JEE Main Chemistry Sample Paper-7

Duration: 1 Hour **Maximum Marks: 100**

Instructions

- This paper contains TWO sections: **Section A** (MCQs) and **Section B** (Numerical).
- Section A contains 20 Multiple Choice Questions.
- Section B contains 5 Numerical Value Questions.
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries **-1 mark**.
- No negative marking for unattempted questions.

Section A — Multiple Choice Questions

Q1. The correct decreasing order of priority of functional groups in IUPAC nomenclature is: [JEE Main 2022]

(A) $-COOH > -CONH_2 > -COCl > -CHO$

(B) $-COOH > -COCl > -CONH_2 > -CHO$

(C) $-COCl > -COOH > -CONH_2 > -CHO$

(D) $-COOH > -CHO > -CONH_2 > -COCl$

Q2. Among the following, the most stable carbocation is: [JEE Main 2023]

(A) $p\text{-}O_2N - C_6H_4 - CH_2^+$

(B) $C_6H_5 - CH_2^+$

(C) $p\text{-}CH_3O - C_6H_4 - CH_2^+$

(D) $p\text{-}CH_3 - C_6H_4 - CH_2^+$

Q3. An unsaturated hydrocarbon 'X' on ozonolysis gives a mixture of methanal and 2-ketopropanal. The structure of 'X' is: [JEE Main 2021]

(A) 2-methylbuta-1,3-diene

(B) Penta-1,3-diene

(C) 2-methylpenta-2,4-diene

(D) 2-methylbut-1-ene

Q4. The major product formed in the reaction of 2-bromo-3-methylbutane with sodium ethoxide in ethanol is: [JEE Main 2024]

(A) 2-methylbut-2-ene

(B) 2-methylbut-1-ene

(C) 3-methylbut-1-ene

(D) 2-ethoxy-3-methylbutane

Q5. The major product of the reaction between *n*-propyl benzene and NBS (N-bromosuccinimide) in the presence of light is: [JEE Main 2022]

(A) 1-bromo-1-phenylpropane

(B) 2-bromo-1-phenylpropane

(C) 3-bromo-1-phenylpropane

(D) *p*-bromo-*n*-propylbenzene

Q6. The major product of the following reaction is:

$$CH_3CH_2CH_2CHO \xrightarrow[2.\ H_3O^+]{1.\ CH_3MgBr} A \xrightarrow{\text{Conc. } H_2SO_4,\Delta} B$$

[JEE Main 2023]

(A) Pent-1-ene

(B) Pent-2-ene

(C) 2-methylbut-2-ene

(D) 2-methylbut-1-ene

Q7. The correct order of acid strength of the following carboxylic acids is: (I) $ClCH_2COOH$ (II) $Cl_2CHCOOH$ (III) Cl_3CCOOH (IV) CH_3COOH [JEE Main 2021]

(A) III > II > I > IV

(B) I > II > III > IV

(C) III > I > II > IV

(D) IV > III > II > I

Q8. Hoffmann bromamide degradation of benzamide gives product A. Reaction of A with $CHCl_3$ and alcoholic KOH gives product B. B is: [JEE Main 2024]

(A) Aniline

(B) Benzyl amine

(C) Phenyl isocyanide

(D) Benzonitrile

Q9. Which of the following statement is NOT true for glucose? [JEE Main 2022]

(A) It gives Schiff's test.

(B) It reacts with hydroxylamine to form an oxime.

(C) The pentaacetate of glucose does not react with hydroxylamine.

(D) It exists in two crystalline forms α and β.

Q10. According to Molecular Orbital Theory, which of the following is diamagnetic? [JEE Main 2023]

(A) O_2

(B) O_2^{2-}

(C) B_2

(D) N_2^+

Q11. The correct shape and I-I-I bond angle of I_3^- ion are: [JEE Main 2021]

(A) Linear, 180°

(B) Trigonal planar, 120°

(C) V-shape, 105°

(D) T-shape, 90°

Q12. The hybridisation of central atoms in IF_7, SF_6, and PCl_5 respectively are: [JEE Main 2024]

(A) sp^3d^3, sp^3d^2, sp^3d

(B) sp^3d^2, sp^3d, sp^3d^3

(C) sp^3d^3, sp^3d, sp^3d^2

(D) sp^3d, sp^3d^2, sp^3d^3

Q13. The spin-only magnetic moment of $[CoF_6]^{3-}$ is (Atomic number of Co = 27): [JEE Main 2022]

(A) 2.84 BM

(B) 4.90 BM

(C) 0 BM

(D) 5.92 BM

Q14. The IUPAC name of the complex $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is: [JEE Main 2023]

(A) Diamminechlorido(methanamine)platinum(II) chloride

(B) Diamminechlorido(methylamine)platinum(II) chloride

(C) Diammine(methanamine)chloridoplatinum(II) chloride

(D) Diammine(methylamine)chloridoplatinum(IV) chloride

Q15. The correct order of first ionization enthalpy for the elements B, C, N, O is: [JEE Main 2021]

(A) B < C < O < N

(B) B < C < N < O

(C) C < B < N < O

(D) B < O < C < N

Q16. The amphoteric oxide among the following is: [JEE Main 2024]

(A) V_2O_5

(B) CrO

(C) Mn_2O_7

(D) Cr_2O_3

Q17. Which of the following lanthanoid ions is diamagnetic? (At. Nos. Ce = 58, Sm = 62, Eu = 63, Yb = 70) [JEE Main 2022]

(A) Ce^{2+}

(B) Sm^{2+}

(C) Eu^{2+}

(D) Yb^{2+}

Q18. The half-life of a first-order reaction is 30 min. The time required for 75% completion of the same reaction is: [JEE Main 2023]

(A) 45 min

(B) 60 min

(C) 90 min

(D) 120 min

Q19. The molar conductivity of a 0.002 M solution of a weak acid HX is 40 S cm^2 mol^{-1}. If the limiting molar conductivity of HX is 400 S cm^2 mol^{-1}, the dissociation constant K_a of the acid is: [JEE Main 2021]

(A) 2×10^{-5}

(B) 4×10^{-4}

(C) 2×10^{-4}

(D) 4×10^{-5}

Q20. For a reaction $A + B \rightarrow C + D$, the entropy change is 40 J K^{-1} mol^{-1} and the enthalpy change is 30 kJ mol^{-1} at 300 K. The Gibbs free energy change for the reaction is: [JEE Main 2024]

(A) 18 kJ mol^{-1}

(B) -18 kJ mol^{-1}

(C) 12 kJ mol^{-1}

(D) 20 kJ mol^{-1}

Section B — Numerical Questions

Q21. The number of radial nodes in $3s$ and $2p$ orbitals are respectively _____ and _____. (Provide sum of nodes). [JEE Main 2022]

Q22. 0.5 g of an organic compound was Kjeldahlised and the ammonia evolved was absorbed in 50 mL of 0.5 M H_2SO_4. The residual acid required 60 mL of 0.5 M NaOH for neutralization. The percentage of nitrogen in the compound is _____. [JEE Main 2023]

Q23. The pH of a buffer solution containing 0.1 M CH_3COONa and 0.01 M CH_3COOH is _____. (Given: pK_a of $CH_3COOH = 4.74$) [JEE Main 2021]

Q24. How many of the following are intensive properties? Internal energy, Boiling point, Molar heat capacity, Volume, Density, Enthalpy. [JEE Main 2024]

Q25. The number of unpaired electrons in the complex $[Fe(CN)_6]^{3-}$ is _____. [JEE Main 2022]

Detailed Solutions

Q1.

Solution

Concept: In IUPAC nomenclature, functional groups are prioritized based on their electron-withdrawing or electron-donating abilities.

Solution: The priority order of functional groups is determined by the inductive and resonance effects. Carboxylic acids, being the most electron-withdrawing, take the highest priority, followed by amides, acyl chlorides, and aldehydes.

Hence, the correct order is:

$$\text{Carboxylic Acid} > \text{Amide} > \text{Acyl Chloride} > \text{Aldehyde}$$

Final Answer: (A)

Answer: (A)

Q2.

Solution

Concept: The stability of carbocations increases with resonance stabilization or inductive effects from substituents.

Solution: The carbocation in $p\text{-}O_2N - C_6H_4 - CH_2^+$ is stabilized by the resonance with the nitro group, which is an electron-withdrawing group. This increases the stability of the carbocation.

Final Answer: (A)

Answer: (A)

Q3.

Solution

Concept: Ozonolysis of conjugated dienes results in the formation of carbonyl compounds (aldehydes and ketones).

Solution: The compound 'X' that produces methanal (formaldehyde) and 2-ketopropanal upon ozonolysis is 2-methylbuta-1,3-diene. The ozonolysis cleavage at the conjugated double bonds leads to these carbonyl products.

Final Answer: (A)

Answer: (A)

Q4.

Solution

Concept: Sodium ethoxide in ethanol induces an elimination reaction, forming an alkene by the E2 mechanism.

Solution: In the reaction of 2-bromo-3-methylbutane with sodium ethoxide, the elimination occurs at the position leading to the formation of the more stable alkene, 2-methylbut-2-ene, due to the higher degree of substitution.

Final Answer: (A)

Answer: (A)

Q5.

Solution

Concept: N-Bromosuccinimide (NBS) adds a bromine atom to the benzylic position of alkylbenzenes under free radical conditions.

Solution: The reaction of *n*-propylbenzene with NBS and light leads to the bromination at the benzylic position, forming 3-bromo-1-phenylpropane.

Final Answer: (C)

Answer: (C)

Q6.

Solution

Concept: Grignard reagents add to the carbonyl carbon of aldehydes, followed by acid workup to form an alcohol. Upon heating with concentrated sulfuric acid, dehydration occurs to form an alkene.

Solution: The reaction of *n*-propyl aldehyde with CH_3MgBr gives the corresponding alcohol. Upon heating with concentrated sulfuric acid, the alcohol undergoes dehydration to form pent-2-ene.

Final Answer: (B)

Answer: (B)

Q7.

Solution

Concept: The acid strength of carboxylic acids is affected by the presence of electron-withdrawing groups, which stabilize the conjugate base.

Solution: The correct order of acidity is determined by the number and strength of electron-withdrawing substituents. The correct order is:

$$Cl_3CCOOH > Cl_2CHCOOH > ClCH_2COOH > CH_3COOH$$

Final Answer: (C)

Answer: (C)

Q8.

Solution

Concept: Hoffmann bromamide degradation involves the removal of the amide group and the formation of an amine.

Solution: Hoffmann bromamide degradation of benzamide leads to the formation of aniline. The reaction of aniline with $CHCl_3$ and alcoholic KOH gives phenyl isocyanide.

Final Answer: (C)

Answer: (C)

Q9.

Solution

Concept: Glucose is a reducing sugar and reacts with hydroxylamine to form an oxime, except when it is acetylated.

Solution: The pentaacetate of glucose does not react with hydroxylamine, which is the exception in this case.

Final Answer: (C)

Answer: (C)

Q10.

Solution

Concept: According to Molecular Orbital Theory, the number of unpaired electrons determines whether a molecule is diamagnetic or paramagnetic.

Solution: O_2^{2-} is diamagnetic because all electrons are paired. In contrast, O_2 has unpaired electrons and is paramagnetic.

Final Answer: (B)

Answer: (B)

Q11.

Solution

Concept: The shape and bond angles in the I_3^- ion are determined by the number of bonding and lone pairs around the central atom.
Solution: The I_3^- ion adopts a linear shape with a bond angle of 180° due to the presence of three iodine atoms and two lone pairs on the central iodine atom.
Final Answer: (A)

Answer: (A)

Q12.

Solution

Concept: The hybridization of the central atom in a molecule is determined by the number of bonding pairs and lone pairs.
Solution: The hybridization of the central atoms are:

$$IF_7 \quad (sp^3d^3), \quad SF_6 \quad (sp^3d^2), \quad PCl_5 \quad (sp^3d)$$

Final Answer: (A)

Answer: (A)

Q13.

Solution

Concept: The spin-only magnetic moment is related to the number of unpaired electrons.
Solution: For $[CoF_6]^{3-}$, the electronic configuration of Co^{3+} (which has 3 unpaired electrons) results in a magnetic moment of:

$$\mu = \sqrt{3(3+2)} = \sqrt{15} \approx 2.84 \text{ BM}$$

Final Answer: (A)

Answer: (A)

Q14.

Solution

Concept: The IUPAC name for a coordination complex follows specific nomenclature rules.

Solution: The IUPAC name of $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is:

Diamminechlorido(methanamine)platinum(II) chloride

Final Answer: (A)

Answer: (A)

Q15.

Solution

Concept: Ionization enthalpy increases across a period due to increasing effective nuclear charge.

Solution: The correct order of first ionization enthalpy for the elements is:

$$B < C < N < O$$

Final Answer: (B)

Answer: (B)

Q16.

Solution

Concept: Amphoteric oxides react with both acids and bases.

Solution: Cr_2O_3 is an amphoteric oxide, as it can react with both acids and bases.

Final Answer: (D)

Answer: (D)

Q17.

Solution

Concept: Lanthanoid ions are paramagnetic or diamagnetic depending on the number of unpaired electrons.

Solution: Yb^{2+} is diamagnetic because it has no unpaired electrons.

Final Answer: (D)

Answer: (D)

Q18.

Solution

Concept: For a first-order reaction, the time for a certain percentage completion is related to the half-life.

Solution: For a first-order reaction, the time for 75% completion is twice the half-life. So, the time is:

$$2 \times 30 \text{ min} = 60 \text{ min}$$

Final Answer: (B)

Answer: (B)

Q19.

Solution

Concept: The dissociation constant K_a is related to the conductivity of the acid.

Solution: Using the formula for dissociation constant and conductivity:

$$K_a = \frac{[\text{conductivity of dissociated ions}]}{[\text{total concentration}]}$$

Final Answer: (A)

Answer: (A)

Q20.

Solution

Concept: Gibbs free energy change $\Delta G = \Delta H - T\Delta S$.

Solution: Using the given values:

$$\Delta G = 30 \text{ kJ mol}^{-1} - 300 \text{ K} \times 40 \text{ J K}^{-1} \text{ mol}^{-1} = 30 \text{ kJ mol}^{-1} - 12 \text{ kJ mol}^{-1} = 18 \text{ kJ mol}^{-1}$$

Final Answer: (A)

Answer: (A)

Q21.

Solution

Concept: Radial nodes in orbitals are given by the formula:

$$\text{Number of radial nodes} = n - l - 1$$

where n is the principal quantum number and l is the azimuthal quantum number.
Solution: For the $3s$ orbital, $n = 3$ and $l = 0$, so the number of radial nodes is:

$$\text{Radial nodes in 3s} = 3 - 0 - 1 = 2$$

For the $2p$ orbital, $n = 2$ and $l = 1$, so the number of radial nodes is:

$$\text{Radial nodes in 2p} = 2 - 1 - 1 = 0$$

Thus, the sum of the nodes is:

$$2 + 0 = 2$$

Final Answer: 2

Answer: (2)

Q22.

Solution

Concept: The nitrogen content in the compound can be calculated using the formula:

$$\text{Percentage of nitrogen} = \frac{\text{Mass of nitrogen}}{\text{Mass of compound}} \times 100$$

The amount of ammonia (NH_3) evolved is used to determine the mass of nitrogen.

Solution: The moles of H_2SO_4 used in Kjeldahlization is:

$$\text{Moles of } H_2SO_4 = 0.5 \text{ M} \times 0.05 \text{ L} = 0.025 \text{ mol}$$

The moles of NaOH used for neutralization is:

$$\text{Moles of NaOH} = 0.5 \text{ M} \times 0.06 \text{ L} = 0.03 \text{ mol}$$

The moles of H_2SO_4 reacted with ammonia is:

$$\text{Moles of } H_2SO_4 \text{ reacted} = 0.03 - 0.025 = 0.005 \,\text{mol}$$

Since each mole of ammonia corresponds to 1 mole of nitrogen, the moles of nitrogen is also 0.005 mol.

The mass of nitrogen is:

$$\text{Mass of nitrogen} = 0.005 \text{ mol} \times 14 \text{ g/mol} = 0.07 \text{ g}$$

The percentage of nitrogen in the compound is:

$$\text{Percentage of nitrogen} = \frac{0.07 \text{ g}}{0.5 \text{ g}} \times 100 = 14\%$$

Final Answer: 14

Answer: (14)

Q23.

Solution

Concept: The pH of a buffer solution is calculated using the Henderson-Hasselbalch equation:

$$\text{pH} = \text{pK}_a + \log\left(\frac{[\text{Base}]}{[\text{Acid}]}\right)$$

where pK_a is the dissociation constant of the acid, and [Base] and [Acid] are the concentrations of the base and acid respectively.

Solution: Given that the concentrations are:

$$[\text{Base}] = 0.1 \text{ M } CH_3COONa, \quad [\text{Acid}] = 0.01 \text{ M } CH_3COOH, \quad \text{pK}_a = 4.74$$

Using the Henderson-Hasselbalch equation:

$$\text{pH} = 4.74 + \log\left(\frac{0.1}{0.01}\right) = 4.74 + \log(10) = 4.74 + 1 = 5.74$$

Final Answer: 5.74

Answer: (5.74)

Q24.

Solution

Concept: Intensive properties are independent of the amount of the substance, while extensive properties depend on the quantity.

Solution: The intensive properties from the list are:

- Boiling point (intensive)
- Density (intensive)

The extensive properties are:

- Internal energy (extensive)
- Molar heat capacity (extensive)
- Volume (extensive)
- Enthalpy (extensive)

Thus, there are 2 intensive properties: Boiling point and Density.

Final Answer: 2

Answer: (2)

Q25.

Solution

Concept: To find the number of unpaired electrons in a complex, we first determine the electron configuration of the central metal ion and then account for any ligands that might cause pairing.

Solution: For the complex $[Fe(CN)_6]^{3-}$, Fe is in the +3 oxidation state, so the electron configuration is:

$$Fe^{3+} : [Ar]3d^5$$

As cyanide (CN^-) is a strong field ligand, it causes pairing of electrons. In an octahedral field, the 5 d-electrons pair up to give no unpaired electrons.

Thus, the number of unpaired electrons is:

$$0$$

Final Answer: 0

Answer: (0)

Answer Key — Section A

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	A	3	A	4	A	5	C
6	B	7	C	8	C	9	C	10	B
11	A	12	A	13	A	14	A	15	B
16	D	17	D	18	B	19	A	20	A

Answer Key — Section B

Q	Ans	Q	Ans
21	2	22	14
23	5.74	24	2
25	0		