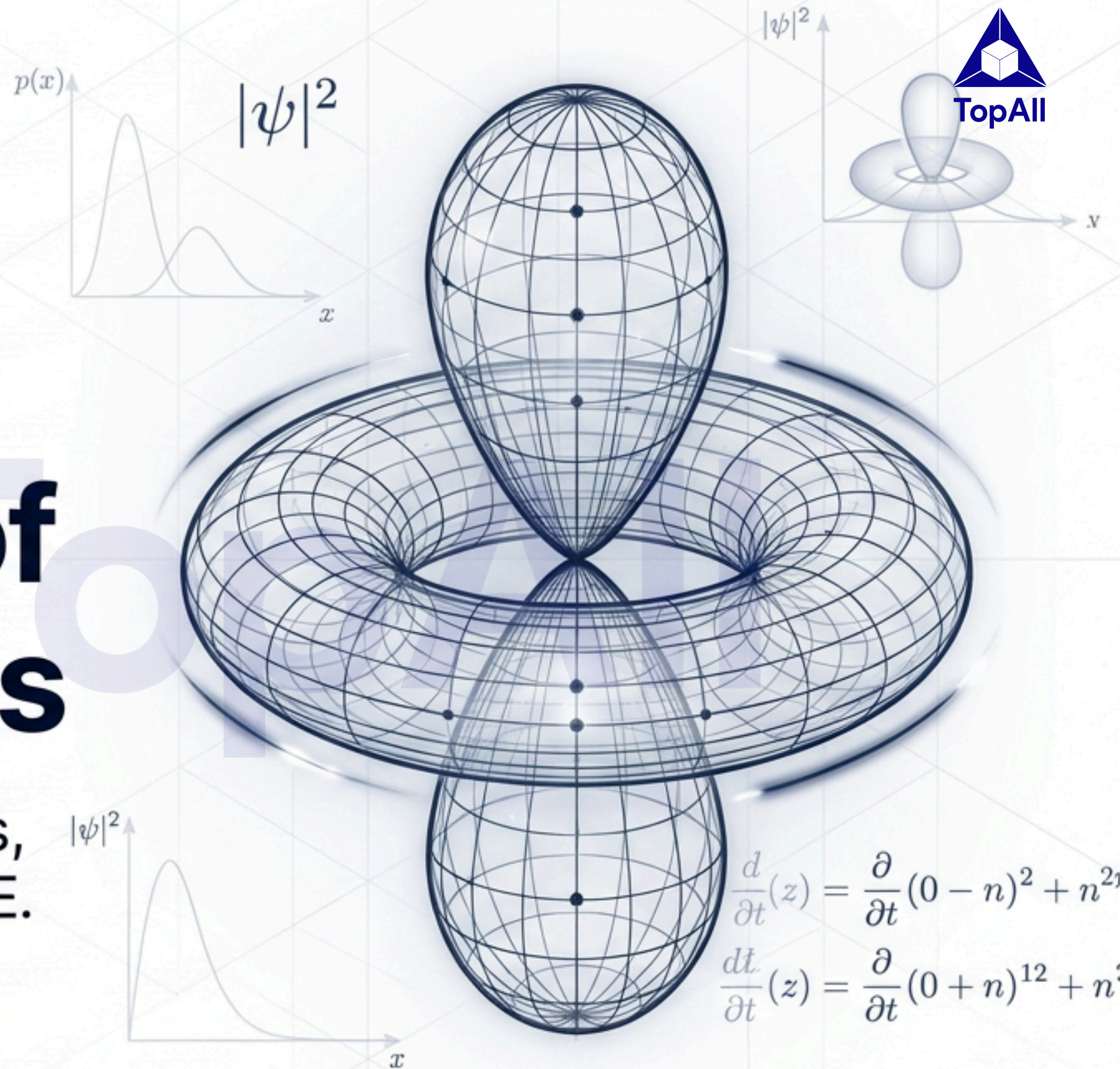


4.2 Electronic Configurations of d-Block Elements

Unlocking the Quantum Blueprint: Rules, Exceptions, and Stabilities for NEET/JEE.



The General Configuration Formula

Transition metals occupy the central d-block (Groups 3–12), where inner d-orbitals are progressively filled across four long periods.

Penultimate shell (receives electrons)



Outermost shell
(contains 1 or 2 electrons)

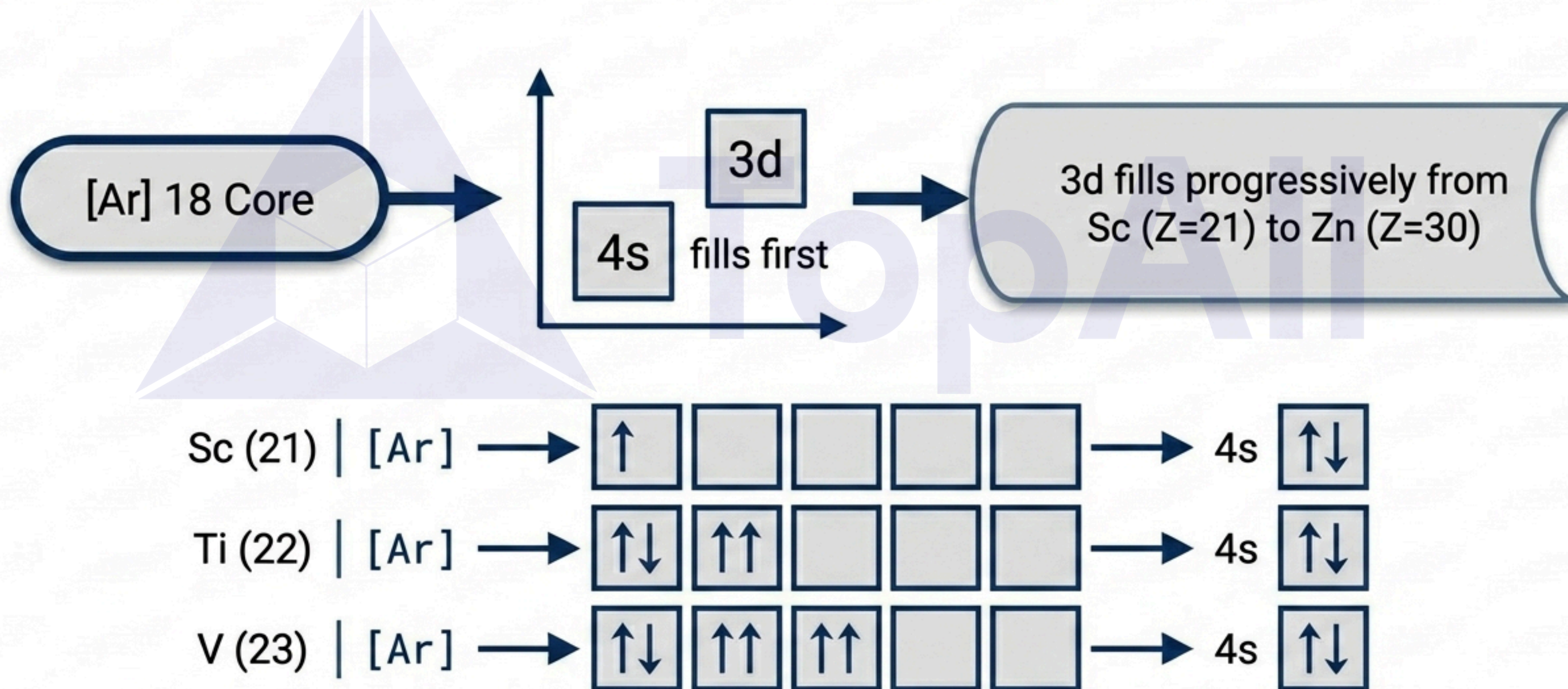


Exam Tip: IUPAC Definition

A transition metal **MUST** have an **incomplete d-subshell** in its neutral atom **OR** in its common ions.

The 3d Series Baseline (Sc to Zn)

Electrons fill the lower-energy 4s orbital before the 3d orbitals. However, the energy gap between them is exceptionally small—setting the stage for quantum shifts.





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$$E=mc^2$$



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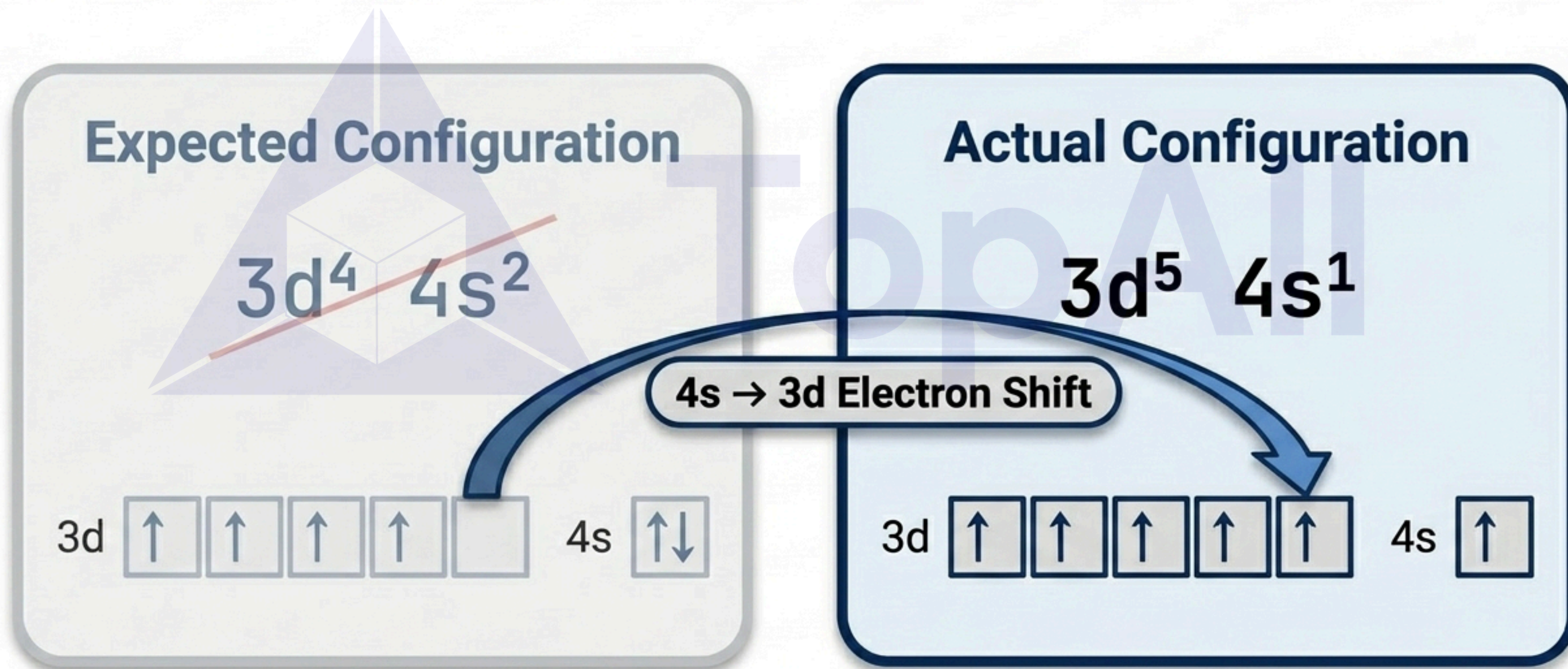
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The Chromium Anomaly ($Z = 24$)

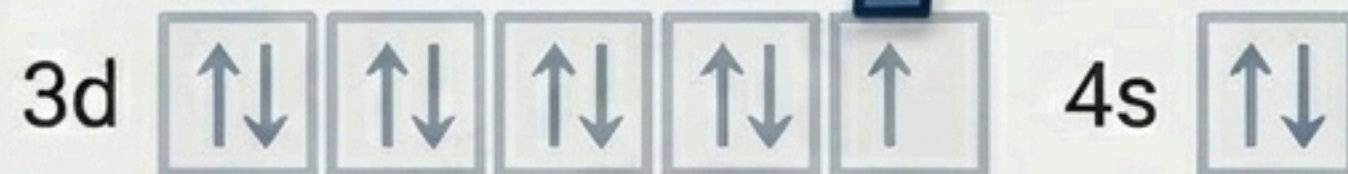
Due to the small energy gap, an electron shifts from 4s to 3d. This creates a half-filled subshell, maximizing thermodynamic stability.



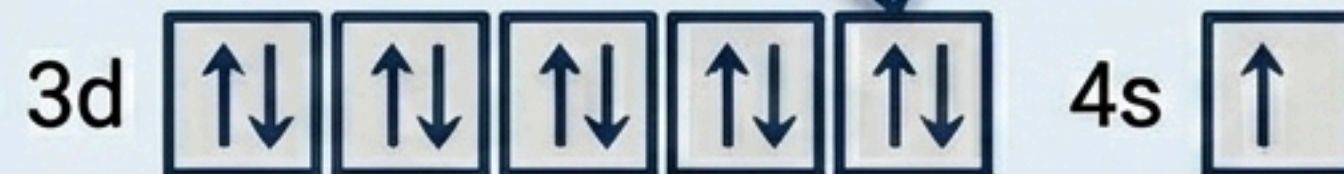
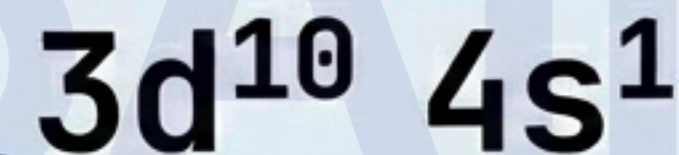
The Copper Anomaly ($Z = 29$)

Copper shifts one 4s electron to achieve a completely filled d^{10} core. This fully packed architecture offers extraordinary stability.

Expected Configuration



Actual Configuration



Completes the subshell

Why Half & Fully-Filled Orbitals Dominate

d^5 and d^{10}



Symmetrical Distribution

Electrons in degenerate orbitals distribute symmetrically, minimizing electron-electron repulsion and shielding the nucleus more effectively.



Exchange Energy

Electrons with parallel spins frequently exchange positions. The greater the number of possible exchanges (d^5), the more energy is released, dropping the system into a lower, highly stable energy state.

Max parallel spins = Max exchange energy released.

Structural Oddities Beyond 3d

The Ultimate Exception



Palladium
(Pd, Z=46)



Palladium is the **ONLY** transition metal with a completely **empty s-orbital** in its ground state.



The Excluded Group 12



Zn, Cd, Hg



IUPAC excludes Group 12. Because their d-orbitals are fully packed in BOTH ground states and common oxidation states, they are technically NOT transition metals.

Why is Silver (Ag) included? It forms Ag^{2+} ($4d^9$) – an incomplete subshell!

?

High-Yield Matrix: Electronic Configurations

Element	Z	Actual Configuration	Unpaired e ⁻ (n)	Exam Trap / Key Feature
Cr	24	[Ar] 3d ⁵ 4s ¹	n=6	Max unpaired e ⁻ in ground state.
Mn	25	[Ar] 3d ⁵ 4s ²	n=5	Stable d ⁵ impacts 3rd ionization enthalpy.
Cu	29	[Ar] 3d ¹⁰ 4s ¹	n=1	Achieves d ¹⁰ stability.
Zn	30	[Ar] 3d ¹⁰ 4s ²	n=0	Diamagnetic; NOT a transition metal.
Pd	46	[Kr] 4d ¹⁰ 5s ⁰	n=0	Unique 5s ⁰ ground state.

Mastering the (n-1)d vs ns energy gap is the key to predicting oxidation states, magnetic moments, and color.



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