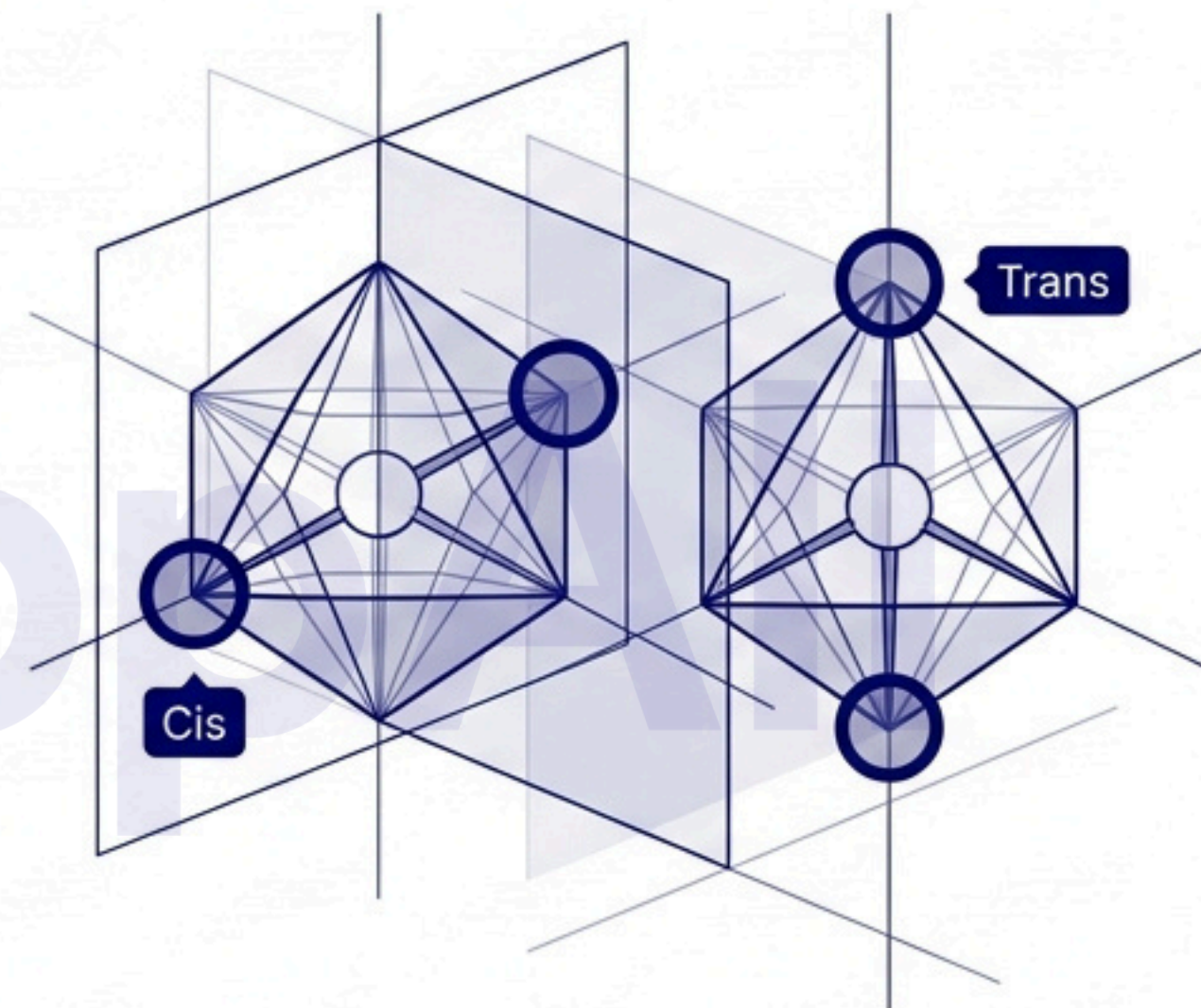


HETEROLEPTIC COMPLEXES

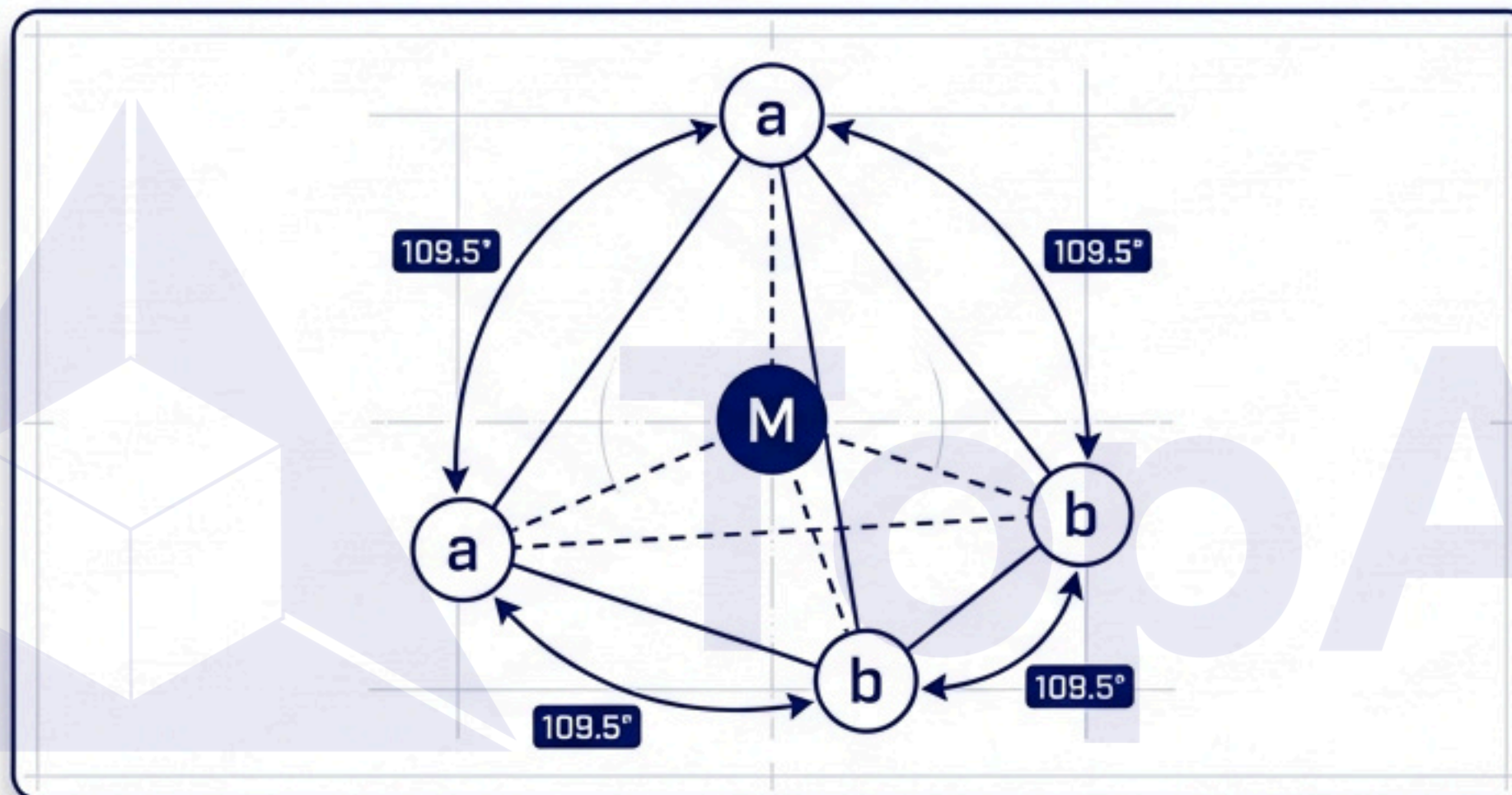
Geometrical Isomerism in Coordination Compounds

Isomers possess the exact same chemical formula and bonds, but differ entirely in their 3D spatial arrangement. Geometrical isomerism specifically arises in heteroleptic complexes due to the distinct geometric positioning of ligands.



Identical atoms. Different architecture.

The Tetrahedral Exception



Tetrahedral complexes with two types of unidentate ligands do not show geometrical isomerism.

Key Insight

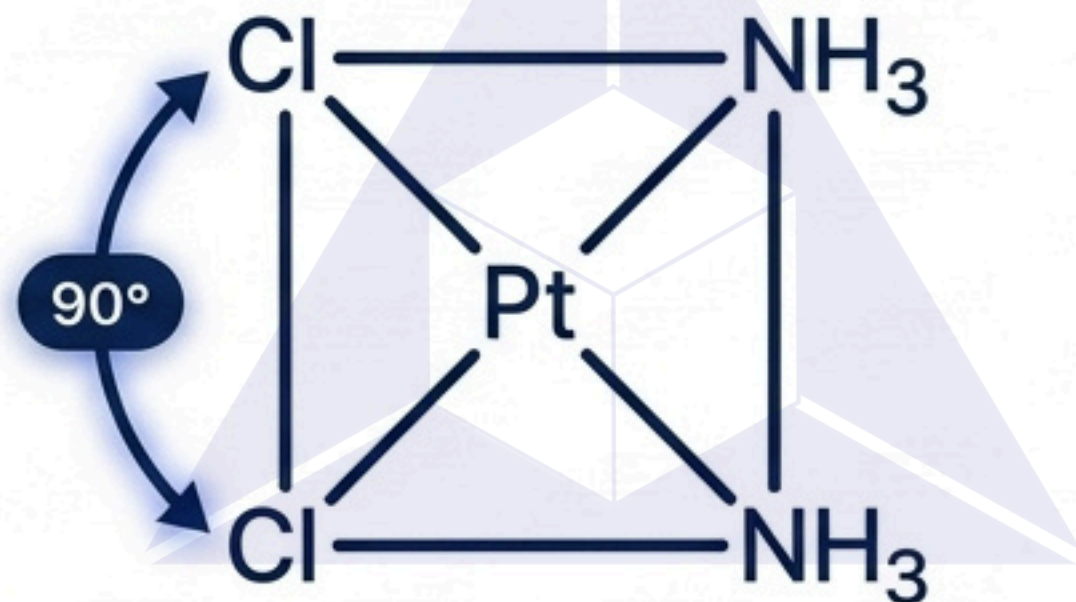
Myth vs. Reality: Because every position in a tetrahedron is exactly 109.5° from the others, all positions are adjacent. Therefore, an 'opposite' position simply does not exist.

Square Planar Complexes

COORDINATION NUMBER 4

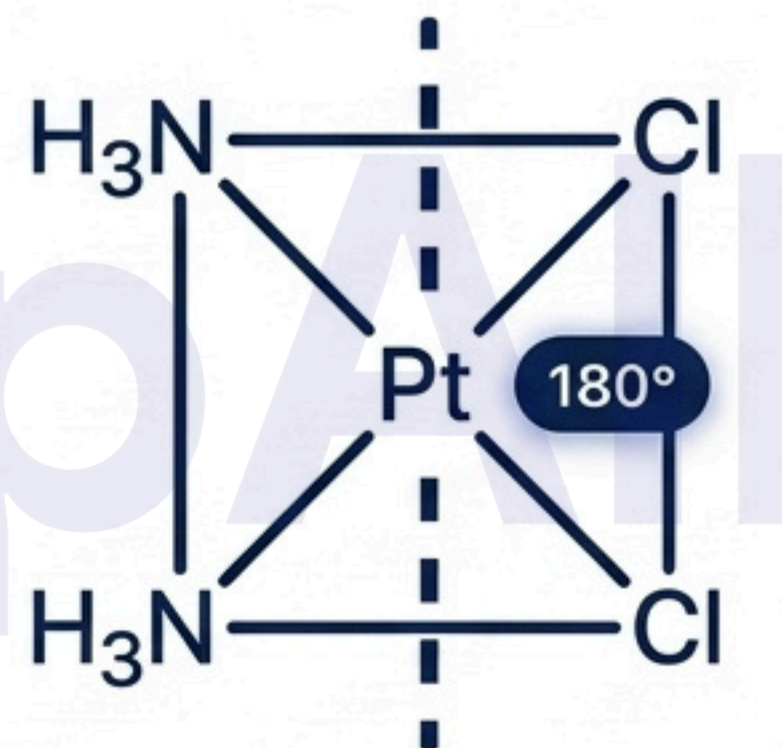
FORMULA: $[MX_2L_2]$

Cis-isomer



Identical ligands occupy adjacent corners.

Trans-isomer



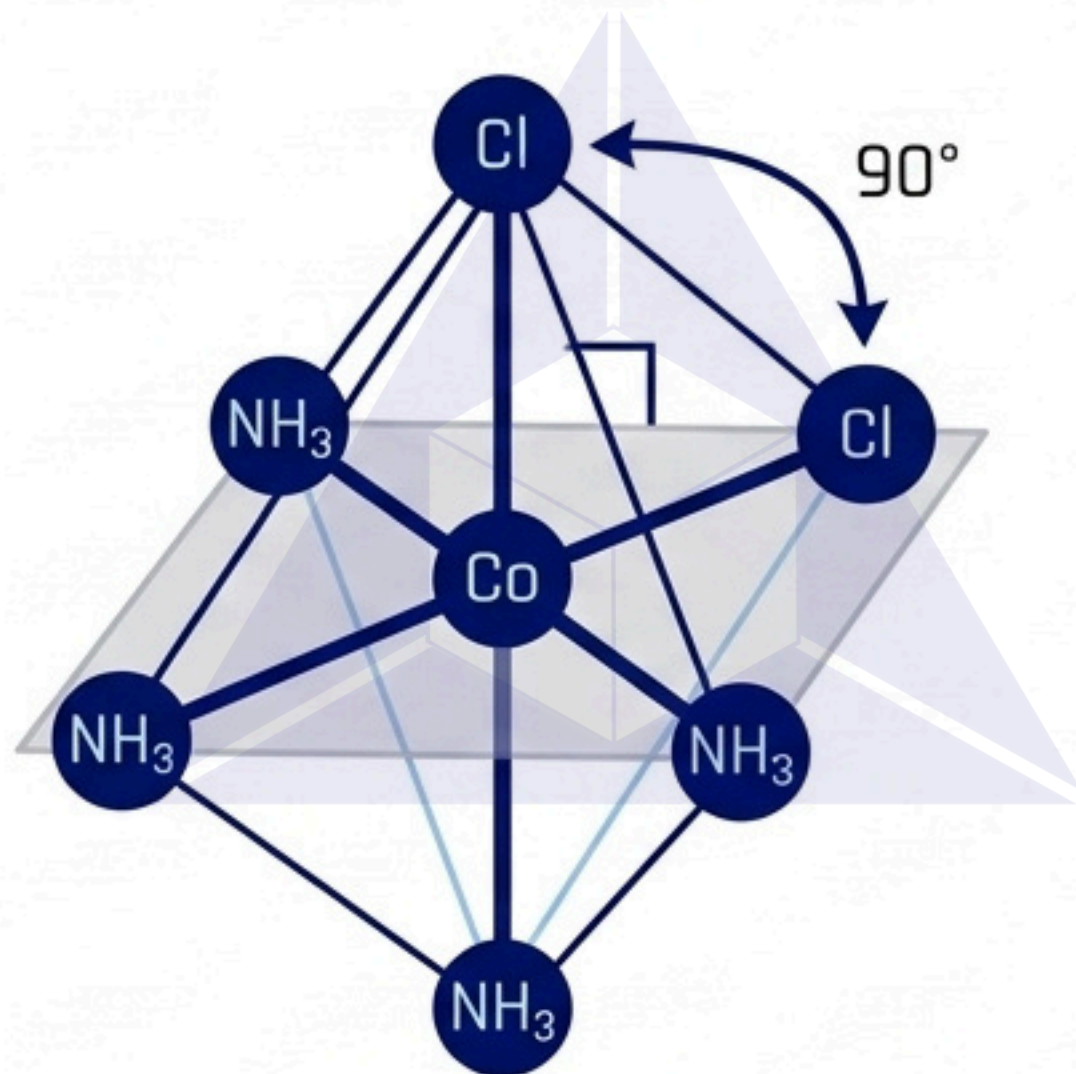
Identical ligands occupy opposite corners.

Octahedral Complexes (Unidentate)

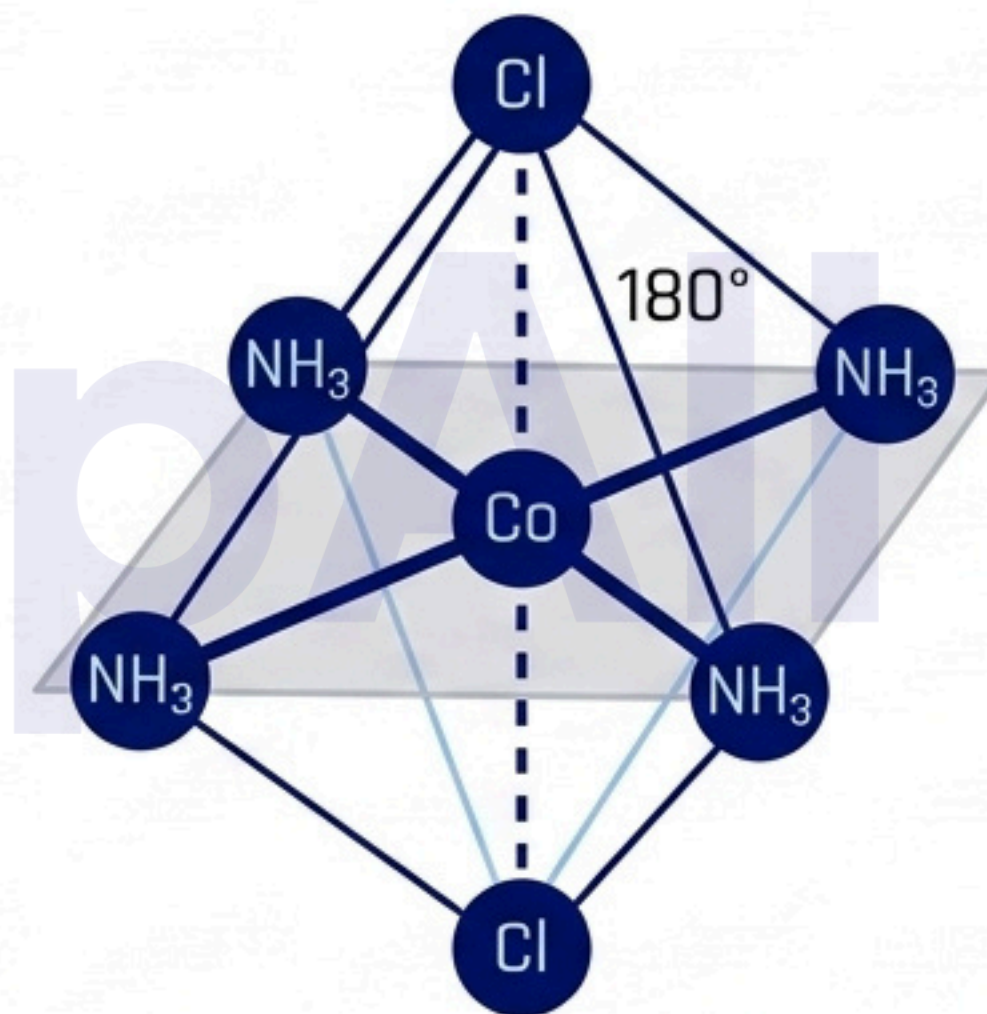
COORDINATION NUMBER 6

FORMULA: $[MX_2L_4]$

Cis-isomer



Trans-isomer



The logic remains identical to square planar: Cis is adjacent, Trans is opposite.



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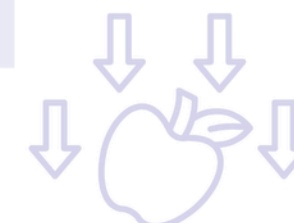
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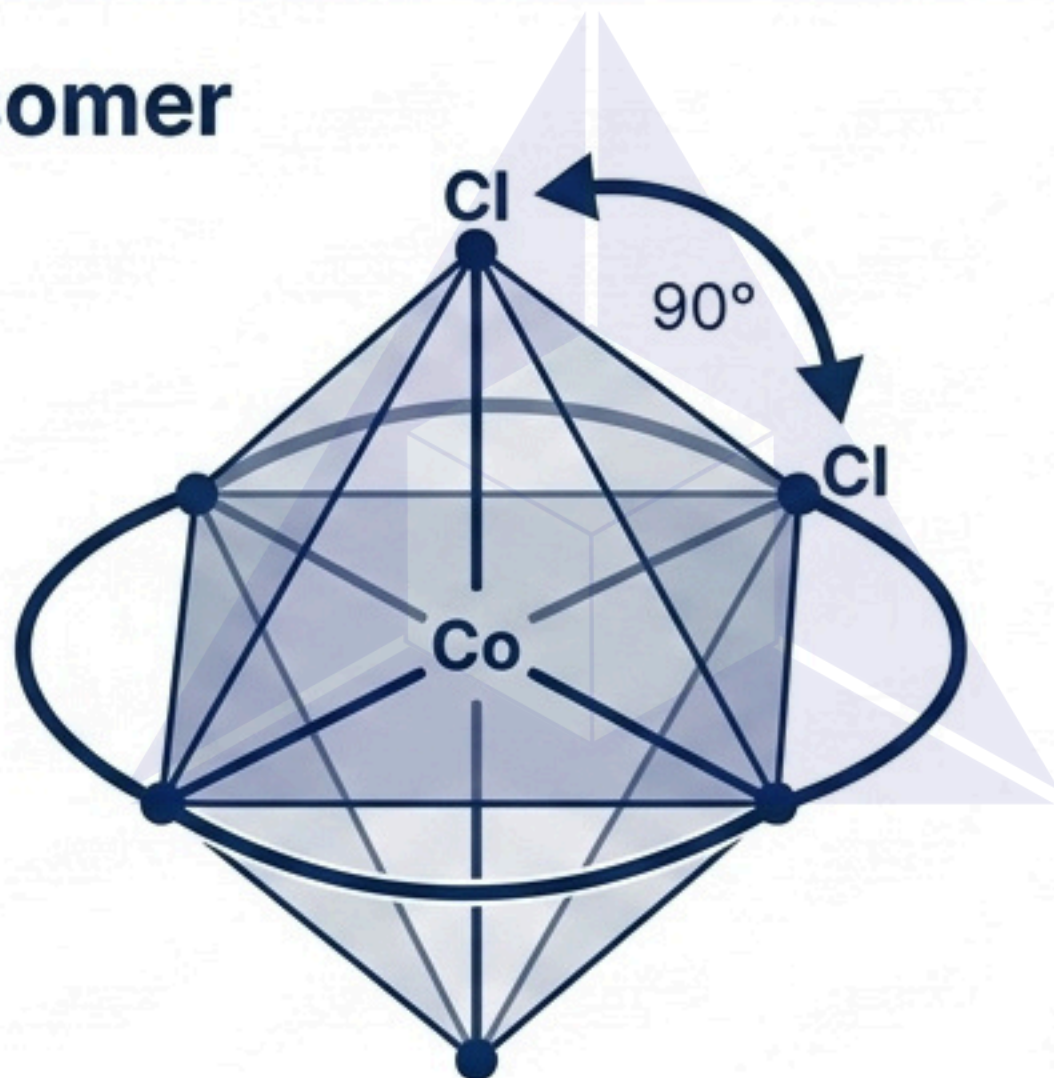


FORMULA: $[MX_2(L-L)_2]$

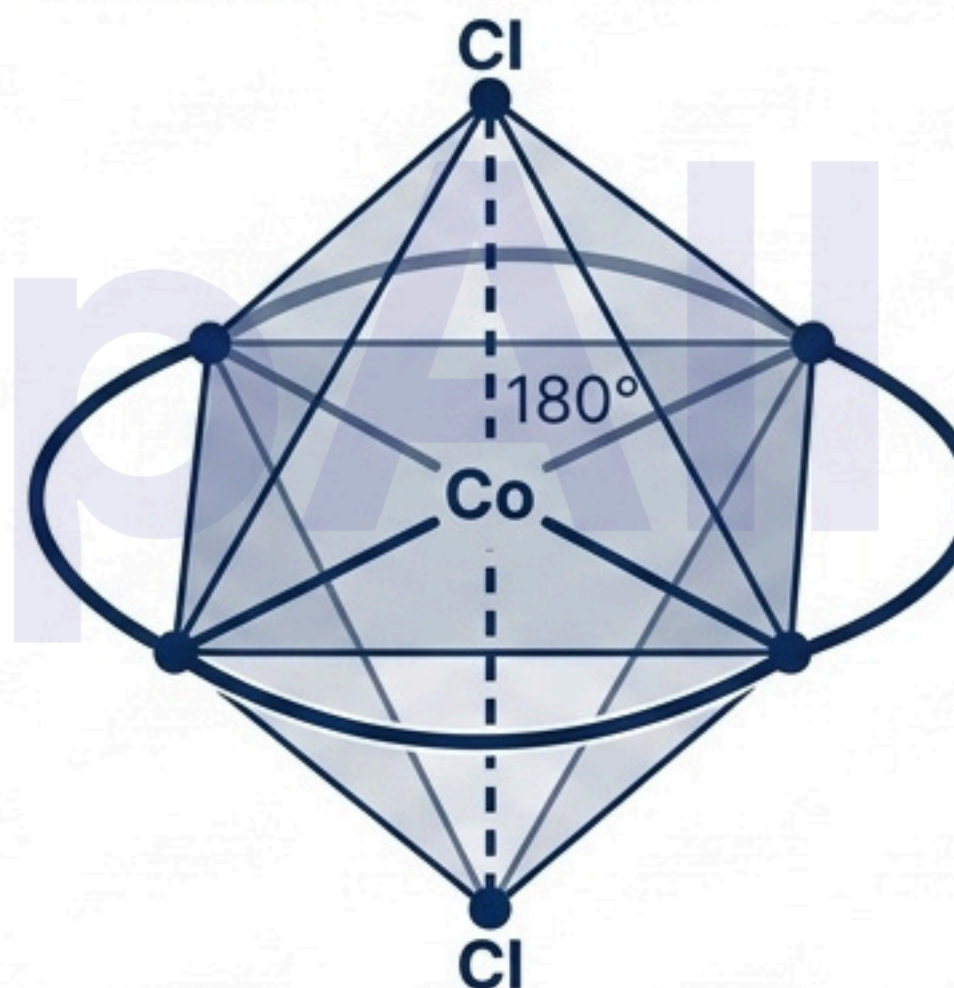
Octahedral Complexes (Didentate)

L-L = Didentate Ligand (e.g., ethane-1,2-diamine)

Cis-isomer

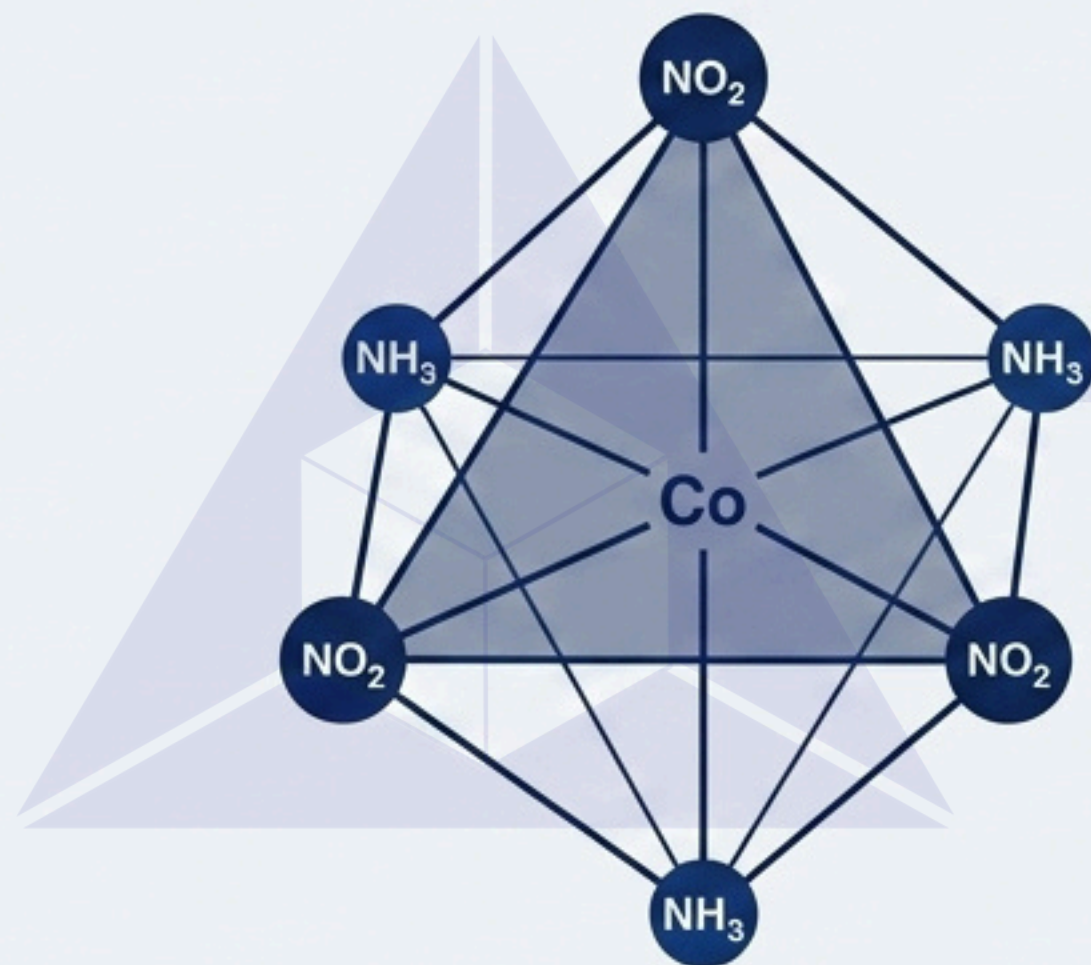
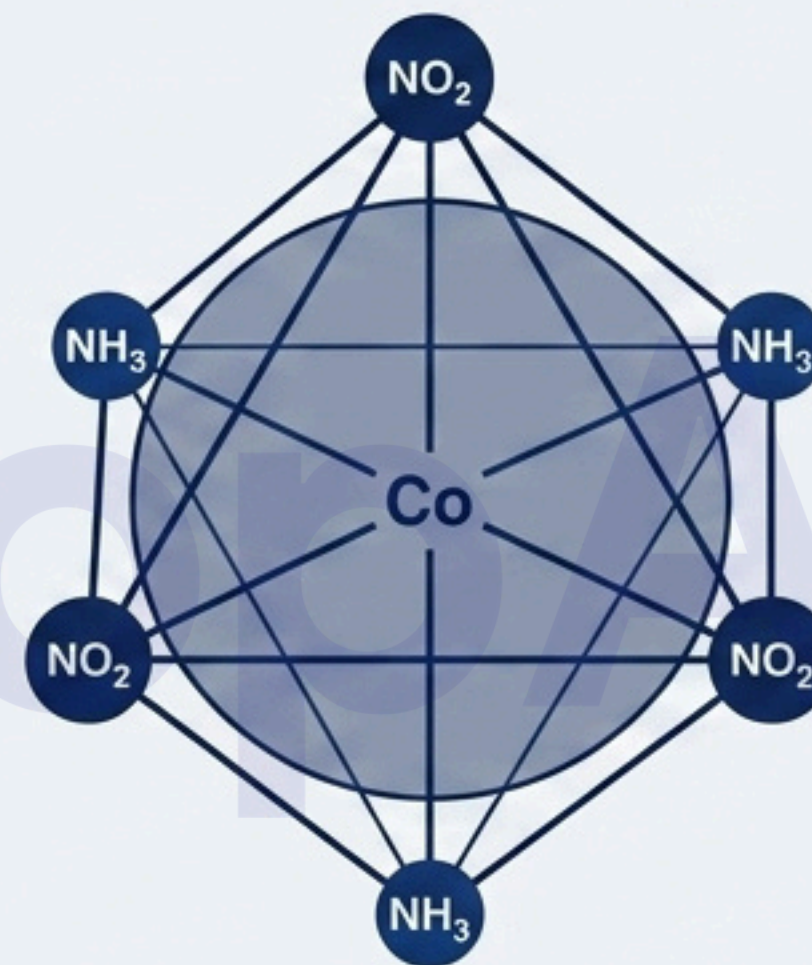


Trans-isomer



Even with complex didentate brackets, geometrical isomerism is still determined by the relative positioning of the unidentate (X) ligands.

Facial (fac) and Meridional (mer) Isomers

**fac-isomer****mer-isomer**

Occurs when three donor atoms of the same ligand are present. Facial atoms occupy adjacent corners of a single octahedral face. Meridional atoms occupy positions around the central meridian plane.

The Isomerism Taxonomy

Formula Type	Geometry	Isomer Types	Visual Key
$[\text{MX}_2\text{L}_2]$	Square Planar	Cis / Trans	
$[\text{MX}_2\text{L}_4]$	Octahedral	Cis / Trans	
$[\text{MX}_2(\text{L-L})_2]$	Octahedral	Cis / Trans	
$[\text{Ma}_3\text{b}_3]$	Octahedral	Fac / Mer	

TAKEAWAYS

Key Spatial Rules



Requirement: Geometrical isomerism strictly requires heteroleptic complexes (different types of ligands).



The Exception: Tetrahedral complexes ($[Ma_2b_2]$) never show geometrical isomerism because all ligand positions are adjacent (109.5°).



The Angles: In both square planar and octahedral geometries, Cis means adjacent (90°) and Trans means opposite (180°).



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