CBSE EXAMINATION PAPER-2025

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 38

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **24 questions.** All questions are **compulsory.**

ii. This question paper is divided into **4 sections.**

iii. **Section A** – questions number **1 to 12** are multiple choice questions Each question carries **1 marks.**

iv. **Section B** – questions number **13 to 16** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **17 to 22** are short answer Each question carries **3 marks.**

vi. **Section D** – questions number **23 to 24** are case based questions

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

viii. Use of calculator is NOT allowed.

Section A

Question 1.

According to Werner's theory of coordination compounds:

[1 Marks]

(A) Primary valences are ionisable.

(B) Both primary and secondary valences are non-ionisable.

(C) Secondary valences are ionisable.

(D) Both primary and secondary valences are ionisable.

Explanation:

The correct option is 'Primary valences are ionisable.' According to Werner's theory, primary valences denote the ionisable part of the metal ion and are satisfied by negative ions, while secondary valences are non-ionisable.

Question 2.

Which of the following complex ion is not optically active?

[1 Marks]

(A) cis-$[Co(en)_2Cl_2]^+$

(B) $[Co(ox)_3]^{3-}$

(C) trans-$[Co(en)_2Cl_2]^+$

(D) $[Co(en)_3]^{3+}$

Explanation:

A molecule is optically active if it cannot be superimposed on its mirror image. The trans isomer of $[Co(en)_2Cl_2]^+$ has a plane of symmetry, meaning its mirror image can be superimposed on the original molecule, making it optically inactive.

Question 3.

Which of the following is the softest metal?

[1 Marks]

(A) Fe

(B) Zn

(C) Cu

(D) Sc

Explanation:

Among the given options (Fe, Zn, Cu, Sc), Zinc (Zn) is the softest metal. The context mentions that transition metals are generally very hard, with exceptions like Zn, Cd, and Hg, which do not display the typical hardness properties of transition elements. This indicates that zinc is comparatively softer than the other metals listed.

Question 4.

The freezing point of one molal KCl solution, assuming KCl to be completely dissociated in water, is: (Kf for water = 1·86 K kg mol^{-1})

[1 Marks]

(A) −1·86°C

(B) +2·72°C

(C) +3·72°C

(D) −3·72°C

Explanation:

To calculate the depression in freezing point (ΔTf), we use the formula ΔTf = i * Kf * m, where i (van't Hoff factor for KCl) = 2 (since KCl dissociates into K+ and Cl−), Kf for water = 1.86 K kg mol^{-1}, and m = 1 molal. Thus, ΔTf = 2 * 1.86 * 1 = 3.72°C. The freezing point will decrease, so the final freezing point = 0°C - 3.72°C = -3.72°C.

Question 5.

A solution of acetone in ethanol:

[1 Marks]

(A) obeys Raoult's law.

(B) shows a negative deviation from Raoult's law.

(C) shows a positive deviation from Raoult's law.

(D) forms an ideal solution.

Explanation:

The correct answer is 'shows a positive deviation from Raoult's law.' This is because when acetone is added to ethanol, it disrupts the hydrogen bonding between ethanol molecules, leading to an increase in vapor pressure. This implies that the solution will exhibit positive deviation from Raoult's law, where the mixture's vapor pressure is higher than expected for an ideal solution.

Question 6.

Which of the following cell converts the energy of combustion of fuel into electrical energy?

[1 Marks]

(A) Mercury cell

(B) Lead storage cell

(C) Dry cell

(D) Fuel cell

Explanation:

The correct answer is 'Fuel cell' because, as stated in the context, fuel cells are designed specifically to convert the energy from the combustion of fuels like hydrogen, methane, and methanol directly into electrical energy.

Question 7.

The unit of rate and rate constant are same for a:

[1 Marks]

(A) Second order reaction

(B) Zero order reaction

(C) First order reaction

(D) Third order reaction

Explanation:

The correct option is 'Zero order reaction'. For a zero order reaction, the unit of rate (mol L^{-1} s^{-1}) is the same as the unit of the rate constant (k), which is also expressed as mol L^{-1} s^{-1} according to the provided context.

Question 8.

Pyranose ring of glucose is formed due to the reaction between:

[1 Marks]

(A) C_1 and C_5

(B) C_1 and C_3

(C) C_1 and C_2

(D) C_1 and C_4

Explanation:

The correct option is C_1 and C_5. The pyranose ring structure of glucose, which is a six-membered ring, is formed when the hydroxyl group (-OH) on carbon atom 5 (C-5) reacts with the aldehyde group (C-1) to create a cyclic structure, leading to the absence of the aldehyde (-CHO) group in the cyclic form.

Question 9.

Assertion (A) : Actinoids show wide range of oxidation states.

Reason (R) : Actinoids are radioactive in nature .

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

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

(D) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

Explanation: Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). The actinoids do indeed exhibit a wide range of oxidation states due to the comparable energies of their 5f, 6d, and 7s orbitals. However, while radioactivity is a characteristic of actinoids, it does not directly explain the complexity of their oxidation states.

Question 10.

Assertion (A) : Hydrolysis of an ester follows first order kinetics.

Reason (R) : The concentration of water does not get altered much during the reaction.

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

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

(D) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)

Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). The hydrolysis of an ester like ethyl acetate is indeed a second order reaction generally, but behaves as pseudo first order due to the large excess of water, which means its concentration remains almost constant throughout the reaction. Therefore, while both statements are true, the reason provided does not directly explain why the assertion holds.

Question 11.

Assertion(A): Boiling point of (CH3)3N is higher than that of $CH_3CH_2CH_2NH_2$.

Reason (R) : Hydrogen bonding is more extensive in $CH_3CH_2CH_2NH_2$.

[1 Marks]

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

(B) Assertion (A) is false, but Reason (R) is true

(C) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(D) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). (CH3)3N (trimethylamine) has steric hindrance that reduces the ability to form hydrogen bonds compared to $CH_3CH_2CH_2NH_2$ (propylamine), which has more hydrogen bonding due to its structure, resulting in a higher boiling point for propylamine despite the assertion.

Question 12.

Assertion (A) : Phenol is strongly acidic as compared to ethanol.

Reason (R) : Phenoxide ion is more stable than ethoxide ion.

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

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

(D) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Explanation:

The correct answer is 'Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A)'. Phenol is more acidic than ethanol due to the stability of the phenoxide ion, which is a result of the delocalization of the negative charge. In contrast, the negative charge in the ethoxide ion is localized, making it less stable. This greater stability of the phenoxide ion compared to the ethoxide ion explains why phenol is more acidic.

Section B

Question 13.

State Henry's law. Why are aquatic species more comfortable in cold water as compared to warm water ?

[2 Marks]

Answer: Henry's law states that the amount of gas dissolved in a liquid is directly proportional to the pressure of the gas above the liquid at a constant temperature, i.e., C = k_H * P, where C is the concentration of the dissolved gas, k_H is Henry's law constant, and P is the gas pressure.
Aquatic species are more comfortable in cold water because solubility of gases like oxygen increases as temperature decreases. So colder water holds more dissolved oxygen than warm water, which aquatic animals need to survive.

Question 14.

Write IUPAC names of the following coordination compounds :

(i) $[CoCl_2(en)_2]SO_4$

(ii) $K_3[Fe(C_2O_4)_3]$

[2 Marks]

Answer: (i) The complex ion is $[CoCl2(en)2]^+$ with $SO4^{2-}$ as the counter ion. The ligands are chlorido (Cl^-) and ethylenediamine (en), which is a bidentate ligand. First name the ligands alphabetically: chlorido then ethylenediamine. Since there are two chlorido and two ethylenediamine ligands, use prefixes di- and di-. The metal is cobalt with an oxidation state +3 determined by the overall charge balance. The IUPAC name is 'Dichloridobis(ethylenediamine)cobalt(III) sulfate'.
(ii) The complex ion is $[Fe(C2O4)3]^{3-}$, where $C2O4^{2-}$ is the oxalato ligand, a bidentate ligand. There are three oxalato ligands attached to Fe. The cation is K^+, with three potassium ions balancing the charge. The oxidation state of Fe is +3. The IUPAC name is 'Potassium trioxalatoiron(III)'.

Question 15.

Differentiate between :

(i) Double salt and Complex compound

(ii) Didentate ligand and Ambidentate ligand

[2 Marks]

Answer: (i) **Double salt** is a salt formed by the combination of two different salts crystallizing together and it dissociates into the original ions in solution.
Complex compound is formed by a central metal ion bonded to ligands forming a coordinate bond, and it does not dissociate into the original salts in solution.

(ii) **Didentate ligand** is a ligand that attaches to the central metal atom through two donor atoms.
Ambidentate ligand is a ligand that has two different donor atoms but attaches to the metal through only one donor atom at a time.

Question 16.

How do you explain the following ?

(a) Presence of an aldehydic group in glucose.

(b) Presence of five – OH groups in glucose.

[2 Marks]

Answer: (a) Glucose contains an aldehydic group (–CHO) in its open-chain form, which classifies it as an aldose sugar. However, in solution, the aldehyde group reacts with the –OH group on C-5 to form a six-membered cyclic hemiacetal, which is why glucose mostly

exists in cyclic form.
(b) Glucose has five –OH groups, one on each carbon except the aldehyde carbon. This is confirmed by acetylation of glucose with acetic anhydride, which produces glucose pentaacetate, showing five hydroxyl groups were present to react.

Section C

Question 17.

Give reasons for the following :

(a) The pH of aqueous NaCl increases when it is electrolysed.

(b) Unlike dry cell, mercury cell has a constant cell potential through its lifetime.

(c) Conductivity of solution decreases with dilution.

[3 Marks]

Answer: (a) During electrolysis of aqueous NaCl, water undergoes reduction at cathode producing OH^- ions which makes the solution basic and increases the pH.
(b) Mercury cell has a constant cell potential because it uses liquid mercury as one electrode which maintains constant concentration of Hg^{2+} ions, resulting in stable emf throughout its life.
(c) The conductivity decreases on dilution because the number of ions per unit volume decreases, so fewer charge carriers are present, reducing the ability of the solution to conduct electricity.

Question 18.

Answer the following about the complexes $[FeF_6]^{3-}$ and $[Fe(CN)_6]^{4-}$:

(i) Write the hybridization involved in each case.

(ii) Which of them is the outer orbital complex and which one is the inner orbital complex ?

(iii) Compare their magnetic behaviour.

[Atomic number : Fe = 26]

[3 Marks]

Answer: (i) In $[FeF_6]^{3-}$, hybridization involved is sp^3d^2. In $[Fe(CN)_6]^{4-}$, hybridization involved is d^2sp^3.
(ii) $[FeF_6]^{3-}$ is an outer orbital complex because it involves sp^3d^2 hybridization using 4s and 4p orbitals and 4d orbital. $[Fe(CN)_6]^{4-}$ is an inner orbital complex as it involves d^2sp^3

hybridization using 3d orbitals of Fe.
(iii) Magnetic behaviour: $[FeF_6]^{3-}$ has five unpaired electrons (high spin), so it is paramagnetic with high magnetic moment. $[Fe(CN)_6]^{4-}$ has all electrons paired (low spin), so it is diamagnetic with no magnetic moment. Thus, $[FeF_6]^{3-}$ is paramagnetic and $[Fe(CN)_6]^{4-}$ is diamagnetic.

Question 19.

(i) What happens to the colour of complex $[Ti(H_2O)_6]^{3+}$ when heated gradually ?

(ii) Write the electronic configuration for d^5 ion if $\Delta_o < P$.

(iii) Write the hybridization and magnetic behaviour of the complex $[Ni(CO)_4]$.

[Atomic number : Ni = 28]

[3 Marks]

Answer: (a) When the complex $[Ti(H_2O)_6]^{3+}$ is heated gradually, its colour changes from violet to green. This happens because heating causes partial substitution of water molecules by other ligands or changes in the crystal field splitting leading to changes in d-d transitions, thus changing the observed colour.
(b) For a d^5 ion with crystal field splitting energy (Δ_o) less than pairing energy (P), the configuration will be high spin. Therefore, the electronic configuration is $t_{2g}^3 e_g^2$ with five unpaired electrons.
(c) In the complex $[Ni(CO)_4]$, nickel has oxidation state zero and electronic configuration of Ni is $3d^8 4s^2$. The hybridization is dsp^2 resulting in a tetrahedral geometry. Since CO is a strong field ligand, it causes pairing of electrons, making the complex diamagnetic (all electrons are paired).

Question 20.

A compound (A) with molecular formula C_4H_5N on reduction with DIBAL-H followed by hydrolysis, gives a compound (B). Compound (B) gives positive Tollens' test but does not give iodoform test. Compound (B) can also be obtained when ethanal is treated with dilute NaOH followed by heating. Identify (A) and (B). Write the reactions of (A) with DIBAL-H followed by hydrolysis.

[3 Marks]

Answer: (a) Compound (A) is an acetonitrile, CH_3CN, because it has formula C_4H_5N and on reduction with DIBAL-H followed by hydrolysis gives an aldehyde. (b) Compound (B) is acetaldehyde, CH_3CHO, since it gives positive Tollens' test (meaning 'aldehyde group present') but does not give iodoform test and can be formed from ethanal treated with dilute NaOH and heating (aldol condensation). (c) The reaction is:

CH_3CN + DIBAL-H (at low temperature) → intermediate imine aluminum complex
Intermediate + H_2O (hydrolysis) → CH_3CHO (acetaldehyde)
Thus, reduction of nitrile (A) with DIBAL-H followed by hydrolysis produces the aldehyde (B).

Question 21.

How will you obtain the following from aniline ? Give chemical equations only.

(a) Sulphanilic acid

(b) Phenylisocyanide

(c) Acetanilide

[3 Marks]

Answer: (a) Sulphanilic acid:
$C_6H_5NH_2 + H_2SO_4$ (conc.) \u2192 $C_6H_5NH_3^+ HSO_4^-$ (anilinium hydrogensulphate)
$C_6H_5NH_3^+ HSO_4^-$ \u2192 $C_6H_4SO_3HNH_2$ (Sulphanilic acid) (heating at 453-473 K)

(b) Phenylisocyanide:
$C_6H_5NH_2 + CHCl_3 + KOH$ \u2192 $C_6H_5NC + KCl + 2H_2O$

(c) Acetanilide:
$C_6H_5NH_2 + (CH_3CO)_2O$ \u2192 $C_6H_5NHCOCH_3 + CH_3COOH$

Question 22.

Vapour pressure of pure water at 298 K is 24·8 mm Hg. Calculate the lowering in vapour pressure of an aqueous solution which freezes at– 0·3°C. (Kf of water = 1·86 K kg mol^{-1})

[3 Marks]

Answer: Given: Vapour pressure of pure water, P_0 = 24.8 mm Hg
Freezing point depression, ΔT_f = 0.3 deg C = 0.3 K
Freezing point depression constant, K_f = 1.86 K kg mol^{-1}

Step 1: Calculate molality (m) of the solution
The formula for freezing point depression is $\Delta T_f = K_f * m$
So, $m = \Delta T_f / K_f = 0.3 / 1.86 = 0.1613$ mol kg^{-1}

Step 2: Calculate mole fraction of solute (X_2)
Let the solvent be water with molality m means m moles of solute per 1 kg of solvent.
Number of moles of solvent (water) in 1 kg = 1000 g / 18 g mol^{-1} = 55.56 mol

Mole fraction of solute,
X_2 = m / (m + moles of solvent) = 0.1613 / (0.1613 + 55.56) = 0.0029

Step 3: Calculate lowering in vapour pressure (ΔP)
Lowering in vapour pressure is given by Raoult's law,
$\Delta P = P_0 * X_2 = 24.8 * 0.0029 = 0.072$ mm Hg

Answer: The lowering in vapour pressure of the solution is 0.072 mm Hg.

Section D

Question 23. Alcohols undergo a number of reactions involving the cleavage of C – OH bond. However, phenols do not undergo reactions involving the cleavage of C – OH bond. Alcohols are weaker acids than water. Alcohols react with halogen acids to form the corresponding haloalkanes. Phenols are stronger acids than alcohols. A characteristic feature of phenols is that they undergo electrophilic substitution reactions such as halogenation, nitration, etc. Since – OH group is a strong activating group, phenol gives trisubstituted products during halogenation, nitration, etc.

Question 24.

The a-amino acids are the building blocks of proteins. All a-amino acids exist as zwitter ion due to which they show amphoteric behaviour. All amino acids are joined through peptide bond. Proteins are broadly classified as globular proteins and fibrous proteins. Globular proteins are water soluble, whereas fibrous proteins are not. The complete structure of protein is discussed at four different levels i.e. primary, secondary, tertiary and quaternary structures. Protein loses its biological activity in denatured form.

(i)

Define the following :

(i) Peptide linkage (ii) Denatured protein

[2 Marks]

Answer: (i) Peptide linkage is a chemical bond formed between the carboxyl group (-COOH) of one amino acid and the amino group (-NH2) of another, resulting in the release of a water molecule. This bond is crucial for linking amino acids to form proteins. (ii) A denatured protein is a protein that has lost its unique three-dimensional structure and biological activity due to external factors such as changes in pH or temperature. This irreversible process disrupts the secondary and tertiary structures of the protein.

Key Points: Peptide linkage is an amide bond formed between -COOH and -NH2; Denatured protein loses its structure and function due to pH or temperature changes.

(2)

Write the names of two different secondary structures of proteins.

[1 Marks]

Answer: The two different secondary structures of proteins are alpha-helix and beta-pleated sheet.

Key Points: alpha-helix-beta-pleated sheet

(3)

Why do amino acids show amphoteric behaviour ?

[1 Marks]

Answer: Amino acids show amphoteric behaviour because they contain both an acidic carboxyl group (-COOH) and a basic amino group (-NH2) in the same molecule. This allows them to act as both acids and bases, thus exhibiting amphoteric properties.

Key Points: Contains both -COOH and -NH2 groups-amphoteric nature-acts as acids and bases

(4)

How can you differentiate between Fibrous protein and Globular protein ?

[1 Marks]

Answer: Fibrous proteins have a long, strand-like structure and are generally insoluble in water, while globular proteins are spherical and water-soluble. The structure of fibrous proteins consists of polypeptide chains running parallel, held together by hydrogen and disulphide bonds, whereas globular proteins such as insulin and

albumins are more compact and fold into specific shapes which allow them to perform various functions.

Key Points: Fibrous proteins are insoluble in water; Globular proteins are water-soluble; Fibrous proteins have a fiber-like structure; Globular proteins are compact and spherical.