CUET 2024 Chemistry Set B Question Paper with Solutions

Total Time Allowed : 60 minutes	Maximum Marks : 200	Total Questions : 50	Questions to be answered : 40

Question 1

Camphor in nitrogen gas is a type of solution:
(1) Gas – Gas
(2) Solid – Gas
(3) Liquid – Gas
(4) Solid – Liquid

Correct Answer: (2)
Solution: Camphor in nitrogen gas represents a solid dissolved in a gas, as camphor sublimes into nitrogen gas, creating a solid-gas solution.

Quick Tip
Sublimation involves the direct transition from solid to gas without passing through the liquid phase.

Question 2

Identify the correct order of organic compounds in the following chemical reaction:

$$2I_2 + Mg \xrightarrow{\text{Dry Ether}} I_2 + H_2O \rightarrow 2 \quad \xrightarrow{Cl_2,\Delta} 2$$

(1) CH_3MgBr
(2) CH_3Br
(3) CH_3Cl
(4) CH_4

Correct Answer: (1)
Solution: The sequence involves the formation of Grignard reagent (CH_3MgBr) in dry ether, followed by subsequent reactions forming CH_3Br, CH_3Cl, and CH_4.

Quick Tip
Grignard reagents are highly reactive and are prepared in dry ether to prevent reactions with moisture.

Question 3

Consider the following statements regarding osmotic pressure:
(A) Molar mass of a protein can be determined using osmotic pressure method.
(B) The osmotic pressure is proportional to the molarity.
(C) Reverse osmosis occurs when a pressure larger than osmotic pressure is applied to the concentrated solution side.
(D) Edema occurs due to retention of water in tissue cells as a result of osmosis.

Choose the correct statements with reference to osmotic pressure:
(1) (A), (B), and (D) only
(2) (A), (B), and (C) only
(3) (A), (B), (C), and (D)
(4) (B), (C), and (D) only

Correct Answer: (3)
Solution: All the statements (A, B, C, and D) are correct. Osmotic pressure is a colligative property proportional to molarity and is used to determine molar masses. Reverse osmosis and edema are practical applications of osmotic pressure.

Quick Tip
Osmotic pressure ($\pi = MRT$) depends on molarity (M), temperature (T), and gas constant (R).

Question 4

Vapour pressures of pure liquids 'A' and 'D' at 50°C are 500 mm Hg and 800 mm Hg, respectively. The binary solution of 'A' and 'D' boils at 50°C and 700 mm Hg pressure. The mole percentage of 'D' in the solution is:
(1) 33.33 mole percent
(2) 66.67 mole percent
(3) 25.75 mole percent
(4) 75.25 mole percent

Correct Answer: (2)
Solution: Using Raoult's Law:

$$P_{\text{solution}} = P_A \cdot \chi_A + P_D \cdot \chi_D$$

Given $P_{\text{solution}} = 700$, $P_A = 500$, $P_D = 800$. Solving, $\chi_D = 0.667$, which corresponds to 66.67% mole percent.

Quick Tip

For binary solutions, mole fraction satisfies $\chi_A + \chi_D = 1$.

Question 5

For the following reaction:

$$2A_2(g) + \frac{1}{4}X(g) \rightarrow 2A_2X(g)$$

If the volume is increased to double its value by decreasing the pressure, and the reaction is first-order with respect to A_2 and second-order with respect to X, the rate of reaction will: (1) Decrease by eight times of its initial value
(2) Increase by eight times of its initial value
(3) Increase by four times of its initial value
(4) Remain unchanged

Correct Answer: (1)
Solution: The rate of reaction is proportional to the concentration of reactants. With the given order, doubling the volume decreases the concentration of A_2 and X by half. Hence, the rate decreases by a factor of 8 (i.e., $1/2^3$).

Quick Tip

Rate law for reactions depends on both the order and the concentrations of the reactants.

Question 6

The total number of sigma bonds present in P_4O_{10} are:
(1) 6
(2) 7
(3) 16
(4) 17

Correct Answer: (3)
Solution: The P_4O_{10} molecule has 4 $P = O$ bonds and 12 $P - O - P$ bonds, giving a total of 16 sigma bonds.

Quick Tip

Each $P - O$ and $P = O$ bond contains one sigma bond.

Question 7

In the electrolysis of alumina to obtain Aluminium metal, the cryolite is added mainly to:
(1) Lower the melting point of alumina.
(2) Dissolve the alumina in the molten cryolite.
(3) Remove the impurities of alumina.
(4) Increase the electrical conductivity.

Correct Answer: (1)
Solution: Cryolite reduces the melting point of alumina and enhances its conductivity, making the electrolysis process more efficient.

Quick Tip
Cryolite acts as a solvent for alumina and lowers the operating temperature of the process.

Question 8

Identify the order of reaction if its rate constant is $k = 2 \times 10^{-2} s^{-1}$:
(1) Zero order
(2) First order
(3) Second order
(4) Half order

Correct Answer: (2)
Solution: The unit of the rate constant (s^{-1}) corresponds to a first-order reaction.

Quick Tip
The units of the rate constant help determine the order of the reaction.

Question 9

For a complex reaction, the order of reaction is equal to:
(1) Sum of stoichiometric coefficients in the balanced chemical reaction.
(2) The molecularity of overall reaction.
(3) Order of fastest step of the reaction.
(4) The molecularity of slowest step of reaction.

Correct Answer: (4)

Solution: For complex reactions, the overall reaction order is determined by the rate-determining step, which is the slowest step.

Quick Tip
The slowest step governs the rate and hence determines the order of the reaction.

Question 10

A molecule X associates in a given solvent as per the following equation:

$$X(X)_n$$

For a given concentration of X, the van't Hoff factor was found to be 0.80, and the fraction of associated molecules was 0.3. The correct value of 'n' is:
(1) 2
(2) 3
(3) 1
(4) 5

Correct Answer: (2)
Solution: The van't Hoff factor i for association is given by:

$$i = 1 - \alpha + \frac{\alpha}{n}$$

Here, $i = 0.8$, $\alpha = 0.3$:

$$0.8 = 1 - 0.3 + \frac{0.3}{n}$$

$$0.8 = 0.7 + \frac{0.3}{n}$$

$$0.1 = \frac{0.3}{n} \implies n = \frac{0.3}{0.1} = 3$$

Thus, the correct answer is **(2)**.

Quick Tip
Use the van't Hoff factor formula for association to determine the value of n.

Question 11

The oxidation number of Co in complex $[Co(H_2NCH_2CH_2NH_2)_2(SO_4)]_2(SO_4)_3$ **is:**
(1) 3

(2) 4
(3) 2
(4) 5

Correct Answer: (1)
Solution: Let the oxidation number of Co be x. The charge on the complex is neutral.
- Ethylenediamine ($H_2NCH_2CH_2NH_2$) is a neutral ligand.
- SO_4^{2-} contributes a charge of -2 inside and -6 outside the complex.

$$x + (0 \cdot 2) + (-2 \cdot 1) = 0 \implies x = +3$$

Thus, the oxidation number of Co is **(1)**.

Quick Tip
Balance the total charge by accounting for the oxidation states of ligands and counter-ions.

Question 12

The correct structure of dipeptide, Gly-Ala (glycyl alanine) is:
(1) $H_2N - CH_2 - CO - NH - CH(CH_3) - COOH$
(2) $HOOC - CH_2 - NH - CO - CH(CH_3) - NH_2$
(3) $HOOC - CH(CH_3) - NH - CO - CH_2 - NH_2$
(4) $H_2N - CH(CH_3) - CO - NH - CH_2 - COOH$

Correct Answer: (1)
Solution: The dipeptide Gly-Ala is formed by linking glycine and alanine. Glycine contributes $H_2N - CH_2 - CO-$, and alanine contributes $-NH - CH(CH_3) - COOH$. The correct structure is:

$$H_2N - CH_2 - CO - NH - CH(CH_3) - COOH$$

Hence, the correct answer is **(1)**.

Quick Tip
To identify peptide structures, recall that the peptide bond links the carboxyl group of one amino acid to the amino group of the next.

Question 13

The total number of ions produced from the complex $[Cr(NH_3)_6]Cl_3$ in aqueous solution will be:

(1) 2
(2) 3
(3) 4
(4) 5

Correct Answer: (3)
Solution: The compound $[Cr(NH_3)_6]Cl_3$ dissociates in aqueous solution as:

$$[Cr(NH_3)_6]Cl_3 \rightarrow [Cr(NH_3)_6]^{3+} + 3Cl^-$$

This dissociation produces one $[Cr(NH_3)_6]^{3+}$ ion and three Cl^- ions, resulting in a total of 4 ions. Hence, the correct answer is **(3)**.

Quick Tip
Count the total number of ions formed after dissociation to determine the answer.

Question 14

Arrange the following in decreasing order of number of molecules contained in:
(A) 16 g of O_2
(B) 16 g of CO_2
(C) 16 g of CO
(D) 16 g of H_2

Choose the **correct** order from the options given below:
(1) (A), (B), (C), (D)
(2) (D), (C), (A), (B)
(3) (B), (A), (D), (C)
(4) (C), (B), (D), (A)

Correct Answer: (2)
Solution: The number of moles is calculated as moles $= \frac{\text{mass}}{\text{molar mass}}$.
- For O_2, moles $= \frac{16}{32} = 0.5$.
- For CO_2, moles $= \frac{16}{44} = 0.3636$.
- For CO, moles $= \frac{16}{28} = 0.5714$.
- For H_2, moles $= \frac{16}{2} = 8.0$.

Thus, the decreasing order is $(D) > (C) > (A) > (B)$. Hence, the correct answer is **(2)**.

Quick Tip

Divide the given mass by the molar mass of the compound to calculate moles for comparison.

Question 15

The Cu metal crystallises into FCC lattice with a unit cell edge length of 361 pm. The radius of Cu atom is:
(1) 127 pm
(2) 181 pm
(3) 157 pm
(4) 108 pm

Correct Answer: (1)
Solution: For an FCC lattice, the relation between the atomic radius r and the edge length a is given by:

$$r = \frac{a}{2\sqrt{2}}$$

Substituting $a = 361\,\text{pm}$:

$$r = \frac{361}{2\sqrt{2}} = \frac{361}{2 \times 1.414} \approx 127\,\text{pm}$$

Thus, the correct answer is **(1)**.

Quick Tip

For FCC lattices, use the formula $r = \frac{a}{2\sqrt{2}}$ to calculate the atomic radius from the edge length.

Question 16

If 75% of a first-order reaction gets completed in 32 minutes, time taken for 50% completion of this reaction is:
(1) 16 minutes
(2) 78 minutes
(3) 8 minutes
(4) 4 minutes

Correct Answer: (1)
Solution: For a first-order reaction, the half-life ($t_{1/2}$) is constant and independent of

concentration. From the relation:

$$\text{Fraction completed} = 1 - e^{-kt}$$

For 75% completion:

$$0.75 = 1 - e^{-k \cdot 32} \implies e^{-k \cdot 32} = 0.25 \implies k \cdot 32 = \ln(4) \implies k = \frac{\ln(4)}{32}$$

The half-life is given by:

$$t_{1/2} = \frac{0.693}{k} = \frac{0.693 \cdot 32}{\ln(4)} = 16\,\text{minutes}.$$

Thus, the correct answer is **(1)**.

Quick Tip
For first-order reactions, use the half-life formula $t_{1/2} = \frac{0.693}{k}$ to calculate the time required for 50% completion.

Question 17

Which of the following compounds will be repelled when placed in an external magnetic field?
(1) $Na_2[CuCl_4]$
(2) $Na_2[CdCl_4]$
(3) $K_4[Fe(CN)_6]$
(4) $K_3[Fe(CN)_6]$

Correct Answer: (3)
Solution: The compound $K_4[Fe(CN)_6]$ contains Fe^{2+}, which has a low-spin configuration due to the strong field ligand CN^-. As a result, it has no unpaired electrons and exhibits diamagnetic behavior, meaning it is repelled by an external magnetic field. Hence, the correct answer is **(3)**.

Quick Tip
Check for unpaired electrons in the metal ion's configuration to determine if the compound is paramagnetic or diamagnetic.

Question 18

The spin-only magnetic moment of Hexacyanomanganate(II) ion is ___BM.
(1) 5.90

(2) 1.73
(3) 4.90
(4) 3.87

Correct Answer: (1)
Solution: The ion $[Mn(CN)_6]^{4-}$ contains Mn^{2+} with a d^5 configuration. Since CN^- is a strong field ligand, it causes pairing of all electrons, resulting in 5 unpaired electrons. The spin-only magnetic moment is calculated as:

$$\mu_s = \sqrt{n(n+2)}\,\text{BM}$$
$$\mu_s = \sqrt{5(5+2)} = \sqrt{35} \approx 5.90\,\text{BM}$$

Thus, the correct answer is **(1)**.

Quick Tip

For spin-only magnetic moment, use the formula $\mu_s = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons.

Question 19

The correct order of increasing boiling points of the following compounds is:
Pentan-1-ol, n-Butane, Pentanal, Ethoxyethane
(1) Ethoxyethane, Pentanal, n-Butane, Pentan-1-ol
(2) Pentanal, n-Butane, Ethoxyethane, Pentan-1-ol
(3) n-Butane, Pentanal, Ethoxyethane, Pentan-1-ol
(4) n-Butane, Ethoxyethane, Pentanal, Pentan-1-ol

Correct Answer: (4)
Solution: Boiling points depend on molecular interactions.
- n-Butane has the lowest boiling point due to weak van der Waals forces.
- Ethoxyethane has stronger dipole-dipole interactions.
- Pentanal has even stronger dipole-dipole interactions due to the carbonyl group.
- Pentan-1-ol has the highest boiling point due to hydrogen bonding.
Thus, the increasing order is n-Butane ¡ Ethoxyethane ¡ Pentanal ¡ Pentan-1-ol. Hence, the correct answer is **(4)**.

Quick Tip

Remember: Hydrogen bonding ¿ Dipole-dipole ¿ Van der Waals forces in determining boiling points.

Question 20

In the following reaction, identify the product D:

$$C_6H_5OH \xrightarrow{Zn\,\text{dust}} A \xrightarrow{CH_3Cl+\text{anh. } AlCl_3} B \xrightarrow{K_2Cr_2O_7+H_2SO_4} C \xrightarrow{H_2SO_4+HNO_3} D$$

(1) o-Nitrobenzoic acid
(2) p-Nitrobenzoic acid
(3) o,p-Dinitrobenzoic acid
(4) m-Nitrobenzoic acid

Correct Answer: (2)
Solution: The reaction proceeds as follows:
1. $C_6H_5OH \xrightarrow{Zn\,\text{dust}} C_6H_6$ (A).
2. $C_6H_6 \xrightarrow{CH_3Cl+\text{anh. } AlCl_3} C_6H_5CH_3$ (B).
3. $C_6H_5CH_3 \xrightarrow{K_2Cr_2O_7+H_2SO_4} C_6H_5COOH$ (C).
4. $C_6H_5COOH \xrightarrow{H_2SO_4+HNO_3}$ p-Nitrobenzoic acid (D).

Thus, the correct answer is **(2)**.

Quick Tip
Understand each step in the reaction sequence and identify the transformations to deduce the final product.

Question 21

The gold number range of some of the lyophilic colloids is given below:
A: 0.005–0.01, B: 0.15–0.25, C: 0.04–1.0, D: 15–25
Which among these can be used as a better protective colloid?
(1) A
(2) B
(3) C
(4) D

Correct Answer: (1)
Solution: The gold number is the minimum amount of a lyophilic colloid in milligrams required to prevent the coagulation of 10 mL of a standard gold sol. A smaller gold number indicates better protective action. Among the given options, A has the lowest gold number (0.005–0.01), making it the most effective protective colloid. Hence, the correct answer is **(1)**.

Quick Tip
A lower gold number signifies better protective colloid efficiency.

Question 22

Reaction of aniline with conc. HNO_3 and conc. H_2SO_4 at 298 K will produce 47% of:
(1) p-Nitroaniline
(2) o-Nitroaniline
(3) m-Nitroaniline
(4) 2,4-Dinitroaniline

Correct Answer: (3)
Solution: In strongly acidic conditions, the amino group ($-NH_2$) of aniline is protonated to form anilinium ion ($-NH_3^+$). This group is meta-directing for electrophilic substitution. Therefore, nitration of aniline under these conditions predominantly produces m-Nitroaniline. Hence, the correct answer is **(3)**.

Quick Tip

In nitration of aniline, acidic conditions lead to meta substitution due to the formation of the protonated amino group.

Question 23

What will be the increasing order of basic strength of the following compounds?

$$C_2H_5NH_2,\ (C_2H_5)_2NH,\ (C_2H_5)_3N,\ C_6H_5NH_2$$

(1) $C_2H_5NH_2 < (C_2H_5)_2NH < (C_2H_5)_3N < C_6H_5NH_2$
(2) $C_6H_5NH_2 < C_2H_5NH_2 < (C_2H_5)_3N < (C_2H_5)_2NH$
(3) $(C_2H_5)_3N < (C_2H_5)_2NH < C_2H_5NH_2 < C_6H_5NH_2$
(4) $(C_2H_5)_2NH < (C_2H_5)_3N < C_6H_5NH_2 < C_2H_5NH_2$

Correct Answer: (2)
Solution: Basic strength depends on the electron-donating ability of substituents and the availability of the lone pair on the nitrogen atom.
- $C_6H_5NH_2$: Weakest base due to resonance with the benzene ring.
- $C_2H_5NH_2$: Moderate base; alkyl group increases electron density on nitrogen.
- $(C_2H_5)_3N$: Steric hindrance reduces basicity despite three alkyl groups.
- $(C_2H_5)_2NH$: Strongest base due to two alkyl groups with minimal steric hindrance.
Thus, the increasing order is: $C_6H_5NH_2 < C_2H_5NH_2 < (C_2H_5)_3N < (C_2H_5)_2NH$. Hence, the correct answer is **(2)**.

Quick Tip

Alkyl groups increase basic strength by donating electrons, but steric hindrance can reduce it.

Question 24

Which of the following compounds will give Hell-Volhard-Zelinsky reaction?
(1) $R - CH_2 - COOH$
(2) $R_3C - CHO$
(3) R_2CO
(4) $H - COOH$

Correct Answer: (1)
Solution: The Hell-Volhard-Zelinsky (HVZ) reaction involves the halogenation of carboxylic acids at the α-position. This reaction requires at least one α-hydrogen in the carboxylic acid. Among the options, $R - CH_2 - COOH$ contains an α-hydrogen and undergoes the HVZ reaction. Hence, the correct answer is **(1)**.

Quick Tip

The HVZ reaction occurs only with carboxylic acids having α-hydrogens.

Question 25

Arrange the following acids in increasing order of their acidic strengths:

$$HCOOH,\ FCH_2COOH,\ NO_2CH_2COOH,\ ClCH_2COOH$$

(1) $HCOOH < FCH_2COOH < NO_2CH_2COOH < ClCH_2COOH$
(2) $HCOOH < NO_2CH_2COOH < ClCH_2COOH < FCH_2COOH$
(3) $NO_2CH_2COOH < HCOOH < ClCH_2COOH < FCH_2COOH$
(4) $HCOOH < ClCH_2COOH < FCH_2COOH < NO_2CH_2COOH$

Correct Answer: (4)
Solution: Acidic strength is influenced by the electron-withdrawing ability of substituents. A stronger electron-withdrawing group increases acidity by stabilizing the conjugate base.
- NO_2CH_2COOH: Most acidic due to strong NO_2 group.
- FCH_2COOH: Second most acidic due to the high electronegativity of F.
- $ClCH_2COOH$: Less acidic than FCH_2COOH.
- $HCOOH$: Weakest acid as it has no electron-withdrawing group.

Thus, the increasing order is: $HCOOH < ClCH_2COOH < FCH_2COOH < NO_2CH_2COOH$. Hence, the correct answer is **(4)**.

Quick Tip
Stronger electron-withdrawing groups like NO_2 increase acidic strength more than halogens.

Question 26

In the following compounds, what is the increasing order of their reactivity towards nucleophilic addition reactions?
Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone
(1) Benzaldehyde < *p*-Tolualdehyde < *p*-Nitrobenzaldehyde < Acetophenone
(2) Acetophenone < Benzaldehyde < *p*-Tolualdehyde < *p*-Nitrobenzaldehyde
(3) Acetophenone < *p*-Tolualdehyde < Benzaldehyde < *p*-Nitrobenzaldehyde
(4) Benzaldehyde < Acetophenone < *p*-Tolualdehyde < *p*-Nitrobenzaldehyde

Correct Answer: (2)
Solution: Reactivity towards nucleophilic addition is influenced by electron-withdrawing and electron-donating groups.
- Acetophenone: Least reactive due to the electron-donating CH_3 group and conjugation with the benzene ring.
- Benzaldehyde: More reactive due to no additional groups.
- *p*-Tolualdehyde: Less reactive than Benzaldehyde due to the electron-donating CH_3 group.
- *p*-Nitrobenzaldehyde: Most reactive due to the strong electron-withdrawing NO_2 group.
Thus, the increasing order is: Acetophenone < Benzaldehyde < *p*-Tolualdehyde < *p*-Nitrobenzaldehyde . Hence, the correct answer is **(2)**.

Quick Tip
Electron-withdrawing groups increase reactivity towards nucleophilic addition, while electron-donating groups decrease it.

Question 27

The Gatterman-Koch reaction is used in the industrial preparation of benzaldehyde. The electrophile involved in this reaction is:
(1) CO^+
(2) $HCl + CO_2 +$ anhydrous $AlCl_3$
(3) $CO +$ anhydrous $AlCl_3$

(4) HCO^+

Correct Answer: (1)
Solution: The Gatterman-Koch reaction involves the preparation of benzaldehyde by introducing a formyl group ($-CHO$) into benzene in the presence of CO, HCl, and $AlCl_3/CuCl$. The electrophile in this reaction is CO^+, generated in situ. Hence, the correct answer is **(1)**.

Quick Tip
Remember that CO^+ is the electrophile in the Gatterman-Koch reaction for formylation of benzene.

Question 28

Formaldehyde undergoes Cannizzaro reaction because:
(A) It has alpha-hydrogen atom.
(B) It does not have alpha-hydrogen atom.
(C) It does not undergo self-oxidation and reduction on heating with concentrated alkali.
(D) It undergoes self-oxidation and reduction on heating with concentrated alkali.

Choose the correct answer from the options given below:
(1) (B) and (C) only
(2) (A) and (C) only
(3) (B) and (D) only
(4) (A) and (D) only

Correct Answer: (3)
Solution: The Cannizzaro reaction is a redox reaction in which one molecule of an aldehyde without an alpha-hydrogen atom is oxidized to a carboxylic acid and another molecule is reduced to an alcohol in the presence of a strong base.
- Formaldehyde ($HCHO$) does not have an alpha-hydrogen atom, which makes it undergo the Cannizzaro reaction.
- During the reaction, $HCHO$ undergoes self-oxidation and reduction in the presence of concentrated alkali.
Thus, the correct statements are (B) and (D).

Quick Tip
For Cannizzaro reactions, always check whether the aldehyde lacks alpha-hydrogens.

Question 29

In the reaction, $(CH_3)_3C-O-CH_3+HI \rightarrow$ **Products,** CH_3OH **and** $(CH_3)_3C-Cl$ **are the products and not** CH_3I **and** $(CH_3)_3C-OH$**. It is because:**
(A) In step 2 of the reaction the departure of the leaving group $(HO-CH_3)$ creates less stable carbocation.
(B) In step 2 of the reaction the departure of the leaving group $(HO-CH_3)$ creates more stable carbocation.
(C) The reaction follows S_N1 mechanism.
(D) The reaction follows S_N2 mechanism.

Choose the correct answer from the options given below:
(1) (B) and (C) only
(2) (A) and (C) only
(3) (B) and (D) only
(4) (A) and (D) only

Correct Answer: (1)
Solution:
- The reaction proceeds via an S_N1 mechanism because the bulky $(CH_3)_3C$ group makes nucleophilic attack at the central carbon difficult.
- The S_N1 mechanism involves the formation of a carbocation intermediate, where the departure of $HO-CH_3$ creates a more stable $(CH_3)_3C^+$ carbocation.
- Thus, CH_3OH and $(CH_3)_3C-Cl$ are formed as products.
Therefore, the correct statements are (B) and (C).

Quick Tip
For S_N1 reactions, look for the stability of the carbocation intermediate.

Question 30

Aniline does not undergo Friedel-Crafts reaction because:
(A) It forms salt with the Lewis acid catalyst, $AlCl_3$.
(B) Nitrogen of aniline acquires negative charge.
(C) Nitrogen of aniline acquires positive charge.
(D) Nitrogen acts as a strong deactivating group in the further reaction.

Choose the correct answer from the options given below:
(1) (A), (B) and (D) only
(2) (A), (B) and (C) only
(3) (A), (C) and (D) only
(4) (B), (C) and (D) only

Correct Answer: (1)
Solution: Aniline does not undergo the Friedel-Crafts reaction due to the following reasons:
- The Lewis acid catalyst $AlCl_3$ reacts with the amine group of aniline to form a salt, thereby deactivating the aromatic ring for further electrophilic substitution.
- Nitrogen acquires a partial negative charge due to resonance, reducing its reactivity.
- Nitrogen acts as a deactivating group in the reaction.
Hence, the correct statements are (A), (B), and (D).

Quick Tip
Aniline's amine group forms a salt with $AlCl_3$, preventing it from undergoing Friedel-Crafts reactions.

Question 31

Although chlorine is an electron-withdrawing group, yet it is ortho- and para-directing in electrophilic aromatic substitution reactions because:
(A) Chlorine withdraws electrons through inductive effect.
(B) Chlorine destabilizes the intermediate carbocation formed during electrophilic substitution.
(C) Chlorine accepts electrons through resonance.
(D) Chlorine releases electrons through resonance.

Choose the correct answer from the options given below:
(1) (A), (B) and (D) only
(2) (A), (B) and (C) only
(3) (A), (C) and (D) only
(4) (B), (C) and (D) only

Correct Answer: (4)
Solution: Chlorine is an electron-withdrawing group due to its high electronegativity, but it also has lone pairs of electrons that participate in resonance.
- The inductive effect of chlorine deactivates the benzene ring slightly.
- However, its resonance effect stabilizes the intermediate carbocation at ortho and para positions.
- Hence, chlorine is ortho- and para-directing.
The correct statements are (B), (C), and (D).

Quick Tip
Remember, halogens are deactivating but still ortho- and para-directing due to resonance effects.

Question 32

In Etard reaction, the final product is:
(1) Aromatic aldehyde
(2) Aromatic chloride
(3) Aromatic amine
(4) Aromatic alcohol

Correct Answer: (1)
Solution: The Etard reaction involves the oxidation of a methyl group attached to an aromatic ring to form an aldehyde. For example, toluene is oxidized to benzaldehyde using chromyl chloride (CrO_2Cl_2) in this reaction.
Thus, the final product in the Etard reaction is an **aromatic aldehyde**.

Quick Tip

The Etard reaction selectively oxidizes methyl groups on aromatic rings to aldehydes.

Question 33

Match List-I with List-II:

List-I	**List-II**
(A)Amino acids linked in a specific sequence	(I)Primary structure of proteins
(B)Regular folding of a specific sequence of amino acids due to H-bonding	(II)Secondary structure of proteins
(C)Fibrous proteins	(III)Quaternary structure of proteins
(D)Spatial arrangement of two or more polypeptide chains	(IV)Tertiary structure of proteins

Choose the correct answer from the options given below:
(1) (A) - (I), (B) - (II), (C) - (III), (D) - (IV)
(2) (A) - (II), (B) - (IV), (C) - (I), (D) - (III)
(3) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
(4) (A) - (III), (B) - (I), (C) - (IV), (D) - (II)

Correct Answer: (1)
Solution:
- The primary structure of proteins refers to the specific sequence of amino acids linked

together by peptide bonds.
- The secondary structure involves folding due to hydrogen bonding, such as in alpha-helices and beta-sheets.
- Fibrous proteins have a quaternary structure, which involves the arrangement of polypeptide chains.
- The tertiary structure involves the spatial arrangement of protein chains.
Thus, the correct matches are:
(A) - (I), (B) - (II), (C) - (III), (D) - (IV).

Quick Tip
Remember, the primary structure is the sequence of amino acids, while secondary, tertiary, and quaternary structures involve folding and arrangements.

Question 34

Match List-I with List-II:

List-I	**List-II**
(A)Tollen's reagent	(I)Rochelle salt
(B)Jones reagent	(II)Conc. HCl and $ZnCl_2$
(C)Lucas reagent	(III)Ammoniacal silver nitrate
(D)Fehling solution	(IV)Chromium trioxide-sulphuric acid

Choose the correct answer from the options given below:
(1) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)
(2) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
(3) (A) - (IV), (B) - (II), (C) - (III), (D) - (I)
(4) (A) - (III), (B) - (II), (C) - (IV), (D) - (I)

Correct Answer: (1)
Solution:
- Tollen's reagent is ammoniacal silver nitrate used to test aldehydes.
- Jones reagent, a mixture of chromium trioxide and sulphuric acid, is a strong oxidizing agent.
- Lucas reagent (conc. HCl and $ZnCl_2$) is used to distinguish between primary, secondary, and tertiary alcohols.
- Fehling solution contains Rochelle salt and is used to test reducing sugars.
Thus, the correct matches are:
(A) - (III), (B) - (IV), (C) - (II), (D) - (I).

Quick Tip

Associate the reagents with their primary uses to recall their combinations quickly.

Question 35

Match List-I with List-II:

List-I	**List-II**
(A)Swarts Reaction	$(I)C_6H_5NH_2 + NaNO_2 + HX + Cu_2X_2 \rightarrow C_6H_5X + N_2$
(B)Finkelstein Reaction	$(II)2RX + 2Na \rightarrow R\text{-}R + 2NaX$
(C)Sandmeyer's Reaction	$(III)RX + AgF \rightarrow R\text{-}F + AgX$
(D)Wurtz Reaction	$(IV)RX + I_2 \rightarrow R\text{-}I + NaX$

Choose the correct answer from the options given below:
(1) (A) - (III), (B) - (II), (C) - (I), (D) - (IV)
(2) (A) - (IV), (B) - (III), (C) - (I), (D) - (II)
(3) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
(4) (A) - (III), (B) - (I), (C) - (IV), (D) - (II)

Correct Answer: (3)
Solution:
- **Swarts Reaction:** Used for preparing alkyl fluorides by reaction of alkyl halides with silver fluoride ($RX + AgF$).
- **Finkelstein Reaction:** Substitution reaction involving $RX + I_2$ to form alkyl iodides.
- **Sandmeyer's Reaction:** Converts aryl amines to aryl halides using $NaNO_2$ and CuX_2.
- **Wurtz Reaction:** Forms alkanes by reacting alkyl halides with sodium metal ($2RX + 2Na$).
Thus, the correct matches are:
(A) - (III), (B) - (IV), (C) - (I), (D) - (II).

Quick Tip

Remember key reactions: Swarts for fluorides, Finkelstein for iodides, Sandmeyer for aryl halides, and Wurtz for alkanes.

Question 36

Match List-I with List-II:

List-I (Biomolecule)	List-II (Function/Diseases)
(A)Vitamin A	(I)Menstrual cycle
(B)Thiamine	(II)Xerophthalmia
(C)Glucocorticoids	(III)Beri-Beri
(D)Estradiol	(IV)Addison's disease

Choose the correct answer from the options given below:
(1) (A) - (III), (B) - (III), (C) - (I), (D) - (IV)
(2) (A) - (IV), (B) - (III), (C) - (II), (D) - (I)
(3) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)
(4) (A) - (II), (B) - (III), (C) - (IV), (D) - (I)

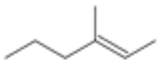
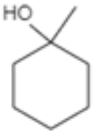
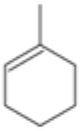
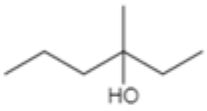
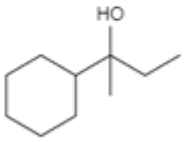
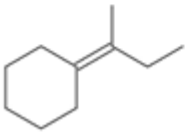
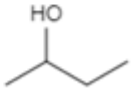
Correct Answer: (4)
Solution:
- **Vitamin A:** Deficiency leads to Xerophthalmia.
- **Thiamine:** Its deficiency causes Beri-Beri.
- **Glucocorticoids:** Deficiency is associated with Addison's disease.
- **Estradiol:** A hormone regulating the menstrual cycle.
Thus, the correct matches are:
(A) - (II), (B) - (III), (C) - (IV), (D) - (I).

Quick Tip

Relate biomolecules to their deficiencies or roles: Vitamin A (vision), Thiamine (nerves), Glucocorticoids (hormones), Estradiol (reproductive health).

Question 37

Match the reactants given in List-I with the correct products in List-II under the reaction of hydration of alkene under acidic condition:

List-I (Reactants)	List-II (Products)
(A) 	(I) 
(B) 	(II) 
(C) 	(III) 
(D) 	(IV) 

Choose the correct answer from the options given below:
(1) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)
(2) (A) - (I), (B) - (III), (C) - (II), (D) - (IV)
(3) (A) - (II), (B) - (I), (C) - (IV), (D) - (III)
(4) (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

Correct Answer: (1)
Solution: The products formed follow Markovnikov's rule in acidic hydration. The correct matches are:
(A) Propene forms $CH_3 - CH(OH)\text{-}CH_3$.
(B) Cyclohexene forms Cyclohexanol.
(C) 1-Butene forms Butan-2-ol.
(D) Isobutylene forms 2-Methyl-2-butanol.

Quick Tip
Markovnikov's rule: In the addition of HX or H_2O to an alkene, the hydrogen atom attaches to the carbon with more hydrogens.

Question 38

Which among the following is not an Analgesic?
(1) Morphene

(2) Heroin
(3) Codeine
(4) Ranitidine

Correct Answer: (4)
Solution:
Ranitidine is a medication used to reduce stomach acid and treat ulcers. It is not an analgesic. Analgesics are drugs used to relieve pain, such as Morphene, Heroin, and Codeine.

Quick Tip
Remember: Analgesics are pain relievers, whereas Ranitidine is used for gastric conditions.

Question 39

The increasing order of acidity of the following compounds based on pKa values is:
(A) $BrCH_2COOH$
(B) $ClCH_2COOH$
(C) FCH_2COOH
(D) HCOOH

Choose the correct answer from the options given below:
(1) (D) <(A) <(B) <(C)
(2) (A) <(D) <(C) <(B)
(3) (B) <(A) <(D) <(C)
(4) (C) <(B) <(D) <(A)

Correct Answer: (1)
Solution:
The acidity depends on the electronegativity of the substituent and its effect on stabilizing the conjugate base:
- HCOOH (formic acid) is less acidic than halogen-substituted acids.
- Among halogen-substituted acids, acidity increases with the electronegativity of the substituent: F > Cl > Br.
Thus, the correct order is: $HCOOH < BrCH_2COOH < ClCH_2COOH < FCH_2COOH$.

Quick Tip
Electronegativity increases acidity due to stronger inductive effects stabilizing the conjugate base.

Question 40

For S_N2 reaction, the increasing order of the reactivity of the following alkyl halides is:
(A) $CH_3CH_2CH_2CH_2Br$
(B) $CH_3CH_2CH(Br)CH_3$
(C) $(CH_3)_2CBr$
(D) $(CH_3)_2CHCH_2Br$

Choose the correct answer from the options given below:
(1) (A) <(B) <(C) <(D)
(2) (A) <(C) <(B) <(D)
(3) (B) <(A) <(D) <(C)
(4) (C) <(B) <(D) <(A)

Correct Answer: (1)
Solution:
For the S_N2 mechanism, the rate depends on steric hindrance. The least hindered molecule reacts fastest. Primary alkyl halides like (A) react faster than secondary halides (B) and tertiary halides (C and D). Thus, the order is: (A) ¡ (B) ¡ (C) ¡ (D).

Quick Tip
In S_N2 reactions, less steric hindrance leads to higher reactivity.

Read the following passage and answer the next five questions based on it:

Battery or cell converts chemical energy of the redox reaction to electrical energy. In fuel cell (a galvanic cell), the chemical energy of combustion of fuels like H_2, ethanol, etc., are directly converted to electrical energy. In a fuel cell, H_2 and O_2 react to produce electricity, where H_2 gas is oxidised at the anode and oxygen is reduced at the cathode. The reactions involved are:

$$\text{Anode reaction: } H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$$

$$\text{Cathode reaction: } O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$$

Given: 67.2 L of H_2 at STP reacts in 15 minutes.

Question 41

The number of moles of hydrogen oxidised is:
(1) 0.33 moles
(2) 33.3 moles

(3) 3.0 moles
(4) 1.33 moles

Correct Answer: (3)
Solution:
The volume of H_2 is 67.2 L at STP. At STP, 1 mole of gas occupies 22.4 L. Therefore:

$$\text{Moles of } H_2 = \frac{67.2}{22.4} = 3.0 \text{ moles.}$$

Quick Tip
Use the relation: 1 mole of gas at STP = 22.4 L.

Question 42

The number of moles of electrons produced in the oxidation of 67.2 L of H_2 at STP is:
(1) 2 moles
(2) 4 moles
(3) 1 mole
(4) 6 moles

Correct Answer: (4)
Solution:
Each mole of H_2 produces 2 moles of electrons:

$$\text{Moles of electrons} = 3 \times 2 = 6 \text{ moles.}$$

Quick Tip
For oxidation, $H_2 \rightarrow 2H^+ + 2e^-$, meaning 2 moles of electrons are released per mole of H_2.

Question 43

The quantity of electricity produced in the oxidation of 67.2 L of H_2 at STP is:
(1) 96500 C
(2) 579000 C
(3) 193000 C
(4) 48250 C

Correct Answer: (2)
Solution:
The charge (Q) is calculated as:

$$Q = n \cdot F$$

where n is the moles of electrons and $F = 96500\,\text{C/mol}$. For 6 moles of electrons:

$$Q = 6 \times 96500 = 579000\,\text{C}.$$

Quick Tip
Faraday's constant $F = 96500\,\text{C/mol}$ relates charge to moles of electrons.

Question 44

If the entire current produced is used for the electrodeposition of Silver (at. wt. 108 g/mol) from Silver (I) solution, the amount of silver deposited will be:
(1) 324 g
(2) 648 g
(3) 108 g
(4) 216 g

Correct Answer: (1)
Solution:
The amount of silver deposited is given by:

$$\text{Mass} = \frac{Q}{n \cdot F} \times M$$

where $Q = 579000\,\text{C}$, $n = 1$, $F = 96500\,\text{C/mol}$, and $M = 108\,\text{g/mol}$:

$$\text{Mass} = \frac{579000}{1 \cdot 96500} \times 108 = 324\,\text{g}.$$

Quick Tip
Use the formula $\text{Mass} = \frac{Q}{n \cdot F} \times M$ for electrodeposition problems.

Question 45

The source of electrical energy on the Apollo moon flight was:
(1) Lead storage battery
(2) A generator set
(3) Ni-Cd cells

(4) H_2-O_2 Fuel cell

Correct Answer: (4)
Solution: The Apollo missions utilized H_2-O_2 fuel cells as their source of electrical energy. These fuel cells produce electricity by combining hydrogen and oxygen, with water being the by-product. This method was lightweight and efficient for space missions.

Quick Tip
Fuel cells are often used in space missions due to their efficiency and ability to produce water as a by-product, which is useful for astronauts.

Read the following passage and answer the next five questions based on it:
Sc Ti V Cr Mn Fe Co Ni Cu Zn
Y Zr Nb Mo Tc Ru Rh Pd Ag Cd
La Hf Ta W Re Os Ir Pt Au Hg

In any transition series, as we move from left to right, the d-orbitals are progressively filled, and their properties vary accordingly.
Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Th Pa U Np Pu Am Cm Bk Cf Es Fm Md No Lr

The above are the two series of f-block elements in which the chemical properties won't change much. The $5f$-series elements are radioactive in nature and mostly are artificially synthesized in laboratories, and thus much is not known about their chemical properties.

Question 46

Identify the incorrect statement.
(1) Second ionisation enthalpy of Ag is greater than second ionisation enthalpy of Pd.
(2) Zr and Hf share almost identical nuclear properties.
(3) The oxidation state of Mn is lower than that of Cr.
(4) Interstitial compounds are non-stoichiometric and neither ionic nor covalent in nature.

Correct Answer: (3)
Solution: The oxidation state of Mn is higher than that of Cr in their respective compounds (e.g., +7 in MnO_4^- vs +6 in $Cr_2O_7^{2-}$). Other statements are correct.

Quick Tip
Remember that Mn can achieve a maximum oxidation state of +7, whereas Cr is limited to +6.

Question 47

Which of the following is the correct order of second ionisation enthalpy?
(1) $V < Cr > Mn$
(2) $V < Cr < Mn$
(3) $V > Cr > Mn$
(4) $V > Cr < Mn$

Correct Answer: (1)
Solution: The second ionisation enthalpy increases as more electrons are removed from stable configurations. Cr has a higher second ionisation enthalpy than V and Mn due to the stability of its half-filled $3d^5$ configuration.

Quick Tip
Half-filled and fully-filled configurations increase ionisation enthalpy due to their extra stability.

Question 48

Which of the following pair of compounds exhibits the same colour in aqueous solution?
(1) $FeCl_2, CuCl_2$
(2) $VOCl_2, CuCl_2$
(3) $VOCl_2, FeCl_2$
(4) $VOCl_2, MnCl_2$

Correct Answer: (2)
Solution: Both $VOCl_2$ and $CuCl_2$ exhibit a green colour in aqueous solution due to the presence of *d-d* transitions.

Quick Tip
Colours in transition metal complexes are primarily due to *d-d* electronic transitions.

Question 49

Which metal has the highest oxidation state in the first-row transition series?
(1) Cr
(2) Fe
(3) Mn

(4) V

Correct Answer: (3)
Solution: Manganese (Mn) achieves a maximum oxidation state of +7 in MnO_4^-, which is the highest in the first-row transition series.

Quick Tip
The maximum oxidation state corresponds to the total number of s and d electrons available for bonding.

Question 50

Why do the actinoids exhibit higher number of oxidation states than lanthanoids?
(1) $4f$ orbitals are more diffused than the $5f$ orbitals.
(2) Energy difference between $5f$ and $6d$ is less with respect to the energy difference between $4f$ and $5d$.
(3) Energy difference between $5f$ and $6d$ is more with respect to the energy difference between $4f$ and $5d$.
(4) Actinoids are more reactive in nature than lanthanoids.

Correct Answer: (2)
Solution: The smaller energy difference between $5f$ and $6d$ orbitals allows actinoids to exhibit a wider range of oxidation states compared to lanthanoids.

Quick Tip
Lower energy gaps between orbitals allow for greater participation in chemical bonding, leading to multiple oxidation states.
