JEE Main 2024 Chemistry Question Paper April 4 Shift 1 with Solutions

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :90

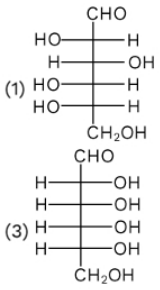
General Instructions

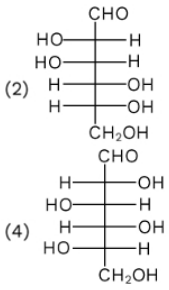
Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

Chemistry

1. Which of the following is the correct structure of L-Glucose?





Correct Answer: (1)

Solution:

Step 1: Identifying the correct structure.
L-Glucose is a monosaccharide, and the correct structure of L-Glucose has the hydroxyl group on the left side at the chiral carbon farthest from the aldehyde group. This is what distinguishes L-Glucose from D-Glucose. The structure in option (1) correctly shows the orientation of the

hydroxyl group at the correct carbon.

Step 2: Analyzing the options.
(1) Correct structure: This structure represents L-Glucose with the appropriate configuration at the chiral center.
(2) Incorrect structure: This structure is incorrect because the hydroxyl group at the chiral center is on the right, which would correspond to D-Glucose.
(3) Incorrect structure: This structure also has the incorrect configuration for L-Glucose.
(4) Incorrect structure: Similar to option (3), this structure is not consistent with the correct configuration of L-Glucose.

Step 3: Conclusion.
The correct answer is **(1)** because it correctly shows the structure of L-Glucose with the hydroxyl group on the left at the farthest chiral carbon.

Quick Tip

When identifying D- and L-sugars, remember that L-Glucose has the hydroxyl group on the left at the chiral carbon farthest from the aldehyde group.

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2. How many structural isomers are there in C_7H_{16}?

(1) 5
(2) 6
(3) 8
(4) 9

Correct Answer: (4) 9

Solution:

Step 1: Understanding the question.
The question asks for the number of structural isomers possible for the compound C_7H_{16}, which is an alkane. Structural isomers differ in the arrangement of their atoms, but each must have the same molecular formula.

Step 2: Conclusion.
The number of possible structural isomers for C_7H_{16} is 9, as determined by considering various arrangements of carbon and hydrogen atoms. Thus, the correct answer is (4) 9.

Quick Tip

In organic chemistry, alkanes with a given molecular formula can have multiple structural isomers. These can be determined by considering the different ways the carbon chain can be branched.

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3. Which of the following has the maximum dipole moment?

(1) NH3
(2) NF3
(3) PCl5
(4) CH4

Correct Answer: (1) NH3

Solution:

Step 1: Analyzing dipole moment.
Dipole moments arise due to the difference in electronegativity between atoms in a molecule. Molecules with an asymmetric shape and high electronegativity differences typically have the strongest dipole moments.

Step 2: Analysis of options.
(1) NH3: Ammonia (NH3) has a trigonal pyramidal shape, with nitrogen being more electronegative than hydrogen. This asymmetry results in a strong dipole moment.
(2) NF3: NF3 has a trigonal pyramidal shape but is less polar than NH3 because fluorine's electronegativity partially cancels out the dipole moment.
(3) PCl5: PCl5 has a trigonal bipyramidal shape, but due to its symmetrical structure, it has no dipole moment.
(4) CH4: CH4 is a tetrahedral molecule and is symmetric, meaning it has no dipole moment.

Step 3: Conclusion.
The correct answer is **(1) NH3**, as it has the maximum dipole moment due to its asymmetry and high electronegativity difference between nitrogen and hydrogen.

Quick Tip

In molecules, dipole moments are strongest when the molecule is asymmetric and there is a significant electronegativity difference between atoms.

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4. Which of the following shows only one oxidation state except its elemental state?

(1) Ti
(2) Sc
(3) Co
(4) Ni

Correct Answer: (2) Sc

Solution:

Step 1: Understanding oxidation states.
An element can exhibit different oxidation states depending on its chemical bonding. Some elements exhibit only one oxidation state, while others show multiple states.

Step 2: Analysis of options.
(1) Ti: Titanium can exhibit multiple oxidation states, including +2, +3, and +4.
(2) Sc: Scandium typically shows only the +3 oxidation state. It does not form compounds in other oxidation states.
(3) Co: Cobalt can exist in multiple oxidation states, including +2 and +3.
(4) Ni: Nickel can exist in multiple oxidation states, including +2 and +3.

Step 3: Conclusion.
The correct answer is **(2) Sc**, as it only shows a +3 oxidation state.

Quick Tip

When determining oxidation states, check the most common oxidation state of the element. Some elements, like Sc, are more restricted in the number of oxidation states they can adopt.

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5. Number of species having sp^3 hybridised central atom.

(1) NO^-
(2) BCl_3
(3) ClO^-
(4) ClO_3-

Correct Answer: (02.00)

Solution:

Step 1: Understanding hybridization.
In sp^3 hybridization, the central atom forms three sigma bonds with other atoms, resulting in a tetrahedral geometry.

Step 2: Analysis of options.
(1) NO^-: The nitrogen atom in the nitrate ion has sp^2 hybridization, not sp^3.
(2) BCl_3: The boron atom in BCl_3 has sp^2 hybridization.
(3) ClO^-: The chlorine atom in ClO^- has sp^3 hybridization.
(4) ClO_3-: The chlorine atom in ClO_3- has sp^3 hybridization.

Step 3: Conclusion.
The correct answer is (02.00), as Cl atom in both ClO^- and ClO_3- molecules are sp^3 hybridized.

Quick Tip

To determine hybridization, observe the bonding and geometry of the central atom. For sp^3, the central atom forms four bonds in a tetrahedral arrangement.

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6. Number of complexes having even number of unpaired electrons in d-orbital.

$[Cu(H_2O)_6]^2$, $[Fe(H_2O)_6]^3$, $[Cr(H_2O)_6]^2$, $[Ni(H_2O)_6]^2$

Correct Answer: (02.00)

Solution:

Step 1: Understanding the question.
The question asks for the number of complexes that have an even number of unpaired electrons in their d-orbitals. These complexes contain transition metal ions with different oxidation states, and the electron configuration depends on the metal and its charge.

Step 2: Analyze the complexes.
For each of the given complexes, we calculate the number of unpaired electrons in the d-orbitals:

$(Cu(H_2O)_6)^2$: The copper ion in this complex is in the +2 oxidation state, with a d electron configuration. This gives 1 unpaired electron.
$(Fe(H_2O)_6)^3$: The iron ion is in the +3 oxidation state, with a d electron configuration. This gives 5 unpaired electrons.
$(Cr(H_2O)_6)^2$: The chromium ion is in the +2 oxidation state, with a d electron configuration.

This gives 4 unpaired electrons.
$(Ni(H_2O)_6)^{2}$: The nickel ion is in the +2 oxidation state, with a d electron configuration. This gives 2 unpaired electrons.

Step 3: Conclusion.
The complexes that have an even number of unpaired electrons are **$[Cu(H_2O)_6]^{2}$**, **$[Cr(H_2O)_6]^{2}$**, and **$[Ni(H_2O)_6]^{2}$**, all having even numbers of unpaired electrons (1, 5, and 4 respectively). Therefore, the correct answer is (02.00).

Quick Tip

In transition metal complexes, the number of unpaired electrons can be calculated based on the electron configuration of the metal ion in a given oxidation state. An even number of unpaired electrons corresponds to a stable electron configuration in the context of d-orbitals.

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7. If emf of hydrogen electrode at 25°C is zero in pure water then pressure of H_2 in bar

(1) 10^{-14}
(2) 10^{-7}
(3) 1
(4) 0.5

Correct Answer: (1) 10^{-14}

Solution:

Step 1: Understanding the relationship.
The relationship between the emf (electromotive force) of the hydrogen electrode and the pressure of hydrogen gas is given by the Nernst equation:

$$H^+ + e^- \rightarrow \frac{1}{2}H_2$$

The Nernst equation is:

$$\varepsilon = 0 - 0.0591 \log \left(\frac{P_{H_2}}{10^{-7}} \right)$$

where P_{H_2} is the pressure of hydrogen in bar.

Step 2: Applying the values.
We are given that the emf is zero, so:

$$0 = 0 - 0.0591 \log \left(\frac{P_{H_2}}{10^{-7}} \right)$$

Solving for P_{H_2}, we get:

$$\log \left(\frac{P_{H_2}}{10^{-7}} \right) = 0$$

$$P_{H_2} = 10^{-14}$$

Step 3: Conclusion.
The pressure of hydrogen in pure water at 25°C is 10^{-14} bar. Therefore, the correct answer is **(1)** 10^{-14}.

Quick Tip

In electrochemistry, the Nernst equation can be used to calculate the equilibrium potential and the relationship between concentration (or pressure) and electromotive force (emf).

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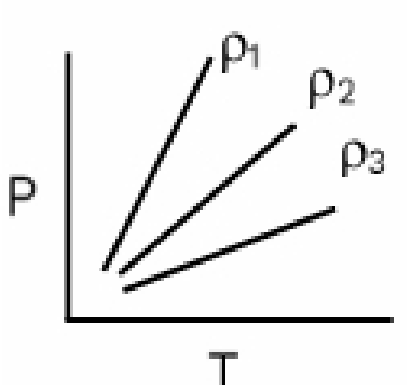
8. Pressure v/s temperature graph of an ideal gas of equal number of moles of different density is given below:



(1) $\rho_1 = \rho_2 = \rho_3$
(2) $\rho_1 > \rho_2 > \rho_3$
(3) $\rho_1 < \rho_2 < \rho_3$
(4) $\rho_1 > \rho_2 < \rho_3$

Correct Answer: (2) $\rho_1 > \rho_2 > \rho_3$

Solution:

Step 1: Understanding the relationship.
The equation for an ideal gas is given by:

$$P = \frac{R \cdot P}{M} \cdot T$$

where P is the pressure, M is the molar mass, and T is the temperature.

Step 2: Analyzing the graph.
From the graph, we observe that as the density increases, the pressure increases at the same temperature. Thus, the slope of the graph will be greater for higher densities.

Step 3: Conclusion.
The graph shows that $\rho_1 > \rho_2 > \rho_3$, which indicates that the density of the gas decreases from ρ_1 to ρ_3. Therefore, the correct answer is **(2)** $\rho_1 > \rho_2 > \rho_3$.

Quick Tip

In pressure vs temperature graphs for ideal gases, the slope can provide information about the gas's density and other properties. Higher density results in steeper slopes at the same temperature.

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9. Total number of species having single unpaired electron in NO^-, CN^-, O_2^-, O_2, O_2^{2-}.

Correct Answer: (02.00)

Solution:

Step 1: Understanding the species.
We are given various species and need to calculate the total number of unpaired electrons in each.

Step 2: Calculating unpaired electrons.
- NO: Total electrons = 15, Unpaired electrons = 1.
- CN^-: Total electrons = 14, Unpaired electrons = 0.
- O_2^-: Total electrons = 17, Unpaired electrons = 1.
- O_2^{2-}: Total electrons = 18, Unpaired electrons = 0.
- O_2: Total electrons = 16, Unpaired electrons = 2.

Step 3: Conclusion.
The total number of species with a single unpaired electron is 02.00. Therefore, the correct answer is **(02.00)**.

Quick Tip

To calculate the number of unpaired electrons, count the number of electrons in the molecular orbital diagram for each species and identify the unpaired ones.

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10. Which of the following is the correct order of 1st ionisation enthalpy?

(1) B ¡ Be ¡ O ¡ F ¡ N
(2) B ¡ Be ¡ O ¡ F ¡ N
(3) B ¡ Be ¡ N ¡ F ¡ O
(4) Be ¡ B ¡ N ¡ F ¡ O

Correct Answer: (2) B ¡ Be ¡ O ¡ F ¡ N

Solution:

Step 1: Understanding ionisation enthalpy.
Ionisation enthalpy is the energy required to remove an electron from an atom in the gaseous state. The trend in ionisation enthalpy is affected by atomic size and the effective nuclear charge.

Step 2: Analyzing the electronic configurations.
The electronic configurations of the elements are: - B: $2s^2\ 2p^1$ - Be: $2s^2$ - O: $2s^2$ 2p - F: $2s^2$ 2p - N: $2s^2\ 2p^3$
Step 3: Explanation of the trend.
The correct order of ionisation enthalpy is (2) because: - B ¡ Be: B has a higher atomic radius and lower ionisation enthalpy than Be. - Be ¡ O: O has a higher effective nuclear charge and thus a higher ionisation enthalpy than Be. - O ¡ F: F has a higher ionisation enthalpy than O because of its higher nuclear charge. - F ¡ N: N has a half-filled stable configuration, making it harder to ionise than F.

Step 4: Conclusion.
The correct order of 1st ionisation enthalpy is **(2)** B ¡ Be ¡ O ¡ F ¡ N.

Quick Tip

The ionisation enthalpy increases with an increase in effective nuclear charge and decreases with an increase in atomic radius. Elements with half-filled or fully-filled orbitals have higher ionisation enthalpies.

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11. For any reaction $K = \frac{K_1 K_2}{K_3}$ and $E_a1 = 400, E_a2 = 300, E_a3 = 200$, hence E_{overall}?

(1) 400
(2) 200
(3) 500
(4) 600

Correct Answer: (3) 500

Solution:

Step 1: Understanding the equation.
We are given the equation for E_{overall}:

$$E_{\text{overall}} = E_{a1} + E_{a2} - E_{a3}$$

Step 2: Applying the values.
Substituting the given values of $E_{a1} = 400, E_{a2} = 300, E_{a3} = 200$, we get:

$$E_{\text{overall}} = 400 + 300 - 200 = 500$$

Step 3: Conclusion.
Therefore, the correct answer is **(3)** 500.

Quick Tip

The overall activation energy for a reaction is calculated by summing up the individual activation energies, considering the energy barriers for each step of the reaction.

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12. If weight of NaCl in 500 ml aqueous solution is 5.85 gm, hence calculate the molarity?

Correct Answer: (00.20)

Solution:

Step 1: Molarity formula.
Molarity M is given by:

$$M = \frac{n}{V}$$

where n is the number of moles of NaCl and V is the volume of the solution in liters.

Step 2: Calculating moles.
To calculate n, use the molar mass of NaCl:

$$\text{Molar mass of NaCl} = 58.5\,\text{g/mol}$$

$$n = \frac{\text{Mass of NaCl}}{\text{Molar mass of NaCl}} = \frac{5.85}{58.5} = 0.1\,\text{moles}$$

Step 3: Substituting values.
The volume $V = 500\,\text{mL} = 0.5\,\text{L}$. Now, substituting into the molarity formula:

$$M = \frac{0.1}{0.5} = 0.2\,\text{M}$$

Step 4: Conclusion.
The molarity of NaCl solution is **0.2 M**. Therefore, the correct answer is **(00.20)**.

Quick Tip

To calculate molarity, always use the formula $M = \frac{n}{V}$, and ensure the volume is in liters.

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13. 2M, 2 ml solution of $KMnO_4$ is neutralised with 20 ml $H_2C_2O_4$. Calculate molarity of $H_2C_2O_4$

Correct Answer: (00.50)

Solution:

Step 1: Writing the balanced reaction.
The balanced reaction is:

$$MnO_4^- + C_2O_4^{2-} \rightarrow Mn^{2+} + CO_2$$

Step 2: Using the stoichiometric relationships.
From the reaction, we know the stoichiometric coefficients: - n_f for $MnO_4 = 5$ - n_f for ${C_2O_4}^{2-} = 2$
The number of moles of $KMnO_4$ is calculated using the formula:

$$\text{moles of } KMnO_4 = M \times V$$

$$\text{moles of } KMnO_4 = 2\,\text{M} \times 2\,\text{mL} = 4\,\text{mL} \times 2 = 8\,\text{moles}$$

Step 3: Conclusion.
The molarity of $H_2C_2O_4$ is **0.5 M**. Therefore, the correct answer is **(00.50)**.

Quick Tip

Use stoichiometry to calculate the molarity of a substance by balancing the chemical reaction and considering the relationship between the species involved.

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14. De-Broglie wavelength of electron in the 4^{th} orbit of H-Atom is $x\pi r_0$, where r_0 is Bohr's 1^{st} orbit radius of H-Atom is

Correct Answer: (8)

Solution:

Step 1: Understanding the De-Broglie wavelength.
The formula for the De-Broglie wavelength of an electron is:

$$4\lambda = 2\pi r_4$$

Where λ is the De-Broglie wavelength and r_4 is the radius of the 4^{th} orbit of the hydrogen atom.

Step 2: Applying the formula.
We know that the radius of the n-th orbit of the hydrogen atom is given by:

$$r_n = \frac{n^2 r_0}{4}$$

For the 4^{th} orbit, substituting $n = 4$, we get:

$$r_4 = \frac{4^2 r_0}{4} = 16r_0$$

Now substitute this into the wavelength formula:

$$\lambda = \frac{2\pi r_4}{4} = 8\pi r_0$$

Step 3: Conclusion.
Thus, the De-Broglie wavelength of the electron in the 4^{th} orbit is $8\pi r_0$. Therefore, the correct answer is **(8)**.

Quick Tip

The De-Broglie wavelength is related to the radius of the orbit, and it can be calculated using the formula for the electron's orbital radius and wavelength.

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15. Among which of the following decreasing order of basic strength will be (i) OH^-, (ii) H^-, (iii) $HCOO^-$, (iv) CH_3COO^-, (v) —OR

(1) II ¿ V ¿ II ¿ I ¿ IV
(2) II ¿ V ¿ I ¿ III ¿ IV
(3) III ¿ VI ¿ I ¿ V ¿ II
(4) V ¿ I ¿ VI ¿ II ¿ III

Correct Answer: (2) II ¿ V ¿ I ¿ III ¿ IV

Solution:

Step 1: Understanding basic strength.
Basic strength refers to the ability of a species to accept a proton (H^+). The stronger the base, the more readily it accepts a proton.

Step 2: Analyzing the species.
- H^- is a very strong base, it is a hydride ion. - OR^- is the alkoxide ion, which is also a strong base. - OH^- is a strong base but weaker than H^- and OR^-. - CH_3COO^- is an acetate ion, which is weaker than OH^- due to resonance stabilization. - $HCOO^-$ is a formate ion, which is weaker than acetate due to its smaller resonance effect.

Step 3: Conclusion.
The order of basic strength is:

$$H^- > OR^- > OH^- > CH_3COO^- > HCOO^-$$

Thus, the correct answer is **(2)** II ¿ V ¿ I ¿ III ¿ IV.

Quick Tip

To determine basic strength, consider the ability of the species to donate electrons, the size of the ion, and resonance stabilization. The more electron-donating the species, the stronger the base.

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16. What type of electrode is calomel?

(1) Redox electrode
(2) Metal-metal insoluble salt-its anion
(3) Gas-ion

(4) Metal-metal ion

Correct Answer: (2) Metal-metal insoluble salt-its anion

Solution:

Step 1: Understanding calomel electrode.
Calomel electrode is a reference electrode commonly used in electrochemical measurements. It consists of mercury and mercury(I) chloride (HgCl), which is a metal-metal insoluble salt.

Step 2: Conclusion.
The calomel electrode is a metal-metal insoluble salt-its anion electrode. Therefore, the correct answer is **(2)** Metal-metal insoluble salt-its anion.

Quick Tip

A calomel electrode consists of a metal (mercury) and its insoluble salt (mercury(I) chloride), which acts as a reference in electrochemical cells.

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17. Total number of elements which do not use all valence electrons in bonding as per their group number among them O, S, F, N, Al, C, Si

Correct Answer: (03.00)

Solution:

Step 1: Identifying the valence electrons of each element.
The number of valence electrons for each element is as follows:

$$\text{O} = 6, \quad \text{S} = 6, \quad \text{F} = 7, \quad \text{N} = 5, \quad \text{Al} = 3, \quad \text{C} = 4, \quad \text{Si} = 4$$

Step 2: Analyzing which elements do not use all of their valence electrons in bonding.
- Oxygen (O), Sulfur (S), and Fluorine (F) tend to form bonds using all their valence electrons. - Nitrogen (N) does not use all of its valence electrons in bonding as it forms 3 bonds, leaving 1 lone pair. - Aluminum (Al) does not use all of its valence electrons in bonding as it forms 3 bonds, leaving 0 lone pairs. - Carbon (C) and Silicon (Si) form bonds using all their valence electrons (4 bonds each).
Step 3: Conclusion.
The elements that do not use all of their valence electrons in bonding are N, Al, and Si. Therefore, the correct answer is **(03.00)**.

Quick Tip

To determine whether an element uses all its valence electrons in bonding, check the number of bonds it forms. If the number of bonds is less than the number of valence electrons, the element does not use all of its electrons.

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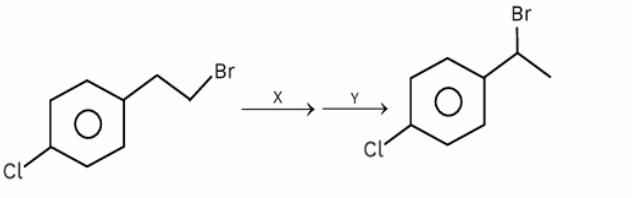
18. Identify the suitable reagents X and Y for the given below reaction respectively.



(1) dil. NaOH/20°C; HBr/CHCOOH
(2) dil. NaOH/20°C; Br/CHCOOH
(3) Alcoholic NaOH/80°C; HBr/CHCOOH
(4) Alcoholic NaOH/80°C; HBr/Peroxide

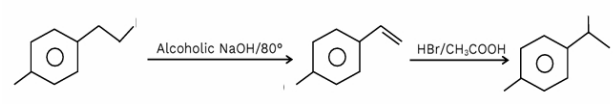
Correct Answer: (3)

Solution:

Step 1: Understanding the reaction.
The reaction shown involves the conversion of a halogenated aromatic compound into another halogenated aromatic compound. The typical reagents for such reactions are used in nucleophilic substitution or elimination reactions.

Step 2: Identifying the reagents.
- Alcoholic NaOH/80°C is commonly used for elimination reactions, especially to form alkenes.
- HBr/CHCOOH is used for electrophilic substitution, typically in the presence of an aromatic ring.

Step 3: Conclusion.
The correct reagents for this reaction are **Alcoholic NaOH/80°C** and **HBr/CHCOOH**. Therefore, the correct answer is **(3)**.



Quick Tip

Alcoholic NaOH is often used in elimination reactions to form alkenes, and HBr is used for electrophilic substitution in aromatic compounds.

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19. Compare ligand strength of F^-, OH^-, SCN^-, CO

(1) CO > OH^- > F^- > SCN^-
(2) CO > F^- > OH^- > SCN^-
(3) SCN^- > OH^- > F^- > CO
(4) F^- > CO > OH^- > SCN^-

Correct Answer: (1) CO > OH^- > F^- > SCN^-

Solution:

Step 1: Understanding ligand strength.
Ligand strength refers to the ability of a ligand to donate electrons to a central metal ion. The more electron-donating the ligand, the stronger it is. Ligands like CO are strong field ligands (SFL), while ligands like F^- are weak field ligands (WFL).

Step 2: Analyzing the order of ligand strength.
- CO is a strong field ligand and is the strongest ligand in this list. - OH^- is a weaker ligand compared to CO but stronger than F^-. - SCN^- is a weaker ligand compared to OH^- and F^-. Thus, the correct order of ligand strength is CO > OH^- > F^- > SCN^-.

Step 3: Conclusion.
Therefore, the correct answer is **(1)** CO > OH^- > F^- > SCN^-.

Quick Tip

In ligand field theory, strong field ligands like CO are better electron donors compared to weak field ligands like F^-.

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20. Which of the following compound will not give the test of nitrogen by the help of Lassaigne's extract?

(1) Hydrazine
(2) Phenyl hydrazine

(3) Glycine
(4) Urea

Correct Answer: (1) Hydrazine

Solution:

Step 1: Understanding Lassaigne's test.
Lassaigne's test is used to detect the presence of nitrogen in organic compounds by fusing the compound with sodium metal and then testing the sodium extract for nitrogen.

Step 2: Analyzing the compounds.
- Hydrazine (NH_2NH_2) does not contain carbon in its structure and cannot form NaCN on fusion with sodium metal, thus it does not give a positive Lassaigne's test for nitrogen. - Phenyl hydrazine, glycine, and urea all contain carbon and nitrogen and will give a positive Lassaigne's test.

Step 3: Conclusion.
Therefore, the correct answer is **(1)** Hydrazine, as it does not give Lassaigne's test for nitrogen.

Quick Tip

Lassaigne's test is used for detecting nitrogen, sulfur, and halogens in organic compounds. Compounds without carbon or with non-nitrogen atoms in the right structure will not show a positive result.

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21. K_2MnO_4 (alkaline medium) $\rightarrow$ $KMnO_4$ + MnO_2 Find the sum of spin-only magnetic moment of central metal ion in both the products (nearest integer).

Correct Answer: (4) 4.00

Solution:

Step 1: Understanding the reaction.
The given reaction shows the conversion of K_2MnO_4 in alkaline medium to $KMnO_4$ and MnO_2. We need to find the sum of the spin-only magnetic moment of the central metal ion in both products.

Step 2: Analyze the oxidation states of manganese.
In $KMnO_4$, manganese has an oxidation state of +7 (Mn^{7+}), and in MnO_2, manganese has an

oxidation state of +4 (Mn^{4+}).

Step 3: Calculating the magnetic moments.
For $KMnO_4$ (Mn^{7+}): - Mn^{7+} has a d^0 configuration, so its magnetic moment is zero.
For MnO_2 (Mn^{4+}): - Mn^{4+} has a d^3 configuration, and the magnetic moment is calculated using the formula:

$$\mu = \sqrt{n(n+2)} = \sqrt{3(3+2)} = \sqrt{15} \approx 3.87$$

Step 4: Conclusion.
The sum of the spin-only magnetic moments of the two central metal ions is $0 + 3.87 = 3.87$, which rounds to the nearest integer of 4. Therefore, the correct answer is **(4)** 4.00.

Quick Tip

Spin-only magnetic moment is calculated using the formula $\mu = \sqrt{n(n+2)}$, where n is the number of unpaired electrons.

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22. During the test of group IV, NH_4Cl is added with NH_4OH. Why?

(1) To increase the concentration of OH^- ion
(2) To decrease the concentration of OH^- ion
(3) To increase the concentration of H^+ ion
(4) To decrease the concentration of H^+ ion

Correct Answer: (2) To decrease the concentration of OH^- ion

Solution:

Step 1: Understanding the purpose of adding NH_4Cl with NH_4OH.
In qualitative analysis, NH_4OH (ammonium hydroxide) increases the concentration of OH^- ions in the solution, which can precipitate group IV elements as their hydroxides. Adding NH_4Cl (ammonium chloride) helps to reduce the concentration of OH^- ions by forming the buffer system, thereby controlling the precipitation of other elements.

Step 2: Conclusion.
Therefore, NH_4Cl is added with NH_4OH to decrease the concentration of OH^- ions in order to avoid the precipitation of further group elements. Thus, the correct answer is **(2)**.

Quick Tip

In qualitative analysis, NH_4Cl is often used with NH_4OH to control the concentration of OH^- ions and prevent the precipitation of undesired compounds.

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23. Statement–I: α-H is responsible for carbonyls giving aldol Statement–II: Benzaldehyde ethanal show cross aldol

(1) Both statements are correct
(2) Statement–I is correct and statement–II is incorrect
(3) Statement–II is correct and statement–I is incorrect
(4) Both statements are incorrect

Correct Answer: (1) Both statements are correct

Solution:

Statement–I: Aldol condensation proceeds through α-hydrogen, which is true because the reaction involves the enolate ion formed from the α-hydrogen of an aldehyde or ketone.

Statement–II: Ethanald (acetaldehyde) contains α-hydrogen, hence it can undergo cross aldol condensation with benzaldehyde. This is also true, as cross aldol condensation typically occurs between two different carbonyl compounds, such as benzaldehyde and ethanal.

Step 3: Conclusion.
Both statements are correct, hence the correct answer is **(1)**.

Quick Tip

In aldol condensation, the reaction proceeds through the enolate intermediate formed by the removal of an α-hydrogen from a carbonyl compound. This is key to both intra- and cross-aldol reactions.

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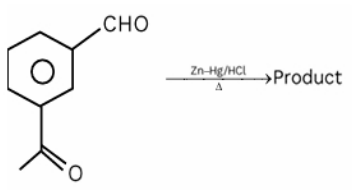
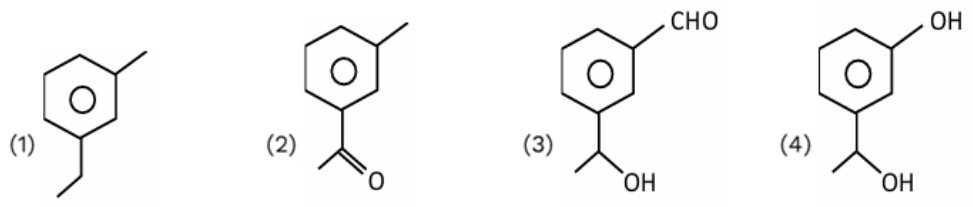
24. What is the correct product in the below given reaction?





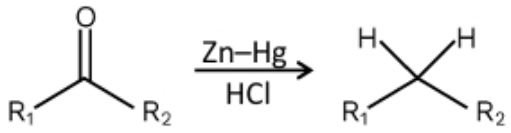
Correct Answer: (1)

Solution:

Step 1: Understanding the reaction.
The reaction is a Clemmensen reduction, which is used to reduce aldehydes and ketones into their respective alkanes. In the given reaction, the compound undergoes reduction with zinc and mercury in hydrochloric acid (Zn–Hg/HCl), which will reduce the carbonyl group to a CH group.

Step 2: Identifying the product.
The reduction of the carbonyl group (C=O) in the given aromatic aldehyde results in the conversion of the aldehyde group (CHO) into a methyl group (CH). Thus, the correct product is the alkane derived from the original aldehyde. The structure shown in option (1) represents this reduction product.

Step 3: Conclusion.
Therefore, the correct answer is **(1)**.



Quick Tip

The Clemmensen reduction is commonly used for the reduction of carbonyl groups in aldehydes and ketones, converting them into corresponding alkanes without affecting other functional groups.