Coordination Chemistry

Complex-ion charge, naming, coordination number, crystal-field theory, magnetism, and Beer's law.

01 Metal oxidation state

CORE RULE

Complex ion in [brackets], counter-ions outside. Complex charge balances the counter-ions; then metal charge + Σ(ligand charges) = complex charge.

02 Naming (IUPAC)

CORE RULE

Cation first. Ligands alphabetical before the metal (ignore di/tri prefixes for ordering). Use bis/tris if the ligand name already has di/tri (ethylenediamine → bis). Anionic complex → metal takes -ate.

03 Coordination number & geometry

CORE RULE

CN = total metal-ligand bonds (monodentate 1, bidentate like en/oxalate 2). CN 2 → linear; 4 → tetrahedral or square planar; 6 → octahedral.

04 d-electron count

CORE RULE

Write the free-metal configuration, then remove electrons (4s before 3d) for the ion. Count d-electrons for CFT. Mn = $[Ar]4s^2 3d^5$ → Mn^{3+} = $[Ar]3d^4$.

05 Crystal field: high vs low spin

CORE RULE

Octahedral d^4-d^7: compare Δ_o with pairing energy P. Δ_o < P → high spin (fill e_g before pairing); Δ_o > P → low spin (pair in t2g first). d^0-d^3 and d^8-d^{10} have only one filling.

06 Square-planar splitting

CORE RULE

Strong-field d^8 ions (Pt^{2+}, Pd^{2+}, Ni^{2+}) adopt square planar, with a distinct d-orbital splitting; the highest orbital ($d_{x^2-y^2}$) stays empty, giving a diamagnetic low-spin d^8.

07 Magnetism

CORE RULE

Any unpaired d-electrons → paramagnetic; all paired → diamagnetic. d^3 octahedral (3 unpaired) and d^8 octahedral (2 unpaired) are the same in either field strength.

08 Isomerism

CORE RULE

Structural isomers (same formula, different connectivity): ionization and linkage. Stereoisomers (same connectivity, different arrangement): cis/trans (geometric) and non-superimposable optical isomers.

09 Beer's law

CORE RULE

$A = \varepsilon c \ell$: A absorbance (unitless), ε molar extinction coefficient ($M^{-1}cm^{-1}$), c concentration (M), ℓ path length (cm). ε is wavelength-specific.

10 Beer's law ratio & dilution

CORE RULE

Same compound, same ε and ℓ: $A_1/A_2 = c_1/c_2$, so $c_2 = A_2 c_1/A_1$ (no need for ε).

For a diluted sample, apply $M_1V_1 = M_2V_2$ to get the diluted concentration BEFORE using $A = \varepsilon c \ell$.