CBSE EXAMINATION PAPER-2023

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 16

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 **3 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 14** are very short answer Each question carries **2 marks.**

v. **Section C** – questions number **15 to 15** are case based questions

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

vii. Use of calculator is NOT allowed.

Section A

Question 1.

Which of the following molecules has a chiral centre correctly labelled with an asterisk (*)?

[1 Marks]

(A) $CH_3C^*Br_2CH_3$

(B) $CH_3C^*HClCH_2Br$

(C) $CH_3C^*HBrCH_3$

(D) $HOCH_2C^*H(OH)CH_2OH$

Explanation:

The correct answer is $HOCH_2C^*H(OH)CH_2OH$. A chiral center is a carbon atom that is bonded to four different groups. In this molecule, the carbon atom marked with an asterisk is attached to four distinct substituents: a hydroxymethyl group ($HOCH_2$), a hydroxyl group (OH), a hydrogen (H), and a methylene group (CH_2OH), making it chiral. The other options do not present a carbon atom bonded to four different groups.

Question 2.

Which of the following alcohols will not undergo oxidation?

[1 Marks]

(A) 3-Methylbutan-2-ol

(B) 2-Methylbutan-2-ol

(C) Butan-2-ol

(D) Butanol

Explanation:

2-Methylbutan-2-ol is the correct answer because it is a tertiary alcohol. Tertiary alcohols are resistant to oxidation under normal conditions, unlike primary and secondary alcohols, which can be oxidized to aldehydes or ketones respectively. The context mentions that alkanes having tertiary hydrogen can be oxidized, but it must be noted that tertiary alcohols generally do not undergo oxidation readily.

Question 3.

A voltaic cell is made by connecting two half cells represented by half equations below: $Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$ $E^o = -0.14$ V $Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $E^o = +0.77$ V Which statement is correct about this voltaic cell?

[1 Marks]

(A) Fe^{2+} is oxidised and the voltage of the cell is 0.91 V

(B) Sn is oxidised and the voltage of the cell is 0.63 V

(C) Fe^{2+} is oxidised and the voltage of the cell is −0.91 V

(D) Sn is oxidised and the voltage of the cell is 0.91 V

Explanation:

The correct answer is 'Sn is oxidised and the voltage of the cell is 0.91 V.' In the voltaic cell, Sn is oxidised from Sn(s) to $Sn^{2+}(aq)$, while Fe^{3+} is reduced to Fe^{2+}. To find the cell voltage, we subtract the standard reduction potential of the oxidised species (Sn, -0.14 V) from that of the reduced species (Fe^{3+}, +0.77 V): 0.77 V - (-0.14 V) = 0.91 V.

Question 4.

Four half reactions I to IV are shown below:

I. $2Cl^- \rightarrow Cl_2 + 2e^-$

II. $4OH^- \rightarrow O_2 + 2H_2O + 2e^-$

III. $Na^+ + e^- \rightarrow Na$

IV. $2H^+ + 2e^- \rightarrow H_2$ Which two of these reactions are most likely to occur when concentrated brine is electrolysed?

[1 Marks]

(A) I and III

(B) I and IV

(C) II and III

(D) II and IV

Explanation:

The correct answer is I and IV. During the electrolysis of concentrated brine, chlorine is generated at the anode (I: $2Cl^- \rightarrow Cl_2 + 2e^-$) and hydrogen is produced at the cathode (IV: $2H^+ + 2e^- \rightarrow H_2$). Reaction II ($4OH^- \rightarrow O_2 + 2H_2O + 2e^-$) is not preferred due to higher overpotential for oxygen generation compared to chlorine, and reaction III is not relevant in this context since sodium does not get reduced in the electrolysis of brine.

Question 5.

Which property of transition metals enables them to behave as catalysts?

[1 Marks]

(A) Alloy formation

(B) Variable oxidation states

(C) High ionisation enthalpy

(D) High melting point

Explanation:

The correct option is 'Variable oxidation states'. Transition metals are known for their ability to adopt multiple oxidation states, which allows them to participate in various chemical reactions and form intermediate complexes, making them effective catalysts.

Question 6.

In the two tetrahedral structures of dichromate ion,

[1 Marks]

(A) All Cr – O bonds are equivalent in length.

(B) All Cr – O bonds are non-equivalent.

(C) 6 Cr – O bonds are equivalent in length.

(D) 4 Cr – O bonds are equivalent in length.

Explanation:

All Cr – O bonds are non-equivalent. In the dichromate ion (Cr2O7^2-), the two tetrahedral structures result in Cr–O bonds that are not all the same in length due to the shared oxygen and the differing angles that arise from its structure, specifically the Cr–O–Cr bond angle of 126°. This creates a situation where some of the bonds behave differently due to the geometry and resonance in the molecule.

Question 7.

1 mole of liquid A and 2 moles of liquid B make a solution having a total vapour pressure 40 torr. The vapour pressure of pure A and pure B are 45 torr and 30 torr respectively. The above solution

[1 Marks]

(A) shows positive deviation.

(B) is a maximum boiling azeotrope.

(C) shows negative deviation.

(D) is an ideal solution.

Explanation:

The correct option is 'shows positive deviation.' The total vapour pressure (40 torr) is lower than what would be expected based on Raoult's law for an ideal solution, which indicates that the interactions between the molecules of A and B are weaker than those in the pure components. Thus, the solution exhibits positive deviation from Raoult's law.

Question 8.

Which of the following would not be a good choice for reducing nitrobenzene to aniline?

[1 Marks]

(A) H_2/Ni

(B) Sn and HCl

(C) $LiAlH_4$

(D) Fe and HCl

Explanation:

The correct option is $LiAlH_4$. While H_2/Ni, Sn and HCl, and Fe and HCl are effective methods for reducing nitrobenzene to aniline, $LiAlH_4$ is a strong reducing agent that would more likely reduce nitro compounds to amines but is generally not preferred for this specific reduction, as it can lead to over-reduction or undesired side reactions.

Question 9.

Hydrolysis of sucrose is called

[1 Marks]

(A) saponification

(B) hydration

(C) esterification

(D) inversion

Explanation:

The correct answer is 'inversion' because hydrolysis of sucrose involves the breakdown of sucrose into its component monosaccharides, glucose and fructose, resulting in a mixture that is sweeter and has different optical rotation compared to the original disaccharide. This process is specifically referred to as 'inversion'.

Question 10.

Which one of the following has lowest pK_a value?

[1 Marks]

(A) $Cl–CH_2–COOH$

(B) $O_2N–CH_2–COOH$

(C) $HCOOH$

(D) $CH_3–COOH$

Explanation:

The compound with the lowest pK_a value is $O_2N–CH_2–COOH$ (Nitroacetic acid). The presence of the electron-withdrawing nitro group ($-NO_2$) increases the acidity of the carboxylic acid, resulting in a lower pK_a compared to the other options which have less electron-withdrawing substituents.

Question 11.

Which of the following cell was used in Apollo space programme?

[1 Marks]

(A) $H_2–O_2$ Fuel cell

(B) Daniel cell

(C) Mercury cell

(D) Dry cell

Explanation:

The correct answer is $H_2–O_2$ Fuel cell, as it directly produces electricity from the reaction of hydrogen and oxygen, which was a key technology utilized during the Apollo space program for powering spacecraft.

Question 12.

The magnetic moment of $[NiCl_4]^{2-}$ is [Atomic number : Ni = 28]

[1 Marks]

(A) 1.82 BM

(B) 5.46 BM

(C) 4.42 BM

(D) 2.82 BM

Explanation: The correct option is 2.82 BM. The $[NiCl_4]^{2-}$ complex has two unpaired electrons, which gives n = 2. Using the formula $\mu = \sqrt{n(n+2)}$, we have $\mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83$ BM, rounded to 2.82 BM. This matches the trend indicating that the magnetic moment will increase with unpaired electrons, confirming it is paramagnetic.

Section B

Question 13. Why is boiling point of o-dichlorobenzene higher than p-dichlorobenzene but melting point of para isomer is higher than ortho isomer?

[2 Marks]

Answer: The boiling point of o-dichlorobenzene is higher than p-dichlorobenzene because the ortho isomer has a polar molecular structure due to the closer position of chlorine atoms, causing stronger intermolecular dipole-dipole interactions and thus requiring more heat to boil.
However, the melting point of the para isomer is higher because p-dichlorobenzene molecules are more symmetrical and pack more efficiently in the solid state, resulting in a more stable crystalline structure and higher melting point.

Question 14.

Give the reaction of glucose with hydrogen cyanide. Presence of which group is confirmed by this reaction ?

[2 Marks]

Answer: Glucose reacts with hydrogen cyanide (HCN) to form a cyanohydrin. In this reaction, HCN adds across the carbonyl group (>C=O) of glucose resulting in the formation of a cyanohydrin compound. This reaction confirms the presence of the carbonyl group, specifically the aldehyde group (-CHO), in glucose.

Section C

Question 15. Nucleophilic Substitution reaction of haloalkane can be conducted according to both SN1 and SN2 mechanisms. SN1 is a two step reaction while SN2 is a single step reaction. For any haloalkane which mechanism is followed depends on factors such as structure of haloalkane, properties of leaving group, nucleophilic reagent and solvent. Influences of solvent polarity: In SN1 reaction, the polarity of the system increases from the

reactant to the transition state, because a polar solvent has a greater effect on the transition state than the reactant, thereby reducing activation energy and accelerating the reaction. In SN2 reaction, the polarity of the system generally does not change from the reactant to the transition state and only charge dispersion occurs. At this time, polar solvent has a great stabilizing effect on Nu than the transition state, thereby increasing activation energy and slowing down the reaction rate. For example, the decomposition rate (SN1) of tertiary chlorobutane at 25 °C in water (dielectric constant 79) is 300000 times faster than in ethanol (dielectric constant 24). The reaction rate (SN2) of 2-Bromopropane and NaOH in ethanol containing 40% water is twice slower than in absolute ethanol. Hence the level of solvent polarity has influence on both SN1 and SN2 reaction, but with different results. Generally speaking, weak polar solvent is favourable for SN2 reaction, while strong polar solvent is favourable for SN1. Generally speaking, the substitution reaction of tertiary haloalkane is based on SN1 mechanism in solvents with a strong polarity (for example ethanol containing water).