CLASS 12 CHEMISTRY EXTRA QUESTIONS

Class 12 Chemistry Chapter 5 Coordination Compounds – Extra Questions with Answers

These extra practice questions for Class 12 Chemistry Chapter 5 – Coordination Compounds go beyond the NCERT textbook exercises to reinforce nomenclature, isomerism, bonding theories, and the applications of coordination compounds. Useful for board exam revision and quick concept checks.

Contents

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Very Short Answer Type Questions (1 Mark)

Q1. Define coordination number of a metal ion in a complex.
Ans: The coordination number is the total number of ligand donor atoms directly bonded to the central metal ion in a coordination entity, e.g. 6 in $[Co(NH_3)_6]^{3+}$.

Q2. What type of isomerism is exhibited by $[Co(NH_3)_5NO_2]Cl_2$ and $[Co(NH_3)_5ONO]Cl_2$?
Ans: **Linkage isomerism** — the ambidentate ligand NO_2^- is bonded through nitrogen (nitrito-N) in the first and through oxygen (nitrito-O) in the second.

Q3. Name the theory that explains the colour and magnetic properties of coordination compounds in terms of d-orbital splitting.
Ans: **Crystal Field Theory (CFT).**

Q4. Give an example of an ambidentate ligand and its two modes of linkage.
Ans: **SCN^-** — it can bind through sulphur (thiocyanato-S) or through nitrogen (isothiocyanato-N).

Short Answer Type Questions (2–3 Marks)

Q5. Why is $[Ni(CN)_4]^{2-}$ square planar and diamagnetic, while $[NiCl_4]^{2-}$ is tetrahedral and paramagnetic, even though both contain Ni^{2+}?
Ans: Ni^{2+} is $3d^8$ in both. CN^- is a **strong-field ligand**, so it forces the two unpaired 3d electrons to pair up, freeing a d-orbital for **dsp^2 hybridisation** (square planar, diamagnetic). Cl^- is a **weak-field ligand**, so pairing does not occur and the complex instead adopts **sp^3 hybridisation** (tetrahedral), retaining 2 unpaired electrons and paramagnetism.

Q6. Calculate the spin-only magnetic moment of $[CoF_6]^{3-}$.
Ans: Co^{3+} is $3d^6$; F^- is a weak-field ligand, giving a **high-spin** configuration ($t_{2g}^4e_g^2$) with **$n=4$** unpaired electrons. $\mu=\sqrt{n(n+2)}$ BM$=\sqrt{(4\times6)}=\sqrt{24}\approx$**4.90 BM**.

Q7. What is the difference between homoleptic and heteroleptic complexes? Classify $[Co(NH_3)_4Cl_2]^+$ and $[Cr(NH_3)_6]^{3+}$.
Ans: A **homoleptic** complex has only one kind of ligand bonded to the metal; a **heteroleptic** complex has more than one kind. $[Co(NH_3)_4Cl_2]^+$ is **heteroleptic** (NH_3 and Cl^-); $[Cr(NH_3)_6]^{3+}$ is **homoleptic** (only NH_3).

Higher Order Thinking Skills (HOTS)

Q8. Two octahedral complexes of Co^{3+}, one with F^- ligands and one with NH_3 ligands, show very different magnetic behaviour despite having the same metal and oxidation state. Explain what this tells you about crystal field splitting, and predict which complex is paramagnetic.
Ans: Co^{3+} is $3d^6$ in both complexes. Since the two complexes behave differently, this shows that the **ligand's field strength**, not just the metal ion, determines whether the complex is high spin or low spin. **F^-** is a weak-field ligand (early in the spectrochemical series), so $[CoF_6]^{3-}$ is **high spin** ($t_{2g}^4e_g^2$, 4 unpaired electrons) and **paramagnetic**. **NH_3** is a comparatively strong-field ligand, so $[Co(NH_3)_6]^{3+}$ is **low spin** ($t_{2g}^6e_g^0$, 0 unpaired electrons) and **diamagnetic**.

Q9. Explain, with reference to the chelate effect, why EDTA forms an exceptionally stable

complex with metal ions like Ca^{2+}, and why this makes it useful both in water-hardness titrations and in treating heavy-metal poisoning.
Ans: EDTA is a **hexadentate ligand** (six donor atoms: four carboxylate oxygens and two amine nitrogens), so it wraps around a metal ion and forms **five interlocking five-membered chelate rings** in a single complex. This multiple-ring "chelate effect" makes the $[M(EDTA)]^{n-}$ complex far more thermodynamically stable than complexes of the same metal with several separate unidentate ligands, since forming one hexadentate complex loses far less entropy than forming six separate metal-ligand bonds independently. This exceptional stability is exactly why EDTA is used to selectively and tightly bind Ca^{2+}/Mg^{2+} in water-hardness titrations (the endpoint reflects essentially complete complexation), and why it can bind toxic heavy-metal ions (e.g. Pb^{2+}) tightly enough in the body to allow their safe excretion during chelation therapy.

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