CBSE EXAMINATION PAPER-2024

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 17

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **15 questions.** All questions are **compulsory.**

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

iii. **Section A** – questions number **1 to 7** are multiple choice questions Each question carries **1 marks.**

iv. **Section B** – questions number **8 to 9** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **10 to 11** are short answer Each question carries **3 marks.**

vi. **Section D** – questions number **12 to 15** 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.

Which of the following does not show variable oxidation states?

[1 Marks]

(A) Cu

(B) Mn

(C) Sc

(D) Fe

Explanation:

Scandium (Sc) does not show variable oxidation states. It primarily exhibits a +3 oxidation state, while manganese (Mn), copper (Cu), and iron (Fe) can exhibit multiple oxidation states due to their ability to lose different numbers of electrons. This is typical in transition metals, whereas Sc is a d-block element that generally shows a fixed oxidation state.

Question 2.

$(CH_3)_2CH-O-CH_3$ when treated with HI gives:

[1 Marks]

(A) $(CH_3)_2CH - OH + CH_3 - I$

(B) $(CH_3)_2CH - I + CH_3OH$

(C) $(CH_3)_2CH - I + CH_3 - I$

(D) $(CH_3)_2CH - OH + CH_3OH$

Explanation:

The correct answer is $(CH_3)_2CH - OH + CH_3 - I$. When $(CH_3)_2CH-O-CH_3$ (an ether) reacts with HI, it acts as an acid and generates an oxonium ion. The iodide ion then acts as a nucleophile, attacking the less hindered carbon (the carbon connected to the -O- group), resulting in the formation of isopropyl alcohol ($(CH_3)_2CH - OH$) and methyl iodide ($CH_3 - I$).

Question 3.

Which of the following compounds on treatment with benzene sulphonyl chloride forms an alkali-soluble precipitate?

[1 Marks]

(A) CH_3CONH_2

(B) $(CH_3)_3N$

(C) $(CH_3)_2NH$

(D) $CH_3CH_2NH_2$

Explanation:

The correct option is CH_3CONH_2 (acetanilide). Upon treatment with benzene sulphonyl chloride, acetanilide forms a sulphonamide which is soluble in alkali. The other compounds do not form precipitates that are alkali-soluble.

Question 4.

The order of increasing basicities of CH_3NH_2 (I), $(CH_3)_2NH$ (II), $(CH_3)_3N$ (III) and $C_6H_5NH_2$ (IV) in aqueous media is:

[1 Marks]

(A) IV < III < I < II

(B) I < II < III < IV

(C) II < III < I < IV

(D) II < I < IV < III

Explanation:

The correct order of increasing basicities is IV < III < I < II. Aniline (IV) has a phenyl group that decreases its basicity due to resonance. Dimethylamine (II) is more basic than methylamine (I) because the two methyl groups provide stronger +I effect than one methyl group. Trimethylamine (III) is the most basic due to the +I effect from the three methyl groups, which greatly enhance its ability to accept protons.

Question 5.

The vitamin which plays an important role in coagulating blood is:

[1 Marks]

(A) Vitamin A

(B) Vitamin E

(C) Vitamin D

(D) Vitamin K

Explanation:

Vitamin K is essential for the blood coagulation process, as it is required for the synthesis of certain proteins that are necessary for blood clotting. Without adequate vitamin K, the

body cannot produce these proteins effectively, leading to increased bleeding and difficulty in clotting.

Question 6.

When a catalyst increases the rate of a chemical reaction, then the rate constant (k):

[1 Marks]

(A) may increase or decrease depending on the order of the reaction

(B) increases

(C) remains constant

(D) decreases

Explanation:

The correct answer is 'remains constant.' A catalyst speeds up a reaction by providing an alternative pathway with a lower activation energy, but it does not change the intrinsic rate constant (k) of the reaction, which is determined by the nature of the reactants and the temperature.

Question 7.

During the electrolysis of aqueous NaCl, the cathodic reaction is:

[1 Marks]

(A) Oxidation of H_2O

(B) Reduction of H_2O

(C) Oxidation of Cl^- ion

(D) Reduction of Na^+ ion

Explanation:

The correct answer is the 'Reduction of H_2O'. During the electrolysis of aqueous sodium chloride, at the cathode (negative electrode), water is reduced to form hydrogen gas and hydroxide ions. The reduction of Na^+ ions is not favored since the reduction potential for water is lower than that for Na^+. Therefore, the primary cathodic reaction is the reduction of water.

Section B

Question 8. Define molal depression constant. How is it related to enthalpy of fusion?

[2 Marks]

Answer: Molal depression constant, also known as freezing point depression constant or cryoscopic constant, is a property of a solvent that indicates how much its freezing point drops when one mole of solute is dissolved in one kilogram of the solvent (1 molal solution).
It is related to the enthalpy of fusion because K_f is proportional to the ratio of the gas constant (R) times the square of the freezing point of the pure solvent (T_f^2) to the enthalpy of fusion ($\u0394H_{fusion}$) of the solvent. Mathematically, $K_f = (R * T_f^2) / \u0394H_{fusion}$. Thus, a solvent with a higher enthalpy of fusion will have a lower molal depression constant and vice versa.

Question 9.

What type of deviation is shown by ethanol and acetone mixture? Give reason.What type of azeotropic mixture is formed by that deviation ?

[2 Marks]

Answer: The ethanol and acetone mixture shows a positive deviation from Raoult's law. This occurs because the intermolecular attractions between ethanol and acetone are weaker than those in the pure components. Consequently, when mixed, the vapor pressure of the solution is higher than predicted by Raoult's law. The azeotropic mixture formed by this deviation is classified as a maximum boiling azeotrope, where the boiling point of the mixture is higher than that of the individual components.

Section C

Question 10.

A solution is prepared by dissolving 5 g of a non-volatile solute in 200 g of water. It has a vapour pressure of 31·84 mm Hg at 300 K. Calculate the molar mass of the solute.

(Vapour pressure of pure water at 300 K = 32 mm Hg)

[3 Marks]

Answer: Given: Mass of solute, m_solute = 5 g
Mass of solvent (water), m_solvent = 200 g = 0.2 kg
Vapour pressure of solution, P_solution = 31.84 mm Hg
Vapour pressure of pure solvent, P_solvent = 32 mm Hg

Step 1: Calculate the lowering of vapour pressure, $\Delta P = P_{solvent} - P_{solution} = 32 - 31.84 = 0.16$ mm Hg

Step 2: Use Raoult's law relation for vapour pressure lowering:
$\Delta P / P_{solvent}$ = mole fraction of solute, x_{solute}

So, $x_{solute} = 0.16 / 32 = 0.005$

Step 3: Let the molar mass of the solute be M (g/mol). Number of moles of solute = $n_{solute} = 5 / M$
Number of moles of solvent (water), $n_{solvent}$ = mass / molar mass = 200 / 18 = 11.11 mol

Step 4: Mole fraction of solute, $x_{solute} = n_{solute} / (n_{solute} + n_{solvent}) \approx n_{solute} / n_{solvent}$ (since n_{solute} is very small)
So, $0.005 = (5 / M) / 11.11$

Step 5: Solve for M:
$5 / M = 0.005 * 11.11 = 0.05555$
$M = 5 / 0.05555 \approx 90$ g/mol

Answer: The molar mass of the solute is approximately 90 g/mol.

Question 11.

A first-order reaction is 25 complete in 40 minutes. Calculate the value of rate constant. In what time will the reaction be 80 % complete ?

Given : log 2 = 0·30, log 3 = 0·48, log 4 = 0·60, log 5 = 0·69

[3 Marks]

Answer: (a) Given that the reaction is 25 % complete in 40 minutes means 75 % of the reactant remains. Let initial concentration be C_0 and concentration after 40 min be C. Then, $C = 0.75\ C_0$.
For a first order reaction, the formula is $\ln(C) = \ln(C_0) - k\,t$ or $\log C = \log C_0 - (k\,t / 2.303)$.
Using concentrations: $\log (C_0 / C) = (k\,t) / 2.303$.
Here, $\log (C_0 / C) = \log (1 / 0.75) = \log (4/3) = \log 4 - \log 3 = 0.60 - 0.48 = 0.12$.
So, $(k * 40) / 2.303 = 0.12 \Rightarrow k = (2.303 * 0.12) / 40 = 0.006909\ min^{-1}$.

(b) To find time for 80 % completion, 20 % reactant remains, so $C = 0.20\ C_0$.
$\log (C_0 / C) = \log (1 / 0.20) = \log 5 = 0.69$.
Using same equation: $(k * t) / 2.303 = 0.69 \Rightarrow t = (2.303 * 0.69) / k = (2.303 * 0.69) / 0.006909 = 230$ minutes approx.

Hence, the rate constant k = 0.006909 min^{-1} and the time for 80 % completion is approximately 230 minutes.

Section D

Question 12. The involvement of (n-1)d electrons in the behaviour of transition elements impart certain distinct characteristics to these elements. Thus, in addition to variable oxidation states, they exhibit paramagnetic behaviour, catalytic properties and tendency for the formation of coloured ions. The transition metals react with a number of non-metals like oxygen, nitrogen and halogens. KMnO4 and K2Cr2O7 are common examples. The two series of inner transition elements, lanthanoids and actinoids, constitute the f-block of the periodic table. In the lanthanoids, there is regular decrease in atomic size with increase in atomic number due to the imperfect shielding effect of 4f-orbital electrons which causes contraction.

Question 13.

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