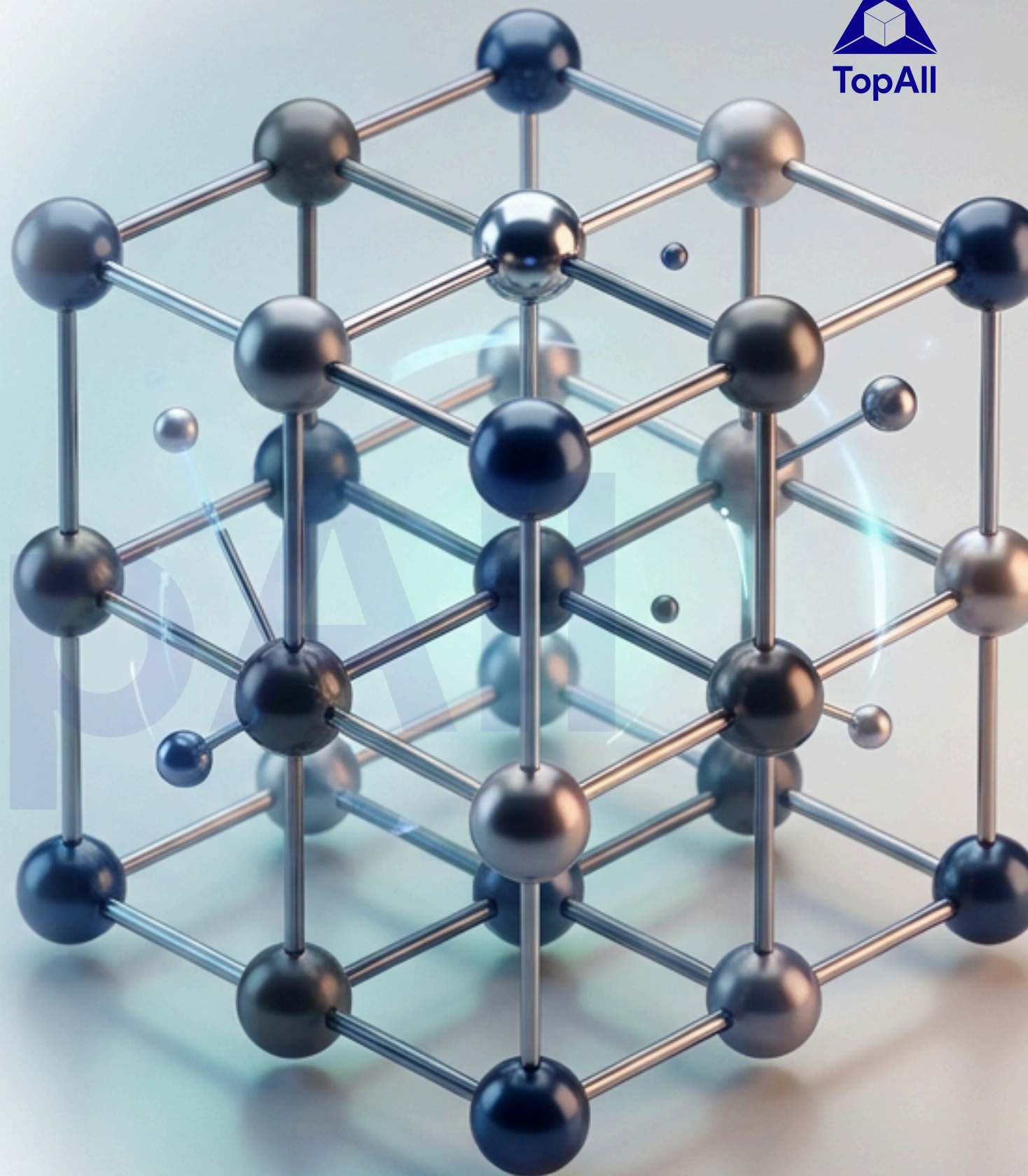


4.4.1 Oxides and Oxoanions of Metals

Unlocking the trends of oxidation states, ionic character, and acidity in transition metals.

NEET/JEE Chemistry

High-Yield Concept



Formation & Foundation

Transition metals react with oxygen at high temperatures to form a wide variety of oxides.

Metal + O₂

High Temperature

Metal Oxide

The Exception

All transition metals form ionic MO oxides except Scandium (Sc).

The Peak Rule

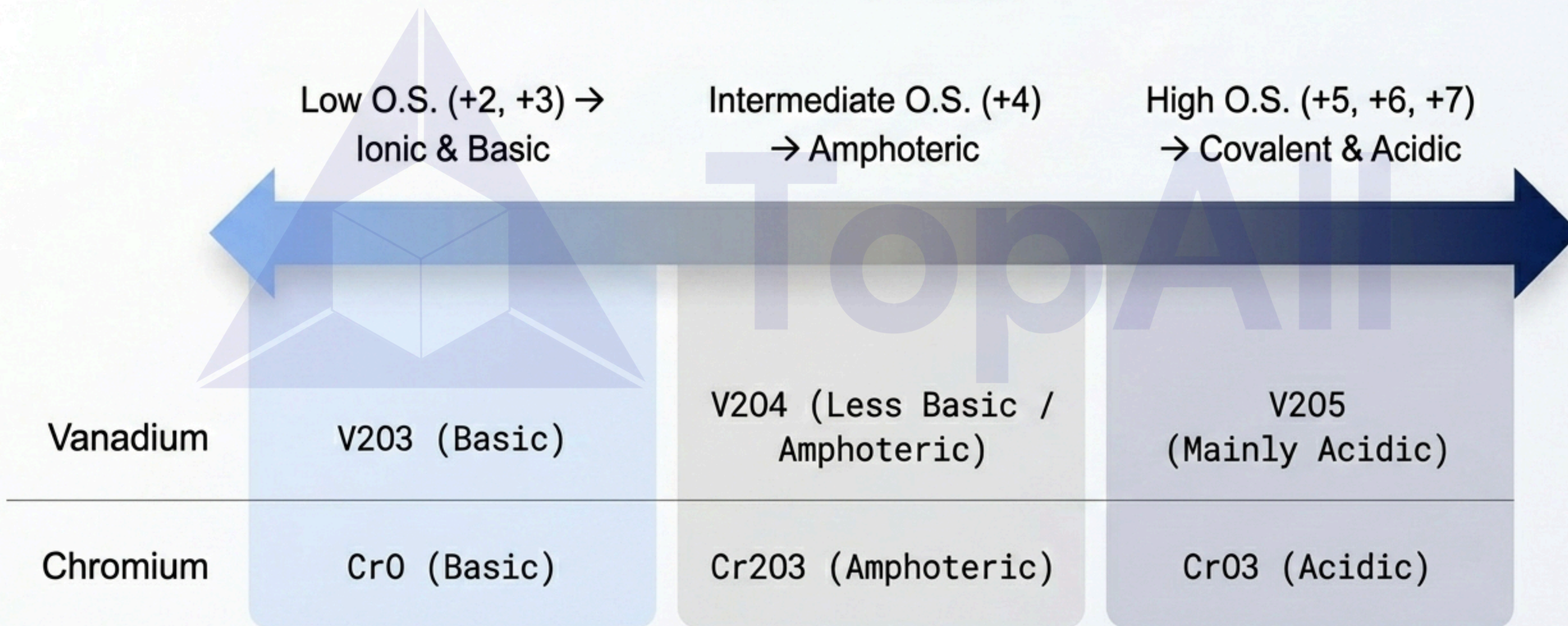
The highest oxidation number in an oxide consistently coincides with the metal's Group Number.

The Range

Achieved progressively across the 3d series, from Sc₂O₃ (Group 3) peaking at Mn₂O₇ (Group 7).

The Oxidation Spectrum

As Oxidation Number increases, ionic character decreases
and acidic character dominates.





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$$E=mc^2$$



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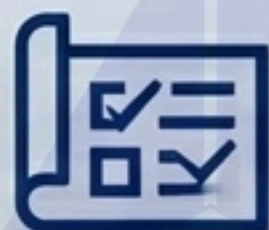
Key Highlights

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Extremes of the d-Block

Characteristics of Metals in High Oxidation States



The Rules

- Beyond Group 7, no higher oxides of Iron above Fe_2O_3 are known.
- High oxidation state = Highly Covalent.
- Predominantly acidic in nature.



Notable Extremes

- Mn_2O_7 : A covalent green oil at room temperature. Gives HMnO_4 in water.
- CrO_3 & V_2O_5 : Exhibit unexpectedly low melting points due to covalent character.
- CrO_3 yields H_2CrO_4 and $\text{H}_2\text{Cr}_2\text{O}_7$ in solution.

Aqueous Behavior: Oxoanions & Cations

How higher oxides dissolve and stabilize in solutions.

Panel 1: Oxoanions (Base/Aqueous Reactions)

Transition metals form tetrahedral $[\text{MO}_4]^{n-}$ ions.

V(V)

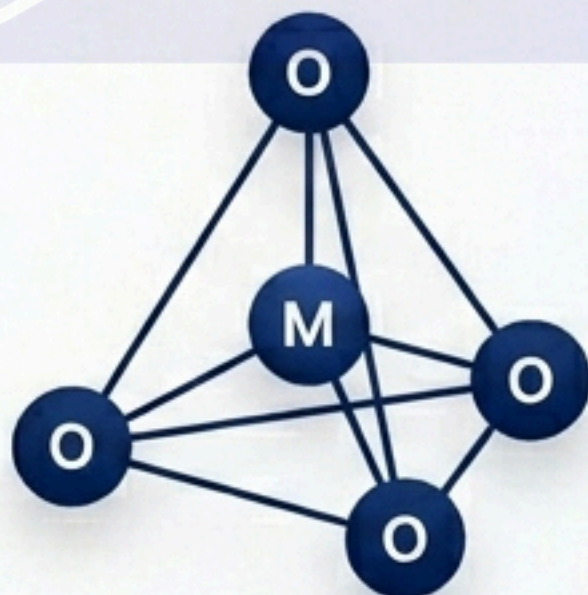
Cr(VI)

Mn(V)

Mn(VI)

Mn(VII)

V_2O_5 reacts with alkalis to give VO_4^{3-} .



Panel 2: Oxocations (Acidic Dissolution)

Sometimes oxygen stabilizes high states as cations rather than full oxides.

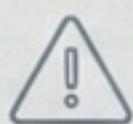
V(V) stabilized as VO_2^+
(from V_2O_5 in acid)

V(IV) stabilized as VO^{2+}
(from V_2O_4 in acid)

Ti(IV) stabilized as TiO^{2+}

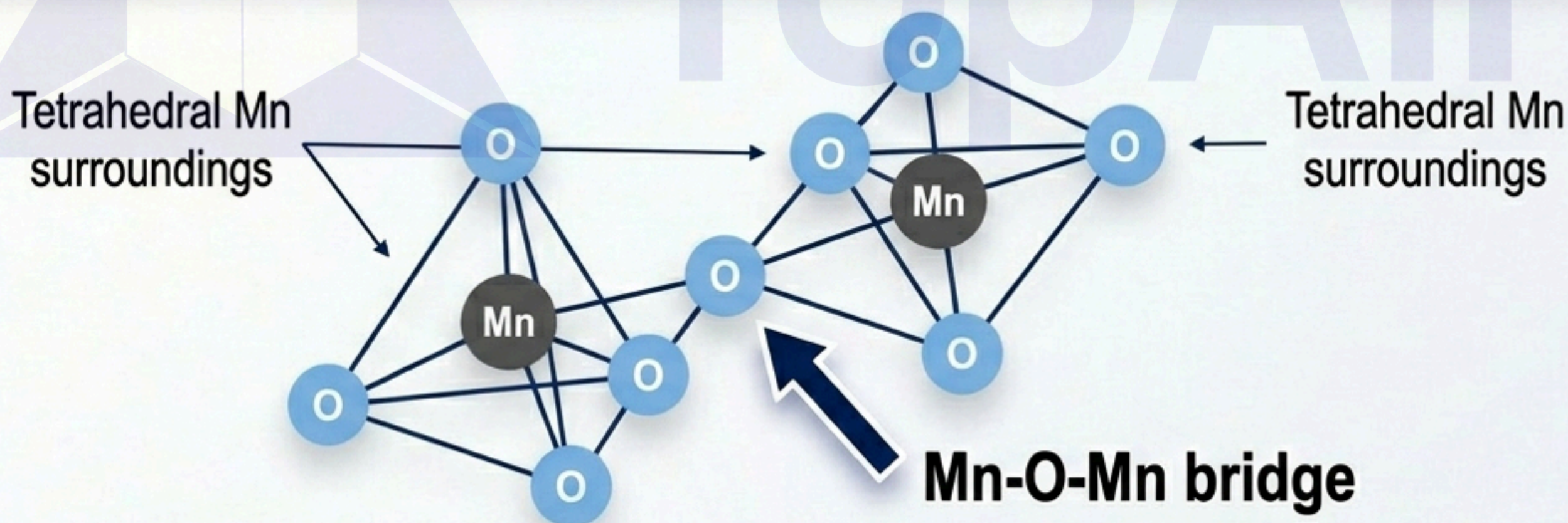
Oxygen's Superpower: Multiple Bonding

Why does Oxygen stabilize highest oxidation states better than Fluorine?



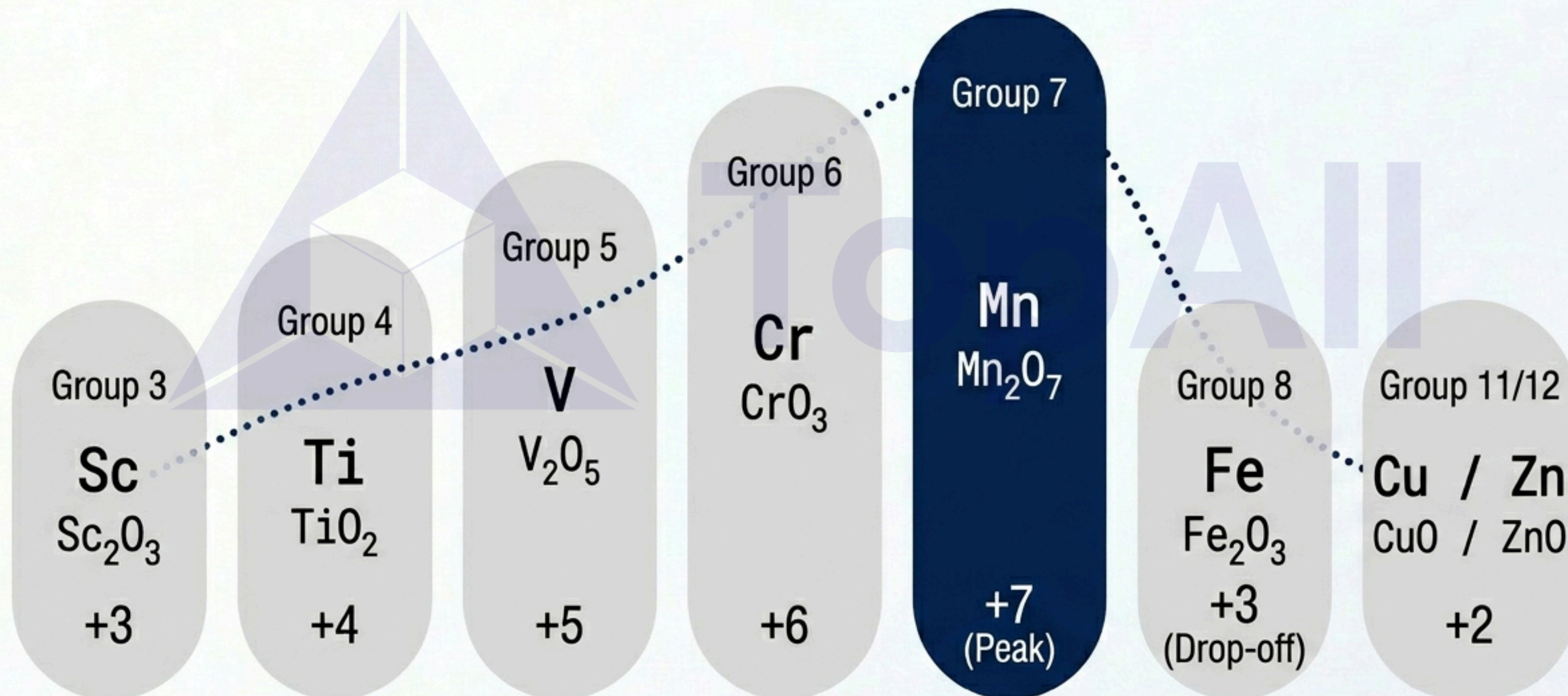
The Paradox: The highest Manganese fluoride is MnF_4 , but the highest oxide is Mn_2O_7 (+7). Why does Oxygen win?

Fluorine relies purely on high lattice energy or single-bond enthalpy. **Oxygen** has the unique ability to form **multiple bonds** ($p\pi-d\pi$ overlap) with transition metals.



Highest Oxides of the 3d Series

The peak at Manganese and the sharp drop-off.



Exam Vault: High-Yield Target Points



Trap 1: The Amphoteric Exceptions

CrO is basic, but Cr_2O_3 is amphoteric and CrO_3 is acidic. V_2O_5 is amphoteric (though mainly acidic).



Trap 2: Physical State Anomalies

Mn_2O_7 is not a solid; it is a covalent green-oil at room temperature. V_2O_5 and CrO_3 have unexpectedly low melting points due to their covalent nature.



Trap 3: The Fluorine vs. Oxygen Rule

Oxygen beats Fluorine in stabilizing high O.S. strictly because of its ability to form multiple bonds ($p\pi-d\pi$ overlap), not electronegativity.



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