

UNIT 4 • d- AND f-BLOCK ELEMENTS

Oxidation States of Transition Elements

Understanding the 'd-block ladder':
Why they vary, how they step, and
where the traps are.



The Language of d-Block Oxidation

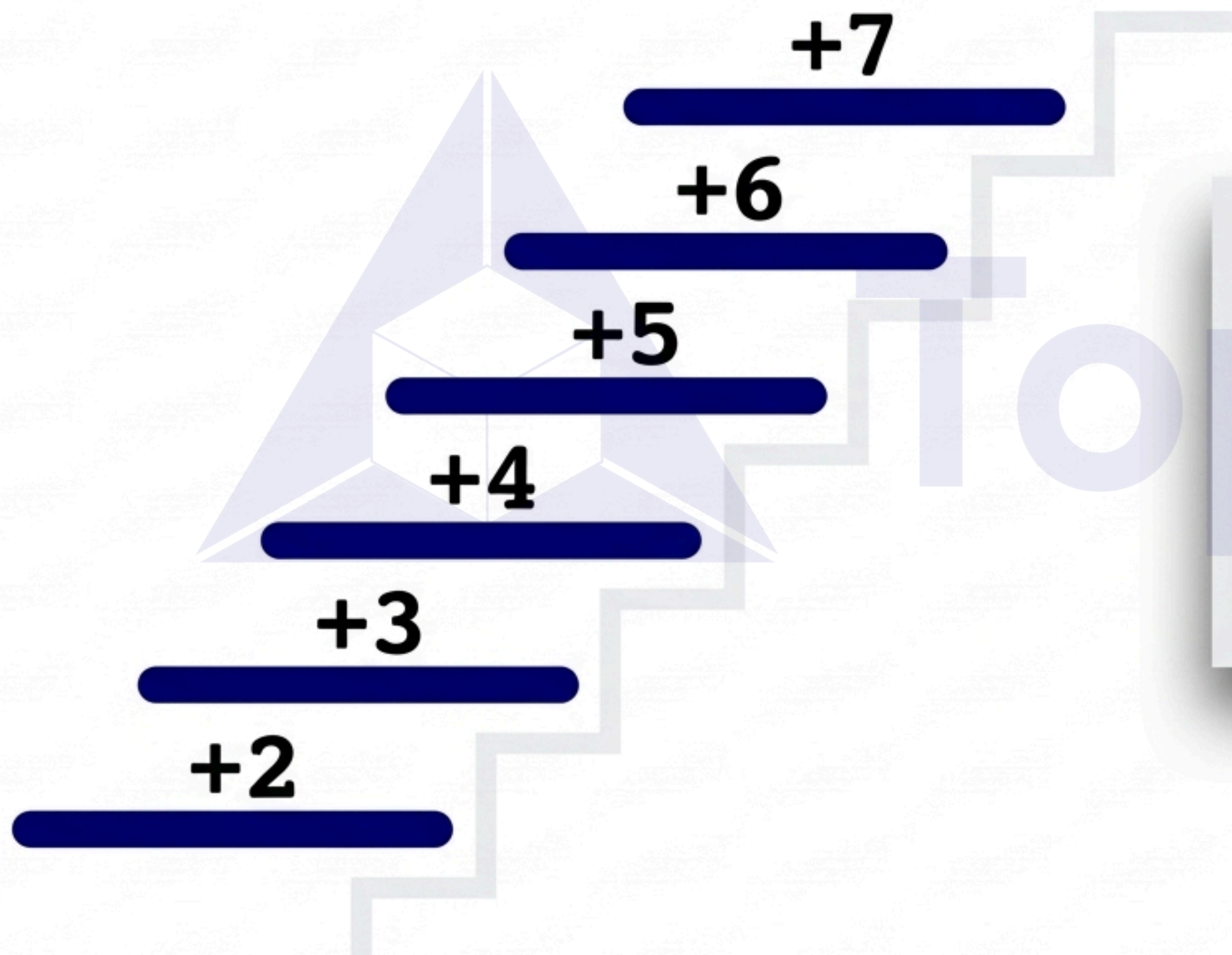
Variable Oxidation States

Arise due to the incomplete filling of d-orbitals. $(n-1)d$, ns electrons have similar energies, allowing both to participate in bonding.

Unit-of-One Steps

Oxidation states change by exactly one unit at a time (e.g., $V(II)$, $V(III)$, $V(IV)$)

The Oxidation Ladder Peaks in the Middle



Manganese exhibits all oxidation states from **+2** to **+7**. The peak variety occurs exactly at the middle of the 3d series.



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

$$E=mc^2$$



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Key Highlights

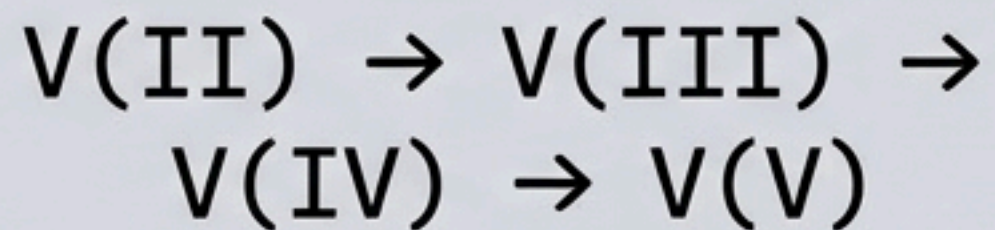
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d-Block vs. p-Block Transitions

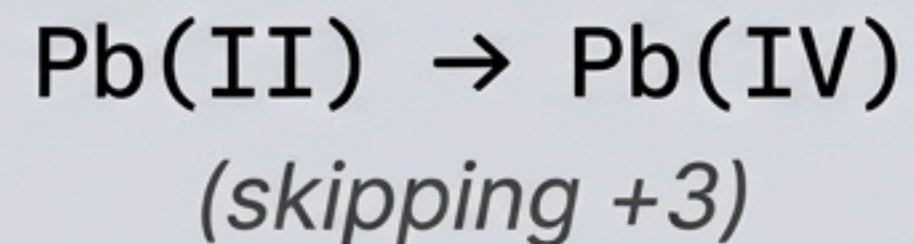
Differs by 1

Driven by individual d-electrons unpairing sequentially.



Differs by 2

Driven by the inert pair effect (ns^2 electrons remaining paired).



The 'Zero' Oxidation State Exception



Transition metals can exhibit an oxidation state of exactly **0**.
In both complexes above, highly effective π -acceptor Carbon Monoxide (CO) ligands allow Nickel and Iron to maintain a **zero** state via synergic bonding.

Concept Check

Which ends of the 3d series exhibit the greatest variety of oxidation states?

Option A

The extremes (Sc and Zn) because they have the most stable shells.

Watch for this! It's tempting to focus on Sc (empty *d*-shell) or Zn (full *d*-shell), but the ends actually have the fewest oxidation states. Sc is only +3; Zn is only +2.

Option B

The middle of the series (e.g., Mn) because they have the most available *d*-electrons to share.

Correct! Variety peaks mid-series. The ends have either too few electrons to lose (Sc) or too many *d*-electrons limiting available orbitals (Zn).

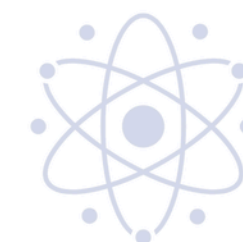
Key Takeaways

- **Variety peaks mid-series.** Manganese (+2 to +7) has the maximum variety. The extremes (Sc, Zn) have the least.
- **Step by 1, sometimes 0.** d-block oxidation states differ by unit-of-one steps, and can even sit at zero (e.g., $\text{Ni}(\text{CO})_4$) when bonded to π -acceptor ligands.



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