JEE MAINS 2023 Chemistry 11 APRIL Shift 1 Question Paper with Solutions

Time Allowed :1 Hours	Maximum Marks :120	Total Questions :30

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 30 questions. All questions are compulsory.
2. This question paper contains only one section - Chemistry
3. In all sections, Questions are multiple choice questions (MCQs) and questions carry 4 mark each.

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61. Which of the following complex has a possibility to exist as meridional isomer?

(1) $[Co(en)_3]Cl_3$

(2) $[Pt(NH_3)_2]Cl_2$

(3) $[Co(en)_3]$

(4) $[Co(NH_3)_3(NO_3)_3]$

Correct Answer: (4) $[Co(NH_3)_3(NO_3)_3]$

Solution: The $[M_3B_3]$ type of compound exists as facial and meridional isomer.

Quick Tip

Facial and meridional isomerism arises in octahedral complexes where the ligands are arranged in such a way that the compound can exist in multiple geometric isomers.

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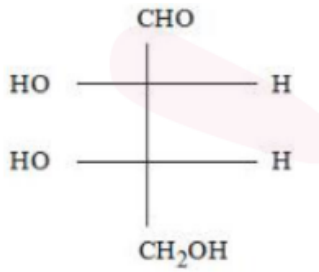
62. L-isomer of tetrose X ($C_4H_8O_4$) gives positive Schiff's test and has two chiral carbons. On acetylation, 'X' yields triacetate. 'X' undergoes following reactions

(1)



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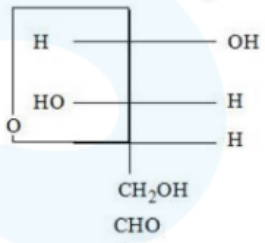

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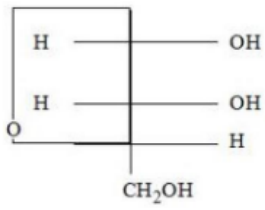

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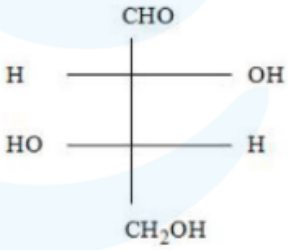
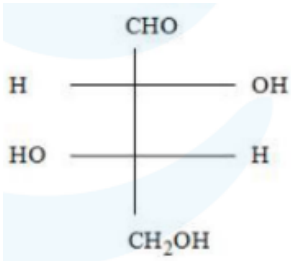
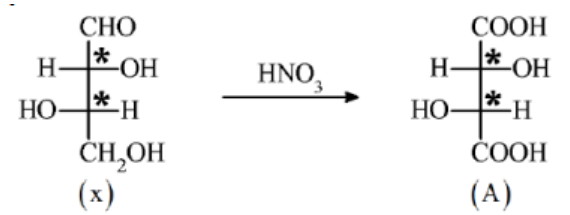
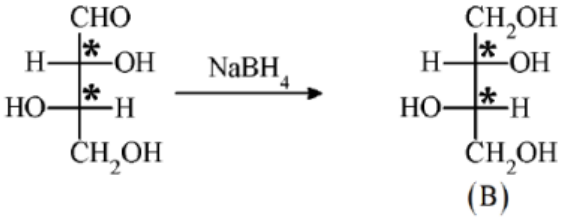


Correct Answer: (4)

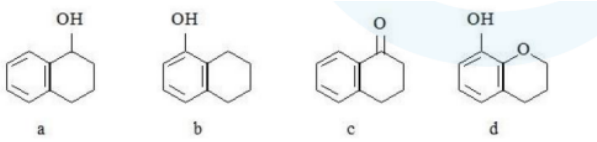




L-tetrose with two chiral centre



Optically active



Solution: The reaction of L-tetrose with HNO_3 results in the formation of a compound with two chiral centers, and on reduction with $NaBH_4$, a compound (B) is formed which is optically active.

Quick Tip

For carbohydrates, reactions such as Schiff's test and acetylation help identify the presence of aldehyde groups and determine the stereochemistry of the compound.

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63. Match list I with list II:

List I	List II
A. KCl	I. Thermoluminescent reactions
B. KCl	II. Fertilizer
C. KOH	III. Sodium potassium pump
D. KOH	IV. Absorber of CO_2

(1) A-III, B-II, C-IV, D-I

(2) A-IV, B-II, C-I, D-III

(3) A-IV, B-III, C-I, D-II

(4) A-V, B-I, C-IV, D-II

Correct Answer: (3) A-IV, B-III, C-I, D-II

Solution: - A. KCl: KCl is used in thermoluminescent reactions, making it related to the light-emitting properties of certain compounds. - B. KCl: KCl is also a fertilizer as it contains potassium and chlorine. - C. KOH: KOH is essential for the sodium-potassium pump, which is crucial for cell function and active transport. - D. KOH: KOH is an absorber of CO_2 because of its basic nature and ability to neutralize CO_2.
Thus, the correct matching is A-IV, B-III, C-I, D-II.

Quick Tip

KCl is often used as a fertilizer because potassium is an essential nutrient for plant growth, and KOH's role in the sodium-potassium pump is vital for maintaining cellular function.

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64. For compound having the formula $GaCl_3$, the correct option from the following is:
(1) Ga forms bond with Cl in $GaCl_3$.
(2) Ga is coordinated with Cl in $GaCl_3$.
(3) Ga is more electronegative than Cl and is present as a cationic part of the salt.
(4) Oxidation state of Ga in $GaCl_3$ is +3.

Correct Answer: (4) Oxidation state of Ga in $GaCl_3$ is +3.

Solution: - Ga forms bond with Cl: $GaCl_3$ shows ionic bonding, and the bond between Ga and Cl is ionic. - Ga is coordinated with Cl: Ga in $GaCl_3$ is in the +3 oxidation state, which results in covalent bonding with Cl. - Ga is more electronegative than Cl: This statement is incorrect as Ga has lower electronegativity than chlorine. - Oxidation state of Ga: In $GaCl_3$, Ga is in the +3 oxidation state.
Therefore, the correct answer is the oxidation state of Ga in $GaCl_3$ is +3.

Quick Tip

In $GaCl_3$, Ga is in the +3 oxidation state, and this compound forms a covalent bond with chlorine.

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65. Thin layer chromatography of a mixture shows the following observation:
Given below are two statements: Statement 1: A is more mobile and interacts with the mobile phase more than C, and C is more than B. Statement 2: A is less mobile and interacts with the stationary phase more than C.

(1) A ¿ B ¿ C

(2) C ¿ A ¿ B

(3) A ¿ C ¿ B

(4) B ¿ C ¿ A

Correct Answer: (3) A ¿ C ¿ B

Solution: According to the observation, A is more mobile and interacts with the mobile phase more than C, and C is more than B.
This suggests that A is more mobile, C is less mobile, and B has the least mobility. Hence the correct order is A ¿ C ¿ B.

Quick Tip

Thin layer chromatography helps in understanding the relative mobility of different substances based on their interaction with the mobile and stationary phases.

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66. When a solution of mixture having two inorganic salts was treated with freshly prepared ferrous sulphate in acidic medium, a dark brown ferric ion was formed when treated with ferric chloride. It gave deep red colour which disappeared on boiling and a brown red ppt was formed. The mixture contains:

(1) CO_3^{2-} NO_3^-

(2) SO_4^{2-} CH_3COO^-

(3) CH_3COO^- $FeCl_3$

(4) SO_4^{2-} CH_3COO^-

Correct Answer: (3) CH_3COO^- $FeCl_3$

Solution: - When a mixture containing the acetates reacts with ferric chloride ($FeCl_3$), it forms a complex and the characteristic brown red precipitate and coloration is formed, which then disappears on boiling. - The reaction suggests the presence of CH_3COO^- and $FeCl_3$ in the mixture, leading to the formation of blood-red and brown colours.
Thus, the correct answer is (3), CH_3COO^- $FeCl_3$.

Quick Tip

When testing for specific ions in inorganic salts, observe changes in colour and precipitate formation which can give clues about the compounds involved.

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67. The polymer X consists of linear molecules and is closely packed. It is prepared in the presence of triethylaluminium and titanium tetrachloride under low pressure. The polymer X is:

(1) Polyacrylonitrile

(2) Polyterephthalate

(3) Low density polyethylene

(4) High density polyethylene

Correct Answer: (3) Low density polyethylene

Solution: - Low density polyethylene (LDPE) is made by free radical polymerization of ethylene. It is prepared under high pressure and with a catalyst like triethylaluminium and titanium tetrachloride. - LDPE has a high degree of branching, making it less dense and more flexible.
Thus, the correct answer is (3), Low density polyethylene.

Quick Tip

Polymerization under high pressure and specific catalysts leads to the formation of low-density polymers with high flexibility.

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68. Match list I with list II:

List I Species	List II Geometry/Shape
A. H_2O	I. Tetrahedral
B. Acetylene	II. Linear
C. NH_3	III. Pyramidal
D. ClO_2	IV. Bent

(1) A-I, B-II, C-III, D-IV

(2) A-IV, B-I, C-III, D-II

(3) A-II, B-IV, C-I, D-III

(4) A-III, B-II, C-IV, D-I

Correct Answer: **(1)** A-I, B-II, C-III, D-IV

Solution: - A. H_2O: Water has a bent shape due to the lone pairs on oxygen, making the geometry bent. - B. Acetylene: Acetylene is a linear molecule with a triple bond between the carbons. - C. NH_3: Ammonia has a trigonal pyramidal shape due to the lone pair on nitrogen. - D. ClO_2: Chlorine dioxide is a bent molecule due to the lone pairs on chlorine.
Thus, the correct matching is A-I, B-II, C-III, D-IV.

Quick Tip

Remember that the geometry of molecules is determined by the number of bonding pairs and lone pairs on the central atom, according to the VSEPR theory.

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69. Given below are two statements:

Statement I: Methane and steam passed over a heated Ni catalyst produces hydrogen gas.

Statement II: Sodium nitrate reacts with NH_4Cl to give H_2O and NaCl.

(1) Both the statement I and II are incorrect

(2) Statement I is incorrect but statement II is correct

(3) Statement I is correct but statement II is incorrect

(4) Both the statements I and II are correct

Correct Answer: (4) Both the statements I and II are correct

Solution: - Statement I is correct. When methane reacts with steam over a nickel catalyst, hydrogen gas is produced in the reaction:

$$CH_4(g) + H_2O(g) \xrightarrow{Ni} CO(g) + 3H_2(g)$$

- Statement II is correct. Sodium nitrate reacts with ammonium chloride to give sodium chloride and water in the reaction:

$$NaNO_3(aq) + NH_4Cl(aq) \rightarrow NaCl(aq) + NaNO_3(aq) + H_2O$$

Thus, the correct answer is (4), Both the statements I and II are correct.

Quick Tip

The reaction of methane and steam over a nickel catalyst is a classic example of a reforming reaction, where hydrogen gas is generated.

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70. The set which does not have ambidentate ligands (labeled as (i)) is:

(1) CO_3^{2-}, NO_3^-, NCS^-

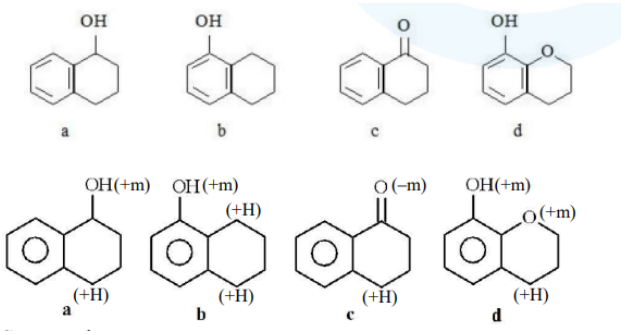
(2) $EDTA^-$, NCS^-, CO_2^{2-}

(3) NO^-, CO_3^{2-}, $EDTA^-$

(4) CO_2^{2-}, ethylene diamine, H_2O

Correct Answer: (4) CO_2^{2-}, ethylene diamine, H_2O

Solution: - Ambidentate ligands are ligands that can coordinate through two different donor atoms, such as NO_3^- and NCS^-. - CO_3^{2-}, NO_3^-, and NCS^- can act as ambidentate ligands, but CO_2^{2-} and ethylene diamine do not. - Hence, the correct set that does not have



ambidentate ligands is (4).

Thus, the correct answer is (4), CO_2^{2-}, ethylene diamine, H_2O.

Quick Tip

Ambidentate ligands are characterized by their ability to bind metal centers through different atoms within the same ligand.

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71. Arrange the following compounds in increasing order of rate of aromatic electrophilic substitution reaction:

(1) (a) ¡ (b) ¡ (c)

(2) (b) ¡ (c) ¡ (a)

(3) (c) ¡ (a) ¡ (b)

(4) (c) ¡ (b) ¡ (a)

Correct Answer: (1) (a) ¡ (b) ¡ (c)

Solution: - Benzene becomes more reactive towards electrophilic aromatic substitution (EAS) when an electron-donating group (-OH, $-NH_2$) is attached to the benzene ring.

- Benzene with electron-withdrawing groups ($-NO_2$, -COOH) decreases the reactivity, as it deactivates the ring towards electrophilic attack.

Thus, the order is:

(a) ¡ (b) ¡ (c)

Quick Tip

Remember that groups like -OH and -NH_2 activate the aromatic ring by donating electron density, whereas -NO_2 and -COOH deactivates it by withdrawing electron density.

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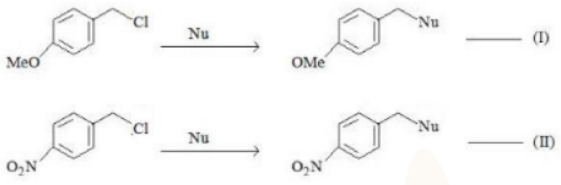
72. Find out the correct statement from the options given below for the above 2 reactions.



Where Nu = Nucleophile

(1) Reaction (I) is of 1st order and reaction (II) is of 2nd order

(2) Reaction (I) and (II) both are 2nd order

(3) Reaction (I) is of 1st order and reaction (II) is of 1st order

(4) Reaction (I) is of 2nd order and reaction (II) is of 1st order

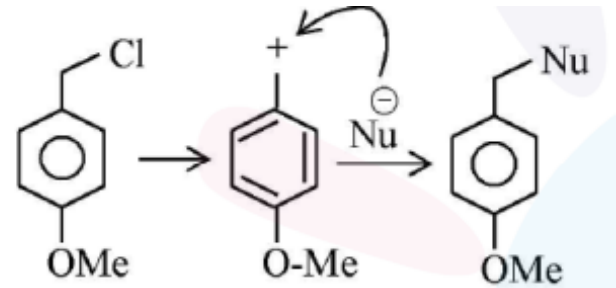
Correct Answer: (3) Reaction (I) is of 1st order and reaction (II) is of 1st order

Solution:

- In the reaction involving an electron-donating group like $-OCH_3$, the electron density on the benzene ring is increased, leading to a faster nucleophilic attack. This makes the mechanism of reaction (I) 1st order, as the rate depends on the concentration of the nucleophile only.

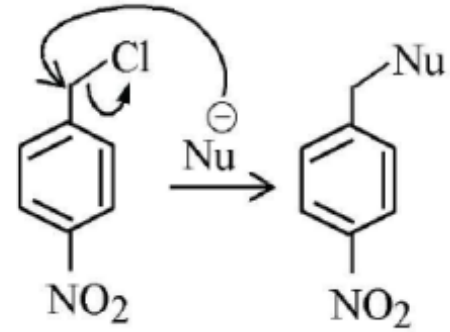
In the reaction involving an electron-withdrawing group like $-NO_2$, the electron density on the benzene ring is decreased, which slows down the nucleophilic substitution and typically follows a 2nd order mechanism, where both the nucleophile and the substrate are involved in the rate-determining step. However, reaction (II) involves a 1st order mechanism because the presence of $-NO_2$ only partially influences the overall rate, which results in an overall first-order reaction.

Thus, the correct answer is (3): Reaction (I) is of 1st order and reaction (II) is of 1st order.



Electron Donating group

S_N1 Mech. : Ist order



Electron withdrawing group

S_N2 Mech: 2nd order

Quick Tip

Remember that electron-donating groups (like -OCH3) increase the nucleophilicity of the aromatic ring, leading to a first-order mechanism, while electron-withdrawing groups (like -NO2) decrease the nucleophilicity, making the reaction mechanism slower.

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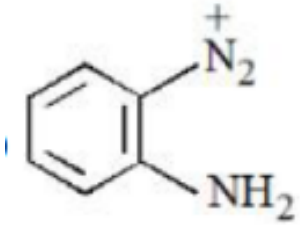
73. o-Phenylenediamine $\xrightarrow{HNO_3} X$ Major Product X is:

(1)



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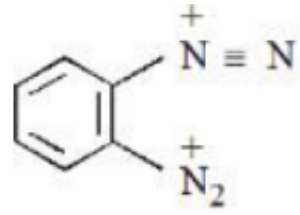

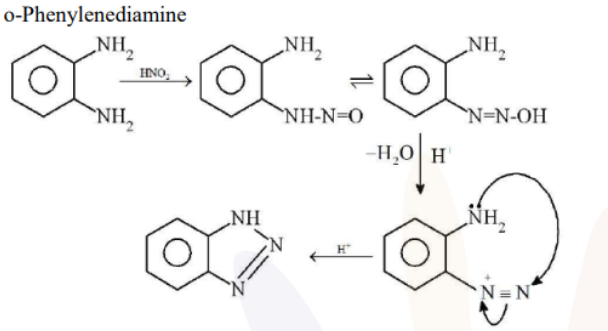

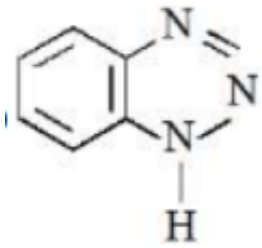

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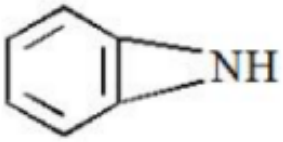

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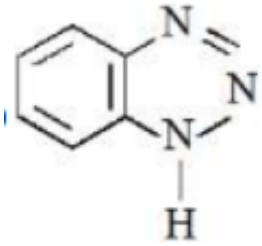

Correct Answer: (3)

Solution:

When o-phenylenediamine is treated with nitric acid, nitration occurs at the position ortho to the amino group. The nitro group (NO_2) replaces the hydrogen attached to the benzene ring, forming a nitrated product. In this case, the major product formed is an imine ($C = N$) structure, which is the result of the reaction between the amino group and the nitro group. Thus, the correct product is a structure with a carbon-nitrogen double bond (C = N).

Quick Tip

When performing reactions involving amines, the functional group often reacts with the reagent to form imines or other derivatives based on the substitution pattern of the aromatic ring.

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74. For elements B, C, N, Li, Be, O and F, the correct order of first ionization enthalpy is:

(1) B ¡ Li ¡ Be ¡ C ¡ O ¡ N ¡ F

(2) Li ¡ C ¡ B ¡ O ¡ N ¡ F

(3) Li ¡ C ¡ B ¡ O ¡ N ¡ F

(4) Li ¡ B ¡ C ¡ O ¡ N ¡ F

Correct Answer: (3) Li ¡ B ¡ C ¡ O ¡ N ¡ F

Solution: The first ionization energy is the energy required to remove an electron from a neutral atom in its gaseous phase. The general trend for the first ionization energy is that it increases across a period (from left to right) and decreases down a group.
Thus, the order of first ionization enthalpy for the elements provided, starting from the lowest, is:

$$\text{Li} < \text{B} < \text{C} < \text{O} < \text{N} < \text{F}$$

Therefore, the correct order is given by option (3).

Quick Tip

The first ionization enthalpy increases from left to right in a period due to an increase in nuclear charge and decreases down a group due to the increased size of atoms.

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75. In the extraction process of copper, the product obtained after carrying out the reactions

$$CuO + H_2 \rightarrow Cu + H_2O$$

is called:

(1) Reduced copper

(2) Blister copper

(3) Copper scrap

(4) Copper slag

Correct Answer: (1) Reduced copper

Solution: In the extraction of copper, when copper oxide (CuO) is reduced by hydrogen gas (H_2), the copper is reduced to its metallic form and water vapor is produced as a byproduct. This process produces what is referred to as reduced copper.

Blister copper, on the other hand, refers to copper that is in a nearly pure state but still contains small amounts of other elements such as sulfur, which can create small bubbles (blisters) on its surface during the smelting process.

Thus, the correct product is reduced copper, which is the result of the reduction of CuO with H_2.

Quick Tip

The reduction of metal oxides with hydrogen gas results in the formation of pure metals, while the process in smelting where impurities cause bubbling forms blister copper.

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76. 25 mL of silver nitrate solution (1M) is added dropwise to 25 mL of potassium iodide (1.05 M) solution. The ions(s) present in very small quantity in the solution is/are:

(1) NO only

(2) Ag and I both

(3) Ag only

(4) I only

Correct Answer: (3) Ag only

Solution: On adding $AgNO_3$ to KI, AgI will form, and the solubility of AgI is very low. As a result, only Ag will remain in very small quantities in the solution. The majority of the I ions will precipitate out as AgI, leaving very few ions in solution.
Thus, the correct answer is Ag ions only.

Quick Tip

When mixing solutions of ionic compounds, check the solubility products (Ksp) to predict whether the ions will precipitate or remain in solution.

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77. Given below are two statements:
Statement I: If BOD value is 4 ppm and dissolved oxygen is 8 ppm, it is a good quality water. Statement II: If the concentration of zinc and nitrate is 5 ppm, then it can be used as good quality water.
(1) Statement I is correct but statement II is incorrect
(2) Statement I is incorrect but statement II is correct
(3) Both statements I and II are incorrect
(4) Both statements I and II are correct

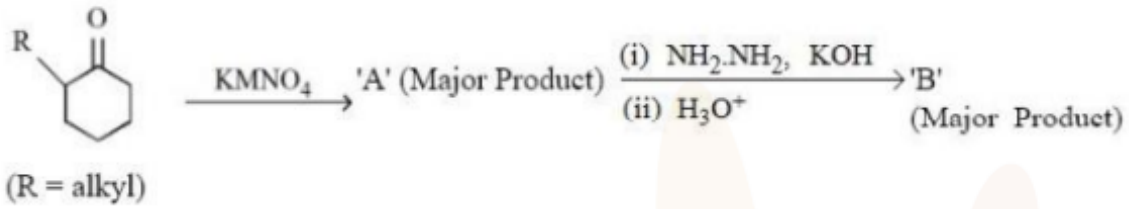
Correct Answer: (4) Both statements I and II are correct

Solution: - **Statement I:** A BOD value of 4 ppm and a dissolved oxygen level of 8 ppm indicate that the water has a good quality because the dissolved oxygen should be higher than the BOD to support aquatic life. - **Statement II:** If the concentration of zinc and nitrate is 5 ppm, this is within permissible limits for drinking water, indicating good quality.
Both statements are correct as they provide accurate interpretations of water quality standards.

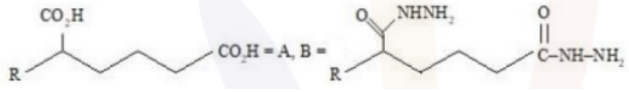
Quick Tip

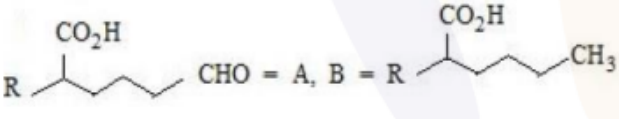
When evaluating water quality, check for parameters like BOD, dissolved oxygen, and concentrations of hazardous elements such as zinc and nitrates.

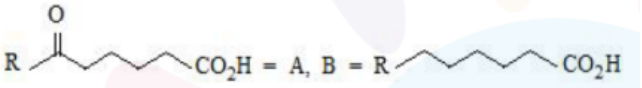
78.

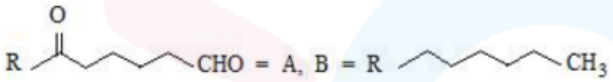


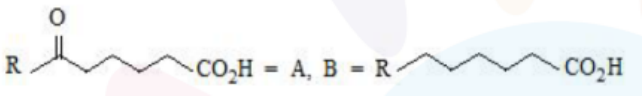
In the above reaction 'A' and 'B' are:

(1) 

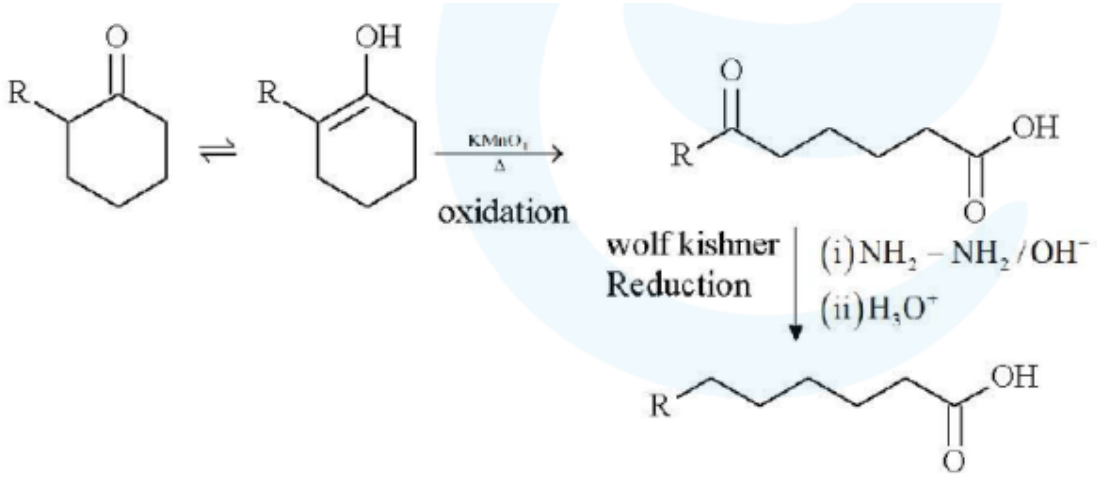
(2) 

(3) 

(4) 

Correct Answer: (3) 

Solution:



- The reaction involves the oxidation of the allyl group to a carboxylic acid group ($COOH$) via $KMnO_4$.

- The second step involves a nucleophilic substitution reaction with NH_3 and $NaOH$, forming the amine group (NH_2).

Thus, the final product is a compound with both $COOH$ and NH_2 groups.

Quick Tip

Oxidation reactions with $KMnO_4$ generally add oxygen to the carbon chain, converting alkyl groups to carboxyl groups.

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79. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R:

Assertion A: In the photoelectric effect electrons are ejected from the metal surface as soon as the beam of light of frequency greater than threshold frequency strikes the surface.

Reason R: When the photon of any energy strikes an electron in the atom transfer of energy from the photon to the electron takes place.

(1) Assertion A is correct but Reason R is not correct

(2) Assertion A is not correct and Reason R is correct

(3) Both A and R are correct and R is the correct explanation of A

(4) Both A and R are correct but R is NOT the correct explanation of A

Correct Answer: (1) Assertion A is correct but Reason R is not correct

Solution: - Assertion A is correct. In the photoelectric effect, electrons are ejected when light of frequency greater than the threshold frequency strikes the surface of a metal. - Reason R is incorrect because the process of energy transfer from the photon to the electron is not the sole factor that leads to the ejection of electrons. The frequency of the light is what matters, not just the energy of the photon.
Thus, the correct option is (1).

Quick Tip

In the photoelectric effect, the energy of the incident light must exceed a certain threshold to eject electrons from the metal surface.

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80. The complex that dissolves in water is:

(1) Fe[Fe(CN)], Prussian Blue insoluble

(2) Fe[Fe(CN)]

(3) K[Co(CO)]

(4) (NH)[As(MoO)]

Correct Answer: (1) Fe[Fe(CN)], Prussian Blue insoluble

Solution: The compound Fe[Fe(CN)] is known as Prussian Blue, and it is insoluble in water. On the other hand, compounds like K[Co(CO)] are soluble due to the ionic nature of the complex.
Thus, the correct answer is (1), as Prussian Blue (Fe[Fe(CN)]) does not dissolve in water.

Quick Tip

Check the solubility of complexes by analyzing their ionic nature and the solubility product (Ksp).

---

81. Solid fuel used in rocket is a mixture of FeO and Al (in ratio 1 : 2) the heat evolved (KJ) per gram of the mixture is _____ (Nearest integer) Given

$\Delta H_f^\circ(Al_2O_3) = -1700\,\textbf{KJ mol}^{-1}$

$\Delta H_f^\circ(Fe_2O_3) = -840\,\textbf{KJ mol}^{-1}$

(1) 2 KJ

(2) 3 KJ

(3) 4 KJ

(4) 5 KJ

Correct Answer: (4) 4 KJ

Solution: The reaction is:

$$Fe_2O_3 + 2Al \rightarrow Al_2O_3 + 2Fe$$

Now calculate the heat evolved:

$$\Delta H = (\Delta H_f^\circ(Al_2O_3)) - (\Delta H_f^\circ(Fe_2O_3))$$

Substitute the given values:

$$\Delta H = (-1700) - (-840) = -860\,\text{KJ/mol}$$

Moles of Fe_2O_3 and Al are in the ratio $1 : 2$. So, 1 mole of Fe_2O_3 weighs $112\,\text{g}$, and 2 moles of Al weigh $54\,\text{g}$.

Total mass of the mixture is:

$$160 + 54 = 214\,\text{g}$$

Now, the heat evolved per gram of the mixture is:

$$\frac{-860\,\text{KJ}}{214} \approx -4.01\,\text{KJ/g}$$

Thus, the heat evolved per gram is approximately 4 KJ. Hence, the correct answer is (4).

Quick Tip

To calculate the heat evolved per gram, divide the total heat by the total mass of the mixture.

---

82. KClO + 6FeSO + 3HSO → KCl + 3Fe(SO) + 3HO The above reaction was studied at 300 K by monitoring the concentration of FeSO, in which initial concentration was 10 M and after half an hour became 8.8 M. The rate of production of Fe(SO) is _____ × 10 mol L¹ s¹

(1) 333

(2) 334

(3) 335

(4) 336

Correct Answer: (1) 333

Solution: Rate of reaction is given by the change in concentration of FeSO:

$$\frac{-\Delta[FeSO]}{\Delta t}$$

Substitute the given values:

$$\frac{-10+8.8}{30\times 60}=\frac{1.2}{1800}=6.67\times 10^{-4}$$

From the given reaction, the rate of production of Fe(SO) is related to the rate of FeSO:

$$\frac{1}{6}\times\frac{-\Delta[FeSO]}{\Delta t}$$

Substitute the value of $\frac{-\Delta[FeSO]}{\Delta t}$:

$$\text{Rate of production of } Fe_2(SO)_3=\frac{3}{6}\times 6.67\times 10^{-4}=333.33\times 10^{-6}$$

Thus, the rate of production of Fe(SO) is 333×10^{-6} mol L¹ s¹. Hence, the correct answer is (1).

Quick Tip

The rate of production of a product in a reaction can be calculated by determining the rate of change of concentration of a reactant and using stoichiometric ratios.

---

83. 0.004 M KSO solution is isotonic with 0.01 M glucose solution. Percentage dissociation of KSO is _____ (Nearest integer)

(1) 70

(2) 75

(3) 80

(4) 85

Correct Answer: (2) 75

Solution: For isotonic solution:

$$i(\text{glucose}) = i(\text{K}_2\text{SO}_4)$$

$$0.01 = i(\text{K}_2\text{SO}_4) \times 0.004$$

$$i(\text{K}_2\text{SO}_4) = \frac{0.01}{0.004} = 2.5$$

Now, for K_2SO_4:

$$i = 1 + (n - 1)$$

$$2.5 = 1 + (n - 1)$$

$n = 3$ for K_2SO_4

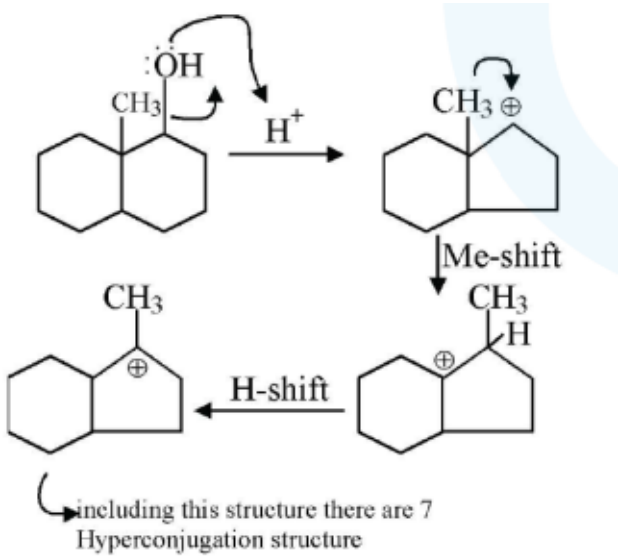
Percentage dissociation:

$$\alpha = \frac{3}{2} = 75\%$$

Thus, the percentage dissociation of $\text{K}_2SO_4 is 75\%. The correct answer is (2).$

Quick Tip

For isotonic solutions, use the equation $i = 1 + (n - 1)$ to find the number of particles and dissociation percentage.



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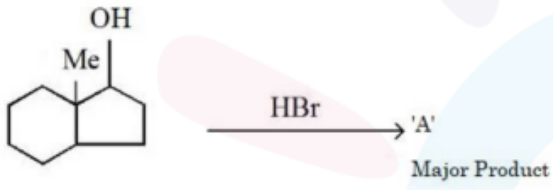
84. The number of hyperconjugation structures involved to stabilize carbocation formed in the below reaction is _____



(1) 6

(2) 7

(3) 8

(4) 9

Correct Answer: (2) 7

Solution:

In the given reaction, the carbocation formed after the removal of H^+ can undergo several hyperconjugation structures. We see that the carbocation can shift, and the hyperconjugation structures involve the bonding electrons of the adjacent C-H bonds.

After shifting, the carbocation is stabilized by the hyperconjugation effect, and counting all the hyperconjugation structures (including the shift), there are 7 such structures.

Thus, the correct number of hyperconjugation structures is 7. Therefore, the correct answer

is (2).

Quick Tip

Hyperconjugation involves the delocalization of electrons from adjacent C-H or C-C bonds to stabilize carbocations.

---

85. A mixture of 1 mole of HO and 1 mole of CO is taken in a 10 liter container and heated to 725 K. At equilibrium, 10 M of water by mass reacts with carbon monoxide according to the equation:

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

The equilibrium constant $K_c \times 10^7$ for the reaction is _____ (Nearest integer)

(1) 44

(2) 45

(3) 46

(4) 47

Correct Answer: (1) 44

Solution: From the given equation, the change in concentrations is:

$$\text{At equilibrium} \quad 1 - 0.4 = 0.6 \quad 0.4 \quad 0.4$$

$$K_c = \frac{0.4 \times 0.4}{0.6 \times 0.6} = \frac{0.16}{0.36} = 0.444 \approx 44$$

Thus, the equilibrium constant is 44×10^7. Therefore, the correct answer is (1).

Quick Tip

To calculate the equilibrium constant, use the relationship between the concentrations of the products and reactants at equilibrium.

---

86. An atomic substance A of molar mass 12 g mol^{-1} has a cubic crystal structure with

edge length of 300 pm. The no. of atoms present in one unit cell of A is _____

(Nearest integer)

(1) 3

(2) 4

(3) 5

(4) 6

Correct Answer: (4) 6

Solution: Given: - Molar mass $M = 12$ g mol^{-1} - Density $d = 3.0$ g mL^{-1} - Edge length $a = 300$ pm $= 300 \times 10^{-12}$ m - Avogadro's number $N_A = 6.02 \times 10^{23}$ mol^{-1}

Formula for number of atoms in one unit cell:

$$Z = \frac{N_A \times M}{d \times a^3}$$

Substitute values:

$$Z = \frac{6.02 \times 10^{23} \times 12}{3.0 \times (300 \times 10^{-12})^3}$$

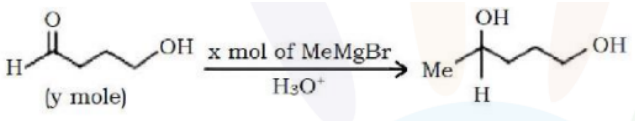
$$Z = 40.635 \times 10^{21} = 6$$

Thus, the number of atoms present in one unit cell is 6. The correct answer is (4).

Quick Tip

The number of atoms in a unit cell can be calculated using the formula $Z = \frac{N_A \times M}{d \times a^3}$.

87.



The ratio x/y on completion of the above reaction is _____

(1) 1

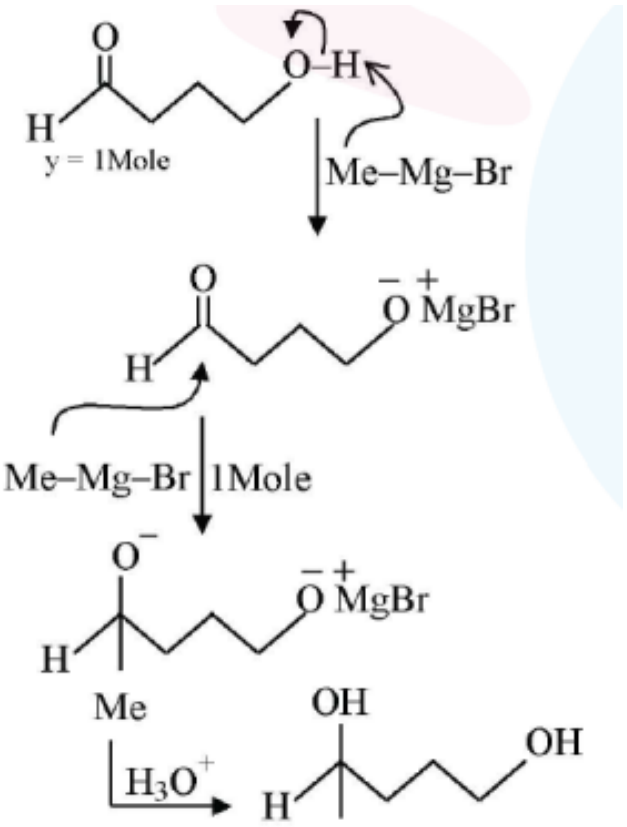
(2) 2

(3) 3

(4) 4

Correct Answer: (2) 2

Solution:



The reaction involves the formation of MeMgBr, with x and y representing the moles of MeMgBr and H, respectively.

From the reaction:

$$\text{H} + \text{MeMgBr} \rightarrow \text{MeMgBr} + \text{OH}^-$$

For the given quantities: - $x = 2$ moles of MeMgBr - $y = 1$ mole of H

Thus, the ratio of x/y is:

$$x/y = 2/1 = 2$$

The correct answer is (2).

Quick Tip

In reactions involving metal organics like MeMgBr, stoichiometry helps find the ratio of reactants and products.

88. The ratio of spin-only magnetic moment values $\mu_{\text{eff}}[Cr(CN)_6]^{3-}/\mu_{\text{eff}}[Cr(H_2O)_6]^{3+}$ is _____

(1) 1

(2) 2

(3) 3

(4) 4

Correct Answer: (1) 1

Solution: The spin-only magnetic moment is calculated using the formula:

$$\mu_{\text{eff}} = \sqrt{n(n+2)}\,\text{BM}$$

For $[Cr(CN)_6]^{3-}$ (d^3):

$$\mu_1 = \sqrt{3(3+2)} = \sqrt{15}\,\text{BM}$$

For $[Cr(H_2O)_6]^{3+}$ (d^3):

$$\mu_2 = \sqrt{3(3+2)} = \sqrt{15}\,\text{BM}$$

Since both have the same electronic configuration, the ratio is:

$$\frac{\mu_1}{\mu_2} = \frac{\sqrt{15}}{\sqrt{15}} = 1$$

Thus, the ratio of magnetic moments is 1. The correct answer is (1).

Quick Tip

For transition metal complexes, the spin-only magnetic moment depends on the number of unpaired electrons.

89. In an electrochemical reaction of lead, at standard temperature, if $E^\circ(\text{Pb}^{2+}/\text{Pb}) = m$ volt and $E^\circ(\text{Pb}^{4+}/\text{Pb}^{2+}) = n$ volt, then the value of $E^\circ(\text{Pb}^{4+}/\text{Pb})$ is given by $m - xn$. The value of x is _____ (Nearest integer)

(1) 1

(2) 2

(3) 3

(4) 4

Correct Answer: (2) 2

Solution: The given reaction is:

$$\text{Pb}^{2+} + 2e^- \rightarrow \text{Pb}$$

$$E^\circ = m \quad \text{and} \quad \Delta G^\circ = -2Fm$$

$$\text{Pb}^{4+} + 4e^- \rightarrow \text{Pb}^{2+}$$

$$E^\circ = n \quad \text{and} \quad \Delta G^\circ = -4Fn$$

Now,

$$\Delta G^\circ = \Delta G_1^\circ - \Delta G_2^\circ$$

$$-2Fm = -4Fn$$

$$2FE = 2Fm + 4Fn \quad \Rightarrow \quad E^\circ = m - 2n$$

Thus, the value of x is 2. The correct answer is (2).

Quick Tip

When dealing with electrochemical reactions, the relationship between the potentials and the standard Gibbs free energies can help calculate the overall cell potential.

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90. A solution of sugar is obtained by mixing 200g of its 25% solution and 500g of its 40% solution (both by mass). The mass percentage of the resulting sugar solution is _____ (Nearest integer)

(1) 35

(2) 36

(3) 37

(4) 38

Correct Answer: (36)

Solution: Given: - Solution (I): Mass of sugar = 200 g, sugar percentage = 25- Solution (II): Mass of sugar = 500 g, sugar percentage = 40

Mass of sugar in solution (I):

$$\frac{25}{100} \times 200 = 50\,\text{g}$$

Mass of sugar in solution (II):

$$\frac{40}{100} \times 500 = 200\,\text{g}$$

Total mass of solution = 200 + 500 = 700 g Total mass of sugar = 50 + 200 = 250 g

Now, the final percentage of sugar is:

$$\frac{250}{700} \times 100 = 35.71 \approx 36$$

Thus, the mass percentage of sugar is 36

Quick Tip

To calculate the mass percentage of a solution, divide the mass of solute by the total mass of the solution and multiply by 100.
