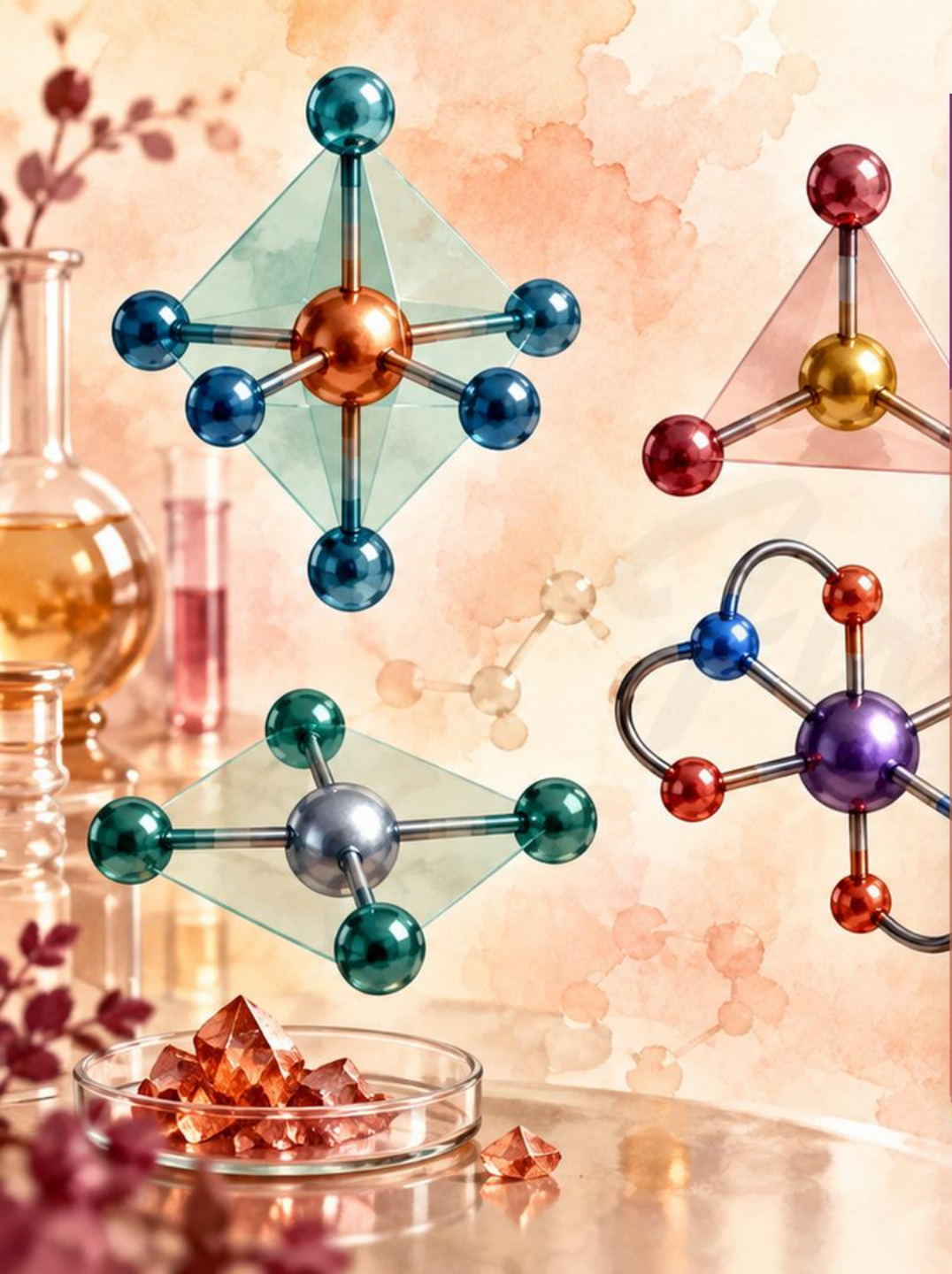




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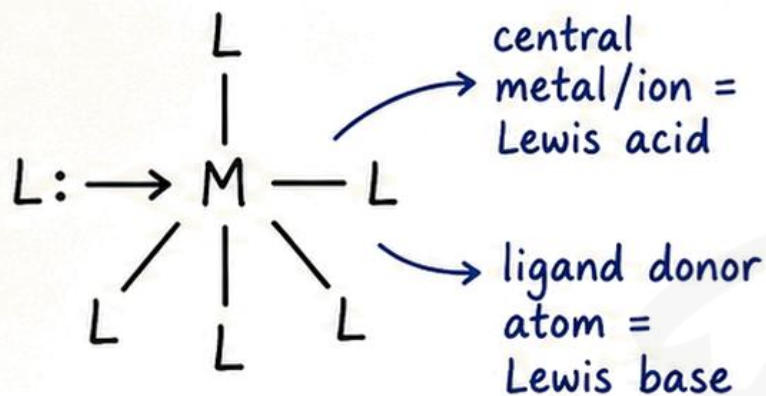
CHAPTER 5

Coordination Compounds

CHAPTER NOTES

COORDINATION COMPOUNDS - OVERVIEW & IMPORTANCE

WHAT ARE THEY?

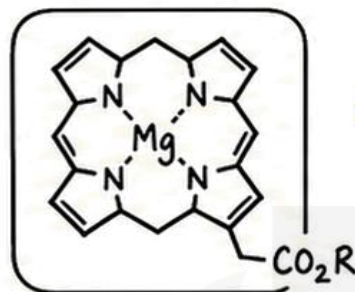


A central metal atom or ion accepts electron pairs from a fixed set of ions or neutral molecules.

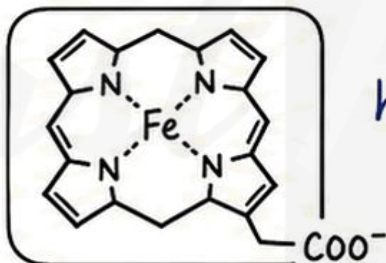
Examples:



BIOLOGICAL BACKBONE



chlorophyll -
Mg centre



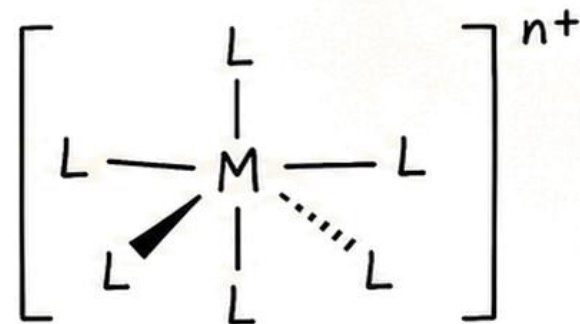
haemoglobin -
Fe centre



vitamin B₁₂ -
Co centre

WHY IMPORTANT?

- analytical detection
- catalysts
- metallurgy & electroplating
- dyes/materials
- medicines

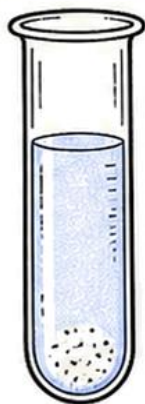


coordination sphere of a complex

Metal + donor ligands → geometry, colour, magnetism & reactivity.

WERNER'S COBALT-AMMONIA CHLORIDE OBSERVATIONS

THE TEST



1 mol
cobalt-ammonia
compound
+
excess
 $\text{AgNO}_3(\text{aq})$,
cold

↓ white $\text{AgCl}(\text{s})$
precipitate

Only outer-sphere Cl^-
gives prompt AgCl ;
do not show AgNO_3
breaking Co-Cl bonds.

⚠ AgNO_3 : corrosive/oxidising;
supervised lab only.

OBSERVATIONS

compound	colour	mol AgCl
$\text{CoCl}_3 \cdot 6\text{NH}_3$	yellow	3
$\text{CoCl}_3 \cdot 5\text{NH}_3$	purple	2
$\text{CoCl}_3 \cdot 4\text{NH}_3$	green	1
$\text{CoCl}_3 \cdot 4\text{NH}_3$	violet	1

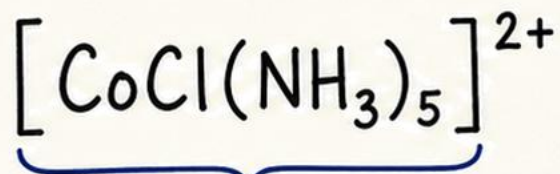
WHAT WERNER SAW

- Different amounts of ionisable chloride.
- Green and violet forms have the same empirical composition but different properties.
- In every member, six groups remain directly attached to Co.
- Evidence for inner sphere, outer sphere and isomerism.

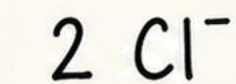
mol AgCl formed = number of free outer-sphere Cl^- per formula unit
(under the stated cold test).

WERNER FORMULATIONS - AgCl & CONDUCTIVITY

	empirical composition	modern formulation	mol AgCl	electrolyte	CN
●	$\text{CoCl}_3 \cdot 6\text{NH}_3$	$[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$	3	1:3	6
●	$\text{CoCl}_3 \cdot 5\text{NH}_3$	$[\text{CoCl}(\text{NH}_3)_5]\text{Cl}_2$	2	1:2	6
●	$\text{CoCl}_3 \cdot 4\text{NH}_3$, green	$[\text{CoCl}_2(\text{NH}_3)_4]\text{Cl}$	1	1:1	6
●	$\text{CoCl}_3 \cdot 4\text{NH}_3$, violet	$[\text{CoCl}_2(\text{NH}_3)_4]\text{Cl}$	1	1:1	6



inner sphere:
6 directly bound groups



outer-sphere
counterions

More outer ions →
more particles in solution →
higher conductivity.

same
formula,

two
geometrical
forms

Secondary valence / coordination number is 6 throughout.

WERNER THEORY - PRIMARY, SECONDARY VALENCE & GEOMETRY

PRIMARY VALENCE

- historical valence linked to oxidation state
- normally ionisable
- satisfied by anions

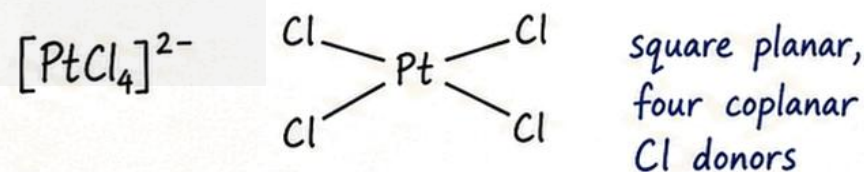
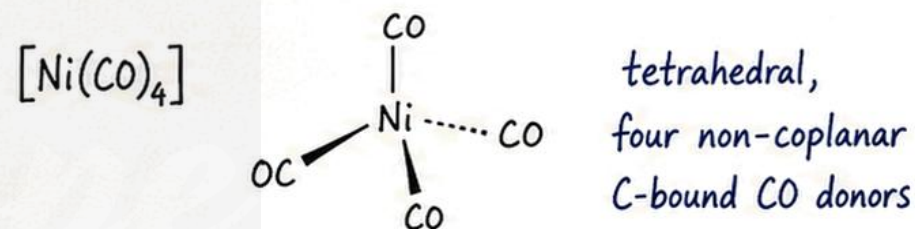
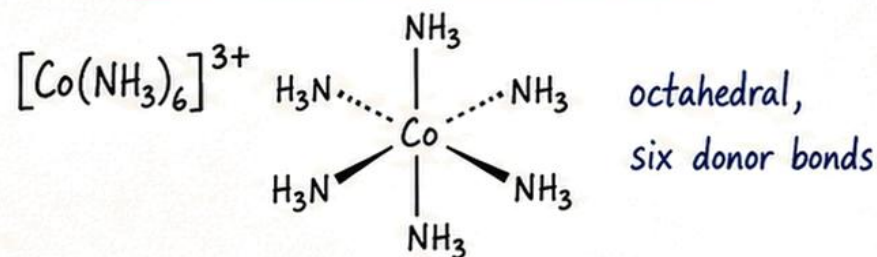
$\text{Co(III)} \rightarrow \text{primary valence} = 3$

SECONDARY VALENCE

- equals coordination number
- non-ionisable in Werner's description
- satisfied by neutral ligands and/or anions
- fixed spatial arrangement

$[\text{Co}(\text{NH}_3)_6]^{3+} \rightarrow \text{secondary valence / CN} = 6$

DEFINITE GEOMETRY



① two kinds of valence $\rightarrow$ | ② primary usually ionisable $\rightarrow$ | ③ secondary equals CN $\rightarrow$ | ④ directly bound groups occupy definite positions

[] square brackets = coordination entity | + - outside ions = counterions

* Werner's historical language; modern bonding models refine it.



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