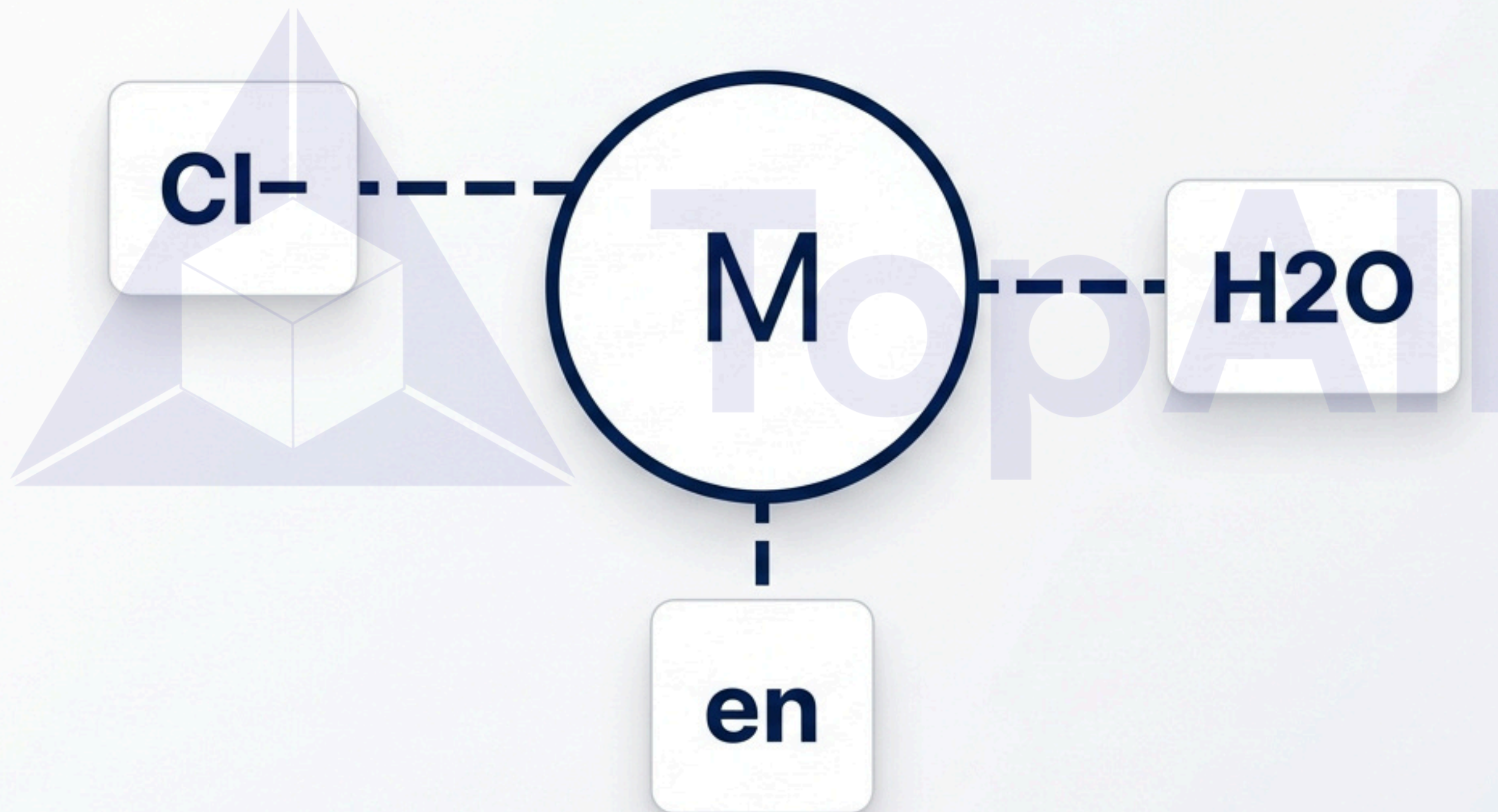


Ligands & Denticity

The Building Blocks of Coordination Compounds

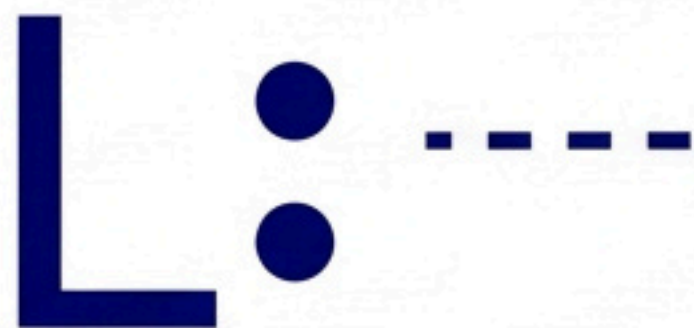


What is a Ligand?

A ligand is an ion or molecule bound to the central metal atom or ion in a coordination entity.

The Ligand

Acts as a Lewis base. It contains at least one donor atom with a lone pair of electrons ready to share.



Coordinate
Covalent Bond

The Central Metal

Acts as a Lewis acid. It accepts the electron pair to form a defined geometrical arrangement.



The Denticity Scale: One, Two, or Many

Unidentate (1 Donor)

Ligands bound through a single donor atom.

Cl⁻ (Chloride)

H₂O (Water)

NH₃ (Ammonia)

Didentate (2 Donors)

Ligands that bind through exactly two donor atoms simultaneously.

ethane-1,2-diamine (en)

oxalate (C₂O₄²⁻)

Polydentate (3+ Donors)

Ligands containing several donor atoms within a single molecule.

N(CH₂CH₂NH₂)₃



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Key Highlights

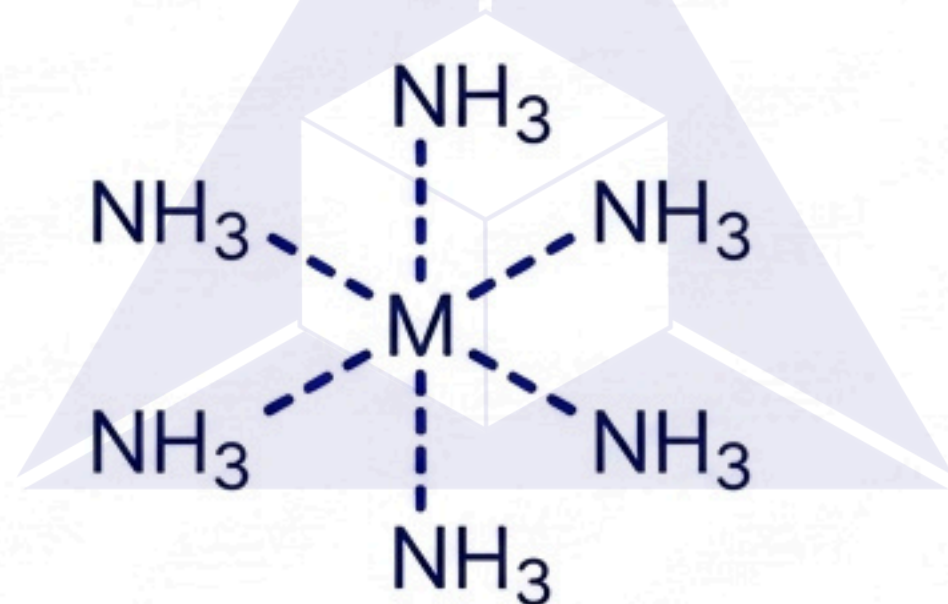
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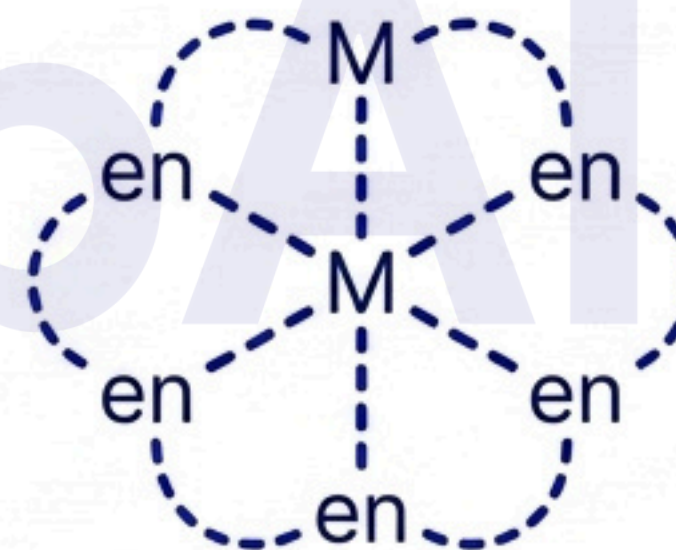
Chelation: The Claw Effect

When a di- or polydentate ligand uses its two or more donor atoms simultaneously to bind a single metal ion, it forms a chelate ligand.

Unidentate Attachments



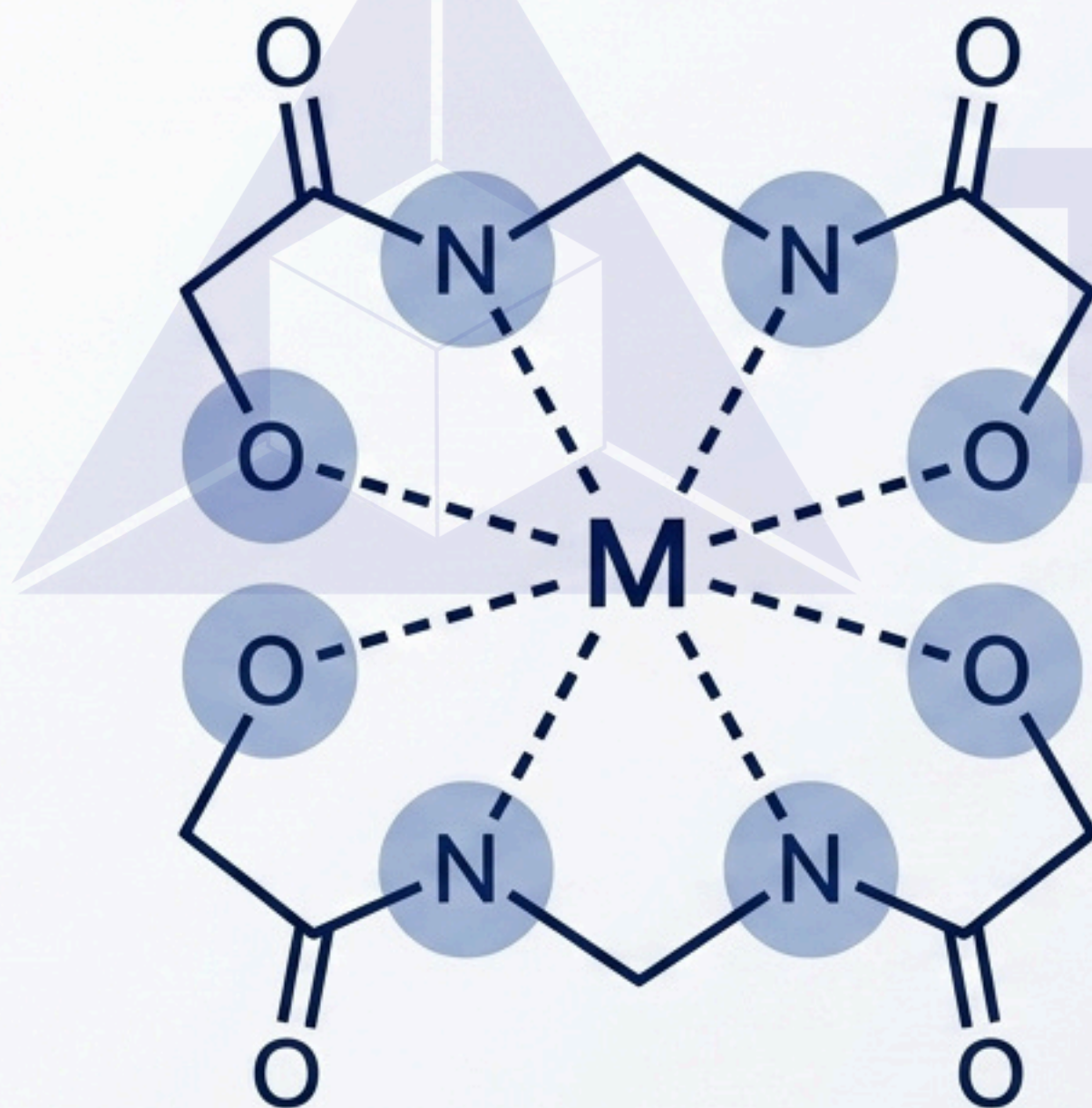
Chelate Rings (The Claw)



Denticity: The exact number of ligating groups a chelate ligand uses to bind. Chelate complexes form closed ring structures around the metal, making them significantly more stable than similar complexes containing only unidentate ligands.

The Hexadentate EDTA4-

Ethylenediaminetetraacetate ion (EDTA4-) is an important and powerful hexadentate ligand.



Denticity: 6 (Hexadentate)

Nitrogen Donors: 2 atoms

Oxygen Donors: 4 atoms

Action: A single EDTA4- molecule can completely encapsulate a metal ion using its six donor arms.

Ambidentate Ligands: The Alternate Donors

An ambidentate ligand has two different donor atoms, but chooses to ligate through either one or the other in a complex, never both at once.

The NO₂⁻ Ion



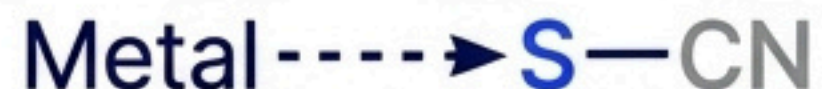
nitrito-N

Can coordinate through N OR O



nitrito-O

The SCN⁻ Ion



thiocyanato-S

Can coordinate through S OR N



thiocyanato-N

Key Takeaways & Exam Traps

Remember: Polydentate vs. Ambidentate



The Trap: Confusing ligands that have multiple donors.

The Fix: Polydentate uses many donors simultaneously (like a claw). Ambidentate has multiple choices but binds with only one at a time (like a toggle).

Remember: Denticity Drives Coordination Number



The Trap: Assuming 3 ligands always means a Coordination Number of 3.

The Fix: Coordination number depends on the number of sigma bonds, not just the number of molecules. For example, 3 didentate en ligands will create 6 total bonds (Coordination Number = 6).



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