

CAREERS 360

PRACTICE **Series**

CBSE Class 12

Chemistry

Question and Solution
2025

SET - 1 OBJECTIVE ANSWERS

Q. 1- (B)

Q.2-(A)

Q.3-(C)

Q.4-(A)

Q.5-(B)

Q.6-(D)

Q.7-(C)

Q.8-B)

Q.9-(C)

Q.10-(D)

Q.11-(B)

Q.12-(C)

Q.13-(B)

Q.14-(A)

Q.15-(A)

Q.16-(D)

SET -2 OBJECTIVE ANSWERS

Q. 1- (D)

Q.2-(A)

Q.3-(A)

Q.4-(B)

Q.5-(C)

Q.6-(D)

Q.7-(D)

Q.8-(C)

Q.9-(B)

Q.10-(C)

Q.11-(D)

Q.12-(B)

Q.13-(A)

Q.14-(C)

Q.15-(A)

Q.16-(B)

SET -3 OBJECTIVE ANSWERS

Q. 1- (A)

Q.2-(B)

Q.3-(A)

Q.4-(C)

Q.5-(D)

Q.6-(B)

Q.7-(B)

Q.8-(C)

Q.9-(D)

Q.10-(C)

Q.11-(C)

Q.12-(D)

Q.13-(A)

Q.14-(B)

Q.15-(D)

Q.16-(A)

SET -1 ANSWERS (SUBJECTIVE)

Q. 17 (A) For a zero-order reaction, the integrated rate equation is:

$$[A] = [A]_0 - kt$$

where:

- $[A]$ = final concentration of A = 0.075M

- $[A]_0$ = initial concentration of A = 0.10M
- k = rate constant = $0.0030 \text{ mol L}^{-1} \text{ s}^{-1}$
- t = time (to be determined)

Substituting the values:

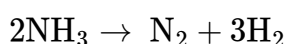
$$0.075 = 0.10 - (0.0030 \times t)$$

$$t = \frac{0.10 - 0.075}{0.0030}$$

$$t = \frac{0.025}{0.0030} = 8.33 \text{ s}$$

Q.17(B)

The decomposition reaction of ammonia (NH_3) follows:



Given:

- Zero-order reaction rate constant $k = 2.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$.

For zero-order reactions, the rate of disappearance of NH_3 is:

$$\text{Rate} = k = 2.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$$

From stoichiometry:

$$\begin{aligned} \text{Rate of formation of } \text{N}_2 &= \frac{1}{2} \times k = \frac{1}{2} \times (2.5 \times 10^{-4}) \\ &= 1.25 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1} \end{aligned}$$

$$\begin{aligned} \text{Rate of formation of } \text{H}_2 &= \frac{3}{2} \times k = \frac{3}{2} \times (2.5 \times 10^{-4}) \\ &= 3.75 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1} \end{aligned}$$

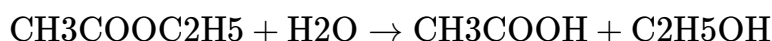
Final Answers:

- Rate of production of $\text{N}_2 = 1.25 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$.
- Rate of production of $\text{H}_2 = 3.75 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$.

Q18(a) Pseudo First Order Reaction:

A **pseudo-first order reaction** is a reaction that is truly of higher order but behaves as a first-order reaction under certain conditions. This happens when the concentration of one reactant is much larger than the other, making its change negligible during the reaction.

Example: Hydrolysis of ethyl acetate in excess water:



Since water is in large excess, the reaction follows **first-order kinetics**, even though it should be second order.

Q18(b) Half-life Period of Reaction ($t_{1/2}$):

The **half-life period** ($t_{1/2}$) of a reaction is the time required for the concentration of a reactant to decrease to half of its initial concentration.

For different orders:

- **Zero-order reaction:**

$$t_{1/2} = \frac{[A]_0}{2k}$$

- **First-order reaction:**

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

For a **first-order reaction**, half-life is independent of concentration.

Q19(a) Transition Elements Generally Form Coloured Compounds:

Transition elements form **coloured compounds** due to the presence of **partially filled d-orbitals**. When light falls on these compounds, **d-d electronic transitions** occur, where electrons move between different d-orbitals. The energy absorbed corresponds to a particular wavelength, and the remaining light gives the compound its colour.

Example:

- - Cu^{2+} (blue)
- Fe^{3+} (yellow-brown)
- Cr^{3+} (green)

Q19(b) Zinc is Not Regarded as a Transition Element:

Zinc (Zn) is **not** considered a transition element because:

1. **It has a completely filled d-orbital** ($3d^{10}$) in both elemental and ionic (Zn^{2+}) forms.
2. **It does not exhibit variable oxidation states** (only +2).
3. **It does not form coloured compounds** or show significant catalytic properties like other transition metals.

Hence, zinc does not meet the criteria of transition elements, which typically have **partially filled d-orbitals**.

Q20: Naming the Coordination Compounds

(a) $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$

IUPAC Name: Tetraammineaquachloridocobalt(III) chloride

- **Co** is cobalt, oxidation state = +3
- **NH_3 (Ammine)** and **H_2O (Aqua)** are neutral ligands.
- **Cl^- (Chlorido)** is a monodentate anionic ligand.
- **Cl_2 outside** represents counter ions.

(b) $[\text{CrCl}_2(\text{en})_2]\text{Cl}$

IUPAC Name: Dichloridobis(ethylenediamine)chromium(III) chloride

- Cr is chromium, oxidation state = +3
- en (ethylenediamine) is a bidentate neutral ligand.
- Cl⁻ (Chlorido) is a monodentate anionic ligand.
- One Cl⁻ is outside as a counter ion.

Q21(a): SN1 Reactivity Comparison

The **SN1 reaction** (unimolecular nucleophilic substitution) depends on **carbocation stability** after leaving group departure.

- The **first compound** is **tert-butyl chloride** (tertiary halide).
- The **second compound** is **isobutyl chloride** (primary halide).

SN1 proceeds faster for tertiary carbocations due to **better stability via hyperconjugation and +I effect of alkyl groups**.

Answer: tert-Butyl chloride undergoes SN1 reaction faster because the **tertiary carbocation formed is more stable**.

Q21(b): Increasing Order of SN2 Reactivity

The **SN2 reaction** (bimolecular nucleophilic substitution) depends on **steric hindrance**—bulkier groups slow the reaction.

Given compounds:

1. **2-Bromo-2-methylbutane** → Highly hindered (tertiary halide) → **Least reactive**
2. **1-Bromopentane** → Primary halide → **Most reactive**
3. **2-Bromopentane** → Secondary halide → **Intermediate reactivity**

Order of increasing SN2 reactivity:

2-Bromo-2-methylbutane < 2-Bromopentane < 1-Bromopentane

Q.22

Using Raoult's Law:

$$P_{\text{solution}} = P_0 \times \chi_{\text{solvent}}$$

where:

- $P_0 = 24\text{mmHg}$ (saturated vapour pressure of water),

$$\chi_{\text{solvent}} = \frac{n_{\text{solvent}}}{n_{\text{solute}} + n_{\text{solvent}}}$$

Given:

- **5% urea solution** means **5g urea in 95g water**.

- **Moles of urea:**

$$n_{\text{urea}} = \frac{5}{60} = 0.0833\text{moles}$$

- **Moles of water:**

$$n_{\text{water}} = \frac{95}{18} = 5.278\text{ moles}$$

- Mole fraction of water:

$$\chi_{\text{water}} = \frac{5.278}{5.278+0.0833} = 0.9846$$

- Saturated vapour pressure:

$$P_{\text{solution}} = 24 \times 0.9846 = 23.63 \text{ mmHg}$$

Final Answer: 23.63 mmHg

Q.23

Given:

- Resistance (R) = $5 \times 10^3 \Omega$,

- Concentration (C) = 0.05 M,

- Length (l) = 40 cm = 0.4 m,

- Area (A) = $0.8 \text{ cm}^2 = 8 \times 10^{-8} \text{ m}^2$.

(a) Resistivity (ρ):

$$\begin{aligned} \rho &= R \times \frac{A}{l} \\ &= (5 \times 10^3) \times \frac{8 \times 10^{-8}}{0.4} \\ &= 1 \times 10^{-3} \Omega \text{ m} \end{aligned}$$

(b) Conductivity (κ):

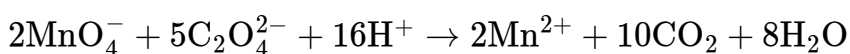
$$\begin{aligned} \kappa &= \frac{1}{\rho} = \frac{1}{1 \times 10^{-3}} \\ &= 10^3 \text{ S m}^{-1} \end{aligned}$$

(c) Molar Conductivity (Λ_m):

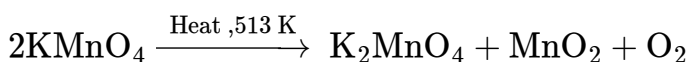
$$\begin{aligned} \Lambda_m &= \frac{\kappa \times 1000}{C} \\ &= \frac{10^3 \times 1000}{0.05} \\ &= 2 \times 10^7 \text{ Sm}^2 \text{ mol}^{-1} \end{aligned}$$

Q.24

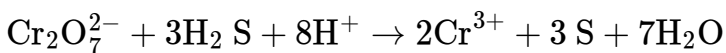
(a) Redox Reaction of MnO_4^- with $\text{C}_2\text{O}_4^{2-}$ in Acidic Medium



(b) Thermal Decomposition of KMnO_4



(c) Dichromate Reaction with H_2S in Acidic Medium



Q25: Hybridization & Magnetic Character Using Valence Bond Theory

(a) $[\text{Co}(\text{NH}_3)_6]^{3+}$

- Cobalt (Co) atomic number = 27 → Electronic configuration: $[\text{Ar}] 3d^7 4s^2$.
- Oxidation state of Co = +3 → Configuration: $[\text{Ar}] 3d^6$.
- NH_3 is a strong field ligand, so low spin complex forms.
- Hybridization: d^2sp^3 (octahedral).
- Magnetic property: Diamagnetic (all electrons paired).

(b) $[\text{Ni}(\text{CO})_4]$

- Nickel (Ni) atomic number = 28 → Configuration: $[\text{Ar}] 3d^8 4s^2$.
- Oxidation state of Ni = 0 → Configuration: $[\text{Ar}] 3d^8 4s^2$.
- CO is a strong field ligand, so low spin complex forms.
- Hybridization: sp^3 (tetrahedral).
- Magnetic property: Diamagnetic (all electrons paired).

Q26(a): Definitions

(i) Enantiomers

Enantiomers are **stereoisomers** that are **non-superimposable mirror images** of each other. They have identical physical and chemical properties except:

- They rotate plane-polarized light in opposite directions.
- They react differently with chiral reagents.

Example: Lactic acid (one enantiomer rotates light clockwise, the other counterclockwise).

(ii) Racemic Mixture

A **racemic mixture** is a **1:1 mixture of two enantiomers** of a chiral compound. Since the enantiomers rotate light in opposite directions with equal magnitude, the net optical rotation is **zero** (optically inactive).

Example: (\pm)-Lactic acid (equal amounts of both enantiomers).

Q26(b): Why is Chlorobenzene Resistant to Nucleophilic Substitution?

Chlorobenzene is **highly resistant to nucleophilic substitution** due to the following reasons:

1. Partial Double Bond Character (Resonance Effect)

- The lone pair on Cl participates in resonance with the benzene ring.
- This creates **partial double bond character** in the **C–Cl bond**, making it stronger and less reactive.

2. sp^2 Hybridization of Carbon

- In chlorobenzene, the carbon attached to chlorine is **sp^2 hybridized**, making the **C–Cl bond shorter and stronger** than the **sp^3 C–Cl bond** in alkyl halides.

3. Steric Hindrance

- The **benzene ring** creates steric hindrance, preventing nucleophiles from attacking easily.

4. Lack of Carbocation Stability

- In **SN1 reactions**, carbocation formation is difficult because **phenyl carbocations are highly unstable**.

Hence, chlorobenzene undergoes **nucleophilic substitution only under drastic conditions**, like **high temperature and strong nucleophiles**.

Q.27 (A)

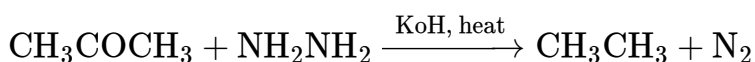
(a) Wolff-Kishner Reduction

- This reaction is used to convert carbonyl compounds (aldehydes and ketones) into alkanes.
- It involves treating the carbonyl compound with hydrazine (NH_2NH_2) in a strong base (KOH) and heating.

Reaction:



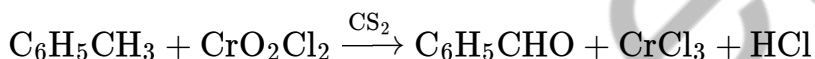
Example:



(b) Etard Reaction

- This reaction selectively oxidizes toluene to benzaldehyde using chromyl chloride (CrO_2Cl_2).

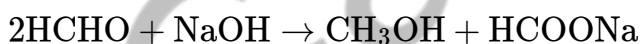
Reaction:



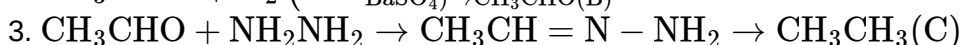
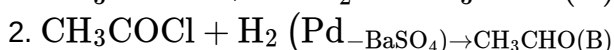
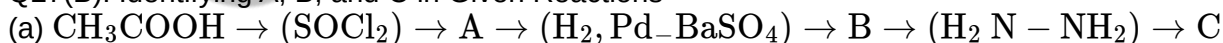
(c) Cannizzaro Reaction

- Aldehydes without α -hydrogen atoms undergo a self-redox reaction in the presence of a strong base (NaOH or KOH).
- One molecule is reduced to an alcohol, while the other is oxidized to a carboxylate anion.

Reaction:



Q27(B): Identifying A, B, and C in Given Reactions



Final Products:

- A = Acetyl chloride (CH_3COCl)
- B = Acetaldehyde (CH_3CHO)
- C = Ethane (CH_3CH_3)

(b) $\text{CH}_3\text{CN} \rightarrow (\text{DIBAL-H}) \rightarrow \text{A} \rightarrow (\text{Dil. NaOH}, \Delta) \rightarrow \text{B} \rightarrow \text{C}$

1. $\text{CH}_3\text{CN} + \text{DIBAL-H} \rightarrow \text{CH}_3\text{CH} = \text{NH}(\text{A})$

2. $\text{CH}_3\text{CH} = \text{NH} + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{CHO}(\text{B})$

3. $\text{CH}_3\text{CHO} + \text{NaOH} \rightarrow \text{CH}_3\text{CH}_2\text{OH}(\text{C})$

Final Products:

- **A** = Imines ($\text{CH}_3\text{CH} = \text{NH}$)

- **B** = Acetaldehyde (CH_3CHO)

- **C** = Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$)

Q28: Definitions

(a) Glycosidic Linkage

- A **glycosidic linkage** is a **covalent bond** that joins two monosaccharide units via an **oxygen bridge (-O-)**.
- Formed by a **condensation reaction** (removal of water).

Example:

$\alpha\text{-D-Glucose} + \alpha\text{-D-Glucose} \rightarrow \text{Maltose}$ (linked via $\alpha\text{-1,4-glycosidic bond}$).

(b) Invert Sugar

- Invert sugar is an equimolar mixture of glucose and fructose formed by hydrolysis of sucrose.

- It is called "invert" because the optical rotation of the solution changes from dextrorotatory ($+66^\circ$) to levorotatory (-39°).

Reaction:



(Sucrose \rightarrow Glucose + Fructose)

(c) Oligosaccharides

- Oligosaccharides are **carbohydrates composed of 2–10 monosaccharide units** linked by glycosidic bonds.
- They are hydrolyzed into **monosaccharides** in acidic or enzymatic conditions.

Examples:

- **Disaccharides:** Sucrose, Maltose, Lactose.
- **Trisaccharides:** Raffinose.

Q29(a): Define Reverse Osmosis & Name a Semipermeable Membrane (SPM) Used

Reverse osmosis (RO) is a process where **solvent molecules move from a concentrated solution to a dilute solution** across a **semipermeable membrane (SPM)** when **external pressure greater than the osmotic pressure** is applied. This process is widely used for **water purification and desalination**.

Example of SPM Used:

- **Cellulose acetate membrane**

- Polyamide membrane
- Thin-film composite (TFC) membrane

Q29(b)(i): Effect of 0.5% NaCl Solution on RBCs

The normal saline concentration for RBCs is 0.9% NaCl (isotonic solution).

- 0.5% NaCl is a hypotonic solution (lower solute concentration than inside RBCs).
- Osmosis occurs, water enters RBCs, causing them to **swell and possibly burst** (hemolysis).

Final Answer: RBCs will swell and may burst due to water influx.

Q29(b)(ii): Higher Osmotic Pressure - 1M KCl vs. 1M Urea
Osmotic pressure (π) is given by:

$$\pi = iCRT$$

where:

- i = Van't Hoff factor (number of particles in solution)
- C = Concentration (Molarity)
- R = Gas constant
- T = Temperature

For:

- KCl: It dissociates into K^+ and Cl^- ($i = 2$), so $\pi = 2MRT$.
- Urea: It does not dissociate ($i = 1$), so $\pi = 1MRT$.

Since i is higher for KCl, the osmotic pressure of **1MKCl** is higher than 1 M urea.

Final Answer: 1M KCl has higher osmotic pressure than 1M urea because KCl dissociates into two ions, increasing the effective particle concentration.

Q29(c): Why Osmotic Pressure is a Colligative Property?

Colligative properties depend only on the **number of solute particles** in solution, **not on their identity**. **Osmotic pressure** depends on **solute concentration (number of particles per unit volume)** rather than their nature.

$$\pi = iCRT$$

Since osmotic pressure is **directly proportional** to the number of solute particles (not their type), it is classified as a **colligative property**.

Final Answer: Osmotic pressure is a colligative property because it depends only on the number of solute particles in solution, not their chemical identity.

Q30(a): Increasing Order of Basic Character with Reason

The given compounds include:

1. p-Nitroaniline (NO_2 at para position, $-\text{NH}_2$ group)
2. m-Nitroaniline (NO_2 at meta position, $-\text{NH}_2$ group)
3. p-Toluidine (CH_3 at para position, $-\text{NH}_2$ group)

Basicity Order Analysis:

- **Electron-donating groups (EDGs) like $-\text{CH}_3$ increase basicity** by enhancing electron density on the nitrogen of the amine group.
- **Electron-withdrawing groups (EWGs) like $-\text{NO}_2$ decrease basicity** by pulling electron density away from the nitrogen.
- **Para-position NO_2 ($-\text{NO}_2$ at p-position) has the strongest -M effect (mesomeric effect)**, making the amine least basic.
- **Meta-position NO_2 ($-\text{NO}_2$ at m-position) has only an -I effect (inductive effect) and no resonance interaction**, making it slightly more basic than the para form.
- **p-Toluidine ($-\text{CH}_3$ at p-position) has an +I effect**, increasing electron density on nitrogen, making it the most basic.

Final Order (Increasing Basicity):

p-Nitroaniline < m-Nitroaniline < p-Toluidine

Q30(b): Why is pK_b of Aniline More than that of Methylamine?

- **Aniline ($\text{C}_6\text{H}_5\text{NH}_2$) is less basic than methylamine (CH_3NH_2)** because of **resonance stabilization** in the benzene ring.
- The lone pair on nitrogen in aniline **participates in conjugation with the benzene ring**, reducing its availability for protonation.
- In contrast, **methylamine is an aliphatic amine where no resonance effect occurs**, and the **+I effect of the $-\text{CH}_3$ group** increases electron density on nitrogen, making it more basic.
- Since **stronger bases have lower pK_b values**, **aniline has a higher pK_b than methylamine**.

Final Answer:

pK_b of aniline is higher than that of methylamine because resonance in aniline reduces the availability of nitrogen's lone pair for protonation, making it less basic than methylamine.

Q(c)(i): Increasing Order of Basic Character in Aqueous Solution

Given compounds:

1. NH_3 (Ammonia)
2. CH_3NH_2 (Methylamine, Primary Amine)
3. $(\text{CH}_3)_2\text{NH}$ (Dimethylamine, Secondary Amine)
4. $(\text{CH}_3)_3\text{N}$ (Trimethylamine, Tertiary Amine)

Basicity Order Analysis in Aqueous Solution:

- **Basic strength of amines in aqueous solution depends on:**
 1. **+I (Inductive) Effect of Alkyl Groups:** Alkyl groups push electron density towards nitrogen, increasing basicity.
 2. **Solvation Effect:** More hydrogen bonding in **primary and secondary amines** makes them more stable, increasing their effective basicity in water.
 3. **Steric Hindrance:** Tertiary amines are **less basic** due to steric hindrance and poor solvation.

Trend of Basicity in Aqueous Solution:

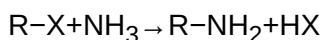
$\text{NH}_3 < (\text{CH}_3)_3\text{N} < \text{CH}_3\text{NH}_2 < (\text{CH}_3)_2\text{NH}$

- **Ammonia (NH_3)** is the least basic.
- **Tertiary amine ($(\text{CH}_3)_3\text{N}$)** is less basic than primary and secondary due to **poor solvation**.
- **Secondary amine ($(\text{CH}_3)_2\text{NH}$)** is the most basic due to **optimal electron donation and solvation balance**.

Final Order (Increasing Basicity):
 $\text{NH}_3 < (\text{CH}_3)_3\text{N} < \text{CH}_3\text{NH}_2 < (\text{CH}_3)_2\text{NH}$

Q(c)(ii): Why is Ammonolysis of Alkyl Halides Not a Good Method to Prepare Pure Amines?

Ammonolysis of alkyl halides involves **nucleophilic substitution**, where ammonia reacts with an alkyl halide to form an amine:



Problems with Ammonolysis:

1. Formation of a Mixture of Amines

- The formed amine (**R-NH₂**) is itself a **strong nucleophile** and reacts further with alkyl halide, leading to **secondary (R₂NH)**, **tertiary (R₃N)**, and even **quaternary ammonium salts (R₄N⁺X⁻)**.
- This makes **separating a pure amine difficult**.

2. Low Yield of Primary Amine

- Since secondary and tertiary amines also form, the yield of the **desired primary amine (R-NH₂)** is low.

3. Difficult Separation

- The mixture of amines requires **complex separation techniques** like **fractional distillation**, making the process inefficient.

Final Answer:

Ammonolysis of alkyl halides is not a good method for preparing pure amines because it leads to a mixture of primary, secondary, and tertiary amines, making separation difficult.

Q31(A)(a): IUPAC Name of CH₃-CH=CH-CHO

- The longest carbon chain contains four carbon atoms.
- The -CHO (aldehyde) functional group takes priority.
- The double bond (-CH=CH-) is present at carbon 2.

IUPAC Name: But-2-enal

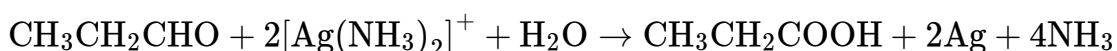
Q31(A)(b): Chemical Test to Distinguish Between Propanal and Propanone

- Propanal (Aldehyde, CH₃CH₂CHO)
- Propanone (Ketone, CH₃COCH₃)

Test: Tollen's Test (Silver Mirror Test)

- Propanal (Aldehyde) gives a positive test, forming a silver mirror.
- Propanone (Ketone) does not react.

Reaction (for propanal):

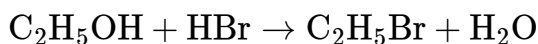
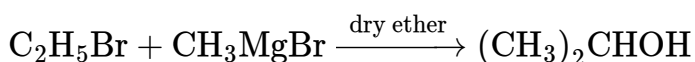


Final Answer: Propanal gives a silver mirror with Tollen's reagent, while propanone does not.

Q31(A)(c): Conversions**(i) Toluene to Benzoic Acid (Using Jones Reagent)**

- Jones reagent ($\text{CrO}_3 + \text{H}_2\text{SO}_4$) is a strong oxidizing agent.
- It oxidizes toluene ($\text{C}_6\text{H}_5\text{CH}_3$) to benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$).

Reaction:

**(ii) Ethanol to Propan-2-ol****1. Convert ethanol to ethyl bromide:****2. Wurtz reaction with methyl bromide:**

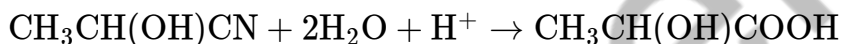
Final Product: Propan-2-ol ($\text{CH}_3\text{CHOHCH}_3$)

(iii) Propanal to 2-Hydroxypropanoic Acid (Lactic Acid)

- Step 1: Propanal undergoes nucleophilic addition with HCN to form cyanohydrin.



- Step 2: Acidic hydrolysis converts the -CN group to -COOH, forming 2-hydroxypropanoic acid (Lactic Acid).

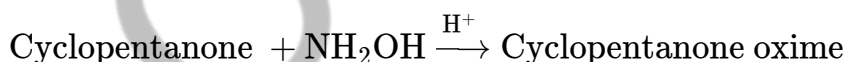


Final Answer: Propanal \rightarrow Cyanohydrin \rightarrow Lactic Acid (2-hydroxypropanoic acid).

Q31(B): Completing the Synthesis**(a) Reaction of Cyclopentanone with Hydroxylamine**

- The given cyclopentanone (five-membered ketone) reacts with hydroxylamine (NH_2OH) in an acidic medium.
- This forms an oxime via nucleophilic addition-elimination.

Reaction:

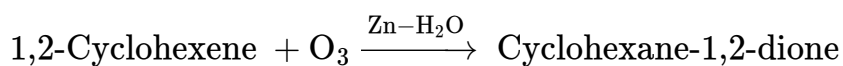


Final Product: Cyclopentanone oxime ($\text{C}_5\text{H}_9\text{NO}$)

(b) Ozonolysis of a Cyclic Alkene

- The final product is cyclohexane-1,2-dione (six-membered diketone).
- Ozonolysis of 1,2-cyclohexene (cyclohexene with a double bond between two carbons) in the presence of $\text{O}_3/\text{Zn} - \text{H}_2\text{O}$ leads to cleavage of the double bond and formation of two carbonyl groups.

Reaction:



Starting Material: 1,2-Cyclohexene

(c) Reaction of 2-Hydroxy-1,2-benzophenone with SOCl₂

- The given compound is 2-hydroxy-1,2-benzophenone (a hydroxyl carboxyl compound).
- SOCl₂ (Thionyl chloride) converts the -COOH group to -COCl (acid chloride).
- On heating, it undergoes intramolecular cyclization, forming coumarin (lactone formation).

Final Product: Coumarin (Benzopyrone)

(d) Reaction of Aldo-Carboxylic Acid with NaCN/HCl

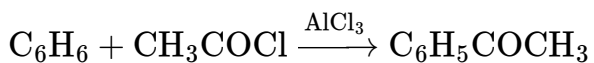
- The given compound has both an -CHO (aldehyde) and -COOH (carboxyl) group.
- NaCN in HCl leads to cyanohydrin formation by addition of -CN to the aldehyde (-CHO) group.

Final Product: α-Hydroxy-α-carboxylic acid (Cyanohydrin derivative)

(e) Friedel-Crafts Acylation of Benzene

- The reaction represents the Friedel-Crafts acylation of benzene.
- Benzene reacts with acetyl chloride (CH₃COCl) in the presence of AlCl₃ catalyst.
- This results in the formation of acetophenone (C₆H₅COCH₃).

Reaction:



Final Product: Acetophenone (C₆H₅COCH₃)

Q32(A)(a): Calculation of Standard Gibbs Energy (ΔG°)

Given reaction:



Standard electrode potentials:

$$E_{\text{Au}^{3+}/\text{Au}}^\circ = +1.5 \text{ V}$$

$$E_{\text{Ca}^{2+}/\text{Ca}}^\circ = -2.87 \text{ V}$$

Step 1: Calculate Standard Cell Potential (E° cell)

$$\begin{aligned} E_{\text{cell}}^\circ &= E_{\text{cathode}}^\circ - E_{\text{anode}}^\circ \\ E_{\text{cell}}^\circ &= (+1.5 \text{ V}) - (-2.87 \text{ V}) \\ E_{\text{cell}}^\circ &= 4.37 \text{ V} \end{aligned}$$

Step 2: Calculate Gibbs Free Energy (ΔG°)

$$\Delta G^\circ = -nFE_{\text{cell}}^\circ$$

where:

- $n = 3$ (electrons transferred)

- $F = 96500 \text{ C mol}^{-1}$

- $E_{\text{cell}}^\circ = 4.37 \text{ V}$

$$\Delta G^\circ = -(3)(96500)(4.37)$$

$$\Delta G^\circ = -1.26 \times 10^6 \text{ J mol}^{-1}$$

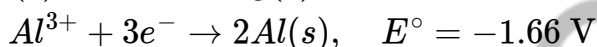
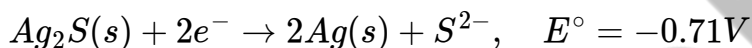
$$\Delta G^\circ = -1260 \text{ kJ mol}^{-1}$$

Conclusion:

Since ΔG° is negative, the reaction is spontaneous at 25°C .

Q32(A)(b): Can Ag_2S Tarnish be Removed Using Aluminium?

Given half-reactions:



To remove tarnish, aluminium must act as a reducing agent, meaning its oxidation potential must be higher than silver's reduction potential.

Step 1: Calculate Cell Potential

$$E_{\text{cell}}^\circ = E_{\text{cathode}}^\circ - E_{\text{anode}}^\circ$$
$$E_{\text{cell}}^\circ = (-0.71\text{V}) - (-1.66\text{V})$$
$$E_{\text{cell}}^\circ = 0.95\text{V}$$

Since E° is positive, the reaction is spontaneous, meaning aluminium can reduce Ag_2S , removing tarnish.

Final Answer:

Yes, placing tarnished silverware in an aluminium pan with NaCl solution will remove the tarnish, as aluminium will reduce Ag_2S to $\text{Ag}(s)$.

Q32(B)(a): Definitions

(i) Cell Potential

- Cell potential (E_{cell}) is the difference in electrode potentials between the cathode and anode in an electrochemical cell.

- It determines the voltage output of the cell.

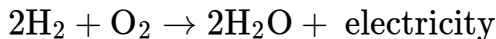
$$E_{\text{cell}} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ}$$

(ii) Fuel Cell

- A fuel cell is an electrochemical cell that continuously converts chemical energy of a fuel (e.g., hydrogen) into electrical energy.

- Unlike batteries, it requires a continuous supply of reactants.

Example: Hydrogen fuel cell:



Q32(B)(b): EMF of the Given Cell

Given cell:



Standard electrode potentials:

$$E_{\text{Cd}^{2+}/\text{Cd}}^{\circ} = -0.40 \text{ V}$$

$$E_{\text{Zn}^{2+}/\text{Zn}}^{\circ} = -0.76 \text{ V}$$

Step 1: Calculate E_{cell}°

$$E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ}$$

$$E_{\text{cell}}^{\circ} = (-0.40) - (-0.76)$$

$$E_{\text{cell}}^{\circ} = 0.36 \text{ V}$$

Step 2: Apply Nernst Equation

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.0591}{n} \log \frac{[\text{Cd}^{2+}]}{[\text{Zn}^{2+}]}$$

where:

- $n = 2$ (electrons transferred),

- $[\text{Cd}^{2+}] = 0.01\text{M}$,

- $[\text{Zn}^{2+}] = 0.1\text{M}$.

$$E_{\text{cell}} = 0.36 - \frac{0.0591}{2} \log \left(\frac{0.01}{0.1} \right)$$

$$E_{\text{cell}} = 0.36 - \frac{0.0591}{2} \times (-1)$$

$$E_{\text{cell}} = 0.36 + 0.0296$$

$$E_{\text{cell}} = 0.39 \text{ V}$$

Final Answer: EMF = 0.39 V at 25°C.

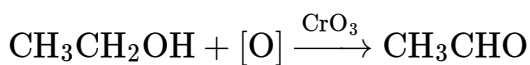
Q33(A): Identifying Compounds A, B, C, D, and E

Given molecular formula: C_2H_6O (ethanol or dimethyl ether).

Step 1: Oxidation of 'A' with CrO_3

- Primary alcohols oxidize to aldehydes and then to carboxylic acids.

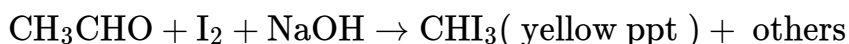
- Ethanol (CH_3CH_2OH) oxidizes to ethanal (acetaldehyde, CH_3CHO).



So, $A = \text{Ethanol}$, $B = \text{Ethanal}$ (CH_3CHO).

Step 2: Iodoform Test

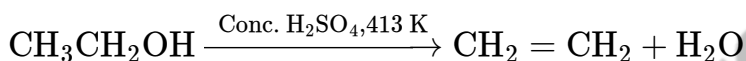
- Ethanal gives a yellow precipitate with iodine and NaOH due to the methyl ketone group ($COCH_3$).



So, $C = \text{Iodoform}$ (CHI_3).

Step 3: Heating A (Ethanol) with H_2SO_4 at 413 K

- Dehydration occurs, forming ethene (C_2H_4).



So, $D = \text{Ethene}$ (C_2H_4).

Step 4: Reaction of Ethene with Excess HI

- Ethene undergoes electrophilic addition of HI, forming ethyl iodide (C_2H_5I).

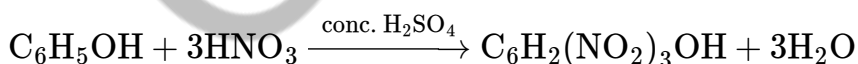


So, $E = \text{Ethyl iodide}$ (C_2H_5I).

Q33(B)(a): Writing Chemical Equations

(i) Phenol + Conc. HNO_3 (Nitration of Phenol)

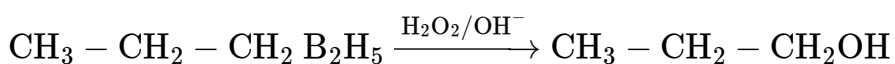
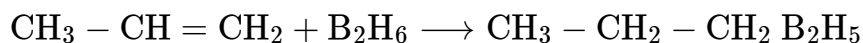
- Phenol undergoes nitration, forming 2,4,6-trinitrophenol (Picric Acid).



(ii) Hydroboration-Oxidation of Propene

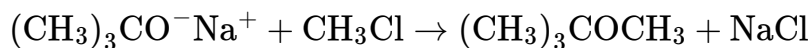
- Step 1: Propene reacts with B_2H_6 (diborane) via anti-Markovnikov addition.

- Step 2: Oxidation by H_2O_2/OH^- forms propan-1-ol.



(iii) Sodium t-Butoxide + CH₃Cl

- SN₂ reaction, where t-butoxide acts as a strong nucleophile.



Final Product: Methyl tert-butyl ether (MTBE).

Final Product: Propan-1-ol (CH₃CH₂CH₂OH).

Q33(B)(b): Test to Distinguish Butan-1-ol and Butan-2-ol

- Lucas Test (ZnCl₂ + HCl):

- Butan-1-ol (Primary alcohol) → No immediate reaction.

- Butan-2-ol (Secondary alcohol) → Cloudy solution in 5 minutes.

Q33(B)(C): Increasing Order of Acid Strength

- Phenol (C₆H₅OH): Most acidic due to resonance stabilization of the phenoxide ion.

- Water (H₂O) : More acidic than ethanol due to better hydrogen bonding.

- Ethanol (CH₃CH₂OH): Least acidic due to the electron-donating effect of the –CH₃ group.

Final Order (Increasing Acid Strength):

Ethanol < Water < Phenol