

CBSE EXAMINATION PAPER-2024

CHEMISTRY

(Solved)

Time allowed : 3 hours

Maximum Marks : 19

General Instructions :

Read the following instructions carefully and follow them :

- i. This question paper contains **16 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 14** are very short answer Each question carries **2 marks**.
- v. **Section C** – questions number **15 to 15** are short answer Each question carries **3 marks**.
- vi. **Section D** – questions number **16 to 16** 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.

The specific sequence in which amino acids are arranged in a protein is called its

[1 Marks]

(A) Secondary structure

(B) Tertiary structure

(C) Primary structure

(D) Quaternary structure

Explanation:

The correct answer is 'Primary structure' because the primary structure of a protein refers to the specific sequence of amino acids that make up the protein chain. This sequence is crucial as it determines the protein's unique characteristics and function.

Question 2.

Out of the following alkenes, the one which will produce tertiary butyl alcohol on acid catalysed hydration is

[1 Marks]

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

(B) $(\text{CH}_3)_2\text{C=CH}_2$

(C) $\text{CH}_3\text{CH}_2\text{CH=CH}_2$

(D) $\text{CH}_3\text{CH=CH}_2$

Explanation:

The correct option is $(\text{CH}_3)_2\text{C=CH}_2$. This alkene, also known as isobutylene, upon acid-catalyzed hydration follows Markovnikov's rule. The hydrogen attaches to the less substituted carbon (the double bond), and the hydroxyl group attaches to the more substituted carbon, resulting in the formation of tertiary butyl alcohol.

Question 3.

Auto-oxidation of chloroform in air and light produces a poisonous gas known as

[1 Marks]

(A) Phosgene

(B) Tear gas

(C) Mustard gas

(D) Phosphine

Explanation:

The correct option is Phosgene. When chloroform undergoes auto-oxidation in the presence of air and light, it can produce phosgene, which is a highly toxic gas. Other options like tear gas, mustard gas, and phosphine are not products of chloroform's auto-oxidation.

Question 4.

Transition metals are known to make interstitial compounds. Formation of interstitial compounds makes the transition metal

[1 Marks]

(A) more metallic

(B) more ductile

(C) more hard

(D) more soft

Explanation:

The correct option is 'more hard'. Interstitial compounds are formed when small atoms fill the interstitial spaces between the larger metal atoms. This can lead to an increase in hardness and strength of the material, making it more difficult to deform compared to the pure metal.

Question 5.

Isotonic solutions have the same

[1 Marks]

(A) volume

(B) osmotic pressure

(C) density

(D) refractive index

Explanation:

The correct option is 'osmotic pressure' because isotonic solutions are defined as solutions that have the same osmotic pressure, which means they exert equal pressure across a semipermeable membrane, preventing water movement in or out of the cells.

Question 6.

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

[1 Marks]

- (A) Ni-Cd cell
- (B) Dry cell
- (C) H₂-O₂ fuel cell
- (D) Mercury cell

Explanation:

The correct answer is H₂-O₂ fuel cell. The Apollo space program utilized hydrogen-oxygen fuel cells to produce electricity and water for the spacecraft, making them essential for the missions.

Question 7.

The rate of a reaction increases sixteen times when the concentration of the reactant increases four times. The order of the reaction is

[1 Marks]

- (A) 2.0
- (B) 2.5
- (C) 1.5
- (D) 0.5

Explanation:

The order of the reaction can be calculated using the rate law. If the concentration is increased by a factor of 4 and the rate increases by a factor of 16, we can use the equation $\text{Rate} \propto [A]^n$. Here, $4^n = 16$. Solving for n gives us $n = 2$, meaning the order of the reaction is 2.0.

Question 8.

Dilution affects both conductivity as well as molar conductivity. Effect of dilution on both is as follows

[1 Marks]

(A) both decrease with dilution

(B) both increase with dilution

(C) conductivity increases whereas molar conductivity decreases on dilution

(D) conductivity decreases whereas molar conductivity increases on dilution

Explanation:

The correct option is 'conductivity decreases whereas molar conductivity increases on dilution.' When a solution is diluted, the concentration of ions decreases, which reduces conductivity. However, molar conductivity, which is the conductivity per unit concentration, increases because the ability of ions to move freely increases in a more dilute solution.

Question 9.

Assertion (A): Zr and Hf are of almost similar atomic radii.

Reason (R): This is due to Lanthanoid contraction.

[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, and Reason (R) is the correct explanation of the Assertion (A). The atomic radii of zirconium (Zr) and hafnium (Hf) are similar due to the lanthanoid contraction, which decreases the size of the lanthanide ions and subsequently affects the size of the elements in the same group of the periodic table.

Question 10.

Assertion (A): The units of rate constant of a zero order reaction and rate of reaction are the same

Reason (R): In a zero order reaction, the rate of reaction is independent of the concentration of reactants.

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

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

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

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

Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). In a zero order reaction, the rate is constant and the units of the rate constant (k) are the same as the units of rate of reaction (e.g., mol/L/s), but the independence of the rate from reactant concentration does not explain the equality of units.

Question 11.

Assertion (A): Inversion of configuration is observed in S_N2 reaction.

Reason (R): The reaction proceeds with the formation of a carbocation.

[1 Marks]

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

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

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

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

Explanation:

Assertion (A) is true, but Reason (R) is false. The S_N2 reaction (bimolecular nucleophilic substitution) indeed leads to an inversion of configuration; however, it does not involve the formation of a carbocation, which is characteristic of S_N1 reactions. Therefore, while the assertion about the S_N2 reaction is correct, the reasoning does not support it.

Question 12.

Assertion (A): p-methoxyphenol is a stronger acid than p-nitrophenol.

Reason (R): Methoxy group shows +I effect whereas nitro group shows -I effect.

[1 Marks]

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

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

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

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

Explanation:

Assertion (A) is false, but Reason (R) is true. p-Nitrophenol is actually a stronger acid than p-methoxyphenol due to the electron-withdrawing -I effect of the nitro group, which stabilizes the negative charge of the phenoxide ion more effectively than the +I effect of the methoxy group destabilizes it.

Section B

Question 13.

Carry out the following conversions:

(i) Nitrobenzene to Aniline

(ii) Aniline to Phenol.

[2 Marks]

Answer: (i) Nitrobenzene to Aniline: Nitrobenzene on reduction with Sn / HCl or Fe / HCl or Zn / HCl is converted into Aniline ($C_6H_5NH_2$). The nitro group ($-NO_2$) is reduced to an amino group ($-NH_2$).

(ii) Aniline to Phenol: Aniline is first diazotized by reacting with $NaNO_2$ and HCl at 0-5 deg C to form benzenediazonium chloride. Then, on warming with water, diazonium group is replaced by hydroxyl group, producing Phenol (C_6H_5OH).

Question 14.

Show that in case of a first order reaction, the time taken for completion of 99% reaction is twice the time required for 90% completion of the reaction. ($\log 10 = 1$)

[2 Marks]

Answer: Solution:

For a first order reaction, the integrated rate law is given as:

$$\ln([R]_0/[R]) = kt$$

where $[R]_0$ is the initial concentration and $[R]$ is the concentration at time t .

Let t_{90} be the time for 90% completion, so 10% reactant remains:

$$[R] = 0.1 [R]_0$$

$$\ln([R]_0/0.1 [R]_0) = k t_{90}$$

$$\ln(10) = k t_{90}$$

$$\text{Using } \log 10 = 1, \ln(10) = 2.303 * 1 = 2.303$$

$$\text{So, } k t_{90} = 2.303$$

Let t_{99} be the time for 99% completion, so 1% reactant remains:

$$[R] = 0.01 [R]_0$$

$$\ln([R]_0/0.01 [R]_0) = k t_{99}$$

$$\ln(100) = k t_{99}$$

$$\ln(100) = 2.303 * 2 = 4.606$$

$$\text{So, } k t_{99} = 4.606$$

Dividing the two equations:

$$(k t_{99}) / (k t_{90}) = 4.606 / 2.303 = 2$$

$$\text{Therefore, } t_{99} / t_{90} = 2$$

Hence, the time taken for 99% completion is twice the time taken for 90% completion for a first order reaction.

Section C

Question 15.

Draw the structures of major product(s) in each of the following reactions

[3 Marks]

Answer: (a) Mononitration of 3-methylphenol: 3-methylphenol has an -OH group and a methyl group at position 3 on the benzene ring. The -OH group is an activating ortho/para directing group and the methyl group is also ortho/para directing but less activating compared to -OH. On mononitration with $\text{HNO}_3/\text{H}_2\text{SO}_4$, the major product is nitration at the position ortho to the -OH group but meta to the methyl group, which is position 2 on the ring. The major product is 2-nitro-3-methylphenol.

(b) Dinitration: When dinitration is carried out on 3-methylphenol under harsher

conditions, two nitro groups attach preferentially at positions ortho and para to the -OH group since it is a strong activating group. Positions 2 and 4 (with respect to -OH) get nitrated leading to 2,4-dinitro-3-methylphenol as the major product. The methyl group at position 3 influences substitution pattern but the strong activation by -OH dominates.

In summary, mononitration mainly gives 2-nitro-3-methylphenol whereas dinitration forms 2,4-dinitro-3-methylphenol as the major products. The directing effect of -OH group determines substitution positions in these electrophilic aromatic substitution reactions. Structures can be drawn showing benzene ring with OH at position 1, methyl at position 3 and nitro groups at the substituted positions.

Section D

Question 16. The oxidation number of the central atom in a complex is defined as the charge it would carry if all the ligands are removed along with the electron pairs that are shared with the central atom. Similarly, the charge on the complex is the sum of the charges of the constituent parts i.e. the sum of the charges on the central metal ion and its surrounding ligands. Based on this, the complex is called neutral if the sum of the charges of the constituents is equal to zero. However, for an anionic or cationic complex, the sum of the charges of the constituents is equal to the charge on the coordination sphere. Based on the above information, answer the following questions.
