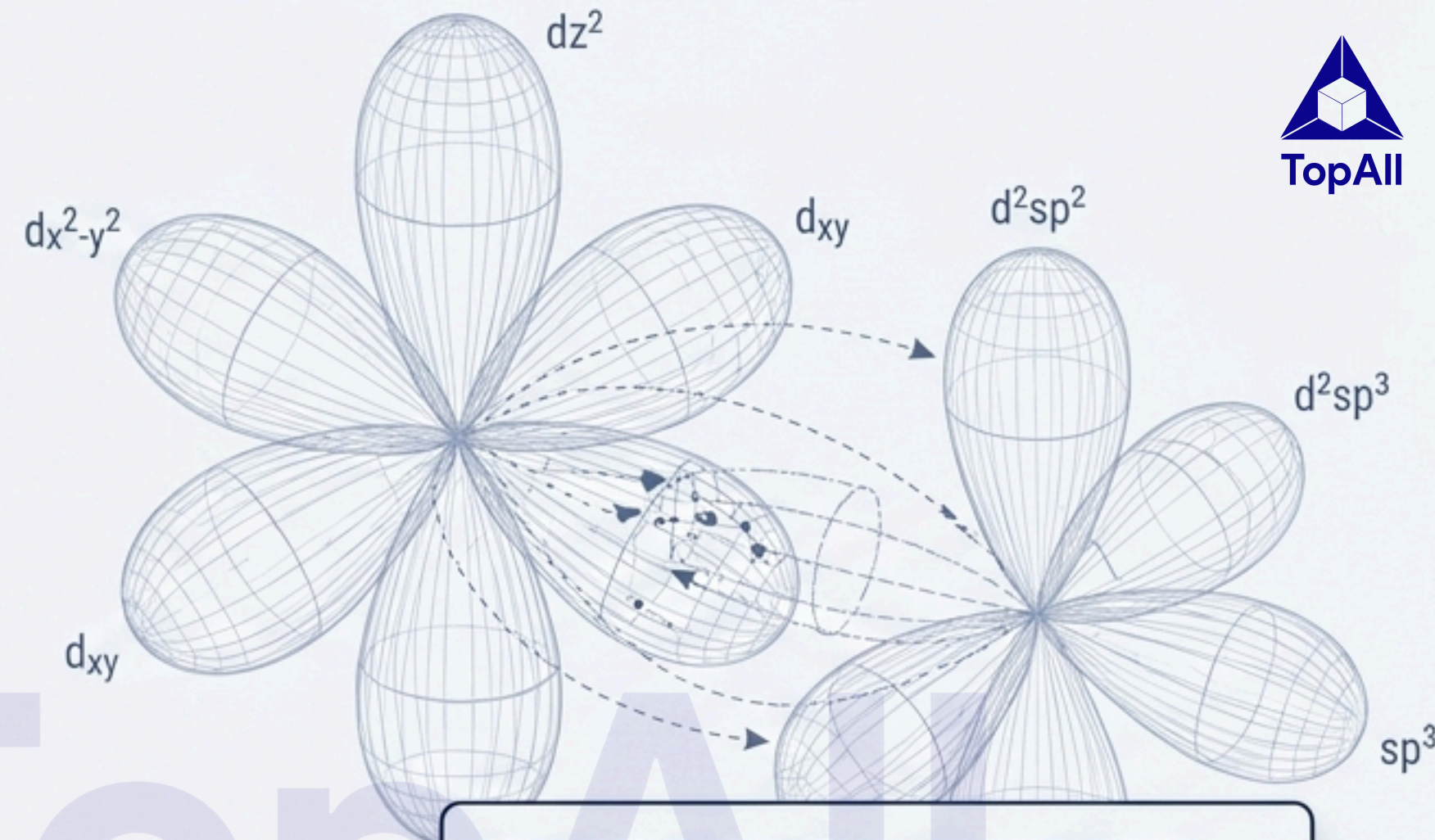


Valence Bond Theory

Predicting Geometry and Magnetism in Coordination Entities

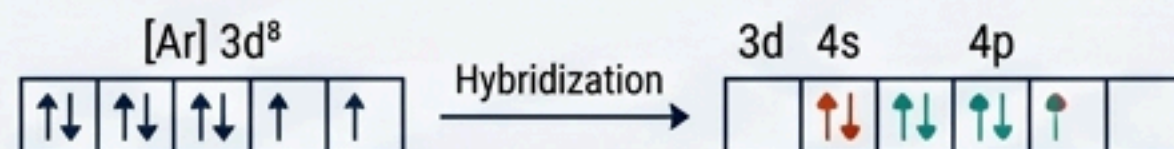


CORE PRINCIPLES

VBT describes the formation of coordinate bonds through the overlap of filled ligand orbitals with empty hybrid orbitals of the central metal atom or ion.

1. Central metal uses its (n-1)d, ns, np, and nd orbitals for hybridization.
2. Hybridization determines the geometry of the complex.
3. Unpaired electrons in the d-orbitals determine the magnetic properties.

ORBITAL STRIP: HYBRIDIZATION EXAMPLE $[\text{Ni}(\text{CN})_4]^{3-}$ (dsp^3)



dsp^2 hybridization leads to square planar geometry.

PREDICTIVE WORKFLOW & LIMITATIONS

1. Determine the oxidation state of the central metal.
2. Write the electronic configuration of the metal ion.
3. Identify the nature of the ligand (strong or weak field).
4. Decide on pairing of electrons and type of hybridization.

WARNING: LIMITATIONS OF VBT

VBT fails to explain the color of complexes, the thermodynamic stability, and gives no quantitative interpretation of magnetic data. It does not distinguish between weak and strong ligands clearly.

SUMMARY: KEY TAKEAWAY

VBT provides a simple and qualitative approach to understand geometry and magnetic behavior based on the concept of hybridization and electron pairing.

The Language of VBT

Inner Orbital / Low Spin

Uses the inner (n-1)d orbitals for hybridisation. Electrons are forced to pair up, minimizing spin.

e.g., d^2sp^3

Outer Orbital / High Spin

Uses the outer nd orbitals for hybridisation. Unpaired electrons remain untouched, maximizing spin.

e.g., sp^3d^2

VBT Hybridisation Reference

Coordination No.	Hybridisation	Geometry
4	sp^3	Tetrahedral
4	dsp^2	Square planar
5	sp^3d	Trigonal bipyramidal
6	sp^3d^2	Octahedral
6	d^2sp^3	Octahedral

Watch these.
CN 6 has two possibilities.



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

$$E=mc^2$$



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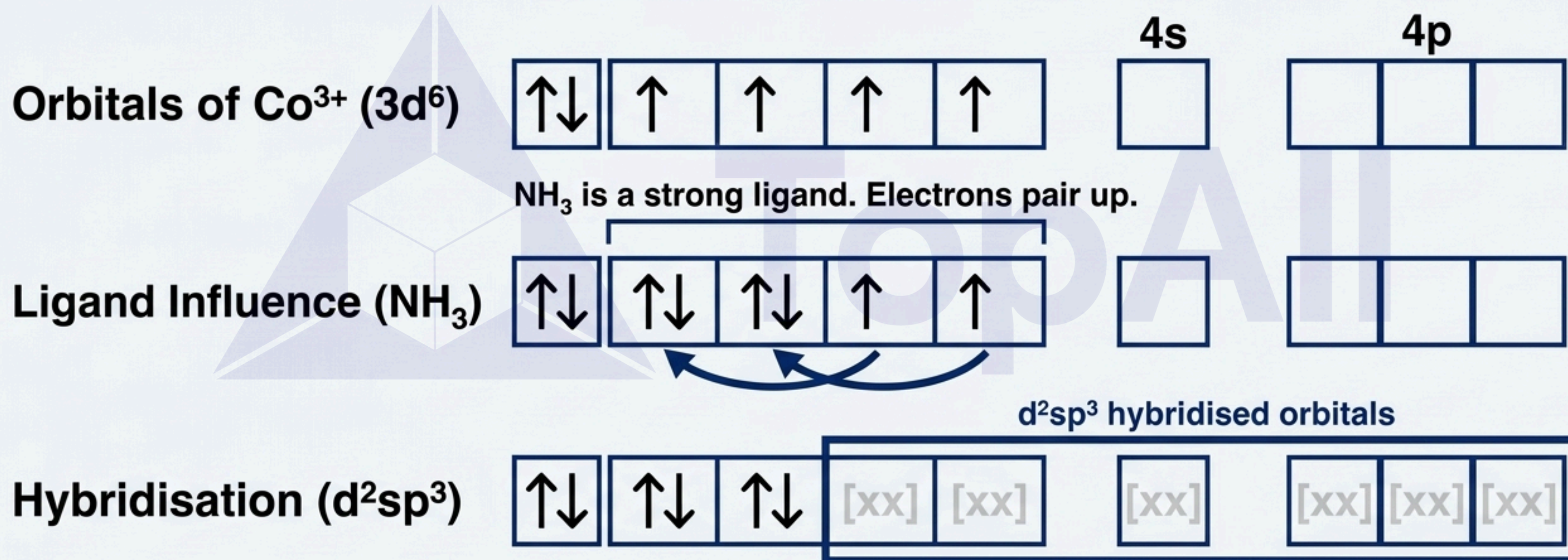
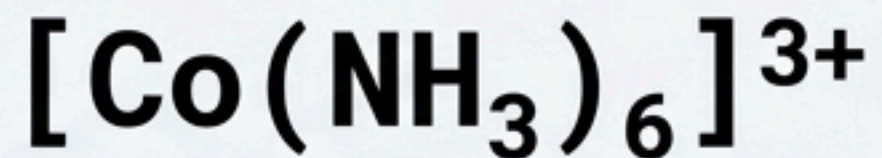
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Key Highlights

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- » 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



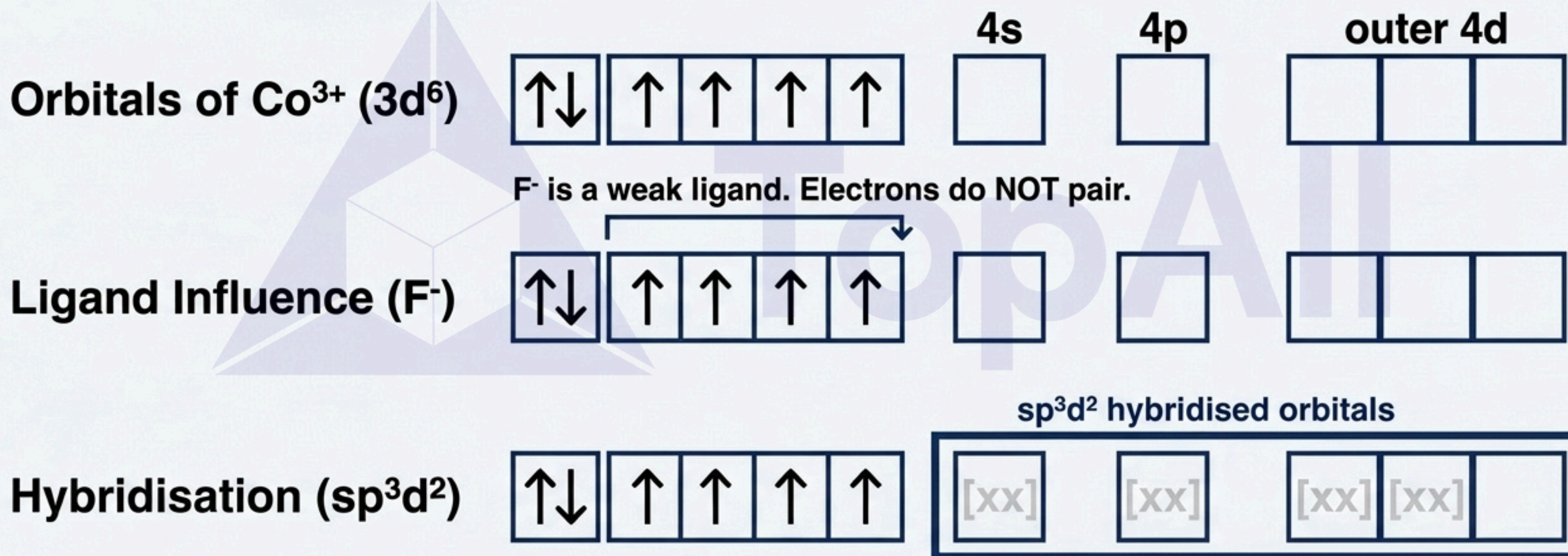
CN 6: Inner Orbital Complex



Geometry: Octahedral

Magnetism: Diamagnetic (0 unpaired)

CN 6: Outer Orbital Complex



Geometry: Octahedral

Magnetism: Paramagnetic (4 unpaired)

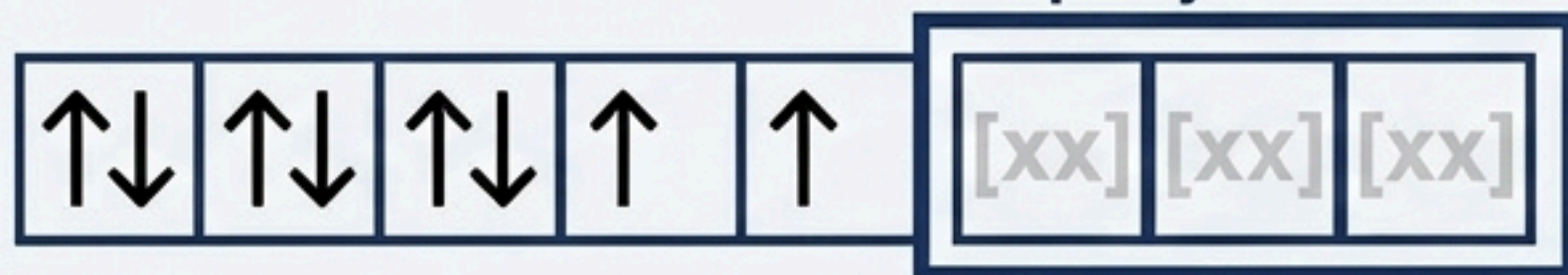
The Coordination Number 4 Paradox.

Both are **Tetrahedral (sp^3)**, but their **magnetic properties are opposites** due to **oxidation states**.

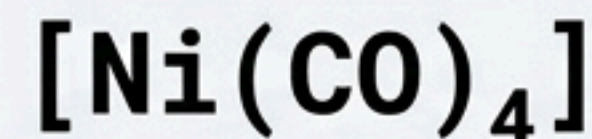


Oxidation State: Ni^{2+} ($3d^8$)

sp^3 hybridised

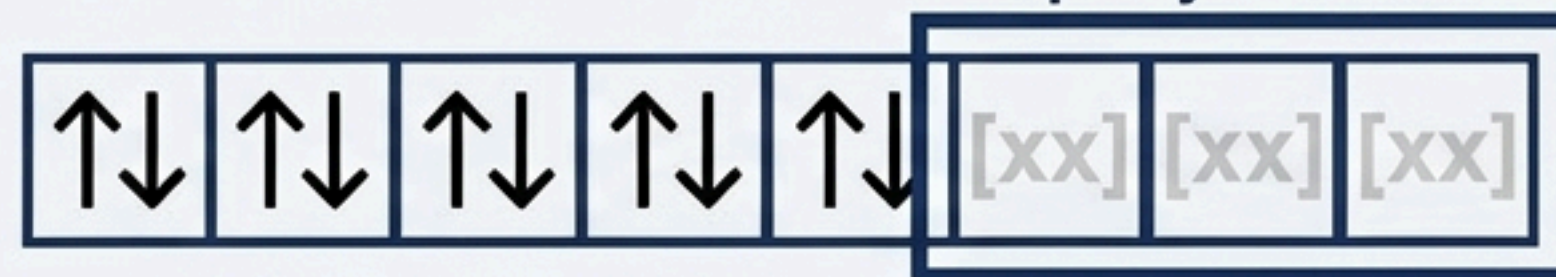


Magnetism: Paramagnetic (2 unpaired)



Oxidation State: Ni^0 ($3d^{10}$)

sp^3 hybridised



Magnetism: Diamagnetic (0 unpaired)

Watch for this.

Coordination number alone never fixes your hybridisation.

CN 6 $\neq$ automatic d^2sp^3

Seeing CN=6 means the geometry is strictly octahedral, but it could be d^2sp^3 (inner) OR sp^3d^2 (outer). You must check the magnetic data or ligand strength to determine which d-orbitals are utilized.

Check Your Understanding

The spin-only magnetic moment of $[\text{MnBr}_4]^{2-}$ is 5.9 BM (indicating 5 unpaired electrons). What is the geometry of the complex ion?

A) Square Planar (dsp^2)

Wrong State

B) Tetrahedral (sp^3)



Correct State

C) Octahedral (sp^3d^2)

Wrong State

Diagnostic Logic: CN is 4, so it's not octahedral. 5 unpaired electrons means all five 3d orbitals are half-filled and cannot be used for hybridisation. It must use the outer orbitals (sp^3).

Summary: Valence Bond Theory



- **Geometry maps directly to hybridisation.**
VBT translates coordination numbers into specific hybridized orbitals (e.g., CN 6 = Octahedral, CN 4 = Tetrahedral or Square Planar).
- **Magnetism reveals the exact orbital.**
Inner orbital complexes (d^2sp^3) pair electrons and are often diamagnetic or low-spin. Outer orbital complexes (sp^3d^2) leave electrons unpaired and are paramagnetic or high-spin.



You've Learned the Theory.

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