



Attempt all questions before checking the answer key. Use current IUPAC names. For each complex, determine oxidation state before discussing d-electron count.

A. Very short answers - 1 mark each

1. Define coordination number.
2. What is an ambidentate ligand? Give an example.
3. Name the ligand NH_3 in coordination nomenclature.
4. Find oxidation state of Co in $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$.
5. Define a chelating ligand.
6. What is meant by coordination sphere?

B. Short answers / practice - 2 marks each

7. Give the IUPAC name of $\text{K}_4[\text{Fe}(\text{CN})_6]$.
8. Write the formula of tetraamminecopper(II) sulphate.
9. Find coordination number and oxidation state of Cr in $[\text{Cr}(\text{en})_3]^{3+}$, where en is ethane-1,2-diamine.
10. Distinguish a double salt from a coordination compound in aqueous solution.
11. Draw geometrical isomers of $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$.
12. Explain linkage isomerism using a nitrite-containing complex.
13. Find oxidation state of Fe in $[\text{Fe}(\text{CN})_6]^{3-}$.
14. Find coordination number in $[\text{PtCl}_4]^{2-}$.
15. Can ethane-1,2-diamine act as a bidentate ligand?
16. Name $[\text{Ag}(\text{NH}_3)_2]^+$.
17. Find unpaired electrons in low-spin octahedral d^6 .
18. Explain why chelation often increases complex stability.

C. Short answers - 3 marks each

19. Give IUPAC names and metal oxidation states for $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ and $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$.
20. Using valence-bond theory, compare hybridisation, geometry and magnetism of $[\text{Ni}(\text{CN})_4]^{2-}$ and $[\text{NiCl}_4]^{2-}$; Ni has $Z = 28$.
21. Explain why $[\text{Fe}(\text{CN})_6]^{4-}$ and $[\text{FeF}_6]^{4-}$ differ in magnetic behaviour; Fe has $Z = 26$.
22. Draw cis and trans forms of $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ and identify their coordination number.

23. Explain crystal-field splitting of d orbitals in an octahedral field and distinguish strong- and weak-field ligands.

24. Describe synergic bonding in metal carbonyls, distinguishing σ donation from π back-bonding.

D. Long answers - 5 marks each

25. State Werner's theory. Explain the different numbers of ionisable chlorides in $\text{CoCl}_3 \cdot 6\text{NH}_3$, $\text{CoCl}_3 \cdot 5\text{NH}_3$ and $\text{CoCl}_3 \cdot 4\text{NH}_3$ using coordination formulae.
26. Discuss structural isomerism in coordination compounds using ionisation, linkage, coordination and solvate isomerism, with one valid pair for each.
27. Compare valence-bond and crystal-field explanations of complexes. Use octahedral d^6 configurations to explain high-spin/low-spin states and numbers of unpaired electrons.
28. For $[\text{Co}(\text{NH}_3)_6]^{3+}$ and $[\text{CoF}_6]^{3-}$, predict oxidation state, d count, spin state, hybridisation and magnetic behaviour in the standard Class XII model; Co has $Z = 27$.
29. Explain geometrical and optical isomerism. Draw cis/trans $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ and show why $[\text{Co}(\text{en})_3]^{3+}$ has non-superimposable mirror-image forms.
30. Explain applications of coordination compounds in qualitative analysis, extraction of metals, biological systems and medicine, with a chemically identified example for each.

ANSWER KEY - Numerical / short answers

4) +3. 9) Coordination number 6; oxidation state +3.
 13) +3. 14) 4. 15) Yes. 16) Diamminesilver(I) ion.
 17) 0. 20) $[\text{Ni}(\text{CN})_4]^{2-}$: dsp^2 , square planar, 0 unpaired; $[\text{NiCl}_4]^{2-}$: sp^3 , tetrahedral, 2 unpaired. 21) CN complex: low-spin d^6 , 0 unpaired; F complex: high-spin d^6 , 4 unpaired. 22) Coordination number 6 for both. 25) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$: 3; $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$: 2; $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$: 1 ionisable chloride. 27) Octahedral d^6 high spin: 4 unpaired; low spin: 0. 28) Both Co^{3+} , d^6 ; NH_3 complex low spin, d^2sp^3 , diamagnetic; F complex high spin, sp^3d^2 , 4 unpaired.