

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

Werner's theory, in three postulates

- two valences: **primary** (ionisable, the oxidation state), **secondary** (satisfied by ligands, fixed for a metal)
- secondary valence is the **coordination number**: fixed directions in space, giving the complex a definite geometry
- every metal satisfies both valences: primary by negative ions, secondary by negative ions or neutral molecules

Vocabulary the rest of the chapter leans on

- coordination sphere**: the metal and its directly attached ligands, written inside square brackets, e.g. $[\text{Co}(\text{NH}_3)_6]^{3+}$
- coordination number**: count of donor atoms bonded to the metal, not ligands (bidentate contributes 2 alone)
- ligand**: a donor atom, ion or molecule attached to the metal
- monodentate**: one atom (NH_3 , Cl^-); **bidentate**: two (ethylenediamine, en; oxalate); **polydentate**: several (EDTA, six)
- ambidentate** ligand: binds through either of two donor atoms, e.g. $-\text{NO}_2$ (N) or $-\text{ONO}$ (O)
- chelate**: the ring a bidentate/polydentate ligand closes; generally beats those donors bound separately

the coordination number is a count of **BONDS** to the metal, not of ligands: one EDTA molecule alone can fill six of them

Q. $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$: find Co's oxidation state, the coordination number, and the likely geometry.

- coordination sphere is $[\text{Co}(\text{NH}_3)_5\text{Cl}]^{2+}$; two Cl^- outside are counter ions, balancing to +2
- inside the bracket, NH_3 is neutral ($5 \times 0 = 0$), bonded Cl is -1: ligand charges sum to -1
- let Co's oxidation state be x: $x + (-1) = +2$, so $x = +3$
- coordination number = donor atoms on Co = $5 (\text{NH}_3) + 1 (\text{Cl}) = 6$

Answer

Co is +3, coordination number 6, octahedral geometry

Naming a coordination compound, the order that matters

- ligands named **alphabetically** before the metal, charge irrelevant; multiplying prefixes (bis-/tris- too) ignored when alphabetising
- anionic ligands end in -o (chloro, cyano, oxalato); neutral keep their name, except ammine, aqua, carbonyl
- the metal's oxidation state is written as a Roman numeral in brackets right after its name
- if the complex ion is anionic, the metal's name takes -ate (ferrate, cuprate, cobaltate)

