JEE Main 2024 Chemistry Question Paper Jan 31 Shift 1 with Solutions

1. Which of the following is amphoteric?
(1) GeO & GeO2
(2) SnO2 & PbO2
(3) SiO2 & GeO2
(4) CO & SiO2

Correct Answer: (2) SnO2 & PbO2

Solution: Step 1: Definition of Amphoteric and Acidic Oxides. Amphoteric oxides are those that can act both as acids and bases depending on the reaction conditions. On the other hand, acidic oxides only act as acids.
Step 2: Analyzing the Options. - (1) GeO & GeO2: Both of these oxides are acidic. GeO_2 behaves as an acidic oxide. - (2) SnO2 & PbO2: These are amphoteric oxides. Both SnO_2 and PbO_2 can react with both acids and bases, acting as both acid and base depending on the conditions. - (3) SiO2 & GeO2: SiO_2 and GeO_2 are acidic oxides, not amphoteric. - (4) CO & SiO2: CO is neutral and SiO_2 is acidic, so this option is not correct for amphoteric oxides.
Step 3: Conclusion. Based on the definitions and analysis, the correct answer is (2) SnO2 & PbO2 because both are amphoteric oxides.

Quick Tip

Amphoteric oxides, such as SnO_2 and PbO_2, can react both with acids and bases.

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2. Match the following:

A) Glucose + HI	i) Gluconic acid
B) Glucose + NaBH4	ii) n-Hexane
C) Glucose + Br2 . H2O	iii) Sorbitol
D) Glucose + HNO3	iv) Saccharic acid

(1) A - iii, B - iii, C - i, D - iv
(2) A - i, B - iii, C - ii, D - iv
(3) A - i, B - ii, C - iv, D - iii
(4) A - iii, B - ii, C - iv, D - i

Correct Answer: (2) A - i, B - iii, C - ii, D - iv

Solution: Step 1: Reaction of Glucose with HI. - Glucose reacts with hydroiodic acid (HI) to form gluconic acid, where the aldehyde group is oxidized to a carboxyl group.
Step 2: Reduction with NaBH4. - Glucose reacts with sodium borohydride (NaBH4) to reduce the aldehyde group to a primary alcohol, forming sorbitol.
Step 3: Reaction with Bromine Water. - Glucose reacts with bromine water, leading to the oxidation of the aldehyde group to a carboxylic acid group, forming gluconic acid.
Step 4: Oxidation with Nitric Acid. - When glucose is treated with nitric acid (HNO3), both glucose and gluconic acid are further oxidized to saccharic acid, which contains two carboxyl groups.
Step 5: Conclusion. - Based on the reactions described, the correct matching of reactants and products is: - A - i: Glucose + HI produces gluconic acid. - B - iii: Glucose + NaBH4 produces sorbitol. - C - ii: Glucose + Br2 . H2O produces n-hexane (oxidation). - D - iv: Glucose + HNO3 produces saccharic acid.

Quick Tip

Remember that NaBH4 is a selective reducing agent, commonly used to reduce aldehydes to alcohols.

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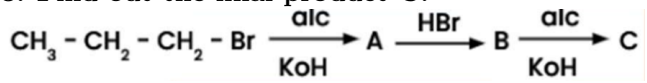
3. Find out the final product C.



(1) Propan - 1 - ol
(2) Propan - 2 - ol
(3) Propene
(4) Propane

Correct Answer: (3) Propene

Solution: Step 1: Understanding the Reaction Mechanism. - In this reaction, the alkyl halide $CH_3CH_2CH_2Br$ undergoes an elimination reaction in the presence of a strong base like KOH. This results in the elimination of the halide ion and the formation of a double bond.
Step 2: Elimination to form an Alkene. - The halide is eliminated, leading to the formation of an alkene. The resulting product is propene, which is an unsaturated hydrocarbon.
Step 3: Conclusion. - The final product is propene because the base induces an elimination reaction, removing the halide ion and forming a double bond between the carbons.

Quick Tip

Elimination reactions generally lead to the formation of alkenes by removing a leaving group (such as a halide) in the presence of a base.

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4. Which compound is white in colour in aqueous medium?
(1) ZnSO4
(2) CuSO4
(3) FeSO4
(4) FeCl3

Correct Answer: (1) ZnSO4

Solution: Step 1: Understanding the Properties of the Compounds. - Zinc sulfate ($ZnSO_4$) is a white solid, and in an aqueous solution, it remains colourless. - Copper sulfate ($CuSO_4$) is blue in colour when dissolved in water. - Iron(II) sulfate ($FeSO_4$) forms a pale green solution in water. - Iron(III) chloride ($FeCl_3$) is yellow in colour.
Step 2: Conclusion. - The correct answer is $ZnSO_4$, which is white in colour in aqueous medium.

Quick Tip

Zinc salts, including $ZnSO_4$, are typically colourless or white due to the fully filled d-orbitals in the Zn(2+) ion.

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5. On which factor does the electrical conductivity of an electrolytic cell not depend?
(1) Concentration of electrolyte
(2) Amount of electrolyte added
(3) Temperature

(4) Nature of electrode

Correct Answer: (4) Nature of electrode

Solution: Step 1: Factors Affecting Conductivity. Electrical conductivity of an electrolytic cell depends on: - The concentration of the electrolyte, as a higher concentration of ions increases conductivity. - The amount of electrolyte added, which directly impacts the number of ions available for conduction. - The temperature, as higher temperatures increase the mobility of ions and hence the conductivity.
Step 2: Conclusion. The conductivity of the electrolytic cell is not affected by the nature of the electrodes, as they merely serve to facilitate the transfer of electrons and do not impact the ion flow.

Quick Tip

The electrical conductivity of an electrolytic cell is influenced by ion concentration, temperature, and the amount of electrolyte, but not by the nature of the electrodes.

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6. Decreasing order of electron gain enthalpy of the following elements (magnitude only): Sulphur - A, Bromine - B, Fluorine - C, Argon - D
(1) A ¿ B ¿ C ¿ D
(2) D ¿ C ¿ B ¿ A
(3) C ¿ B ¿ A ¿ D
(4) A ¿ B ¿ D ¿ C

Correct Answer: (3) C ¿ B ¿ A ¿ D

Solution: Step 1: Electron gain enthalpy concept. Electron gain enthalpy is the energy released when an electron is added to a neutral atom in the gas phase. More negative values indicate a greater tendency to gain an electron.
Step 2: Explanation of trends. - Fluorine (C) has the highest electron gain enthalpy because its small size and high nuclear charge attract electrons strongly. - Bromine (B) follows next due to its larger size compared to Fluorine. - Sulphur (A) has a lower electron gain enthalpy than Bromine due to its larger size. - Argon (D) is an inert gas and does not tend to accept an electron, thus has a positive electron gain enthalpy.
Step 3: Conclusion. The correct order of electron gain enthalpy is: Fluorine > Bromine > Sulphur > Argon.

Quick Tip

Electron gain enthalpy generally increases across a period and decreases down a group due to decreasing atomic size and increasing nuclear charge.

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7. If one faraday of electricity is used in the discharging of Cu^{2+}, then find the mass (in g) of Cu deposited.
(1) 31.75 g
(2) 45.9 g
(3) 65.3 g
(4) 27.5 g

Correct Answer: (1) 31.75 g

Solution: Step 1: Faraday's Law of Electrolysis. One faraday of electricity corresponds to the transfer of 1 mole of electrons. In the case of Cu^{2+}, 2 electrons are required to deposit one mole of Cu.
Step 2: Calculation. - 2 faradays of electricity are required to deposit 1 mole of Cu, which has a molar mass of 63.5 g. - Therefore, passing 1 faraday of electricity will deposit half the mass, i.e., $63.5/2 = 31.75$ g of copper.

Step 3: Conclusion. The mass of Cu deposited after passing 1 faraday of electricity is 31.75 g.

Quick Tip

1 Faraday corresponds to the charge required to deposit 1 mole of a monovalent ion. For a divalent ion, it deposits half the mass of the ion's molar mass.

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8. Statement I: Dichromates are generally made from chromates. Statement II: Manganate ions are diamagnetic.
(1) Both statement I and statement II are false
(2) Statement I is true but statement II is false
(3) Statement I is false but statement II is true
(4) Both statement I and statement II are true

Correct Answer: (2) Statement I is true but statement II is false

Solution: Step 1: Analyzing Statement I. Dichromates are indeed generally made from chromates by adding an acidic solution to chromate salts. The transformation occurs as:

$$\text{Chromate} + \text{Acid} \rightarrow \text{Dichromate}.$$

Step 2: Analyzing Statement II. Manganate ions (MnO_4^{2-}) are paramagnetic, not diamagnetic. This is because of the presence of unpaired electrons in the Mn^{2+} ion.
Step 3: Conclusion. Statement I is true, but Statement II is false, so the correct answer is (2).

Quick Tip

Manganate ions are paramagnetic, meaning they have unpaired electrons in their d-orbitals. Dichromates are made by acidifying chromates.

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9. Which has the highest electron gain enthalpy?
(1) F
(2) Cl
(3) Br
(4) I

Correct Answer: (1) F

Solution: Step 1: Understanding electron gain enthalpy. Electron gain enthalpy is the energy released when an electron is added to an atom in the gas phase. Fluorine has the highest electron gain enthalpy because of its small size and high electronegativity.
Step 2: Trend in electron gain enthalpy. - Fluorine (F) has the highest electron gain enthalpy due to its very high electronegativity and small atomic radius. - Chlorine (Cl) follows, but its electron gain enthalpy is less than Fluorine. - Bromine (Br) and Iodine (I) have progressively lower electron gain enthalpies as their size increases.
Step 3: Conclusion. Fluorine has the highest electron gain enthalpy because it is the smallest halogen and has the greatest tendency to accept an electron.

Quick Tip

Electron gain enthalpy generally increases across a period (from left to right) and decreases down a group due to increasing atomic size and decreasing electron affinity.

10. Which of the following gives positive deviation from Raoult's Law?
(1) Ethanol + acetone
(2) Benzene + toluene
(3) Acetone + chloroform
(4) Chloroethane + bromoethane

Correct Answer: (1) Ethanol + acetone

Solution: Step 1: Understanding Raoult's Law. Raoult's law states that the partial vapor pressure of each volatile component in a solution is directly proportional to its mole fraction in the solution.
Step 2: Positive Deviation. - Positive deviation from Raoult's law occurs when the intermolecular forces between the molecules of the two components are weaker than the forces between the molecules of the individual components. - In the case of Ethanol + Acetone, the hydrogen bonding between ethanol molecules is disrupted, and the dipole-dipole interaction between acetone molecules is weaker, causing higher vapor pressure (positive deviation).
Step 3: Conclusion. Ethanol + acetone forms an ideal solution that shows positive deviation due to weaker interactions between ethanol and acetone molecules.

Quick Tip

Positive deviation occurs when intermolecular forces in the solution are weaker than in the pure components.

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11. Assertion: Noble gases have very high boiling point. Reason: Noble gas have weak dispersion forces.
(1) Both A and R are true and R is the correct explanation of A.
(2) Both A and R are true but R is not the correct explanation of A.
(3) A is true but R is false.
(4) A is false but R is true.

Correct Answer: (4) A is false but R is true.

Solution: Step 1: Noble Gases and Boiling Point. Noble gases have very low boiling points, not high, because they have weak intermolecular forces (Van der Waals forces) and do not readily form bonds.
Step 2: Weak Dispersion Forces. - The weak dispersion forces between noble gas atoms in their atomic form are responsible for their low boiling points. - Thus, while statement A is false, statement R (weak dispersion forces) is true.
Step 3: Conclusion. The correct answer is (4) A is false but R is true.

Quick Tip

Noble gases have low boiling points due to weak dispersion forces between their atoms.

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12. Statement I: pKa value of Phenol and ethanol is 10.0 and 15.9 respectively. Statement II: Ethanol is more acidic than phenol.
(1) Both statement I and statement II are false
(2) Statement I is true but statement II is false
(3) Statement I is false but statement II is true
(4) Both statement I and statement II are true

Correct Answer: (2) Statement I is true but statement II is false

Solution: Step 1: Understanding pKa values. - The pKa of phenol is 10.0, and the pKa of ethanol is 15.9. The lower the pKa value, the stronger the acid. Hence, phenol is more acidic than ethanol.
Step 2: Analyzing the Statements. - Statement I is true because the pKa values given for phenol and ethanol are correct. - Statement II is false because phenol, with a lower pKa value, is more acidic than ethanol.
Step 3: Conclusion. The correct answer is (2) Statement I is true but statement II is false.

Quick Tip

Acidity increases with a lower pKa value, so phenol is more acidic than ethanol.

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13. Which of the following does not give colour with conc. H_2SO_4?
(1) NaBr
(2) CaF2
(3) NaNO3
(4) I^-

Correct Answer: (3) NaNO3

Solution: Step 1: Reaction of acids with salts. When concentrated sulfuric acid is added to halides, it generally produces halogen gases (such as Br_2, I_2, etc.) that give color.
Step 2: Explanation of Each Option. - NaBr reacts with H_2SO_4 to produce bromine (Br_2), which has a brown color. - CaF2 does not react with H_2SO_4 to produce a colored gas, so no color change is observed. - NaNO3 does not react with H_2SO_4 in a way that would produce a colored gas. - I^- reacts with H_2SO_4 to produce iodine gas, which is purple.
Step 3: Conclusion. NaNO3 is the correct answer because it does not produce a colored gas when treated with concentrated sulfuric acid.

Quick Tip

Halides generally react with concentrated sulfuric acid to form halogen gases, which often impart characteristic colors.

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14. Which of the following have six electrons in carbon?
(1) Carbocation
(2) Carbanion
(3) Carbon free radical
(4) None of the above

Correct Answer: (1) Carbocation

Solution: Step 1: Understanding the carbon species. - A **carbocation** has three bonds and one empty orbital, resulting in a total of 6 electrons around the carbon atom. - A **carbanion** has three bonds and one lone pair of electrons, giving the carbon 8 electrons. - A **carbon free radical** has three bonds and one unpaired electron, which gives it 7 electrons.
Step 2: Conclusion. The correct answer is **(1) Carbocation**, as it has exactly 6 electrons around the carbon atom.

Quick Tip

A carbocation is a species where the carbon has only 6 electrons, making it electron-deficient and highly reactive.

15. Adsorption method is used in:
(1) Chromatography
(2) Extractional method
(3) Distillation method
(4) Sublimation

Correct Answer: (1) Chromatography

Solution: Step 1: Understanding adsorption. - **Adsorption** refers to the accumulation of molecules or ions on the surface of a solid or liquid. - In **chromatography**, the stationary phase is adsorbent (such as silica gel or alumina), which adsorbs components of the mixture being separated.
Step 2: Conclusion. The correct answer is **(1) Chromatography**, which is based on the principle of adsorption.

Quick Tip

In chromatography, adsorption is used to separate components of a mixture based on their different affinities to the stationary phase.

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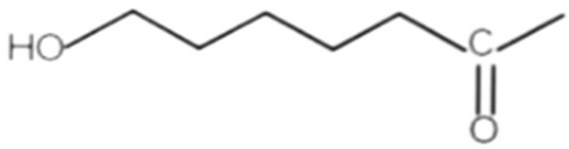
16. Correct IUPAC name of the following compound:



(1) 7-Hydroxyheptan-2-one
(2) 6-Hydroxyheptan-2-one
(3) 2-Oxoheptan-7-ol
(4) 1-Hydroxy-6-oxoheptane

Correct Answer: (1) 7-Hydroxyheptan-2-one

Solution: Step 1: Analyzing the structure. - The compound shown has a hydroxyl group (-OH) at position 7 and a keto group (C=O) at position 2 of a heptane chain. - The correct IUPAC name is based on numbering the carbon chain so that the functional groups (hydroxy and carbonyl) get the lowest possible numbers.
Step 2: Conclusion. The correct name is **7-Hydroxyheptan-2-one**, as it correctly identifies the position of the functional groups.

Quick Tip

When naming organic compounds, always assign the lowest possible locants to functional groups based on IUPAC rules.

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17. White colour compound is
(1) Ammonium molybdate
(2) Ammonium sulphide
(3) Lead sulphate
(4) Lead iodide

Correct Answer: (3) Lead sulphate

Solution: Step 1: Identifying the white compound. - **Ammonium molybdate** and **Ammonium sulphide** are both yellow or colorless in their respective forms. - **Lead iodide** is yellow, and **Lead sulphate** is white in color.
Step 2: Conclusion. Lead sulphate is the white compound, and the correct answer is (3).

Quick Tip

Lead sulphate ($PbSO_4$) is a white, crystalline compound commonly formed as a product of lead reactions.

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18. Statement I: Alcohols can act as nucleophile as well as electrophile. Statement II: Alcohols react with metals to form alkoxide and liberate H2.
(1) Both statement I and statement II are false
(2) Statement I is true but statement II is false
(3) Statement I is false but statement II is true
(4) Both statement I and statement II are true

Correct Answer: (4) Both statement I and statement II are true

Solution: Step 1: Analyzing Statement I. - **Alcohols** are versatile compounds. They can act as nucleophiles, meaning they can donate electrons (e.g., in substitution reactions), and they can act as electrophiles when the alcohol is protonated (e.g., in dehydration reactions).
Step 2: Analyzing Statement II. - Alcohols react with metals to form **alkoxides** and liberate **H2** gas. This is a characteristic reaction of alcohols with active metals like sodium.
Step 3: Conclusion. Both statements are correct, so the correct answer is (4).

Quick Tip

Alcohols can act both as nucleophiles (in substitution reactions) and electrophiles (when protonated in acid catalysis).

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19. How many of the following compounds have sp^3 hybridized central atom? H_2O, NH_3, SiO_2, SO_2, CO and BF_3
Correct Answer: 4

Solution: Step 1: Identify hybridization of central atoms. - **H_2O**: The oxygen atom is sp^3 hybridized. - **NH_3**: The nitrogen atom is sp^3 hybridized. - **SiO_2**: The silicon atom is sp^3 hybridized. - **SO_2**: The sulfur atom is sp^2 hybridized (not sp^3). - **CO**: The carbon atom is sp hybridized (not sp^3). - **BF_3**: The boron atom is sp^2 hybridized (not sp^3).
Step 2: Conclusion. The compounds with sp^3 hybridized central atoms are H_2O, NH_3, and SiO_2, which gives a total of 4 compounds.

Quick Tip

Sp^3 hybridization occurs when the central atom forms four sigma bonds, typical in molecules like water and methane.

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20. Moles of CH_4 required for formation of 22 g of CO_2 is m $\times 10^2$. The value of m is:
Correct Answer: 50

Solution: Step 1: Moles of CO_2 formation. From the balanced equation for the combustion of methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

- The molar mass of CO_2 is 44 g/mol, so the number of moles of CO_2 formed from 22 g is:

$$\frac{22}{44} = 0.5\,\text{mol}.$$

Step 2: Moles of CH_4. According to the reaction, 1 mole of CH_4 produces 1 mole of CO_2. Therefore, 0.5 moles of CO_2 would require 0.5 moles of CH_4.
- The number of moles of CH_4 required for 22 g of CO_2 is $0.5\,\text{mol} \times 10^2 = 50$.
Step 3: Conclusion. The value of m is **50**.

Quick Tip

For stoichiometric calculations, always use the molar ratio from the balanced equation to determine the amount of reactant required.

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21. The total number of different alkanes formed when the following mixture is subjected to electrolysis: CH_3COONa (aq) and C_2H_5COONa (aq)
Correct Answer: 3

Solution: Step 1: Electrolysis of carboxylates. - Electrolysis of sodium acetate (CH_3COONa) will form **ethane** and **methane**. - Electrolysis of sodium propionate (C_2H_5COONa) will form **butane** and **ethane**.
Step 2: Conclusion. The different alkanes formed are ethane, butane, and propane, so the total is 3 alkanes.

Quick Tip

Electrolysis of carboxylates can form alkanes by reduction of the carboxylate group to a methyl or ethyl group.

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22. Which of the following are generally used in batteries?
Correct Answer: Zn, Cd, Hg, Mn, Fe

Solution: Step 1: Battery materials. - Materials used in batteries typically include **Zn** (zinc), **Cd** (cadmium), **Hg** (mercury), **Mn** (manganese), and **Fe** (iron) due to their ability to act as anode or cathode materials in different battery types.
Step 2: Conclusion. The correct answer is **(1) Zn, Cd, Hg, Mn, Fe**, as they are commonly used in various types of batteries.

Quick Tip

Zn, Cd, and Mn are commonly used in dry cells and rechargeable batteries due to their electrochemical properties.

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23. Number of Geometrical Isomers of $[Pt(en)_2Cl_2]$
Correct Answer: 2

Solution: Step 1: Understanding the structure of $[Pt(en)_2Cl_2]$. The compound $[Pt(en)_2Cl_2]$ consists of platinum as the central metal ion surrounded by two ethylenediamine (en) ligands and two chloride (Cl) ligands.

Step 2: Analyzing the geometrical isomers. - Since the platinum ion is in a coordination number of 6, it forms an octahedral complex. - The two **en** ligands are bidentate, meaning each can bind at two points to the platinum, creating a situation where two isomers can arise based on the relative positioning of the chloride ions. - These two isomers are **cis** and **trans** isomers, based on the relative positioning of the chloride ions in the octahedral geometry.
Step 3: Conclusion. The number of geometrical isomers of $[\mathrm{Pt}(en)_2Cl_2]$ is **2**: the cis and trans isomers.

Quick Tip

Geometrical isomers occur when ligands can occupy different positions around the central metal, creating distinct spatial arrangements.
