CBSE EXAMINATION PAPER-2022

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 44

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **17 questions.** All questions are **compulsory.**

ii. This question paper is divided into **3 sections.**

iii. **Section A** – questions number **1 to 2** are case based questions

iv. **Section B** – questions number **3 to 4** are short answer

v. **Section C** – questions number **5 to 17** are long answer

vi. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

vii. Use of calculator is NOT allowed.

Section A

Question 1. Amines constitute an important class of organic compounds derived by replacing one or more hydrogen atoms of ammonia molecule by alkyl/aryl groups. Amines are usually formed from nitro compounds, halides, amides, etc. They exhibit hydrogen bonding which influences their physical properties. Alkyl amines are found to be stronger bases than ammonia. In aromatic amines, electron releasing and withdrawing groups, respectively increase and decrease their basic character. Reactions of amines are governed by availability of the unshared pair of electrons on nitrogen. Influence of the number of hydrogen atoms at nitrogen atom on the type of reactions and nature of products is responsible for identification and distinction between primary, secondary and tertiary amines. Reactivity of aromatic amines can be controlled by acylation process.

Question 2.

Read the following passage and answer the questions that follow :

Amines constitute an important class of organic compounds derived by replacing one or more hydrogen atoms of ammonia molecule by alkyl/aryl groups. Amines are usually formed from nitro compounds, halides, amides, etc. They exhibit hydrogen bonding which influences their physical properties. Alkyl amines are found to be stronger bases than ammonia. In aromatic amines, electron releasing and withdrawing groups, respectively increase and decrease their basic character. Reactions of amines are governed by availability of the unshared pair of electrons on nitrogen. Influence of the number of hydrogen atoms at nitrogen atom on the type of reactions and nature of products is responsible for identification and distinction between primary, secondary and tertiary amines. Reactivity of aromatic amines can be controlled by acylation process.

(1)

Why does aniline not give Friedel-Crafts reaction ?

[1 Marks]

Answer: Aniline does not give Friedel-Crafts reaction because it reacts with the Lewis acid catalyst aluminium chloride to form a salt. This makes the nitrogen positively charged, which deactivates the ring and prevents further reaction. Thus, aniline's unshared electron pair on nitrogen is unavailable for Friedel-Crafts reaction as stated in the passage.

Key Points: Aniline forms salt with AlCl3 - Nitrogen becomes positively charged - Positive charge deactivates aromatic ring for Friedel-Crafts

(2)

Arrange the following in the increasing order of their pKb values :

$C_6H_5NH_2$, NH_3, $C_2H_5NH_2$, $(CH_3)_3N$

[1 Marks]

Answer: The increasing order of pKb values is (CH3)3N < C2H5NH2 < NH3 < C6H5NH2. Alkyl amines like (CH3)3N and C2H5NH2 are stronger bases (lower pKb) than NH3 because alkyl groups release electrons, increasing basicity. Aromatic amine C6H5NH2 has the highest pKb because the phenyl group withdraws electrons, decreasing basic strength as mentioned in the passage.

Key Points: Alkyl amines have lower pKb (stronger bases) than ammonia - Aromatic amines have higher pKb due to electron withdrawing phenyl group - Basicity depends on availability of nitrogen's lone pair electrons

(3)

How can you distinguish between $CH_3CH_2NH_2$ and $(CH_3CH_2)_2NH$ by Hinsberg test ?

[1 Marks]

Answer: By Hinsberg test, $CH_3CH_2NH_2$ (primary amine) reacts with Hinsberg reagent to form a soluble sulfonamide which is soluble in alkali, while $(CH_3CH_2)_2NH$ (secondary amine) forms an insoluble sulfonamide precipitate, distinguishing the two clearly, as the test depends on the number of hydrogen atoms on nitrogen as explained in the passage.

Key Points: Primary amine reacts with Hinsberg reagent to form soluble sulfonamide - Secondary amine forms insoluble sulfonamide precipitate - Distinction depends on number of hydrogen atoms on nitrogen

(4)

How will you convert the following :

(i) Benzoic acid to aniline

(ii)Aniline to p-bromoaniline

[2 Marks]

Answer: (i) Convert benzoic acid to benzamide by reaction with ammonia, then heat benzamide with bromine and sodium hydroxide to get aniline through Hofmann bromamide reaction.
(ii) Treat aniline with bromine water at room temperature to get p-bromoaniline directly due to the activating effect of amino group, as explained in the passage about reactions governed by availability of unshared electrons on nitrogen. This substitution occurs mainly at para position because of resonance effect.

Key Points: Benzoic acid to benzamide to aniline via Hofmann bromamide reaction - Aniline reacts with bromine water to form p-bromoaniline - Amino group activates benzene ring directing bromination at para position

(5)

Write the structures of A and B in the following reactions :

[2 Marks]

Answer: Structure A is a primary amine having one alkyl group attached to nitrogen along with two hydrogen atoms ($R\text{-}NH_2$).
Structure B is a tertiary amine where nitrogen is attached to three alkyl groups and no hydrogen atoms (R_3N).
According to the passage, amines are formed by replacing hydrogen atoms of ammonia with alkyl/aryl groups, and the number of hydrogens on nitrogen helps distinguish primary, secondary and tertiary amines.

Key Points: A is a primary amine with one alkyl group and two hydrogens - B is a tertiary amine with three alkyl groups and no hydrogens - Number of hydrogens on nitrogen differentiates primary, secondary, tertiary amines

Section B

Question 3.

In the given reaction

($N2(g) + 3H_2(g) \rightarrow 2NH_3(g)$,

the rate of formation of NH3 is $3{\cdot}6 \times 10^{-4}$ mol L^{-1} s^{-1} . calculate the

(i) rate of reaction and (1)

(ii) rate of disappearance of $H_2(g)$.(1)

[2 Marks]

Answer: (i) The balanced chemical reaction is: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$.
The rate of reaction is defined based on the change in concentration of reactants or products per unit time, divided by their stoichiometric coefficients.
Given, rate of formation of $NH_3 = 3.6 \times 10^{-4}$ mol L^{-1} s^{-1}.
From the equation, 2 moles of NH_3 are formed for every 1 mole of N_2 reacted.
Therefore, rate of reaction = (1/2) * rate of formation of NH_3 = (1/2) * 3.6×10^{-4} = 1.8×10^{-4} mol L^{-1} s^{-1}.

(ii) Rate of disappearance of H_2:
The stoichiometric ratio of H_2 to NH_3 is 3:2.
So, rate of disappearance of H_2 = 3/2 * rate of formation of NH_3 = 3/2 * 3.6×10^{-4} = 5.4×10^{-4} mol L^{-1} s^{-1}.

> **Key Points: Balanced chemical equation - Rate of reaction formula with stoichiometric coefficients - Calculation of rate of disappearance of H2 using stoichiometric ratio**

Question 4.

(i) State Kohlrausch' law of law of independent migration of ions.

(ii)Calculate the degree of dissociation (α) of CH_3COOH if Λ_m and Λ°_m of CH_3 COOH) are 48 S cm^2 mol^{-1} and 400 S cm^2 mol^{-1} respectively.

[3 Marks]

Answer: (i) **Kohlrausch' law of independent migration of ions** states that the molar conductivity at infinite dilution of an electrolyte is equal to the sum of the molar ionic conductivities of its constituent ions. In other words, each ion contributes independently to the total conductivity.

(ii) Given:
Molar conductivity at concentration (Λ_m) = 48 S cm² mol^{-1}
Molar conductivity at infinite dilution (Λ°_m) = 400 S cm² mol^{-1}

Degree of dissociation (α) is given by:
$\alpha = \Lambda_m / \Lambda^\circ_m$
Thus,
$\alpha = 48 / 400 = 0.12$

Therefore, the degree of dissociation of CH_3COOH is 0.12 or 12%.

Key Points: Kohlrausch law states molar conductivity at infinite dilution equals sum of ionic conductivities - Degree of dissociation is ratio of molar conductivity to molar conductivity at infinite dilution - $\alpha = \Lambda_m / \Lambda^\circ_m$

Section C

Question 5.

Write the hybridisation and magnetic character of the following complexes :

(i) $[NiCl4]^{2-}$

(ii)$[Co(NH_3)_6]^{3+}$

(iii)[FeF6] $^{3-}$

[Atomic number : Ni = 28, Co = 27, Fe = 26]

[3 Marks]

Answer: (a) **[NiCl4] 2- complex:** Ni has atomic number 28 and its electronic configuration is [Ar] 3d8 4s2. In [NiCl4] 2-, Ni is in +2 oxidation state with configuration 3d8. Chloride (Cl-) is a weak field ligand and does not cause pairing of electrons. Hence, the complex is tetrahedral with sp3 hybridisation. It is paramagnetic due to presence of two unpaired electrons.

(b) **[Co(NH3)6] 3+ complex:** Co atomic number is 27, electronic configuration is [Ar] 3d7 4s2. In +3 oxidation state it is 3d6. NH3 is a strong field ligand, causing pairing of electrons in the d orbitals. The complex has octahedral geometry with d2sp3 hybridisation (inner orbital complex). It is diamagnetic as all electrons are paired.

(c) **[FeF6] 3- complex:** Fe atomic number 26, in +3 oxidation state electronic configuration is 3d5.

Fluoride (F-) is a weak field ligand and does not cause pairing of electrons. The complex is octahedral and involves sp3d2 hybridisation (outer orbital complex). It is paramagnetic with five unpaired electrons due to weak ligand field.

Key Points: [NiCl4] 2- is tetrahedral sp3 and paramagnetic - [Co(NH3)6] 3+ is octahedral d2sp3 and diamagnetic - [FeF6] 3- is octahedral sp3d2 and paramagnetic

Question 6.

(i) Write the IUPAC name of the following complex : $[Co(NH_3)_4(H_2O)Cl]Cl_2$. (1)

(ii) What is the difference between an Ambidentate ligand and a Bidentate ligand ?(1)

(ii) Out of $[Fe(NH_3)_6]^{3+}$ and $[Fe(C_2O_4)_3]^{3-}$, which complex is more stable and why ?(1)

[3 Marks]

Answer: (a) The IUPAC name of the complex $[Co(NH_3)_4(H_2O)Cl]Cl_2$ is **Tetraaquamonochlorocobalt(III) chloride**. Explanation: The complex has 4 ammonia (ammine) ligands, 1 water (aqua) ligand, and 1 chloride ligand bonded to cobalt which is in the +3 oxidation state. The remaining 2 chloride ions are counter ions.
(b) Difference between Ambidentate and Bidentate ligands:
Ambidentate ligand can coordinate to the metal through either of two different atoms but only one atom binds at a time. For example, the thiocyanate ion (SCN−) can bind through sulfur or nitrogen.
Bidentate ligand has two donor atoms that simultaneously coordinate to the metal ion forming a ring structure. Example is ethylenediamine (en).
(c) The complex $[Fe(C_2O_4)_3]$ □⁻ is more stable than $[Fe(NH_3)_6]$ □⁺ because C_2O_4− (oxalate ion) is a bidentate ligand forming chelate rings which increase the stability of the complex due to the chelate effect, while NH_3 is a monodentate ligand. Hence, the presence of chelating ligands makes $[Fe(C_2O_4)_3]$ □⁻ more stable.

Key Points: IUPAC name of [Co(NH3)4(H2O)Cl]Cl2 - Ambidentate ligand binds through one of two atoms - Bidentate ligand binds through two atoms simultaneously - Chelate effect increases stability of complexes with bidentate ligands - [Fe(C2O4)3]3- more stable than [Fe(NH3)6]3+

Question 7.

Calculate the emf of the following cell :

$Zn\ (s)|Zn^{2+}\ (0{\cdot}01\ M)\ ||\ (0{\cdot}001\ M)\ Ag^{+}\ |Ag\ (s)$

Given : $E^{\Theta}\ Zn^{2+}/Zn = -\ 0{\cdot}76$ V and

$E^{\Theta}\ Ag^{+}/Ag = +\ 0{\cdot}80$ V

[log 2 = 0·3010, log 3 = 0·4771, log 10 = 1]

[3 Marks]

Answer: Step 1: Determine the standard emf of the cell (E_{cell}^{o}).

Zn/Zn^{2+} is the anode (oxidation), $E_{Zn}^{o} = -0.76$ V

Ag^{+}/Ag is the cathode (reduction), $E_{Ag}^{o} = +0.80$ V

So, $E_{cell}^{o} = E_{cathode}^{o} - E_{anode}^{o} = 0.80\ V - (-0.76\ V) = 1.56$ V

Step 2: Write the Nernst equation for the cell:

$E_{cell} = E_{cell}^{o} - (0.059/2) * \log(< [Zn^{2+}]$ anode side / $[Ag^{+}]^{2}$ cathode side $>)$

Since the reaction is $Zn\ (s) + 2Ag^{+}\ (aq) \rightarrow Zn^{2+}\ (aq) + 2Ag\ (s)$, n = 2 electrons.

Step 3: Substitute the given values:

$[Zn^{2+}] = 0.01$ M, $[Ag^{+}] = 0.001$ M

Calculate reaction quotient $Q = [Zn^{2+}] / [Ag^{+}]^{2} = 0.01 / (0.001)^{2} = 0.01 / 0.000001 = 10,000$

Step 4: Calculate log Q:

$\log 10,000 = \log(10^{4}) = 4 * \log 10 = 4 * 1 = 4$

Step 5: Calculate emf using Nernst equation:

$E_{cell} = 1.56\ V - (0.059 / 2) * 4 = 1.56\ V - 0.118 * 2 = 1.56\ V - 0.236 = 1.324$ V

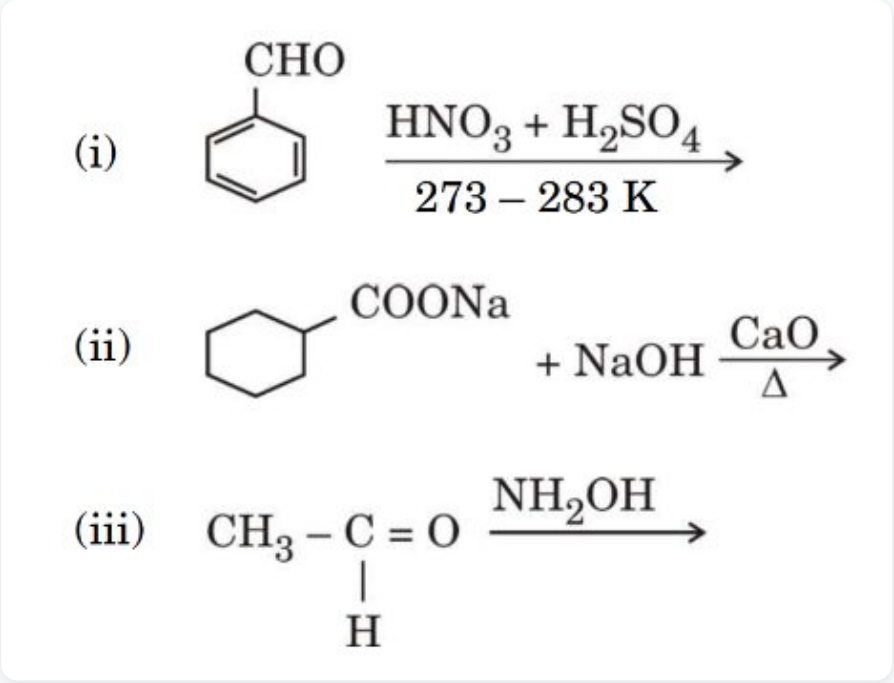
Answer: The emf of the cell under the given concentrations is 1.324 V.

Key Points: Identify anode and cathode - Calculate standard emf using standard reduction potentials - Use Nernst equation to calculate emf under non-standard conditions - Calculate reaction quotient Q - Substitute values and calculate log Q - Calculate final emf value

Question 8.

Write the major products in the following :

[3 Marks]



Answer: (a) Mononitration of 3-methylphenol: 3-methylphenol has an -OH group and a methyl group attached to the benzene ring. The -OH group is an activating and ortho/para directing group, while the methyl group is a weakly activating and also ortho/para directing group. During mononitration, the nitro group (-NO2) mainly substitutes at the position ortho to the -OH group, which is also meta to the methyl group, because the -OH group activation is stronger. Therefore, the major product is 2-nitro-3-methylphenol. Minor products at other ortho/para positions may also form but are less significant.

(b) Dinitration of 3-methylphenol: In dinitration, two nitro groups are introduced into the benzene ring. The first nitro group enters mainly at the position ortho to the -OH group (position 2), as in mononitration. The second nitro group usually enters at the position para to the -OH group (position 4), since both positions 2 and 4 are activated. Hence, the major product of dinitration is 2,4-dinitro-3-methylphenol. Minor isomers with nitro groups at other available ortho/para positions may also form but are generally not reported as major products.

Summary: The -OH group directs the nitration mainly to ortho and para positions relative to itself, over the methyl group. Hence, the positions 2 and 4 relative to -OH are the main substitution sites for nitro groups in mono and dinitration respectively.

Key Points: Mononitration gives 2-nitro-3-methylphenol - Dinitration gives 2,4-dinitro-3-methylphenol - The -OH group directs substitution ortho and para positions mainly

Question 9.

(i) Oxidation of propanal is easier than propanone. Why ?

(ii) How can you distinguish between Acetophenone and Benzophenone ?

(iii) Draw the structure of the following derivative : 2,4-Dinitrophenylhydrazone of Propanone

[3 Marks]

Answer: (i) Oxidation of propanal is easier than propanone because propanal is an aldehyde whereas propanone is a ketone. Aldehydes have a hydrogen atom attached to the carbonyl carbon, making them more reactive and easily oxidizable to carboxylic acids. Ketones lack this hydrogen and hence are resistant to oxidation under normal conditions.
(ii) Acetophenone and Benzophenone can be distinguished by their physical properties and chemical tests. Acetophenone is a methyl ketone and gives a positive iodoform test producing a yellow precipitate, whereas benzophenone does not give this test as it lacks the methyl group adjacent to the carbonyl. Also, their melting points and solubilities differ.
(iii) The structure of 2,4-Dinitrophenylhydrazone of propanone is formed by the reaction of propanone with 2,4-dinitrophenylhydrazine. It has the structure CH3-CO-CH3 reacting at the carbonyl group with NH-NH-C6H3-(NO2)2 (at positions 2 and 4), forming CH3-C=N-NH-C6H3-(NO2)2 (2,4-dinitrophenylhydrazone derivative). This structure has a double bond between the carbonyl carbon and the nitrogen of the hydrazone group, with two nitro groups attached to the benzene ring at positions 2 and 4.

Key Points: Aldehydes oxidize easier than ketones due to hydrogen on carbonyl carbon - Acetophenone gives iodoform test while Benzophenone does not - 2,4-Dinitrophenylhydrazone derivative involves reaction of ketone with 2,4-Dinitrophenylhydrazine forming a hydrazone

Question 10.

A first order reduction takes 30 minutes for 75% decomposition. Calculate t1/2.

Given : [log 2 = 0·3, log 3 = 0·48, log 4 = 0·6, log 5 = 0·7]

[3 Marks]

Answer: Solution:
For a first order reaction, the relation between concentration and time is given by:
log ([A]_0 / [A]) = kt / 2.303
Where [A]_0 is initial concentration, [A] is concentration at time t, k is the rate constant.

Given that 75% decomposition takes place in 30 minutes, so 25% of original concentration remains.
Therefore, [A] / [A]_0 = 0.25

Using the formula:
log (1 / 0.25) = kt / 2.303
log 4 = k * 30 / 2.303
Given log 4 = 0.6, so:
0.6 = k * 30 / 2.303
k = (0.6 * 2.303) / 30 = 0.04606 min^{-1}

The half-life $t_{1/2}$ for a first order reaction is:

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

$= 0.693 / 0.04606 = 15.05$ minutes

Answer: The half-life $t_{1/2}$ of the reaction is approximately 15 minutes.

Key Points: First order reaction equation - Use of log relation for concentration decay - Calculation of rate constant k and then half-life t1/2

Question 11.

Write three differences between Lyophobic sol and Lyophilic sol.

[3 Marks]

Answer: Lyophobic sols and lyophilic sols are two distinct types of colloidal solutions that differ significantly in their properties and behaviors. Firstly, lyophobic sols, such as those formed by metal particles in water, have low affinity for the dispersion medium, making them less stable and more prone to coagulation. In contrast, lyophilic sols, like gelatin or starch in water, have a high affinity for the solvent and are more stable due to strong interaction with the medium. Secondly, the preparation of lyophobic sols usually involves physical methods, such as dispersion or grinding, while lyophilic sols can be prepared through chemical reactions or by simply dissolving the solute in the solvent. Lastly, lyophilic sols exhibit a greater viscosity than the dispersion medium due to their larger particle size and interactions, whereas lyophobic sols typically behave more like the solvent, exhibiting lower viscosity. This highlights their differing characteristics and applications in various scientific and industrial fields.

Key Points: 1. Stability: Lyophobic sols are less stable and prone to coagulation, while lyophilic sols are more stable due to solvent affinity. 2. Preparation: Lyophobic sols are made through physical methods, whereas lyophilic sols can be made by chemical reactions or dissolving solutes. 3. Viscosity: Lyophilic sols have higher viscosity due to particle interactions, while lyophobic sols resemble the viscosity of the solvent.

Question 12.

(i) Write the dispersed phase and dispersion medium of 'milk'.

(ii) What is the cause of Brownian movement in colloidal particles ?

(iii) Why does physisorption decrease with increase in temperature ?

[3 Marks]

Answer: (i) Milk is a colloidal solution where the dispersed phase is fat globules and the dispersion medium is water. (ii) Brownian movement in colloidal particles is caused due to the constant and random bombardment of the colloidal particles by the molecules of the dispersion medium. This causes the particles to move in a zigzag manner. (iii) Physisorption decreases with increase in temperature because it is a physical adsorption involving weak van der Waals forces which release less heat. Increasing temperature gives particles more kinetic energy which helps them to overcome these weak forces and desorb from the surface, thus reducing adsorption.

Key Points: Dispersed phase of milk is fat globules - Dispersion medium of milk is water - Brownian movement caused by collision of medium molecules with colloidal particles - Physisorption involves weak forces - Adsorption decreases with temperature due to increased kinetic energy helping desorption

Question 13.

From the given EΘ values of the first row transition elements, answer the following questions :

(i) Why is Mn2+ / Mn value highly negative as compared to other elements ?

(ii) what is the reason for the irregularity in the above EΘ Values ?

(iii) Why is E Θ Cu² + / Cu value exceptionally positive ?

[3 Marks]

$E^{\ominus}_{M^{2+}/M}$	Cr	Mn	Fe	Co	Ni	Cu	Zn
	− 0·91	− 1·18	− 0·44	− 0·28	− 0·25	+ 0·34	− 0·76

Answer: (i) The EΘ value for Mn^{2+}/Mn is highly negative because manganese has a half-filled $3d^5$ electronic configuration in Mn^{2+} which is very stable. To reduce Mn^{2+} to Mn metal, this stable half-filled configuration is lost which requires more energy, making the reduction potential more negative. **(ii)** The irregularity in the EΘ values across first row transition metals is due to variations in electronic configurations, especially the extra stability of half-filled (d^5) and fully filled (d^{10}) subshells. Factors like ionization energy, hydration enthalpy, and lattice energy also contribute, leading to non-linear trends. **(iii)** The EΘ value for Cu^{2+}/Cu is exceptionally positive because copper metal has a completely filled $3d^{10}$ configuration, which is very stable. The stability of Cu metal makes it easier to form Cu^{2+} ions and thus shows a high positive electrode potential.

Key Points: Mn2+ has stable half-filled d5 configuration - Irregularity caused by half-filled and fully filled d subshell stability - Cu2+/Cu has stable fully filled d10 configuration

resulting in positive potential

Question 14.

Write the equation involved in the following reactions :

(i) Rosenmund reduction

(ii) Etard reaction

(iii) Stephen reaction

[3 Marks]

Answer: (i) Rosenmund reduction:
The Rosenmund reduction is used to reduce acid chlorides to aldehydes. The reaction involves the reduction of an acid chloride using hydrogen gas in the presence of palladium on barium sulfate catalyst.

$R\text{-}COCl + H_2\ (Pd/BaSO_4) \longrightarrow R\text{-}CHO + HCl$

Here, R-COCl is an acid chloride and R-CHO is the corresponding aldehyde.

(ii) Etard reaction:
The Etard reaction oxidizes methyl groups attached to aromatic rings into aldehyde groups using chromyl chloride (CrO_2Cl_2).

$C_6H_5\text{-}CH_3 + CrO_2Cl_2 \longrightarrow C_6H_5\text{-}CH{=}O + CrCl_3$

Toluene ($C_6H_5\text{-}CH_3$) is oxidized to benzaldehyde ($C_6H_5\text{-}CHO$).

(iii) Stephen reaction:
The Stephen reaction reduces nitriles to aldehydes in the presence of stannous chloride ($SnCl_2$) and hydrochloric acid (HCl) followed by hydrolysis.

$R\text{-}CN + 2[H]\ (SnCl_2/HCl) \longrightarrow R\text{-}CH{=}NH \cdot HCl$ (iminium salt)
Then,
$R\text{-}CH{=}NH \cdot HCl + H_2O \longrightarrow R\text{-}CHO + NH_4Cl$

Here, a nitrile (R-CN) is first converted to an iminium salt and then hydrolyzed to the aldehyde (R-CHO).

Key Points: Rosenmund reduction converts acid chlorides to aldehydes - Etard reaction oxidizes methyl group to aldehyde using chromyl chloride - Stephen reaction reduces nitriles to aldehydes via iminium salt intermediate

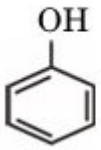
Question 15.

(i) Which acid of each pair would you expect to be stronger ? Give reason.

(ii) Distinguish between Pentan-2-one and Pentan-3-one.

[3 Marks]

(I) CH_3COOH or $F-CH_2-COOH$

(II)  or CH_3-COOH

Answer: (i) Which acid of each pair would you expect to be stronger? Give reason.
The strength of an acid depends on the stability of its conjugate base. More stable conjugate base means stronger acid. Electron withdrawing groups near the acidic proton stabilize the conjugate base through inductive effect, increasing acidity. Also, resonance stabilization increases acid strength. For example, in dicarboxylic acids, the acid with carboxyl groups closer together is stronger due to intramolecular hydrogen bonding and stronger electron withdrawing effect.

(ii) Distinguish between Pentan-2-one and Pentan-3-one.
Pentan-2-one and Pentan-3-one are positional isomers of pentanone with the carbonyl group at different positions in the pentane chain.
- Pentan-2-one has the carbonyl group (C=O) attached to the second carbon atom in the chain. Its structure is CH_3-CO-CH_2-CH_2-CH_3.
- Pentan-3-one has the carbonyl group attached to the third carbon atom. Its structure is CH_3-CH_2-CO-CH_2-CH_3.
These differences cause variation in physical and chemical properties such as boiling points and reactivity due to the position of the ketone group.

Key Points: Acid strength depends on conjugate base stability - Electron withdrawing groups increase acidity by stabilizing conjugate base - Pentan-2-one has carbonyl at C2, Pentan-3-one at C3 - They are positional isomers with different physical and chemical properties

Question 16.

Account for the following :

(i) Transition metals and their compounds show catalytic activities.

(ii) Account for the following :Zn, Cd and Hg are non-transition elements.

(iii) Zr and Hf are of almost identical atomic radii.

[3 Marks]

Answer: (a) Transition metals and their compounds show catalytic activity because they can adopt multiple oxidation states and have unfilled d orbitals. This allows them to form intermediate compounds with reactants and provide a surface for the reaction to take place, thus speeding up the chemical reactions. For example, Fe in the Haber process and V_2O_5 in the Contact process act as catalysts.
(b) Zn, Cd and Hg are considered non-transition elements because their electronic configurations are $(n-1)d^{10}ns^2$. This means their d orbitals are completely filled in both the ground state and common oxidation states. Since transition elements require partly filled d orbitals to exhibit typical properties like variable oxidation states and formation of coloured compounds, Zn, Cd and Hg do not fit this criteria and are thus classified as non-transition elements.
(c) Zr and Hf have almost identical atomic radii due to the lanthanide contraction. Lanthanides, which are elements between them in the periodic table, have poor shielding effect because 4f electrons do not shield the nuclear charge effectively. This causes a greater attraction between the nucleus and outer electrons in Hf, decreasing its size and resulting in atomic radii similar to Zr.

Key Points: Transition metals show catalytic activity due to variable oxidation states and unfilled d orbitals - Zn, Cd and Hg have full d orbitals and do not show typical transition metal properties - Lanthanide contraction causes similar atomic radii of Zr and Hf

Question 17.

How will you carry out the following conversions :

(i) Propanal to Propane.(1)

(ii) Ethanal to But- 2-enal.(1)

(iii) Ethanoic acid to ethanamide.(1)

[3 Marks]

Answer: (i) **Propanal to Propane:** Propanal (CH_3CH_2CHO) can be converted into propane ($CH_3CH_2CH_3$) by reducing the aldehyde group to a methyl group. This is done by catalytic hydrogenation using hydrogen gas (H_2) in presence of a catalyst like palladium on carbon (Pd/C) or by using reducing agents like zinc amalgam (Zn(Hg)) and hydrochloric acid (HCl).
(ii) **Ethanal to But-2-enal:** Ethanal (CH_3CHO) can be converted into but-2-enal by an aldol condensation reaction. In the presence of dilute sodium hydroxide (NaOH), two molecules of ethanal

undergo aldol condensation to form 3-hydroxybutanal which upon heating or dehydration gives but-2-enal (crotonaldehyde).

(iii) **Ethanoic acid to Ethanamide:** Ethanoic acid (CH_3COOH) is converted into ethanamide (CH_3CONH_2) by first converting it into an acid chloride using reagents like thionyl chloride ($SOCl_2$). The acid chloride then reacts with concentrated ammonia (NH_3) to form ethanamide.

Key Points: Reductive conversion with H_2/Pd or Zn(Hg)/HCl - Aldol condensation using NaOH for ethanal - Conversion via acid chloride intermediate using $SOCl_2$ and NH_3 for amide formation