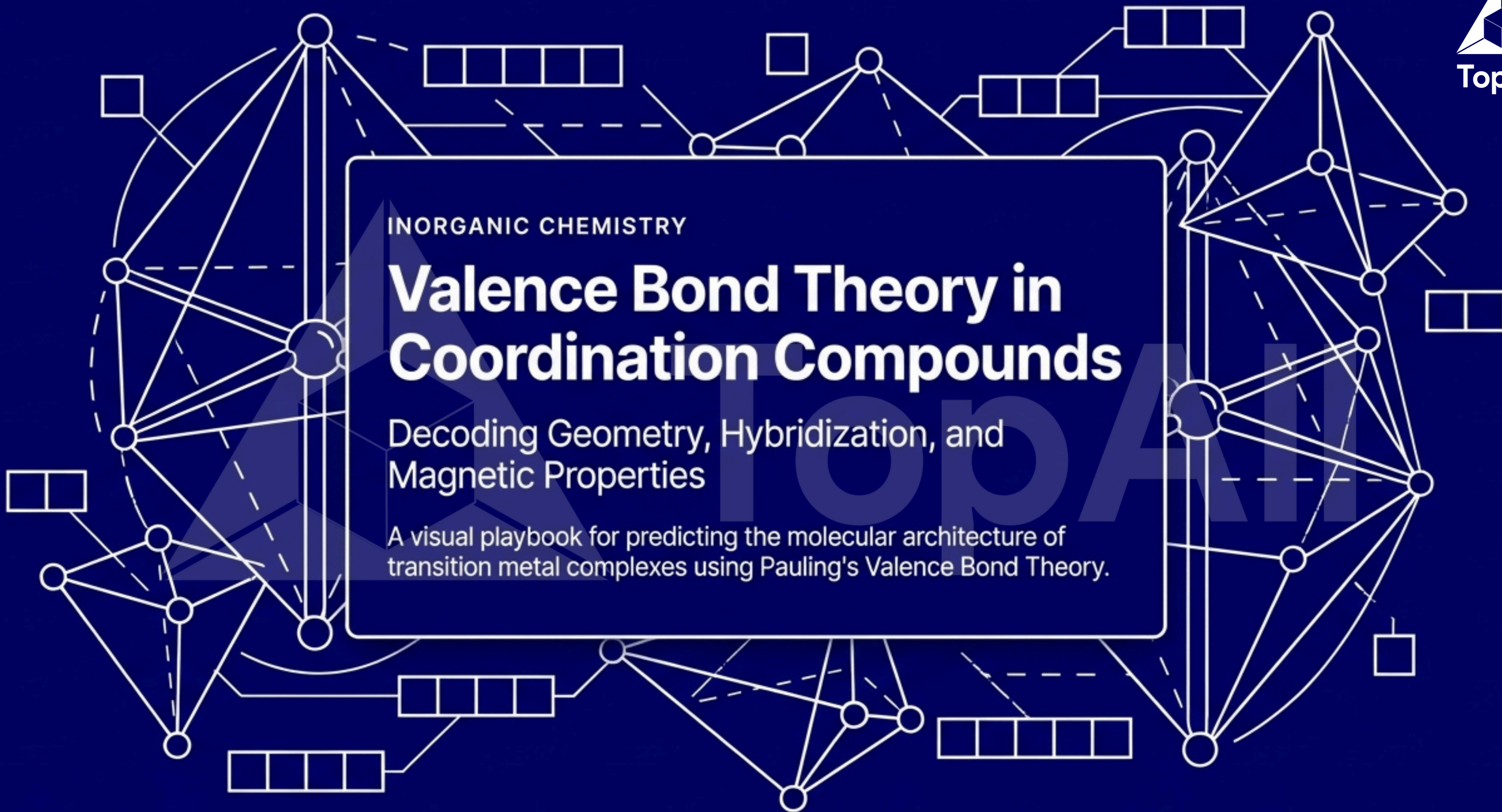


INORGANIC CHEMISTRY

Valence Bond Theory in Coordination Compounds

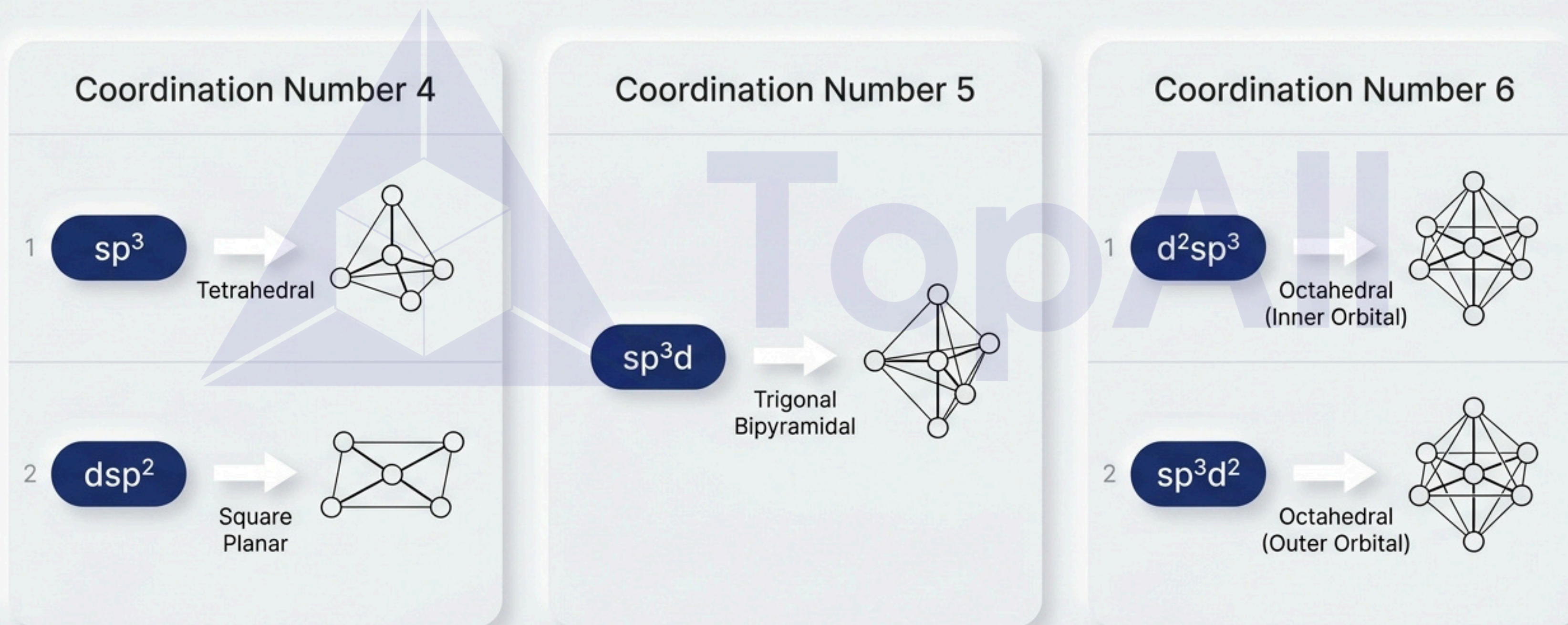
Decoding Geometry, Hybridization, and
Magnetic Properties

A visual playbook for predicting the molecular architecture of
transition metal complexes using Pauling's Valence Bond Theory.



The Geometry & Hybridization Matrix

Under VBT, the central metal ion utilizes its empty (n-1)d, ns, np, or nd orbitals to create equivalent hybridized orbitals, directly dictating the physical shape of the complex.



[Co(NH₃)₆]³⁺: Forced Pairing

Coordination No: 6

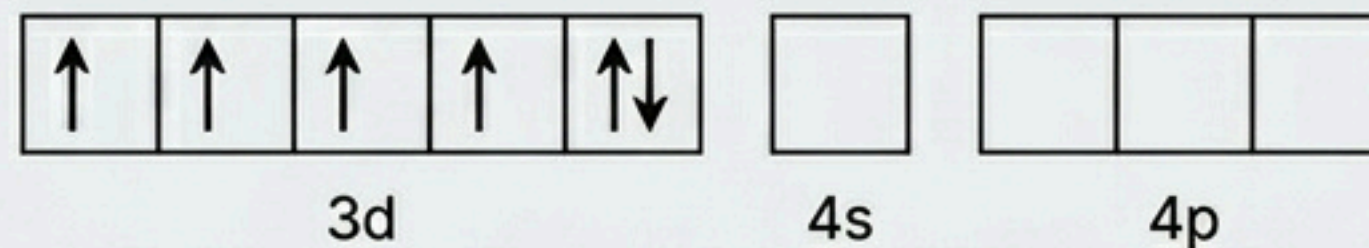
Octahedral

Inner Orbital / Low Spin

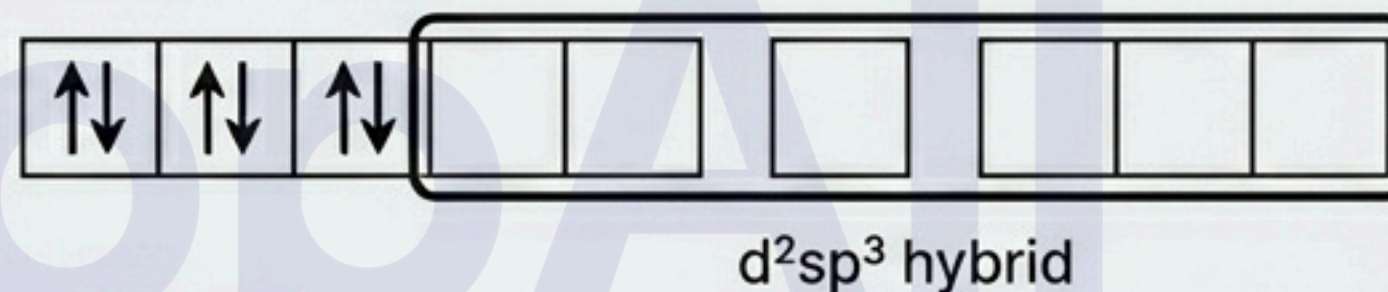
Diamagnetic

Six NH₃ molecules force the 3d electrons to pair up against Hund's rule, emptying two inner d orbitals for hybridization.

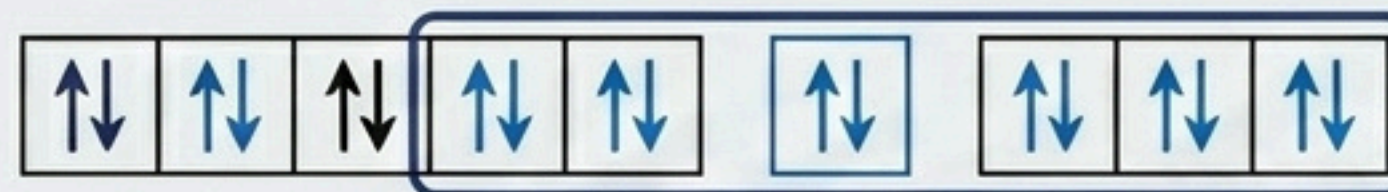
Orbitals of
Co³⁺ ion



d²sp³ hybridized
orbitals of Co³⁺



[Co(NH₃)₆]³⁺
complex



Six pairs of electrons from six NH₃ molecules



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

Practice Now



At prep.topall.app

Key Highlights

- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



[CoF₆]³⁻: Utilizing Outer Orbitals

Coordination No: 6

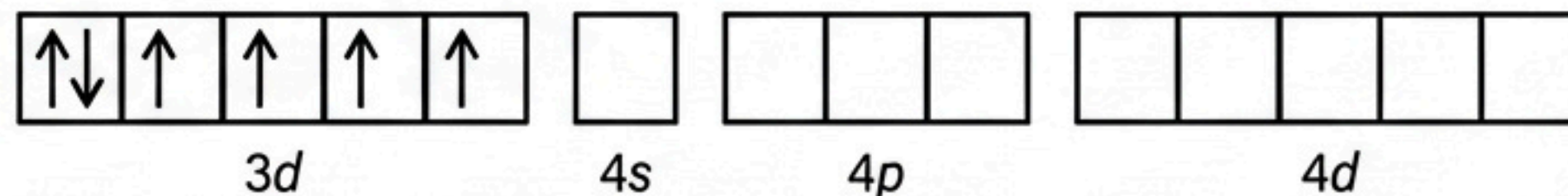
Octahedral

Outer Orbital / High Spin

Paramagnetic

F⁻ is a weak ligand. It cannot force the 3d electrons to pair. Instead, the complex must use outer 4d orbitals to accommodate the ligands.

Orbitals of Co³⁺ ion

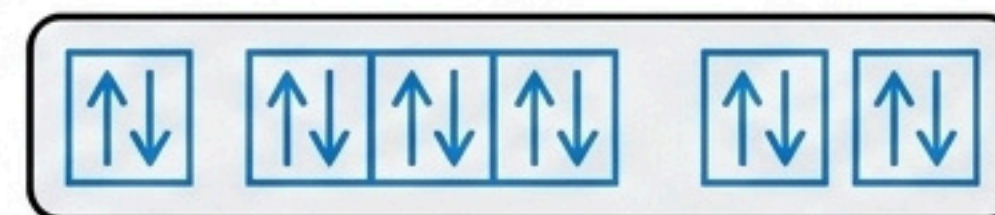


sp^3d^2 hybridized orbitals of Co³⁺



sp^3d^2 hybrid

[CoF₆]³⁻ complex



Six pairs of electrons from six F⁻ ions

$[\text{NiCl}_4]^{2-}$: The Tetrahedral State

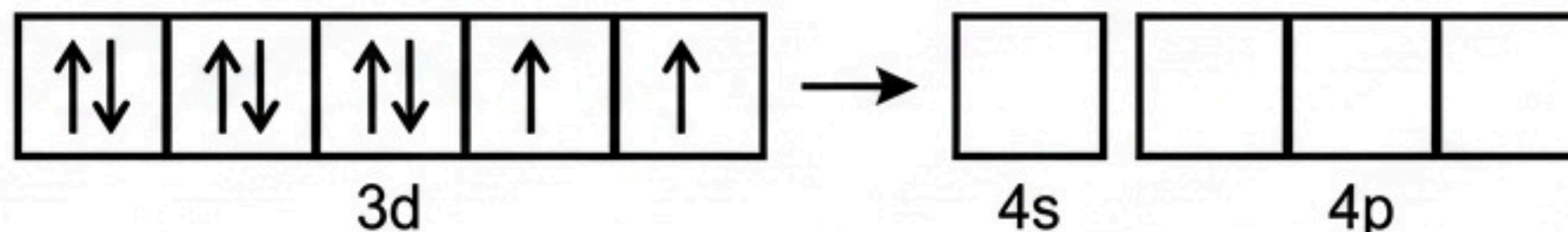
Coordination No: 4

Tetrahedral

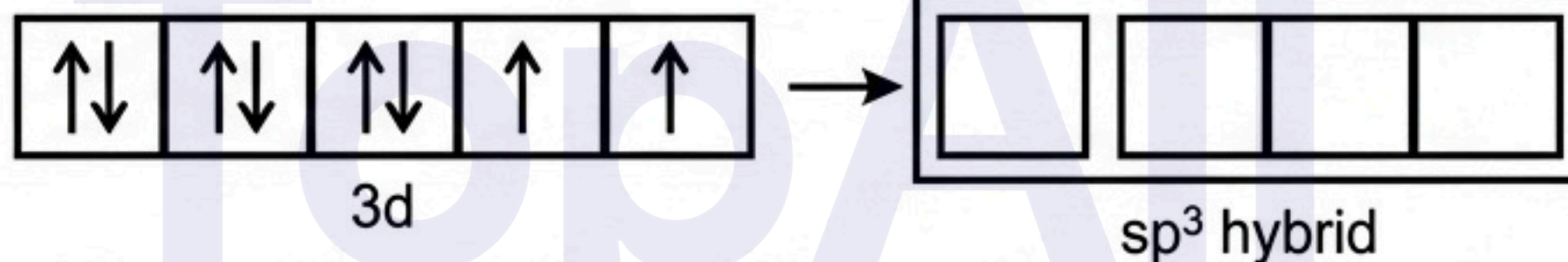
Paramagnetic

Nickel(II) is a d^8 system. The four Cl^- ligands donate pairs into an sp^3 hybrid, leaving the two unpaired 3d electrons untouched.

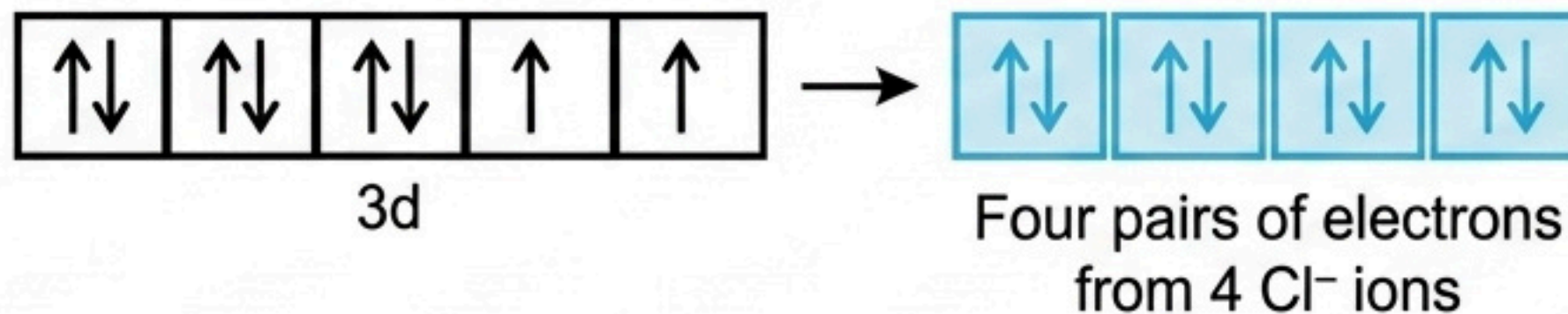
Orbitals of Ni^{2+} ion



sp^3 hybridized orbitals of Ni^{2+}



$[\text{NiCl}_4]^{2-}$ complex



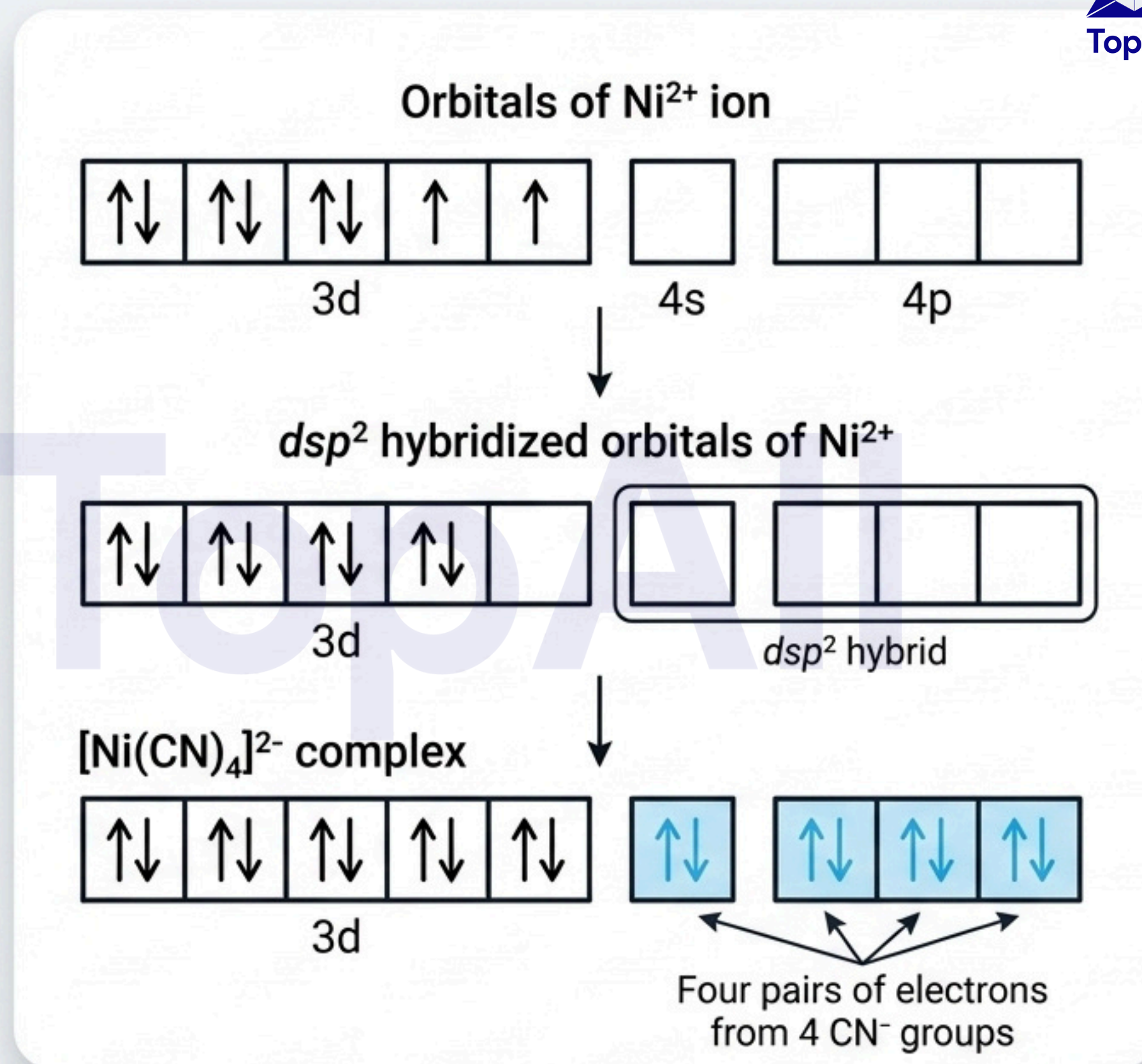
$[\text{Ni}(\text{CN})_4]^{2-}$: The Square Planar Shift

Coordination No: 4

Square Planar

Diamagnetic

The strong CN^- ligand forces the two unpaired 3d electrons to pair up, **emptying one inner d orbital**. This completely changes the hybridization from sp^3 to dsp^2 .



The VBT Master Matrix

A holistic comparison of our four key complexes.

Complex	CN	Hybridization	Geometry	Spin State	Magnetism
$[\text{Co}(\text{NH}_3)_6]^{3+}$	6	d^2sp^3	Octahedral	Low	Diamagnetic
$[\text{CoF}_6]^{3-}$	6	sp^3d^2	Octahedral	High	Paramagnetic
$[\text{NiCl}_4]^{2-}$	4	sp^3	Tetrahedral	—	Paramagnetic
$[\text{Ni}(\text{CN})_4]^{2-}$	4	dsp^2	Square Planar	—	Diamagnetic

SUMMARY

VBT Cheat Sheet

The Geometry Rule

- ✚ **CN=6** is always **Octahedral**.
- ✚ **CN=4** is a fork in the road: **Tetrahedral (sp^3)** or **Square Planar (dsp^2)**.

The Magnetic Link

- ✚ **Diamagnetic:** All electrons are **paired** (often forced by **strong ligands**).
- ✚ **Paramagnetic:** **Unpaired** electrons remain (no forced pairing).

Inner vs Outer

- ✚ If inner **($n-1$)d** orbitals are used (e.g., **3d**), it's an **Inner Orbital / Low Spin** complex.
- ✚ If outer **n d** orbitals are used (e.g., **4d**), it's an **Outer Orbital / High Spin** complex.



You've Learned the Theory.

Now Let's Test It.

Reading notes gets you knowledge.

Practicing MCQs gets you marks.

That's exactly what TopAll Pro is built for.

Try TopAll Pro Now

What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**
AI Recommendation Analysis your Tests and tell you where you need to improve.



Practice the moment you finish studying
Jump in while the concept is still fresh in your head

4.5L+
MCQs

1.5L+
Students

AI Powered
In-Depth Analysis