JEE Main Chemistry Sample Paper-15

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 order of stability for the following carbocations is: (I) $CH_2 = CH - \overset{+}{C}H_2$, (II) $CH_3 - CH_2 - \overset{+}{C}H_2$, (III) $C_6H_5 - \overset{+}{C}H_2$, (IV) $\overset{+}{C}H_2 - OCH_3$ [JEE Main JEE Mains 2023]

(A) IV > III > I > II

(B) III > IV > I > II

(C) IV > I > III > II

(D) III > I > IV > II

Q2. Which of the following compounds will show geometrical isomerism? [JEE Main JEE Mains 2022]

(A) 2-Phenylpropene

(B) 1,1-Diphenyl-1-propene

(C) 1-Phenyl-2-butene

(D) 3-Phenyl-1-butene

Q3. The major product of the reaction of 3-methyl-2-pentene with HBr in the presence of benzoyl peroxide is: [JEE Main JEE Mains 2024]

(A) 3-bromo-3-methylpentane

(B) 2-bromo-3-methylpentane

(C) 1-bromo-3-methylpentane

(D) 3-bromo-2-methylpentane

Q4. Which of the following undergoes S_N1 reaction most rapidly? [JEE Main JEE Mains 2022]

(A) Ethyl chloride

(B) Isopropyl chloride

(C) Benzyl chloride

(D) Chlorobenzene

Q5. An ether (X) $C_4H_{10}O$ on treatment with excess HI gives only one type of alkyl halide. The ether is: [JEE Main JEE Mains 2023]

(A) Methyl isopropyl ether

(B) Diethyl ether

(C) Methyl n-propyl ether

(D) Ethyl methyl ether

Q6. Which of the following will not give a yellow precipitate with $I_2/NaOH$? [JEE Main JEE Mains 2024]

(A) Acetophenone

(B) Pentan-2-one

(C) Pentan-3-one

(D) Ethanol

Q7. The product formed in the Aldol condensation of benzaldehyde and acetone in the presence of dilute $NaOH$ is: [JEE Main JEE Mains 2022]

(A) Benzyl alcohol

(B) 4-Phenylbut-3-en-2-one

(C) 1-Phenylbut-2-en-1-one

(D) 2-Hydroxy-2-phenylpropan-1-one

Q8. The strongest base among the following in aqueous solution is: [JEE Main JEE Mains 2023]

(A) Dimethylamine

(B) Trimethylamine

(C) Methylamine

(D) Ammonia

Q9. The linkage present in proteins between α-amino acids is: [JEE Main JEE Mains 2024]

(A) Glycosidic linkage

(B) Peptide linkage

(C) Phosphodiester linkage

(D) Hydrogen bond

Q10. The shape of XeF_4 and SF_4 are respectively: [JEE Main JEE Mains 2023]

(A) Square planar and Tetrahedral

(B) Square planar and See-saw

(C) Tetrahedral and See-saw

(D) Square pyramidal and See-saw

Q11. Which of the following species is paramagnetic? [JEE Main JEE Mains 2022]

(A) N_2

(B) O_2

(C) F_2

(D) C_2

Q12. The formal charge on the central oxygen atom in O_3 is: [JEE Main JEE Mains 2024]

(A) 0

(B) +1

(C) -1

(D) +2

Q13. The hybridization and magnetic nature of $[Co(NH_3)_6]^{3+}$ are: [JEE Main JEE Mains 2023]

(A) sp^3d^2, Diamagnetic

(B) d^2sp^3, Diamagnetic

(C) d^2sp^3, Paramagnetic

(D) sp^3d^2, Paramagnetic

Q14. The IUPAC name of $[Pt(NH_3)_2Cl(NH_2CH_3)]Cl$ is: [JEE Main JEE Mains 2024]

(A) Diamminechlorido(methylamine)platinum(II) chloride

(B) Diammine(methylamine)chloridoplatinum(II) chloride

(C) Diamminechlorido(aminomethane)platinum(II) chloride

(D) Diamminechlorido(methylamine)platinum(IV) chloride

Q15. The correct order of oxidizing power of the following is: [JEE Main JEE Mains 2023]

(A) $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$

(B) $MnO_4^- < Cr_2O_7^{2-} < VO_2^+$

(C) $Cr_2O_7^{2-} < MnO_4^- < VO_2^+$

(D) $VO_2^+ < MnO_4^- < Cr_2O_7^{2-}$

Q16. The element with the highest second ionization enthalpy is: [JEE Main JEE Mains 2022]

(A) Cu

(B) Zn

(C) Cr

(D) Mn

Q17. The correct order of ionic radii is: [JEE Main JEE Mains 2024]

(A) $N^{3-} > O^{2-} > F^{-} > Na^{+}$

(B) $Na^{+} > F^{-} > O^{2-} > N^{3-}$

(C) $F^{-} > O^{2-} > N^{3-} > Na^{+}$

(D) $N^{3-} > Na^{+} > O^{2-} > F^{-}$

Q18. The limiting molar conductivity (Λ_m°) for $NaCl, KBr$, and KCl are 126, 152, and 150 $S\,cm^2\,mol^{-1}$ respectively. The Λ_m° for $NaBr$ is: [JEE Main JEE Mains 2023]

(A) 128

(B) 176

(C) 278

(D) 302

Q19. The number of moles of $KMnO_4$ required to oxidize one mole of FeC_2O_4 in acidic medium is: [JEE Main JEE Mains 2023]

(A) 0.6

(B) 1.5

(C) 0.2

(D) 1.2

Q20. For a reaction to be spontaneous at all temperatures: [JEE Main JEE Mains 2024]

(A) $\Delta H > 0, \Delta S > 0$

(B) $\Delta H < 0, \Delta S < 0$

(C) $\Delta H < 0, \Delta S > 0$

(D) $\Delta H > 0, \Delta S < 0$

Section B — Numerical Questions

Q21. For a first-order reaction, the time required for 75% completion is 60 minutes. Calculate the time required for 50% completion (in minutes). Answer: [JEE Main JEE Mains 2022]

Q22. The wavelength of the first line of the Lyman series for Hydrogen is λ. The wavelength of the first line of the Balmer series for the same is $\frac{x}{5}\lambda$. Determine the value of x. Answer: [JEE Main JEE Mains 2023]

Q23. For the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, the equilibrium constant K_p is 4. If the total pressure is 1 atm, calculate the degree of dissociation (α). (Round off to two decimal places) Answer: [JEE Main JEE Mains 2024]

Q24. A solution containing 1.8g of glucose ($M_w = 180$) in 100g of water results in a boiling point elevation of $0.052\,K$. Determine the molal elevation constant (K_b) of water in $K\,kg\,mol^{-1}$. Answer: [JEE Main JEE Mains 2023]

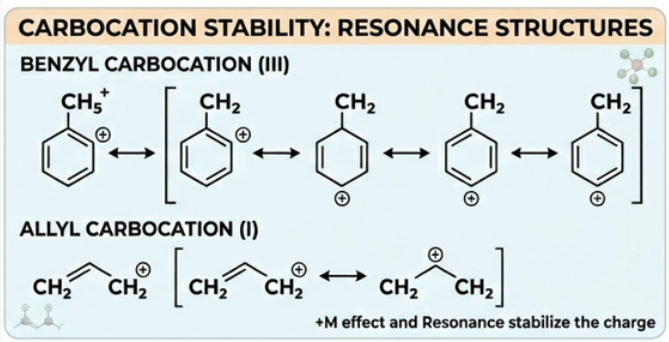
Q25. The combustion of 1 mole of benzene (C_6H_6) at 298 K gives $CO_2(g)$ and $H_2O(l)$. Calculate the value of Δn_g for this reaction. Answer: [JEE Main JEE Mains 2022]

Detailed Solutions

Q1.

Solution

Concept: Carbocation stability depends mainly on resonance, hyperconjugation, and inductive effects. Resonance is the strongest stabilizing factor because it spreads the positive charge over multiple atoms.



Step-by-Step Solution: Let us analyze each carbocation carefully: (I) Allyl carbocation → the positive charge is delocalized over two carbons due to resonance. (II) Primary carbocation → no resonance, no strong stabilization, hence least stable. (III) Benzyl carbocation → highly stable because the positive charge is delocalized over the benzene ring (many resonance structures). (IV) $CH_2^+ - OCH_3$ → oxygen donates electron density via +M effect, stabilizing the carbocation.

Now comparing: Benzyl (maximum resonance) > Oxygen stabilized > Allyl > Primary

Final Answer:

$$III > IV > I > II$$

Answer: (B)

Q2.

Solution

Concept: Geometrical isomerism occurs when there is restricted rotation (double bond) and each carbon has two different substituents.

Step-by-Step Solution: Check each option: (A) 2-Phenylpropene → one carbon has identical groups → no isomerism. (B) 1,1-Diphenyl → both phenyl groups on same carbon → no isomerism. (C) 1-Phenyl-2-butene → both double bonded carbons have different groups → satisfies condition. (D) 3-Phenyl-1-butene → terminal double bond → no restriction → no isomerism.

Thus only option (C) shows geometrical isomerism.

Answer: (C)

Q3.

Solution

Concept: In presence of peroxide, HBr follows Anti-Markovnikov addition via free radical mechanism.

Step-by-Step Solution: Normally, Markovnikov rule applies, but peroxide changes mechanism. In Anti-Markovnikov addition: - Bromine attaches to less substituted carbon - Hydrogen attaches to more substituted carbon

In 3-methyl-2-pentene: Double bond is between C2 and C3 Less substituted carbon is C2 Thus Br attaches to C2 → forming 3-bromo-2-methylpentane.

Answer: (D)

Q4.

Solution

Concept: S_N1 reaction proceeds via carbocation formation. More stable carbocation → faster reaction.

Step-by-Step Solution: Ethyl chloride → forms primary carbocation → unstable Isopropyl chloride → secondary → moderately stable Benzyl chloride → forms benzyl carbocation → highly stabilized by resonance Chlorobenzene → does not form carbocation easily

Thus benzyl chloride reacts fastest.

Answer: (C)

Q5.

Solution

Concept: Ethers react with HI to form alcohol and alkyl iodide, and further give alkyl iodides.

Step-by-Step Solution: If ether has two identical alkyl groups → only one type of alkyl iodide forms. Diethyl ether has two ethyl groups → produces only ethyl iodide. Other ethers have different groups → give different products.

Thus only diethyl ether satisfies the condition.

Answer: (B)

Q6.

Solution

Concept: Iodoform test is given by compounds containing CH_3CO- group or ethanol.
Step-by-Step Solution: (A) Acetophenone → has CH_3CO- → gives test (B) Pentan-2-one → methyl ketone → gives test (C) Pentan-3-one → no CH_3CO- group → does NOT give test (D) Ethanol → oxidizes to acetaldehyde → gives test
Thus only pentan-3-one fails.

Answer: (C)

Q7.

Solution

Concept: Aldol condensation forms α, β-unsaturated carbonyl compounds.
Step-by-Step Solution: Acetone forms enolate ion in presence of NaOH. This enolate attacks benzaldehyde. Initially forms β-hydroxy ketone. On heating, water is removed → double bond forms.
Final product becomes conjugated ketone.

Answer: (B)

Q8.

Solution

Concept: Basic strength depends on electron donation (+I effect) and solvation.
Step-by-Step Solution: Methylamine → +I effect present Dimethylamine → stronger +I and good solvation → strongest Trimethylamine → steric hindrance reduces solvation Ammonia → weakest
Thus dimethylamine is strongest base.

Answer: (A)

Q9.

Solution

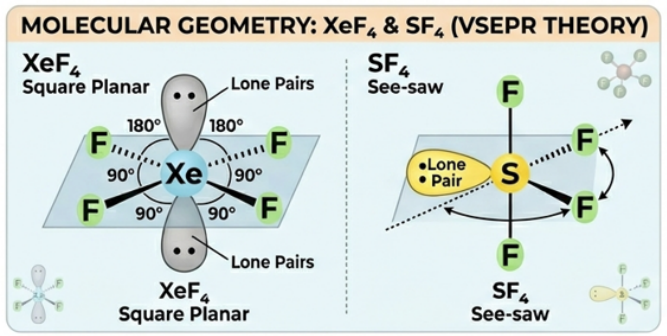
Concept: Proteins are polymers of amino acids connected via peptide bonds.
Step-by-Step Solution: When two amino acids react: - Carboxyl group of one reacts with amino group of another - Water molecule is eliminated - Bond formed is peptide bond
This repeats to form protein chain.

Answer: (B)

Q10.

Solution

Concept: VSEPR theory predicts shape based on electron pair repulsion.



Step-by-Step Solution: XeF_4: - 6 electron pairs $\rightarrow$ 2 lone pairs - Lone pairs opposite $\rightarrow$ square planar shape

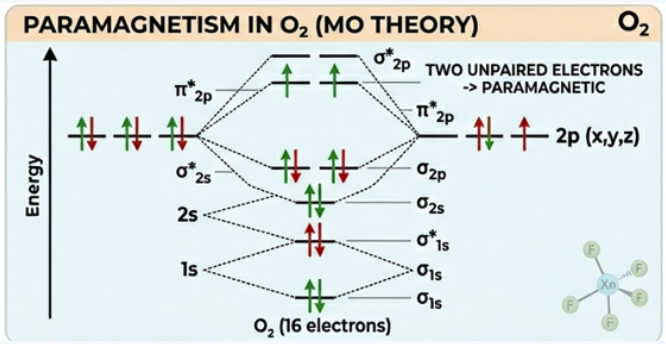
SF_4: - 5 electron pairs $\rightarrow$ 1 lone pair - Shape becomes see-saw

Answer: (B)

Q11.

Solution

Concept: Paramagnetism arises due to presence of unpaired electrons. To determine this, we use Molecular Orbital (MO) Theory.



Step-by-Step Solution: Let us check each molecule: N_2: All electrons are paired in bonding orbitals $\rightarrow$ diamagnetic O_2: Last two electrons enter π^* antibonding orbitals separately $\rightarrow$ 2 unpaired electrons F_2: All electrons are paired $\rightarrow$ diamagnetic C_2: All electrons paired $\rightarrow$ diamagnetic

Only O_2 has unpaired electrons, hence it is paramagnetic.

Real-Life Insight: Paramagnetic substances are attracted by a magnetic field due to unpaired electrons.

Answer: (B)

Q12.

Solution

Concept: Formal charge helps determine charge distribution in molecules. Formula:

$$FC = V - (L + \frac{1}{2}B)$$

Step-by-Step Solution: In ozone (O_3), central oxygen forms one double bond and one single bond.
For central O: Valence electrons = 6 Lone electrons = 2 Bonding electrons = 6

$$FC = 6 - (2 + 3) = +1$$

Thus central oxygen carries +1 charge.

Answer: (B)

Q13.

Solution

Concept: Hybridization and magnetic nature depend on ligand strength and electron pairing.
Step-by-Step Solution: Co^{3+} → electronic configuration = $3d^6$
NH_3 is a strong field ligand → causes pairing of electrons.
After pairing: - All electrons paired → diamagnetic - Inner orbitals used → d^2sp^3 hybridization
Thus complex becomes low spin and diamagnetic.

Answer: (B)

Q14.

Solution

Concept: IUPAC naming rules for coordination compounds:

- Name ligands alphabetically
- Neutral ligands → ammine, methylamine
- Negative ligands → chlorido

Step-by-Step Solution: Ligands present: - 2 NH_3 → diammine - Cl^- → chlorido - NH_2CH_3 → methylamine
Arrange alphabetically: ammine → chlorido → methylamine
Metal = platinum(II)

Answer: (A)

Q15.

Solution

Concept: Oxidizing power depends on ability to gain electrons. Higher reduction potential → stronger oxidizing agent.

Step-by-Step Solution: Compare known trends: VO_2^+ → weakest oxidizing agent $Cr_2O_7^{2-}$ → moderate MnO_4^- → strongest oxidizing agent

Thus increasing order is:

$$VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$$

Answer: (A)

Q16.

Solution

Concept: Second ionization energy is the energy required to remove an electron from a singly charged ion. Stable configurations require more energy to remove electrons.

Step-by-Step Solution: Zn: configuration = $3d^{10}4s^2$ After losing one electron → $3d^{10}4s^1$ (very stable) Removing second electron disturbs stable configuration → requires high energy

Other elements do not have such stable configuration.

Answer: (B)

Q17.

Solution

Concept: Isoelectronic species have same number of electrons but different nuclear charge. Higher nuclear charge → smaller size.

Step-by-Step Solution: All ions have 10 electrons: $N^{3-}, O^{2-}, F^-, Na^+$

Compare nuclear charge: N (7) < O (8) < F (9) < Na (11)

Thus size decreases in same order:

$$N^{3-} > O^{2-} > F^- > Na^+$$

Answer: (A)

Q18.

Solution

Concept: Kohlrausch Law states:

$$\Lambda^\circ = \lambda^+ + \lambda^-$$

Step-by-Step Solution: Given:

$$NaCl = 126, \quad KCl = 150, \quad KBr = 152$$

Formula:

$$NaBr = NaCl + KBr - KCl$$

$$= 126 + 152 - 150 = 128$$

Answer: (B)

Q19.

Solution

Concept: Redox reactions must be balanced using electron transfer method.
Step-by-Step Solution: MnO_4^- in acidic medium gains 5 electrons. Oxalate ion gives electrons during oxidation.
Balancing reaction shows: 1 mole FeC_2O_4 requires 0.2 mole $KMnO_4$
This comes from stoichiometric coefficients after balancing.

Answer: (C)

Q20.

Solution

Concept: Gibbs free energy:

$$\Delta G = \Delta H - T\Delta S$$

Step-by-Step Solution: For reaction to be spontaneous at all temperatures: ΔG must always be negative.
This is only possible when: $\Delta H < 0$ (exothermic) $\Delta S > 0$ (increase in disorder)
Thus reaction remains spontaneous at all temperatures.

Answer: (C)

Q21.

Solution

Concept:

For a first-order reaction:

$$t = \frac{2.303}{k} \log \frac{[A]_0}{[A]}$$

Also, important standard results: - Time for 50% completion (half-life):

$$t_{1/2} = \frac{0.693}{k}$$

- Time for 75% completion:

$$t_{75\%} = \frac{2.303}{k} \log 4$$

Step-by-Step Solution:

Given:

$$t_{75\%} = 60 \text{ min}$$

We know:

$$\log 4 = 0.602$$

So,

$$60 = \frac{2.303}{k} \times 0.602$$

$$60 = \frac{1.386}{k}$$

$$k = \frac{1.386}{60} = 0.0231 \, \text{min}^{-1}$$

Now calculate half-life:

$$t_{1/2} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{0.693}{0.0231}$$

$$t_{1/2} = 30 \text{ min}$$

Real-Life Analogy: Think of radioactive decay — half of the material always decays in a fixed time regardless of initial amount.

Final Answer: 30 minutes

Answer: (30)

Q22.

Solution

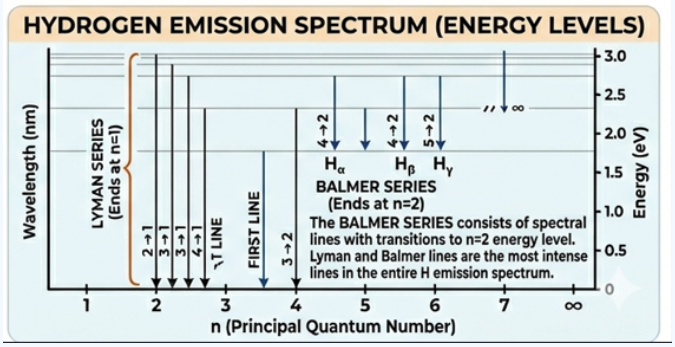
Concept:

Rydberg formula:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Lyman series: - $n_1 = 1$, $n_2 = 2$

Balmer series: - $n_1 = 2$, $n_2 = 3$



Step-by-Step Solution:

First line of Lyman:

$$\frac{1}{\lambda} = R\left(1 - \frac{1}{4}\right) = \frac{3R}{4}$$

First line of Balmer:

$$\frac{1}{\lambda'} = R\left(\frac{1}{4} - \frac{1}{9}\right)$$

$$= R \times \frac{5}{36}$$

Now ratio:

$$\frac{\lambda'}{\lambda} = \frac{3/4}{5/36}$$

$$= \frac{3}{4} \times \frac{36}{5} = \frac{27}{5}$$

Given:

$$\lambda' = \frac{x}{5}\lambda$$

So:

$$\frac{x}{5} = \frac{27}{5} \Rightarrow x = 27$$

Final Answer: 27

Answer: (27)

Q23.

Solution

Concept:

For dissociation:

$$N_2O_4 \rightleftharpoons 2NO_2$$

If degree of dissociation $= \alpha$

$$K_p = \frac{4\alpha^2 P}{1-\alpha^2}$$

Step-by-Step Solution:

Given:

$$K_p = 4, \quad P = 1\,atm$$

So:

$$4 = \frac{4\alpha^2}{1-\alpha^2}$$

Divide both sides by 4:

$$1 = \frac{\alpha^2}{1-\alpha^2}$$

Cross multiply:

$$1 - \alpha^2 = \alpha^2$$

$$1 = 2\alpha^2$$

$$\alpha^2 = \frac{1}{2}$$

$$\alpha = 0.707$$

Rounded to two decimals:

$$\alpha = 0.71$$

Final Answer: 0.71

Answer: (0.71)

Q24.

Solution

Concept:

Boiling point elevation:

$$\Delta T_b = K_b \times m$$

Molality:

$$m = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

Step-by-Step Solution:

Moles of glucose:

$$= \frac{1.8}{180} = 0.01\, mol$$

Mass of water:

$$100g = 0.1kg$$

Molality:

$$m = \frac{0.01}{0.1} = 0.1$$

Now:

$$\Delta T_b = 0.052$$

$$K_b = \frac{\Delta T_b}{m} = \frac{0.052}{0.1}$$

$$K_b = 0.52$$

Real-Life Analogy: Adding sugar increases boiling point slightly — same principle.

Final Answer: 0.52

Answer: (0.52)

Q25.

Solution

Concept:

$$\Delta n_g = \text{moles of gaseous products} - \text{moles of gaseous reactants}$$

Step-by-Step Solution:

Balanced reaction:

$$C_6H_6 + \frac{15}{2}O_2 \rightarrow 6CO_2 + 3H_2O(l)$$

Gaseous species: - Reactants: $O_2 = \frac{15}{2} = 7.5$ - Products: $CO_2 = 6$

(Note: H_2O is liquid $\rightarrow$ not counted)

$$\Delta n_g = 6 - 7.5 = -1.5$$

Final Answer: -1.5

Answer: (-1.5)

Answer Key — Section A

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

Answer Key — Section B

Q	Ans	Q	Ans
21	30	22	27
23	0.71	24	0.52
25	-1.5		