JEE Main Chemistry Sample Paper-9

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. Which of the following carbocations is the most stable?   [JEE Main 2024]

(A) $CH_3CH_2^+$

(B) $(CH_3)_2CH^+$

(C) $(CH_3)_3C^+$

(D) $C_6H_5CH_2^+$

Q2. The total number of structural isomers possible for molecular formula C_3H_6O is: [JEE Main 2022]

(A) 6

(B) 7

(C) 8

(D) 9

Q3. The major product of reaction of Propene with Cl_2 at $500°C$ is: [JEE Main 2023]

(A) 1,2-dichloropropane

(B) Allyl chloride

(C) Isopropyl chloride

(D) Vinyl chloride

Q4. Which of the following reacts fastest with aqueous KOH? [JEE Main 2024]

(A) CH_3Cl

(B) C_6H_5Cl

(C) $CH_2 = CH - Cl$

(D) $(CH_3)_3C - Cl$

Q5. Phenol reacts with $CHCl_3/NaOH$ to give Salicylaldehyde. This reaction is: [JEE Main 2024]

(A) Kolbe reaction

(B) Reimer-Tiemann reaction

(C) Etard reaction

(D) Cannizzaro reaction

Q6. Which of the following will not undergo Aldol condensation? [JEE Main 2025]

(A) Acetaldehyde

(B) Acetone

(C) Benzaldehyde

(D) Propanal

Q7. Reduction of Benzoyl chloride with $H_2/Pd-BaSO_4$ produces: [JEE Main 2023]

(A) Benzyl alcohol

(B) Benzene

(C) Benzaldehyde

(D) Benzoic acid

Q8. Aniline reacts with cold HNO_2/HCl followed by Cu_2Cl_2 give: [JEE Main 2022]

(A) Benzene

(B) Chlorobenzene

(C) Phenol

(D) Nitrobenzene

Q9. Which of the following vitamins is water-soluble?   [JEE Main 2021]

(A) Vitamin A

(B) Vitamin D

(C) Vitamin E

(D) Vitamin C

Q10. The hybridisation and shape of SF_4 are: [JEE Main 2023]

(A) sp^3d, See-saw

(B) sp^3d, Tetrahedral

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

(D) sp^3, Pyramidal

Q11. Which molecule has the highest dipole moment?   [JEE Main 2024]

(A) NF_3

(B) NH_3

(C) CO_2

(D) CH_4

Q12. According to MOT, which of the following is diamagnetic?   [JEE Main 2025]

(A) O_2

(B) B_2

(C) C_2

(D) N_2^+

Q13. The spin-only magnetic moment of $[Fe(CN)_6]^{4-}$ is: [JEE Main 2024]

(A) 0 BM

(B) 1.73 BM

(C) 4.90 BM

(D) 5.92 BM

Q14. The IUPAC name of $[Pt(NH_3)_2Cl_2]$ is: [JEE Main 2022]

    (A) Diamminedichloridoplatinum(II)

    (B) Diamminedichloridoplatinum(IV)

    (C) Dichloridodiammineplatinum(II)

    (D) Platinumdiamminedichloride

Q15. Which of the following is the strongest oxidizing agent?   [JEE Main 2021]

    (A) F_2

    (B) Cl_2

    (C) Br_2

    (D) I_2

Q16. The shape of XeF_2 is: [JEE Main 2023]

    (A) Bent

    (B) Linear

    (C) V-shape

    (D) Trigonal planar

Q17. Which transition element shows maximum oxidation states? [JEE Main 2024]

    (A) Sc

    (B) Ti

    (C) Mn

    (D) Fe

Q18. If rate of reaction doubles when concentration of reactant quadrupled, the order is: [JEE Main 2024]

    (A) 1

    (B) 2

(C) 0.5

(D) 0

Q19. At infinite dilution, molar conductivity of a strong electrolyte: [JEE Main 2022]

(A) Decreases

(B) Increases to maximum

(C) Constant

(D) Zero

Q20. For reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, increased pressure: [JEE Main 2023]

(A) Right

(B) Left

(C) No change

(D) K_c increases

Section B — Numerical Questions

Q21. The number of chiral centers in open-chain Fructose is ____.   [JEE Main 2024]

Q22. Total atoms present in a unit cell of a BCC crystal is ____.   [JEE Main 2024]

Q23. The oxidation state of Manganese in $KMnO_4$ is ____.   [JEE Main 2023]

Q24. The pH of $10^{-3}M$ $NaOH$ solution at 298K is ____.   [JEE Main 2022]

Q25. The coordination number of Co in $[Co(en)_3]^{3+}$ is ____.   [JEE Main 2025]

Detailed Solutions

Q1.

> ### Solution
>
> **Concept:** Stability of Carbocations: Carbocation stability is governed by inductive effects and hyperconjugation. The more alkyl groups attached to the positive carbon, the more stable it is due to $+I$ effect and $\sigma - p$ conjugation.
>
> **Solution:** 1. $CH_3CH_2^+$: Primary (1°) carbocation. 2. $(CH_3)_2CH^+$: Secondary (2°) carbocation. 3. $(CH_3)_3C^+$: Tertiary (3°) carbocation (9 α-hydrogens). 4. $C_6H_5CH_2^+$: Benzyl carbocation (Resonance stabilized). Among these, the tertiary carbocation $(CH_3)_3C^+$ is the most stable due to maximum hyperconjugation.
>
> **Answer: (C)**

Q2.

> ### Solution
>
> **Concept:** Structural Isomerism in Carbonyls: For C_3H_6O, the degree of unsaturation is 1. It can be an aldehyde, ketone, cyclic alcohol, or cyclic ether.
>
> **Solution:** The 9 structural isomers are: 1. Propanal (Aldehyde) 2. Propanone (Ketone) 3. Allyl alcohol ($CH_2 = CH - CH_2OH$) 4. Methyl vinyl ether ($CH_3 - O - CH = CH_2$) 5. Cyclopropanol 6. Oxetane (4-membered cyclic ether) 7. 2-Methyloxirane 8. Prop-1-en-1-ol (Enol) 9. Prop-1-en-2-ol (Enol)
>
> **Answer: (D)**

Q3.

> ### Solution
>
> **Concept:** Allylic Halogenation: At high temperatures (500°C), chlorine reacts with alkenes via a free radical mechanism rather than addition across the double bond.
>
> **Solution:** When Propene ($CH_3 - CH = CH_2$) reacts with Cl_2 at 500°C, substitution occurs at the allylic carbon (the sp^3 carbon adjacent to the double bond). This yields **Allyl chloride** ($CH_2 = CH - CH_2Cl$).
>
> **Answer: (B)**

Q4.

> **Solution**
>
> **Concept:** Nucleophilic Substitution (S_N1): Aqueous KOH promotes S_N1 or S_N2. For bulky tertiary halides, S_N1 is highly favored as it forms a stable 3° carbocation.
>
> **Solution:** $(CH_3)_3C-Cl$ (Tert-butyl chloride) reacts fastest because it forms a very stable tertiary carbocation intermediate. Vinyl chloride ($CH_2 = CH - Cl$) and Chlorobenzene (C_6H_5Cl) are inert to nucleophilic substitution due to partial double bond character of the $C-Cl$ bond.
>
> **Answer: (D)**

Q5.

> **Solution**
>
> **Concept:** Named Reactions of Phenol: The reaction of phenol with chloroform in the presence of sodium hydroxide to introduce an aldehyde group at the ortho position.
>
> **Solution:** The conversion of Phenol to Salicylaldehyde using $CHCl_3/NaOH$ is known as the **Reimer-Tiemann reaction**. The intermediate involved is dichlorocarbene ($: CCl_2$).
>
> **Answer: (B)**

Q6.

> **Solution**
>
> **Concept:** Aldol Condensation Criteria: Aldol condensation requires the presence of at least one α-hydrogen atom in the aldehyde or ketone.
>
> **Solution:** 1. Acetaldehyde: Has 3 α-H. 2. Acetone: Has 6 α-H. 3. Propanal: Has 2 α-H. 4. **Benzaldehyde** (C_6H_5CHO): Has **no α-hydrogen** atoms (the carbon adjacent to $-CHO$ is part of the benzene ring and has no H). Thus, it does not undergo Aldol condensation.
>
> **Answer: (C)**

Q7.

> **Solution**
>
> **Concept:** Rosenmund Reduction: Selective reduction of acyl chlorides to aldehydes using hydrogen gas over palladium supported on barium sulfate.
>
> **Solution:** Benzoyl chloride (C_6H_5COCl) is reduced by H_2 in the presence of $Pd-BaSO_4$ (poisoned catalyst) to produce **Benzaldehyde**. The $BaSO_4$ acts as a catalyst poison to prevent further reduction to alcohol.
>
> **Answer: (C)**

Q8.

> ### Solution
>
> **Concept:** Sandmeyer Reaction: Diazotization followed by replacement of the diazonium group with a halide using cuprous salts.
>
> **Solution:** 1. Aniline + HNO_2/HCl (cold) $\rightarrow$ Benzene diazonium chloride. 2. Benzene diazonium chloride + Cu_2Cl_2 $\rightarrow$ **Chlorobenzene**. This sequence is the standard preparation of aryl chlorides from primary aromatic amines.
>
> **Answer: (B)**

Q9.

> ### Solution
>
> **Concept:** Classification of Vitamins: Vitamins are classified as fat-soluble (A, D, E, K) or water-soluble (B-complex and C).
>
> **Solution:** Vitamins A, D, and E are fat-soluble and stored in the body's adipose tissue. **Vitamin C** (Ascorbic acid) is water-soluble and must be supplied regularly in the diet as it is excreted in urine.
>
> **Answer: (D)**

Q10.

> ### Solution
>
> **Concept:** VSEPR Theory: Steric Number = (Valence electrons of central atom + Number of monovalent atoms - charge)/2.
>
> **Solution:** For SF_4: S has 6 valence e^-. Steric Number = $(6+4)/2 = 5$. Hybridisation: sp^3d. Structure: 4 Bond pairs + 1 Lone pair. To minimize repulsion, the lone pair occupies the equatorial position, resulting in a **See-saw** shape.
>
> **Answer: (A)**

Q11.

> ### Solution
>
> **Concept:** Molecular Polarity: Dipole moment depends on the difference in electronegativity and the vector sum of individual bond moments.
>
> **Solution:** CO_2 and CH_4 are symmetrical and have $\mu = 0$. In NH_3 and NF_3, N has a lone pair. In **NH_3**, the orbital dipole due to the lone pair and the $N-H$ bond dipoles are in the same direction, leading to a high net dipole moment. In NF_3, the $N-F$ dipoles oppose the lone pair dipole.
>
> **Answer: (B)**

Q12.

> **Solution**
>
> **Concept:** Magnetic Properties (MOT): A molecule is diamagnetic if all its electrons are paired and paramagnetic if it has one or more unpaired electrons.
>
> **Solution:** 1. O_2: 2 unpaired electrons in π^* orbitals (Paramagnetic). 2. B_2: 2 unpaired electrons in π orbitals (Paramagnetic). 3. **C_2**: 12 electrons. Configuration: $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 \pi 2p_y^2$. All electrons are paired (Diamagnetic). 4. N_2^+: 13 electrons, one unpaired (Paramagnetic).
>
> **Answer: (C)**

Q13.

> **Solution**
>
> **Concept:** Crystal Field Theory (CFT): The magnetic moment is calculated using the formula $\mu = \sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons.
>
> **Solution:** In $[Fe(CN)_6]^{4-}$, Fe is in +2 oxidation state (d^6). CN^- is a **strong field ligand**, causing all 6 electrons to pair up in the t_{2g} orbitals. Number of unpaired electrons $(n) = 0$. $\mu = \sqrt{0(0+2)} = 0$ BM.
>
> **Answer: (A)**

Q14.

> **Solution**
>
> **Concept:** IUPAC Nomenclature: Rules: Alphabetical order for ligands, metal name followed by oxidation state in Roman numerals.
>
> **Solution:** In $[Pt(NH_3)_2Cl_2]$, ligands are Ammine (NH_3) and Chlorido (Cl). Platinum is in +2 state. Alphabetically: Ammine comes before Chlorido. Name: **Diamminedichloridoplatinum(II)**.
>
> **Answer: (A)**

Q15.

> **Solution**
>
> **Concept:** Periodic Trends in Halogens: Oxidizing power depends on electron gain enthalpy, bond dissociation enthalpy, and hydration enthalpy.
>
> **Solution:** **F_2** is the strongest oxidizing agent in the periodic table. This is primarily due to its very low $F - F$ bond dissociation enthalpy and the very high hydration enthalpy of the resulting F^- ion.
>
> **Answer: (A)**

Q16.

> **Solution**
>
> **Concept:** Geometry of Noble Gas Compounds: XeF_2 has 8 valence electrons. Steric Number $= (8 + 2)/2 = 5$.
>
> **Solution:** For XeF_2: Hybridisation is sp^3d. There are 2 bond pairs and 3 lone pairs. The 3 lone pairs occupy the equatorial positions of the trigonal bipyramid to minimize repulsion, leaving the $F - Xe - F$ atoms in a **Linear** arrangement.
>
> **Answer: (B)**

Q17.

> **Solution**
>
> **Concept:** Transition Metals: Oxidation states depend on the number of $(n - 1)d$ and ns electrons available for bonding.
>
> **Solution:** **Manganese (Mn)** has the electronic configuration $3d^5 4s^2$. It can show the maximum number of oxidation states ranging from $+2$ to $+7$ because it has the maximum number of unpaired electrons in the d-subshell available for sharing.
>
> **Answer: (C)**

Q18.

> **Solution**
>
> **Concept:** Rate Law and Order: Rate $R = k[A]^n$, where n is the order.
>
> **Solution:** Given: $R_2/R_1 = 2$ when $[A]_2/[A]_1 = 4$. $2 = (4)^n \Rightarrow 2^1 = (2^2)^n \Rightarrow 2^1 = 2^{2n}$. Comparing powers: $1 = 2n \Rightarrow n = 0.5$. The order of the reaction is **0.5**.
>
> **Answer: (C)**

Q19.

> **Solution**
>
> **Concept:** Kohlrausch's Law: For strong electrolytes, molar conductivity (Λ_m) increases with dilution and reaches a limiting value at infinite dilution.
>
> **Solution:** At infinite dilution, the inter-ionic attractions become negligible. For a strong electrolyte, the molar conductivity **increases to a maximum** limiting value (denoted as Λ_m°).
>
> **Answer: (B)**

Q20.

> **Solution**
>
> **Concept:** Le Chatelier's Principle: An increase in pressure shifts the equilibrium toward the side with fewer moles of gas.
>
> **Solution:** Reaction: $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. Left side: 1 mole of gas. Right side: 2 moles of gas. Increasing pressure will shift the equilibrium to the **Left** (toward PCl_5) to decrease the number of moles and relieve the pressure.
>
> **Answer: (B)**

Q21.

> **Solution**
>
> **Concept:** Stereochemistry of Carbohydrates: A chiral center is a carbon atom attached to four different groups.
>
> **Solution:** Open-chain Fructose: $HOCH_2 - C(= O) - CH(OH) - CH(OH) - CH(OH) - CH_2OH$. The chiral carbons are C_3, C_4, and C_5. Total number of chiral centers = **3**.
>
> **Answer: (3)**

Q22.

> **Solution**
>
> **Concept:** Solid State Lattice: Body-Centered Cubic (BCC) unit cell.
>
> **Solution:** 1. Atoms at 8 corners: $8 \times 1/8 = 1$ atom. 2. Atom at the body center: $1 \times 1 = 1$ atom. Total atoms per unit cell = $1 + 1 =$ **2**.
>
> **Answer: (2)**

Q23.

> **Solution**
>
> **Concept:** Oxidation Numbers: In $KMnO_4$, the sum of oxidation states is zero.
>
> **Solution:** $K = +1, O = -2$. Let $Mn = x$. $1 + x + 4(-2) = 0$ $1 + x - 8 = 0$ $x = +7$. The oxidation state of Mn is **7**.
>
> **Answer: (7)**

Q24.

> ## Solution
>
> **Concept:** pH of Bases: $pOH = -\log[OH^-]$ and $pH + pOH = 14$ at 298K.
> **Solution:** $[NaOH] = 10^{-3}M \Rightarrow [OH^-] = 10^{-3}M$. $pOH = -\log(10^{-3}) = 3$. $pH = 14 - 3 = $ **11**.
>
> Answer: (11)

Q25.

> ## Solution
>
> **Concept:** Coordination Number: Total number of coordinate bonds formed with the central metal ion.
> **Solution:** 'en' (ethylenediamine) is a **bidentate** ligand, meaning each 'en' molecule forms 2 coordinate bonds. For 3 'en' ligands, Coordination Number $= 3 \times 2 = $ **6**.
>
> Answer: (6)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	3	22	2
23	7	24	11
25	6		