CLASS 12 CHEMISTRY EXTRA QUESTIONS

Class 12 Chemistry Chapter 4 The d- and f-Block Elements – Extra Questions with Answers

These extra practice questions for Class 12 Chemistry Chapter 4 – The d- and f-Block Elements go beyond the NCERT textbook exercises to reinforce electronic configurations, oxidation states, magnetic properties, and the chemistry of the lanthanoids and actinoids. Useful for board exam revision and quick concept ch...

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Very Short Answer Type Questions (1 Mark)

Q1. Define transition elements.
Ans: Transition elements are those which have an incompletely filled d-subshell in the ground state of the atom or in any one of their commonly occurring oxidation states.

Q2. Why are Zn, Cd and Hg not regarded as transition elements?
Ans: Because their d-subshell is completely filled ($3d^{10}$, $4d^{10}$, $5d^{10}$ respectively) both in the elemental state and in their common +2 oxidation state.

Q3. Which is the most common oxidation state shown by lanthanoids?
Ans: **+3**, since it corresponds to losing the two 6s electrons and one 4f/5d electron, giving a reasonably stable configuration common across the series.

Q4. Name a member of the lanthanoid series that is diamagnetic.
Ans: **Lu^{3+}** ($[Xe]4f^{14}$, fully-filled 4f subshell, no unpaired electrons) and **Ce^{4+}** ([Xe], empty 4f subshell) are both diamagnetic.

Short Answer Type Questions (2–3 Marks)

Q5. Explain why the second and third transition series (4d and 5d) elements of a group resemble each other much more closely than either resembles the first (3d) series element of the same group.
Ans: This is a consequence of **lanthanoid contraction**: the steady decrease in atomic/ionic size across the lanthanoids (which lie between the 4d and 5d series) means that by the time the 5d series begins, its atoms are almost the same size as the corresponding 4d atoms rather than noticeably larger, as would otherwise be expected. As a result, elements like Zr/Hf and Nb/Ta show near-identical radii and very similar chemical properties, while the smaller 3d element of the same group behaves quite differently.

Q6. What is meant by "spin-only" magnetic moment? Calculate it for Fe^{3+} (Z=26).
Ans: The **spin-only magnetic moment** assumes the magnetic moment of a transition-metal ion arises purely from the spin of its unpaired electrons (orbital contribution is neglected), given by $\mu=\sqrt{n(n+2)}$ BM, where n is the number of unpaired electrons. Fe^{3+} (Z=26, minus 3 electrons): $[Ar]3d^5$, a high-spin, fully unpaired configuration with **n=5**. $\mu=\sqrt{(5\times7)}=\sqrt{35}\approx$**5.92 BM**.

Q7. Why does copper not liberate hydrogen gas from dilute acids, unlike most other first-series transition metals?
Ans: Copper has a positive standard electrode potential, $E^\circ(Cu^{2+}/Cu)=+0.34V$, unlike other first-series transition metals which have negative E° values. This positive value means the energy required to atomise and ionise copper is not fully compensated by its (comparatively low) hydration enthalpy, so the overall process of displacing H^+ as H_2 gas is thermodynamically unfavourable for copper.

Higher Order Thinking Skills (HOTS)

Q8. Two octahedral complexes of Fe are found to have magnetic moments of 4.90 BM and 5.92 BM respectively. Identify the likely oxidation state and spin state of iron in each, with reasoning.

Ans: Using $\mu=\sqrt{n(n+2)}$: a moment of 4.90 BM corresponds to **n=4** unpaired electrons (since $\sqrt{(4\times6)}=\sqrt{24}\approx4.90$), consistent with high-spin **Fe^{2+}** ($3d^6$, high-spin $t_{2g}^4e_g^2$). A moment of 5.92 BM corresponds to **n=5** unpaired electrons (since $\sqrt{(5\times7)}=\sqrt{35}\approx5.92$), consistent with high-spin **Fe^{3+}** ($3d^5$, high-spin $t_{2g}^3e_g^2$, all five d-electrons unpaired). Both values match the high-spin (weak-field ligand) case rather than a low-spin arrangement, since low-spin Fe^{2+} (t_{2g}^6, 0 unpaired) would be diamagnetic and low-spin Fe^{3+} (t_{2g}^5, 1 unpaired) would give only ≈1.73 BM.

Q9. Explain, using electronic configuration and stability arguments, why manganese shows the maximum number of oxidation states among the first-series transition elements, and why its very highest oxidation state (+7) is only found in oxo-compounds and not as a simple cation.
Ans: Manganese's ground-state configuration, $[Ar]3d^54s^2$, sits at the exact midpoint of the first transition series, giving it access to the widest possible spread of oxidation states (+2 to +7) because all seven of its 4s and 3d electrons can, in principle, be progressively involved in bonding — more than any element to its left (fewer available electrons) or right (increasingly stable, less available d-electrons as pairing sets in). However, a hypothetical Mn^{7+} simple cation would require removing all 7 electrons, an enormously endothermic process that no real chemical reaction could supply. Instead, the +7 state is reached only in oxo-species like **MnO_4^-**, where strongly electronegative, pπ–dπ-bonding oxygen atoms share electron density with manganese covalently rather than requiring full ionisation, stabilising the high formal oxidation state without an actual +7 charge ever existing on a bare Mn ion.

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