JEE Main Chemistry Sample Paper-19

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 total number of stereoisomers for the compound $[Co(en)_2Cl_2]^+$ is: [JEE Main 2021]

(A) 2

(B) 3

(C) 4

(D) 6

Q2. Which of the following compounds will not show a color change when treated with acidic $K_2Cr_2O_7$? [JEE Main 2020]

(A) SO_2

(B) H_2S

(C) $FeSO_4$

(D) CO_2

Q3. The major product of the reaction: $Anisole + HI \xrightarrow{\Delta} \ldots$ is: [JEE Main 2023]

(A) Phenol and Methyl Iodide

(B) Iodobenzene and Methanol

(C) Phenol and Methanol

(D) Iodobenzene and Methyl Iodide

Q4. The correct order of the boiling points of the following amines is:
(I) $n-butylamine$
(II) $diethylamine$
(III) $ethyldimethylamine$ [JEE Main 2022]

(A) I > II > III

(B) III > II > I

(C) II > I > III

(D) I > III > II

Q5. Among the following, the most stable free radical is: [JEE Main 2021]

(A) $CH_3\dot{C}H_2$

(B) $(CH_3)_2\dot{C}H$

(C) $(CH_3)_3\dot{C}$

(D) $C_6H_5\dot{C}H_2$

Q6. The product formed when Benzaldehyde reacts with concentrated $NaOH$ is: [JEE Main 2019]

(A) Benzyl alcohol and Sodium benzoate

(B) Benzyl alcohol and Benzene

(C) Sodium benzoate and Water

(D) Cinnamic acid

Q7. Which of the following is a "globular" protein? [JEE Main 2024]

(A) Keratin

(B) Myosin

(C) Insulin

(D) Collagen

Q8. The correct order of $C-O$ bond strength in CO, CO_2, CO_3^{2-} is: [JEE Main 2022]

(A) $CO > CO_2 > CO_3^{2-}$

(B) $CO_3^{2-} > CO_2 > CO$

(C) $CO_2 > CO > CO_3^{2-}$

(D) $CO > CO_3^{2-} > CO_2$

Q9. Which of the following molecules has a non-zero dipole moment? [JEE Main 2021]

(A) XeF_4

(B) BF_3

(C) NF_3

(D) CCl_4

Q10. The primary reason for the "Lanthanoid Contraction" is: [JEE Main 2023]

(A) Poor shielding of $4f$ electrons

(B) Effective shielding of $4f$ electrons

(C) Increase in nuclear charge

(D) Decrease in nuclear charge

Q11. The correct order of the hydration enthalpy of alkali metal ions is: [JEE Main 2020]

(A) $Li^+ > Na^+ > K^+ > Rb^+$

(B) $Rb^+ > K^+ > Na^+ > Li^+$

(C) $Li^+ > K^+ > Na^+ > Rb^+$

(D) $Na^+ > Li^+ > K^+ > Rb^+$

Q12. Which of the following gives a white precipitate with $AgNO_3$ but does not react with $NaOH$? [JEE Main 2022]

(A) Chlorobenzene

(B) Benzyl chloride

(C) Ethyl chloride

(D) Vinyl chloride

Q13. The magnetic moment of $[NiCl_4]^{2-}$ is $2.82\,B.M.$ The geometry of the complex is: [JEE Main 2021]

(A) Square planar

(B) Tetrahedral

(C) Octahedral

(D) Trigonal bipyramidal

Q14. For the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, if the degree of dissociation is 0.2 at 1 atm, the K_p is: [JEE Main 2024]

(A) 0.17

(B) 0.34

(C) 0.50

(D) 0.68

Q15. The standard reduction potentials of three metals A, B, and C are $+0.5\,V$, $-3.0\,V$, and $-1.2\,V$ respectively. The reducing power order is: [JEE Main 2019]

(A) B > C > A

(B) A > C > B

(C) C > B > A

(D) A > B > C

Q16. The number of angular nodes for a $4d$ orbital is: [JEE Main 2021]

(A) 1

(B) 2

(C) 3

(D) 4

Q17. Which of the following is an example of a "disaccharide"? [JEE Main 2023]

(A) Glucose

(B) Fructose

(C) Ribose

(D) Maltose

Q18. The rate of a reaction increases 4-fold when the temperature is raised from $300\,K$ to $320\,K$. The activation energy is: [JEE Main 2022]

(A) $50.3\,kJ/mol$

(B) $52.9\,kJ/mol$

(C) $55.1\,kJ/mol$

(D) $60.2\,kJ/mol$

Q19. The solubility of $AgCl$ is minimum in: [JEE Main 2021]

(A) $0.1\,M\ NaCl$

(B) $0.1\,M\ CaCl_2$

(C) Pure water

(D) $0.1\,M\ NH_4OH$

Q20. The IUPAC name for $CH_3COCH(CH_3)_2$ is: [JEE Main 2020]

(A) 3-methylbutan-2-one

(B) 2-methylbutan-3-one

(C) Isopropyl methyl ketone

(D) 2-methylpentan-3-one

Section B — Numerical Questions

Q21. The ratio of the mass of an α-particle to the mass of a proton is approximately ____. (Integer value). [JEE Main 2022]

Q22. A solution contains 1 mole of liquid A and 3 moles of liquid B. The vapor pressure of pure A is 100 mmHg and pure B is 200 mmHg. The total vapor pressure of the solution is ____ mmHg. [JEE Main 2023]

Q23. For the reaction $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$, the rate constant is 2.0×10^{-3} $mol^{-2}L^2s^{-1}$. The overall order of the reaction is ____. [JEE Main 2024]

Q24. The number of lone pairs on the central atom of ClO_3^- is ____. [JEE Main 2021]

Q25. If the pH of a solution is 3, the concentration of OH^- ions is 1×10^{-x} M. The value of x is ____. [JEE Main 2025]

Detailed Solutions

Q1.

Solution

Concept: Stereoisomers are molecules with the same molecular formula and connectivity but different spatial arrangements. Chiral centers are necessary for stereoisomerism.
Solution: - $[Co(en)_2Cl_2]^+$ has two ethylenediamine (en) ligands and two chloride ions. - The two en ligands are bidentate, and their arrangement can lead to stereoisomerism. - Since there are two bidentate ligands, there are 2 possible stereoisomers due to the different spatial arrangements.
Conclusion: The total number of stereoisomers for the compound is 2.
Final Answer: (A)

Answer: (A)

Q2.

Solution

Concept: Acidic $K_2Cr_2O_7$ is a strong oxidizing agent that reacts with reducing agents like SO_2, H_2S, and $FeSO_4$ but does not react with non-reducing substances like CO_2.
Solution: - SO_2 and H_2S are reducing agents and will react with $K_2Cr_2O_7$. - $FeSO_4$ also undergoes oxidation in the presence of $K_2Cr_2O_7$. - CO_2 is a stable compound and will not react with $K_2Cr_2O_7$.
Conclusion: CO_2 will not show a color change when treated with acidic $K_2Cr_2O_7$.
Final Answer: (D)

Answer: (D)

Q3.

Solution

Concept: The reaction of anisole with HI involves nucleophilic substitution of the methoxy group by an iodine atom, followed by the formation of phenol and methyl iodide.
Solution: - In the reaction, the methoxy group in anisole reacts with HI to form phenol and methyl iodide. - The reaction proceeds via the nucleophilic substitution mechanism, where the methoxy group is replaced by the iodine atom.
Conclusion: The major product is phenol and methyl iodide.
Final Answer: (A)

Answer: (A)

Q4.

Solution

Concept: The boiling point of amines depends on the number of alkyl groups attached to the nitrogen. Primary amines have higher boiling points due to hydrogen bonding, while tertiary amines have lower boiling points due to the lack of hydrogen bonding.
Solution: - n-Butylamine (a primary amine) has the highest boiling point due to hydrogen bonding. - Diethylamine (a secondary amine) has a lower boiling point than n-butylamine but higher than ethyldimethylamine. - Ethyldimethylamine (a tertiary amine) has the lowest boiling point due to lack of hydrogen bonding.
Conclusion: The correct order of boiling points is $I > II > III$.
Final Answer: (A)

Answer: (A)

Q5.

Solution

Concept: Free radicals are stabilized by electron-donating groups. Tertiary free radicals are more stable than secondary, which in turn are more stable than primary free radicals.
Solution: - $CH_3\dot{C}H_2$ (a primary free radical) is less stable. - $(CH_3)_2\dot{C}H$ (a secondary free radical) is more stable due to the electron-donating methyl groups. - $(CH_3)_3\dot{C}$ (a tertiary free radical) is the most stable due to the maximum electron-donating effect from three methyl groups. - $C_6H_5\dot{C}H_2$ (a benzyl free radical) is also stabilized by resonance but is less stable than a tertiary alkyl radical.
Conclusion: The most stable free radical is $(CH_3)_3\dot{C}$.
Final Answer: (C)

Answer: (C)

Q6.

Solution

Concept: The reaction of benzaldehyde with $NaOH$ forms cinnamic acid through the benzoin condensation or aldol condensation mechanism.
Solution: - In the presence of $NaOH$, benzaldehyde undergoes condensation to form cinnamic acid, which is an ,-unsaturated carboxylic acid.
Conclusion: The product formed is cinnamic acid.
Final Answer: (D)

Answer: (D)

Q7.

Solution

Concept: Globular proteins are spherical in shape and are water-soluble, unlike fibrous proteins, which are insoluble and have long, thread-like structures.
Solution: - Keratin, myosin, and collagen are examples of fibrous proteins, which are insoluble in water. - Insulin is a globular protein that is soluble in water and spherical in shape.
Conclusion: The globular protein is insulin.
Final Answer: (C)

Answer: (C)

Q8.

Solution

Concept: Bond strength in carbon-oxygen bonds increases with the presence of electron-withdrawing groups.
Solution: - CO_2 has a stronger $C = O$ bond than CO_3^{2-} because the latter has resonance stabilization. - The $C = O$ bond in CO is stronger than in CO_2 because there is no resonance in CO.
Conclusion: The correct order of $C - O$ bond strength is $CO > CO_2 > CO_3^{2-}$.
Final Answer: (A)

Answer: (A)

Q9.

Solution

Concept: A molecule will have a non-zero dipole moment if it has an asymmetric structure with polar bonds.
Solution: - XeF_4 has a square planar geometry and does not have a dipole moment. - BF_3 has a trigonal planar geometry and is symmetrical, so it has no dipole moment. - NF_3 has a trigonal pyramidal geometry with a non-zero dipole moment. - CCl_4 is a tetrahedral molecule with no dipole moment due to its symmetry.
Conclusion: NF_3 has a non-zero dipole moment.
Final Answer: (C)

Answer: (C)

Q10.

Solution

Concept: Lanthanoid contraction refers to the gradual decrease in ionic radii of the lanthanoids as the atomic number increases, due to poor shielding of the $4f$ electrons.
Solution: - The lanthanoid contraction is primarily due to poor shielding of the $4f$ electrons by other $4f$ electrons. - This causes an increase in effective nuclear charge and leads to smaller ionic radii.
Conclusion: The primary reason for the lanthanoid contraction is poor shielding of $4f$ electrons.
Final Answer: (A)

Answer: (A)

Q11.

Solution

Concept: The hydration enthalpy of alkali metal ions is inversely proportional to their size and directly proportional to their charge.
Solution: - Li^+ has the highest hydration enthalpy due to its small size. - The hydration enthalpy decreases as we move down the group from Na^+ to K^+ and Rb^+.
Conclusion: The correct order of hydration enthalpy is $Li^+ > Na^+ > K^+ > Rb^+$.
Final Answer: (A)

Answer: (A)

Q12.

Solution

Concept: AgNO reacts with alkyl halides to form a white precipitate of AgCl if the alkyl group is able to undergo nucleophilic substitution.
Solution: - Chlorobenzene and vinyl chloride are not reactive towards AgNO under normal conditions. - Benzyl chloride and ethyl chloride react with AgNO to form a white precipitate of AgCl, but vinyl chloride does not undergo substitution with AgNO.
Conclusion: Vinyl chloride does not react with AgNO.
Final Answer: (D)

Answer: (D)

Q13.

Solution

Concept: The geometry of a complex can be determined based on its electronic configuration and the number of ligands.
Solution: - For $[NiCl_4]^{2-}$, the complex has 4 ligands arranged in a tetrahedral geometry. - The magnetic moment of 2.82 $B.M.$ indicates the presence of unpaired electrons, consistent with a tetrahedral geometry.
Conclusion: The geometry of $[NiCl_4]^{2-}$ is tetrahedral.
Final Answer: (B)

Answer: (B)

Q14.

Solution

Concept: The equilibrium constant K_p is related to the degree of dissociation for the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$.
Solution: - The degree of dissociation α is given as 0.2. - Using the formula for K_p and applying the degree of dissociation, we can calculate the value of K_p.
Conclusion: The K_p is 0.34.
Final Answer: (B)

Answer: (B)

Q15.

Solution

Concept: The reducing power of metals is inversely related to their reduction potential.
Solution: - The metal with the most negative reduction potential will be the strongest reducing agent. - Based on the standard reduction potentials, B is the strongest reducing agent, followed by C, and A is the weakest.
Conclusion: The reducing power order is $B > C > A$.
Final Answer: (A)

Answer: (A)

Q16.

Solution

Concept: The number of angular nodes in an orbital is given by l, the azimuthal quantum number. For a $4d$ orbital, $l = 2$, and the number of angular nodes is 2.
Solution: - A $4d$ orbital has 2 angular nodes (since $l = 2$).
Conclusion: The number of angular nodes for a $4d$ orbital is 2.
Final Answer: (B)

Answer: (B)

Q17.

Solution

Concept: Disaccharides are carbohydrates composed of two monosaccharide units joined by a glycosidic bond.
Solution: - Maltose is a disaccharide formed by two glucose units linked by an alpha-1,4-glycosidic bond.
Conclusion: The disaccharide is maltose.
Final Answer: (D)

Answer: (D)

Q18.

Solution

Concept: The activation energy can be calculated using the Arrhenius equation:

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

where k_2 and k_1 are the rate constants at temperatures T_2 and T_1, respectively.
Solution: - Given: - The rate of reaction increases by a factor of 4 when the temperature is increased from $300\,K$ to $320\,K$. - Using the formula and solving for E_a, we find $E_a = 50.3\,kJ/mol$.
Conclusion: The activation energy is $50.3\,kJ/mol$.
Final Answer: (A)

Answer: (A)

Q19.

Solution

Concept: The solubility of a salt is affected by the common ion effect, where the presence of a common ion decreases the solubility of the salt.

Solution: - $AgCl$ is least soluble in $0.1M\ NaCl$ because the common ion Cl^- decreases its solubility.

Conclusion: The solubility of $AgCl$ is minimum in $0.1M\ NaCl$.

Final Answer: (A)

Answer: (A)

Q20.

Solution

Concept: The IUPAC name of a ketone is derived from the parent hydrocarbon and the position of the substituent.

Solution: - The IUPAC name for $CH_3COCH(CH_3)_2$ is 3-methylbutan-2-one, as the methyl group is attached at position 3.

Conclusion: The IUPAC name is 3-methylbutan-2-one.

Final Answer: (A)

Answer: (A)

Q21.

Solution

Concept: An α-particle consists of 2 protons and 2 neutrons. The mass of an α-particle is the sum of the masses of 2 protons and 2 neutrons, while the mass of a proton is approximately the same as the mass of a neutron.

Solution: - The mass of an α-particle is approximately:

$$\text{Mass of } \alpha\text{-particle} = 2 \times \text{mass of proton} + 2 \times \text{mass of neutron}$$

- Since the mass of a proton is approximately equal to the mass of a neutron, the mass of an α-particle is approximately:

$$\text{Mass of } \alpha\text{-particle} \approx 4 \times \text{mass of proton}$$

- The ratio of the mass of an α-particle to the mass of a proton is approximately:

$$\frac{\text{Mass of } \alpha\text{-particle}}{\text{Mass of proton}} = 4$$

Conclusion: The ratio of the mass of an α-particle to the mass of a proton is 4.

Final Answer: 4

Answer: (4)

Q22.

Solution

Concept: Raoult's Law states that the total vapor pressure of a solution is the sum of the vapor pressures of the individual components, each multiplied by its mole fraction in the solution.

Solution: - Given: - The mole fraction of liquid A $= \frac{1}{1+3} = \frac{1}{4}$, - The mole fraction of liquid B $= \frac{3}{4}$, - Vapor pressure of pure A $= 100$ mmHg, - Vapor pressure of pure B $= 200$ mmHg. - The total vapor pressure of the solution is given by:

$$P_{\text{total}} = P_A \cdot X_A + P_B \cdot X_B$$

$$P_{\text{total}} = 100 \times \frac{1}{4} + 200 \times \frac{3}{4}$$

$$P_{\text{total}} = 25 + 150 = 175\,\text{mmHg}$$

Conclusion: The total vapor pressure of the solution is 175 mmHg.

Final Answer: 175

Answer: (175)

Q23.

Solution

Concept: The overall order of a reaction is the sum of the exponents of the concentration terms in the rate law.

Solution: - The rate constant has the units $mol^{-2}L^2s^{-1}$, which implies that the rate law is of the form:

$$\text{Rate} = k[NO]^2[O_2]$$

- From the rate law, the exponents of the concentration terms are: - The order with respect to NO is 2, - The order with respect to O_2 is 1. - Therefore, the overall order of the reaction is:

$$\text{Overall order} = 2 + 1 = 3$$

Conclusion: The overall order of the reaction is 3.

Final Answer: 3

Answer: (3)

Q24.

Solution

Concept: In ClO_3^-, the central chlorine atom is surrounded by three oxygen atoms, and the structure is trigonal pyramidal. The number of lone pairs on the central atom can be calculated by considering the total valence electrons and the bonds formed.

Solution: - The valence electrons of Cl = 7, - Each oxygen atom contributes 6 valence electrons, so for three oxygens, the total is $3 \times 6 = 18$. - The total number of valence electrons is $7 + 18 = 25$. - The chlorine atom forms 3 bonds with oxygen, using 6 electrons, leaving $25 - 6 = 19$ electrons. - Since there are 3 bonding pairs, the remaining 19 electrons will be in the form of lone pairs on chlorine. - The number of lone pairs on chlorine is $\frac{19}{2} = 2$.

Conclusion: The number of lone pairs on the central atom in ClO_3^- is 2.

Final Answer: 2

Answer: (2)

Q25.

Solution

Concept: The relationship between pH and the concentration of OH^- ions is given by:

$$pH + pOH = 14$$

$$pOH = -\log[OH^-]$$

Solution: - Given: $pH = 3$,

$$pOH = 14 - pH = 14 - 3 = 11$$

- The concentration of OH^- ions is:

$$[OH^-] = 10^{-pOH} = 10^{-11}$$

Conclusion: The value of x is 11.

Final Answer: 11

Answer: (11)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	4	22	175
23	3	24	2
25	11		