-1}$

At t = 60 s, [R] = 0.17 M

$k = \frac{2.303}{60}\log\left(\frac{0.55}{0.17}\right) = \frac{2.303}{60} \times 0.5099$

$= 1.96 \times 10^{-2} s^{-1}$

At t = 90 s, [R] = 0.085 M

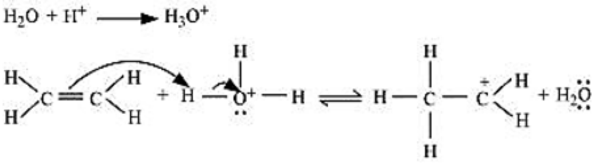
$k = \frac{2.303}{90}\log\left(\frac{0.55}{0.085}\right) = \frac{2.303}{90} \times (0.8109)$

$k = 2.07 \times 10^{-2} s^{-1}$

24. The mechanism of hydration of ethene to form ethanol involves three steps.

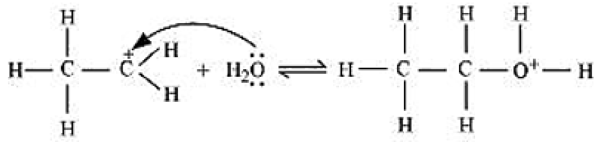
Step 1:

Protonation of ethene to form carbocation by electrophilic attack of H_3O^+:



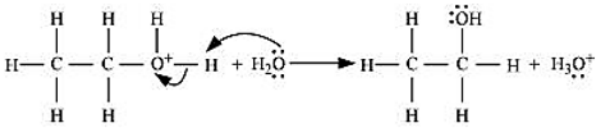
Step 2:

Nucleophilic attack of water on carbocation:



Step 3:

Deprotonation to form ethanol:



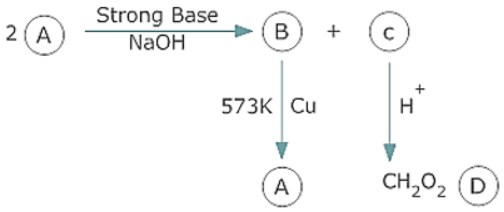
OR

i. 2-Chloropropane to 1-propanol
  - a. alc. KOH heat,
  - b. HBr peroxide
  - c. alc. KOH, heat

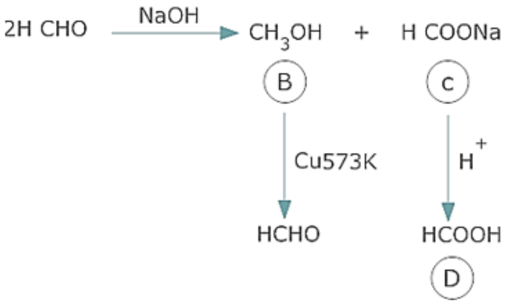
ii. Isopropyl alcohol to iodoform
  I_2/NaOH heat

iii. Chlorobenzene to p-nitrophenol
  - a. Conc. HNO_{3+} conc. H_2SO_4
  - b. aq NaOH (15%), 433 K (c) dil. HCl

25.



Since (D) is a carboxylic acid with one carbon only, it is HCOOH. As it is obtained from (C) acidification, (C) COONa and (A) is HCHO which on treatment with strong base (NaOH) gives CH_3OH & HCOONa. This is Cannizzaro reaction in which formaldehyde undergoes self oxidation and reduction(disproportion) on treatment with concentrated alkali. The reactions are as follows:-



26. **At anode:** $2Fe(s) \rightarrow 2Fe^{2+} + 4e^-$

$E^0(_{Fe^{2+}/\ Fe})$ = -0.44 V

Cathode: $O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$; E^0cell (H^+O_2/H_2O) = 1.23V

The overall reaction being:

$2Fe(s) + O_2(g) + 4H^+(aq) \rightarrow 2Fe^{2+}(aq) + 2H_2O(l)$; E^0cell = 1.67V

The ferrous ions are further oxidized by atmosphere oxygen to ferric ions which came out as rust in the form of hydrated ferric oxide ($Fe_2O_3.nH_2O$)

The method to prevent rusting of iron is by Barrier protection.

27. i. When ethyl chloride is treated with aqueous KOH, it undergoes hydrolysis to form ethanol and KCl.

$$\underset{Ethyl\ chloride}{CH_3 - CH_2 - Cl} \xrightarrow[(Hydrolysis)]{KOH_{(aq)}} \underset{Ethanol}{CH_3 - CH_2 - OH} + KCl$$

ii. When methyl bromide is treated with sodium in the presence of dry ether, ethane and NaBr is formed. This reaction is known as the Wurtz reaction.

$$\underset{Methyl\ bromide}{2CH_3 - Br} + 2Na \xrightarrow[(wurtz\ reaction)]{Dry\ ether} \underset{Ethane}{CH_3 - CH_3} + 2NaBr$$

iii. When methyl chloride is treated with KCN, it undergoes a nucleophilic substitution reaction to give methyl cyanide and KCl.

$$\underset{Methyl\ chloride}{CH_3-Cl} + KCN \xrightarrow[\text{nucleophilic substitution}]{} \underset{Methyl\ cyanide}{CH_3-CN} + KCl$$

28. We have,

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

At Cathode (Reduction):

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

At Anode (Oxidation):

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

The cell will be represented as:

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

i. From half cell reaction, Zinc acts as Anode, i.e. zinc electrode will be negatively charged.

ii. The current will flow from silver to zinc in the external circuit and inside the solution, ions are responsible as shown in the half cell reaction. Zn^{2+} is formed in the anode container and goes to the solution and in the cathode container, Ag^{+} goes from solution to the silver metal(cathode) and gets deposited. To maintain the concentration of ions in both the containers, salt bridge is used which contain an electrolyte i.e. KCl.

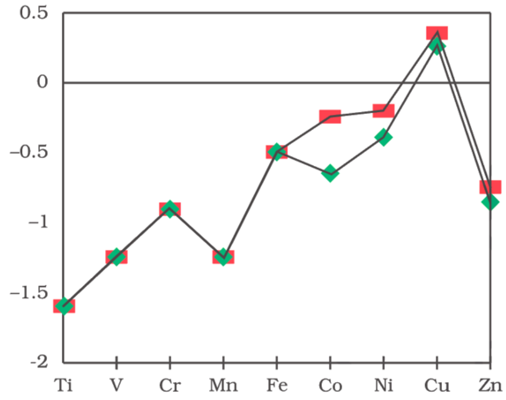
iii. At anode : $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^{-}$

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

Section D

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

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) Due to the removal of an electron from the stable d^{10} configuration of Zn^{2+}.

OR

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.

(ii) 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.

(iii)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. **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°C 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) A starch has two components: amylose and amylopectin. Amylose is water soluble.

(ii) Primary structure of proteins tells about the sequence in which various amino acids are linked with each other.

(iii)Deficiency of A cause Xerophthalmia and E causes muscular weakness.

(iv)Sucrose on dydrolysis gives equimolar mixture of D-glucose and D-fructose.

$$\underset{Sucrose}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{H^+} \underset{Glu\cos e}{C_6H_{12}O_6} + \underset{Fructose}{C_6H_{12}O_6}$$

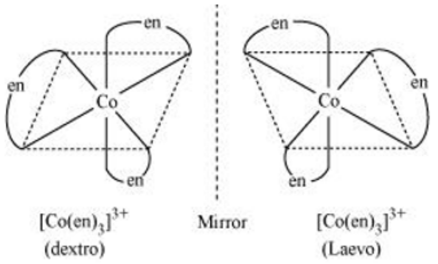
(v) Lactose is present in milk as sugar. Two monosaccharide units (i.e., glucose and galactose) are present in it. Such oligosaccharides are called disaccharides.

(vi)**Glycosidic linkage:** It is the linkage which joins two monosaccharides through oxygen atom. It is present in carbohydrates.

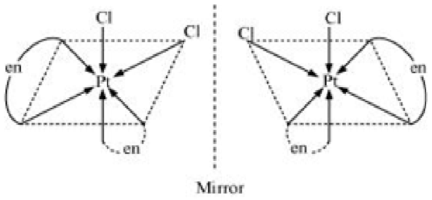
Peptide Linkage: It is the linkage which joins two amino acids through - CO-NH- bond. It is present in proteins.

(vii)Monosaccharide - Glucose, Fructose etc.
Disaccharide - Sucrose, maltose etc.
Polysaccharide - Cellulose, starch etc.

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



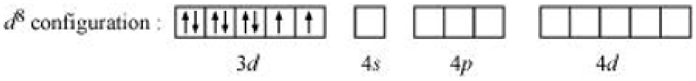
ii. $[PtCl_2(en)_2]^{2+}$



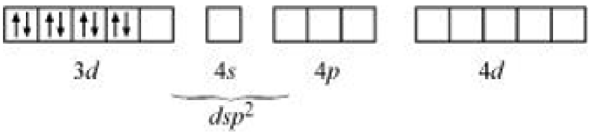
iii. $[Cr(NH_3)_2Cl_2(en)]^+$

OR

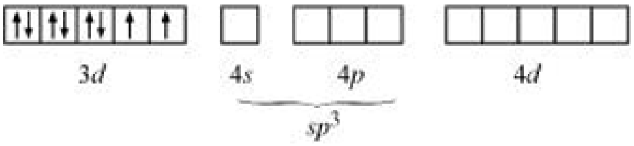
Ni is in the +2 oxidation state i.e., in d^8 configuration.



There are 4 CN^- ions. Thus, it can either have a tetrahedral geometry or square planar geometry. Since CN^- ion is a strong field ligand, it causes the pairing of unpaired 3d electrons.



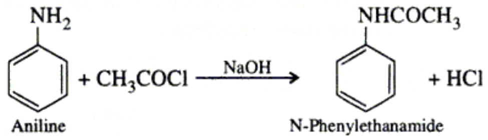
It now undergoes dsp^2 hybridization. Since all electrons are paired, it is diamagnetic. In case of $[NiCl_4]^{2-}$, CN^- ion is a weak field ligand. Therefore, it does not lead to the pairing of unpaired 3d electrons. Therefore, it undergoes sp^3 hybridization.



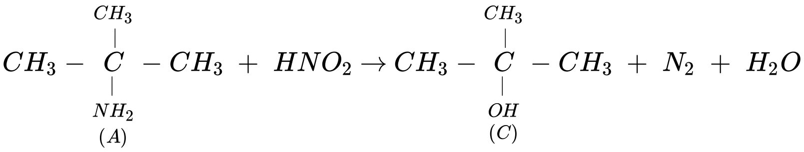
Since there are 2 unpaired electrons in this case, it is paramagnetic in nature.

33. A. i. $\underset{Ethyl\ isocyanide}{C_2H_5N\equiv C} + 2H_2O \xrightarrow{H^+} \underset{Ethyl\ amine}{C_2H_5NH_2} + \underset{Methanoic\ acid}{HCOOH}$

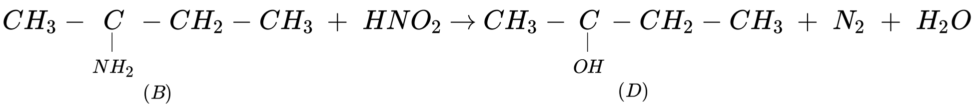
ii.



B. The following reactions lead to the identification of A and B:

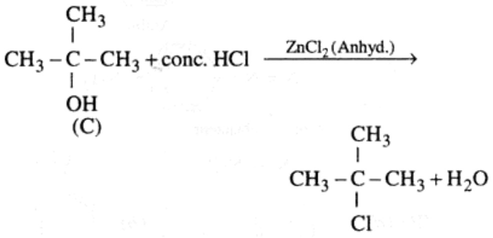


$$\underset{(A)}{CH_3-\overset{CH_3}{\underset{NH_2}{C}}-CH_3} + HNO_2 \rightarrow \underset{(C)}{CH_3-\overset{CH_3}{\underset{OH}{C}}-CH_3} + N_2 + H_2O$$



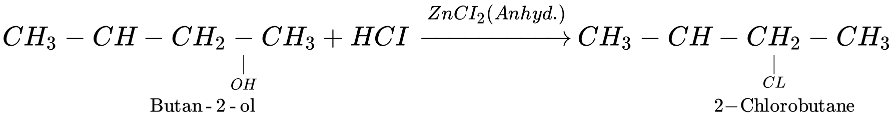
$$\underset{(B)}{CH_3-\underset{NH_2}{C}-CH_2-CH_3} + HNO_2 \rightarrow \underset{(D)}{CH_3-\underset{OH}{C}-CH_2-CH_3} + N_2 + H_2O$$

C.

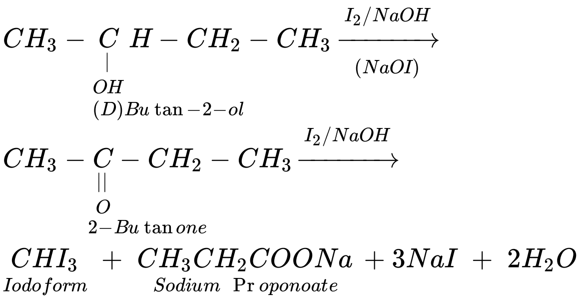


$$\underset{(C)}{CH_3-\overset{CH_3}{\underset{OH}{C}}-CH_3} + \text{conc. HCl} \xrightarrow{ZnCl_2\text{ (Anhyd.)}} CH_3-\overset{CH_3}{\underset{Cl}{C}}-CH_3 + H_2O$$

‘C’ is resistant to oxidation because tertiary alcohols do not undergo oxidation. It gives turbidity immediately with Lucas reagent. ‘D’ responds to Lucas reagent within 5 minutes because it is secondary alcohol and turbidity appears after 5 minutes.



$$\underset{\text{Butan-2-ol}}{CH_3-\underset{OH}{CH}-CH_2-CH_3} + HCI \xrightarrow{ZnCI_2(Anhyd.)} \underset{\text{2−Chlorobutane}}{CH_3-\underset{CL}{CH}-CH_2-CH_3}$$



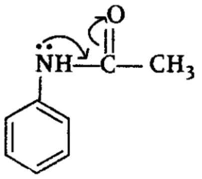
$$\underset{(D)Butan-2-ol}{CH_3-\underset{OH}{C}H-CH_2-CH_3} \xrightarrow[(NaOI)]{I_2/NaOH}$$

$$\underset{2-Butanone}{CH_3-\underset{O}{\underset{||}{C}}-CH_2-CH_3} \xrightarrow{I_2/NaOH}$$

$$\underset{Iodoform}{CHI_3} + \underset{Sodium\ Proponoate}{CH_3CH_2COONa} + 3NaI + 2H_2O$$

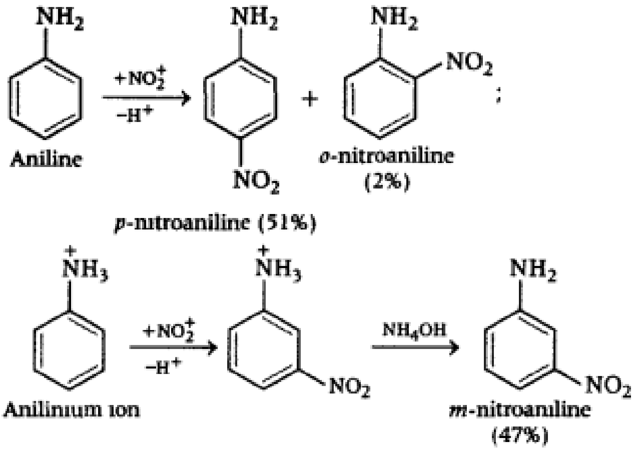
OR

a. i. Due to the electron-withdrawing effect of the acetyl group, the lone pair of electrons on N-atom is attracted by the acetyl group. As a result, the lone pair of electrons on N-atom is not exclusively available for donation to the benzene ring and hence, activating the effect of the - NH_2 group is reduced.

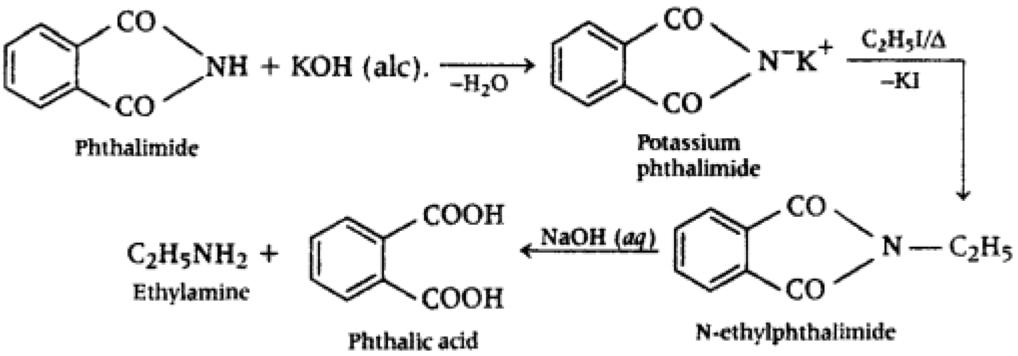


ii. In aromatic amines, the lone pair of electrons present on nitrogen takes part in resonance and hence, not available for donation. Alsoaniline is more stable than anilinium ion. Hence aniline has a very little tendency to accept a proton to form anilinium ion. However, in aliphatic amines, the lone pair is easily available for donation. That's why aliphatic amines are more basic than aromatic amines.

iii. Nitration is usually carried out with a mixture of conc. HNO_3 and cone. H_2SO_4. So in the presence of these acids, aniline gets protonated to form anilinium ion. Therefore, the reaction mixture consists of aniline + and anilinium ion. $-NH_2$ group in aniline is o,p-directing and activating, whereas the $\overset{+}{NH_3}$ group in anilinium ism-directing and deactivating. Now, nitration of aniline mainly gives p-nitroaniline due to steric hindrance at a-position and the nitration of anilinium ion gives m-nitroaniline.



b. i. Gabriel phthalimide reaction Phthalimide on treatment with ethanolic KOHgives potassium phthalimide which on heating with a suitable alkyl halide gives N-substituted phthalimide, which upon subsequent hydrolysis with alkali gives primary amines.



This reaction is called Gabriel phthalimide reaction.

ii. Coupling reaction Arenediazonium salts react with highly reactive (i.e. electron-rich) aromatic compounds such as aniline, phenols to form brightly coloured azo compounds, Ar-N = N-Ar. This reaction is called a coupling reaction. e.g. Benzene diazonium chloride reacts with aniline in faintly acidic medium (pH 4- 5) at 273·278K, in which the molecule at its para-position is coupled with the diazonium salt to form p-aminoazobenzene.

This is an example of a coupling reaction.