

a metal in the middle, ligands donating a pair each, and one number that fixes the shape

What a Coordination Compound Is *

- a central metal atom or ion is surrounded by **ligands**, linked through coordinate bonds
- a coordinate bond: the shared electron pair comes entirely from the ligand
- drawn conventionally as an arrow pointing to the electron acceptor
- metal ion (electron-deficient) is the acceptor, the Lewis acid
- ligand (electron-pair donor) is the Lewis base
- forming a complex is a Lewis acid-base interaction
- cisplatin $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$: Pt surrounded by 2 NH_3 and 2 Cl^-
- all four donate a lone pair to the central $\text{Pt}(\text{II})$

Types of Ligands

- monodentate**: one donor atom shares an electron pair, e.g. Cl^- , OH^- , CN^-
- polydentate**: two or more donor atoms bind the same metal
- en and oxalate are **bidentate**: two donor atoms each
- EDTA^{4-} binds via 4 O and 2 N: **hexadentate** on its own
- ambidentate**: two different donor atoms, uses either one, never both
- $-\text{NO}_2$ links through N, $-\text{ONO}$ through O
- $-\text{SCN}$ links through S, $-\text{NCS}$ through N

Double Salt versus Coordination Complex

- double salt** dissociates completely into simple ions in water
- Mohr's salt $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ gives Fe^{2+} , NH_4^+ , SO_4^{2-}
- carnallite $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$ behaves the same way
- coordination complex**: at least one complex ion survives dissociation intact
- $\text{K}_4[\text{Fe}(\text{CN})_6]$ gives 4K^+ and $[\text{Fe}(\text{CN})_6]^{4-}$, which does not fall apart
- the test is chemical, not just naming
- dissolved $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ gives no test for free Co^{3+} or NH_3
- but AgNO_3 still precipitates all 3 moles of ionisable Cl^- as AgCl

Q. $\text{K}_4[\text{Fe}(\text{CN})_6]$: find the charge number of the complex ion and the oxidation state of Fe.

- the coordination sphere $[\text{Fe}(\text{CN})_6]$ balances the charge of 4 K^+ outside it
- so the complex ion is $[\text{Fe}(\text{CN})_6]^{4-}$
- charge of complex = O.S. of Fe + $6 \times (\text{charge of } \text{CN}^-)$
= O.S.(Fe) - 6
- $-4 = \text{O.S. of Fe} - 6$, so O.S. of Fe = $-4 + 6$



$\text{K}_4[\text{Fe}(\text{CN})_6]$ dissociates into 4 K^+ and the complex ion $[\text{Fe}(\text{CN})_6]^{4-}$, which stays intact

Answer

charge number of the complex ion is -4,
oxidation state of Fe is +2