JEE Main Chemistry Sample Paper-1

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. Total number of chiral centers in molecule: [JEE Main 2024]

(A) 2

(B) 3

(C) 4

(D) 5

Q2. Compounds exhibiting geometrical isomerism: [JEE Main 2023]

(A) 1-phenylpropene

(B) 2-methylbut-2-ene

(C) Propene

(D) 1,1-dichloroethene

Q3. Major product with 2-bromopentane + alcoholic KOH: [JEE Main 2022]

(A) Pent-1-ene

(B) trans-Pent-2-ene

(C) cis-Pent-2-ene

(D) Pentan-2-ol

Q4. Reagent for hex-3-yne → trans-hex-3-ene: [JEE Main 2025]

(A) $Na/liq.\ NH_3$

(B) $H_2, Pd/BaSO_4$

(C) $LiAlH_4$

(D) $NaBH_4$

Q5. Order of acid strength of substituted phenols: [JEE Main 2024]

(A) p-nitrophenol < p-chlorophenol < phenol < p-cresol

(B) p-cresol < phenol < p-chlorophenol < p-nitrophenol

(C) phenol < p-cresol < p-chlorophenol < p-nitrophenol

(D) p-nitrophenol > phenol > p-chlorophenol > p-cresol

Q6. Organic compound C_3H_6O, no Tollen's but 2,4-DNP derivative: [JEE Main 2021]

(A) Propanal

(B) Propanone

(C) Ethylmethyl ether

(D) Allyl alcohol

Q7. Best reagent for $R-CH_2-OH \rightarrow R-CHO$: [JEE Main 2023]

(A) $KMnO_4$

(B) $K_2Cr_2O_7$

(C) CrO_3 in anhydrous medium (PCC)

(D) $LiAlH_4$

Q8. Base NOT present in DNA: [JEE Main 2022]

(A) Adenine

(B) Guanine

(C) Cytosine

(D) Uracil

Q9. Carbylamine reaction is given by: [JEE Main 2025]

(A) Primary amines

(B) Secondary amines

(C) Tertiary amines

(D) Both Primary and Secondary amines

Q10. Molecule with highest dipole moment: [JEE Main 2024]

(A) NF_3

(B) NH_3

(C) BF_3

(D) CCl_4

Q11. Diamagnetic species according to MO theory: [JEE Main 2021]

(A) O_2

(B) B_2

(C) C_2

(D) N_2^+

Q12. Bond order of O_2^{2-}: [JEE Main 2023]

(A) 1

(B) 1.5

(C) 2

(D) 2.5

Q13. Spin-only magnetic moment of $[CoF_6]^{3-}$ (BM): [JEE Main 2022]

(A) 4.90

(B) 5.92

(C) 2.83

(D) 0

Q14. Number of geometric isomers of $[Co(en)_2Cl_2]^+$: [JEE Main 2025]

(A) 2

(B) 3

(C) 4

(D) 1

Q15. Oxoacid of Phosphorus with P–P bond: [JEE Main 2024]

(A) $H_4P_2O_7$

(B) $H_4P_2O_5$

(C) $H_4P_2O_6$

(D) H_3PO_4

Q16. Color of $KMnO_4$ is due to: [JEE Main 2021]

(A) d-d transition

(B) Charge transfer from ligand to metal

(C) Charge transfer from metal to ligand

(D) Presence of unpaired electrons in d-orbital

Q17. Highest electron gain enthalpy: [JEE Main 2023]

(A) F

(B) Cl

(C) Br

(D) I

Q18. Reaction order w.r.t B if rate doubles with [A]×2, 8× when [A]&[B]×2: [JEE Main 2022]

(A) 1

(B) 2

(C) 3

(D) 0

Q19. Energy to excite Li^{2+} electron 1st $\rightarrow$ 4th orbit: [JEE Main 2025]

(A) 12.75 eV

(B) 114.75 eV

(C) 13.6 eV

(D) 122.4 eV

Q20. Thermodynamic parameters for $H_2O(s) \rightarrow H_2O(l)$ at 273 K, 1 atm: [JEE Main 2024]

(A) $\Delta G = 0, \Delta S > 0$

(B) $\Delta G > 0, \Delta S > 0$

(C) $\Delta G < 0, \Delta S < 0$

(D) $\Delta G = 0, \Delta S < 0$

Section B — Numerical Questions

Q21. 0.1 molal aqueous solution of weak acid HA, 30% ionized, $K_f = 1.86$. Freezing point is $-0.x^\circ C$. Find x: [JEE Main 2024]

Q22. FCC lattice, atom A at corners, atom B at face centers. One B missing. Formula is A_2B_x. Find x: [JEE Main 2023]

Q23. Isothermal reversible expansion of 2 moles ideal gas, V : 10 L $\rightarrow$ 100 L, $T = 300$ K. Work is $X \times 10^3$ J. Find X: [JEE Main 2025]

Q24. Wavelength of first Balmer line of H atom is X nm. Find $X/10$: [JEE Main 2022]

Q25. Moles of $K_2Cr_2O_7$ required to oxidize 6 moles of Fe^{2+} to Fe^{3+}: [JEE Main 2024]

Detailed Solutions

Q1.

Solution

Concept: A chiral center is generally a tetrahedral carbon attached to four different groups.

Solution: To solve this question, we inspect the given structure and count all asymmetric carbon atoms. Each such carbon must have four different substituents.

On careful examination of the molecule, the total number of chiral centers is

4

Final Answer: (C)

Answer: (C)

Q2.

Solution

Concept: Geometrical isomerism is possible only when each doubly bonded carbon carries two different substituents.

Solution: Check each compound:

1-phenylpropene

has different groups on both double bonded carbons, so it shows geometrical isomerism.

2-methylbut-2-ene

has two identical methyl groups on one double bonded carbon, so no geometrical isomerism.

Propene

has two hydrogens on one double bonded carbon, so no geometrical isomerism.

1,1-dichloroethene

has two identical chlorine atoms on one carbon, so no geometrical isomerism.

Thus only 1-phenylpropene shows geometrical isomerism.

Final Answer: (A)

Answer: (A)

Q3.

Solution

Concept: Alcoholic KOH causes β-elimination and according to Saytzeff rule, the more substituted alkene is the major product.

Solution: For 2-bromopentane with alcoholic KOH, dehydrohalogenation occurs:

$$CH_3CHBrCH_2CH_2CH_3 \rightarrow \text{alkene}$$

The more substituted alkene formed is pent-2-ene. Among its stereoisomers, the trans form is more stable than the cis form.

Hence the major product is

trans-pent-2-ene

Final Answer: (B)

Answer: (B)

Q4.

Solution

Concept: Reduction of alkynes with sodium in liquid ammonia gives trans-alkenes, whereas Lindlar catalyst gives cis-alkenes.

Solution: To convert

hex-3-yne $\rightarrow$ trans-hex-3-ene

we need dissolving metal reduction:

$$Na/\text{liq. } NH_3$$

This specifically forms the trans alkene.

Final Answer: (A)

Answer: (A)

Q5.

Solution

Concept: Electron-withdrawing groups increase acidity of phenols by stabilizing phenoxide ion, while electron-donating groups decrease acidity.
Solution: Among the given substituents:

$$-p\text{-nitro}$$

is strongly electron withdrawing, so it increases acidity most.

$$-p\text{-chloro}$$

has a net electron-withdrawing effect, so it is more acidic than phenol.

$$-p\text{-methyl}$$

is electron donating, so it decreases acidity.
Therefore the correct order is:

$$p\text{-cresol} < phenol < p\text{-chlorophenol} < p\text{-nitrophenol}$$

Final Answer: (B)

Answer: (B)

Q6.

Solution

Concept: 2,4-DNP test is given by aldehydes and ketones. Tollen's test is given by aldehydes, but not by simple ketones.
Solution: The molecular formula is

$$C_3H_6O$$

and it gives 2,4-DNP derivative, so it must contain a carbonyl group. Since it does not give Tollen's test, it cannot be an aldehyde.
Thus it must be the ketone:

Propanone

Final Answer: (B)

Answer: (B)

Q7.

Solution

Concept: Primary alcohol can be oxidized to aldehyde using a mild oxidizing agent like PCC without further oxidation to carboxylic acid.
Solution: Strong oxidizing agents like

$$KMnO_4,\ K_2Cr_2O_7$$

usually oxidize primary alcohols all the way to carboxylic acids.
To stop oxidation at the aldehyde stage, the best reagent is PCC:

CrO_3 in anhydrous medium

Final Answer: (C)

Answer: (C)

Q8.

Solution

Concept: DNA contains adenine, guanine, cytosine, and thymine. Uracil is present in RNA, not DNA.
Solution: Hence the base not present in DNA is

Uracil

Final Answer: (D)

Answer: (D)

Q9.

Solution

Concept: Carbylamine reaction is characteristic only of primary amines.
Solution: Primary amines react with chloroform and alcoholic KOH to produce isocyanides having foul smell:

$$RNH_2 + CHCl_3 + 3KOH \rightarrow RNC + 3KCl + 3H_2O$$

Secondary and tertiary amines do not show this reaction.
Final Answer: (A)

Answer: (A)

Q10.

Solution

Concept: Dipole moment depends on both bond polarity and molecular geometry.
Solution:

$$BF_3$$

and

$$CCl_4$$

are symmetric molecules, so their net dipole moment is zero.
Both

$$NF_3$$

and

$$NH_3$$

are pyramidal, but in

$$NH_3$$

the bond moments and lone pair direction reinforce more strongly. In

$$NF_3$$

they partially oppose.
Therefore

$$NH_3$$

has the highest dipole moment.
Final Answer: (B)

Answer: (B)

Q11.

Solution

Concept: Diamagnetic species have all electrons paired.

Solution:

$$O_2$$

is paramagnetic.

$$B_2$$

is paramagnetic.

$$N_2^+$$

has one unpaired electron, so paramagnetic.

$$C_2$$

has all electrons paired in MO theory, so it is diamagnetic.

Final Answer: (C)

Answer: (C)

Q12.

Solution

Concept: Bond order is

$$\frac{N_b - N_a}{2}$$

Solution: For

$$O_2$$

bond order is 2.

Adding two electrons to form

$$O_2^{2-}$$

fills antibonding orbitals and reduces bond order by 1.

So,

$$\text{Bond order of } O_2^{2-} = 1$$

Final Answer: (A)

Answer: (A)

Q13.

Solution

Concept: In

$$[CoF_6]^{3-}$$

cobalt is in +3 oxidation state:

$$Co^{3+} : 3d^6$$

Since

$$F^-$$

is a weak field ligand, it forms a high-spin complex.

Solution: High-spin

$$d^6$$

configuration has 4 unpaired electrons.

Spin-only magnetic moment:

$$\mu = \sqrt{n(n+2)}$$

$$\mu = \sqrt{4(4+2)} = \sqrt{24} \approx 4.90 \text{ BM}$$

Final Answer: (A)

Answer: (A)

Q14.

Solution

Concept: The octahedral complex

$$[Co(en)_2Cl_2]^+$$

shows cis and trans geometrical isomerism.

Solution: There are only two geometrical arrangements:

cis and trans

Hence the number of geometrical isomers is

2

Final Answer: (A)

Answer: (A)

Q15.

Solution

Concept: Hypophosphoric acid contains a P–P bond.
Solution: Among the given oxoacids, the one containing a P–P bond is

$$H_4P_2O_6$$

Final Answer: (C)

Answer: (C)

Q16.

Solution

Concept: In permanganate ion, color is mainly due to charge transfer transitions, not d-d transition.
Solution: In

$$MnO_4^-$$

manganese is in +7 oxidation state, which is

$$d^0$$

So d-d transitions are not possible. The purple color is due to charge transfer from ligand oxygen to metal manganese.
Final Answer: (B)

Answer: (B)

Q17.

Solution

Concept: Electron gain enthalpy of chlorine is more negative than fluorine because fluorine is very small and electron-electron repulsion is higher in its compact 2p shell.
Solution: Hence the highest electron gain enthalpy among the given halogens is for

$$Cl$$

Final Answer: (B)

Answer: (B)

Q18.

Solution

Concept: Let the rate law be

$$r = k[A]^m[B]^n$$

Solution: When

$$[A] \rightarrow 2[A]$$

rate doubles, so

$$2^m = 2 \Rightarrow m = 1$$

When both

$$[A] \text{ and } [B]$$

are doubled, rate becomes 8 times:

$$2^m \cdot 2^n = 8$$

Since

$$m = 1$$

$$2^{1+n} = 8 = 2^3$$

So,

$$1 + n = 3 \Rightarrow n = 2$$

Hence order with respect to B is

$$2$$

Final Answer: (B)

Answer: (B)

Q19.

Solution

Concept: For hydrogen-like species,

$$E_n = -13.6\frac{Z^2}{n^2} \text{ eV}$$

Solution: For

$$Li^{2+}, \quad Z = 3$$

So,

$$E_1 = -13.6 \times 9 = -122.4 \text{ eV}$$

$$E_4 = -13.6 \times \frac{9}{16} = -7.65 \text{ eV}$$

Energy required:

$$\Delta E = E_4 - E_1 = (-7.65) - (-122.4) = 114.75 \text{ eV}$$

Final Answer: (B)

Answer: (B)

Q20.

Solution

Concept: At equilibrium for phase transition,

$$\Delta G = 0$$

For melting,

$$S_{liquid} > S_{solid}$$

so

$$\Delta S > 0$$

Solution: At

$$273 \text{ K}, \ 1 \text{ atm}$$

ice and water are in equilibrium. Hence

$$\Delta G = 0, \qquad \Delta S > 0$$

Final Answer: (A)

Answer: (A)

Q21.

Solution

Concept: For a weak electrolyte,

$$i = 1 + \alpha(\nu - 1)$$

For

$$HA \rightleftharpoons H^+ + A^-$$

$$\nu = 2$$

So

$$i = 1 + \alpha$$

Solution: Given

$$m = 0.1, \quad \alpha = 0.30, \quad K_f = 1.86$$

Hence

$$i = 1 + 0.30 = 1.30$$

Depression in freezing point:

$$\Delta T_f = iK_f m$$

$$\Delta T_f = 1.30 \times 1.86 \times 0.1$$

$$\Delta T_f = 0.2418 \approx 0.24^\circ C$$

Thus freezing point is

$$-0.24^\circ C$$

So,

$$x = 24$$

Final Answer: $x = 24$

Answer: (24)

Q22.

Solution

Concept: In FCC lattice:

$$\text{corner atoms} = 8 \times \frac{1}{8} = 1$$

$$\text{face center atoms} = 6 \times \frac{1}{2} = 3$$

Solution: A occupies corners, so

$$A = 1$$

B occupies face centers, but one B atom is missing. So effective B atoms:

$$5 \times \frac{1}{2} = 2.5$$

Thus formula is

$$AB_{2.5}$$

Multiplying by 2:

$$A_2B_5$$

Therefore,

$$x = 5$$

Final Answer: $x = 5$

Answer: (5)

Q23.

Solution

Concept: Work done in reversible isothermal expansion of ideal gas is

$$w = nRT \ln \frac{V_2}{V_1}$$

Solution: Given,

$$n = 2, \quad R = 8.314, \quad T = 300 \text{ K}$$

$$\frac{V_2}{V_1} = \frac{100}{10} = 10$$

So,

$$w = 2 \times 8.314 \times 300 \times \ln 10$$

Using

$$\ln 10 \approx 2.303$$

$$w \approx 2 \times 8.314 \times 300 \times 2.303$$

$$w \approx 11487 \text{ J} \approx 11.49 \times 10^3 \text{ J}$$

Hence

$$X \approx 11.5$$

Final Answer: $X = 11.5$

Answer: (11.5)

Q24.

Solution

Concept: First Balmer line corresponds to transition

$$n = 3 \rightarrow n = 2$$

Formula:

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{5}{36}\right)$$

Solution: The known wavelength of the first Balmer line is approximately

$$656 \text{ nm}$$

So,

$$X = 656$$

Therefore,

$$\frac{X}{10} = 65.6$$

Final Answer: $X/10 = 65.6$

Answer: (65.6)

Q25.

Solution

Concept: In acidic medium,

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$$

One mole of

$$K_2Cr_2O_7$$

accepts 6 electrons.

Solution: Each

$$Fe^{2+} \rightarrow Fe^{3+}$$

loses 1 electron.

So 6 moles of

$$Fe^{2+}$$

release 6 moles of electrons.

Hence required moles of

$$K_2Cr_2O_7$$

are

$$1$$

Final Answer: 1

Answer: (1)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	24	22	5
23	11.5	24	65.6
25	1		