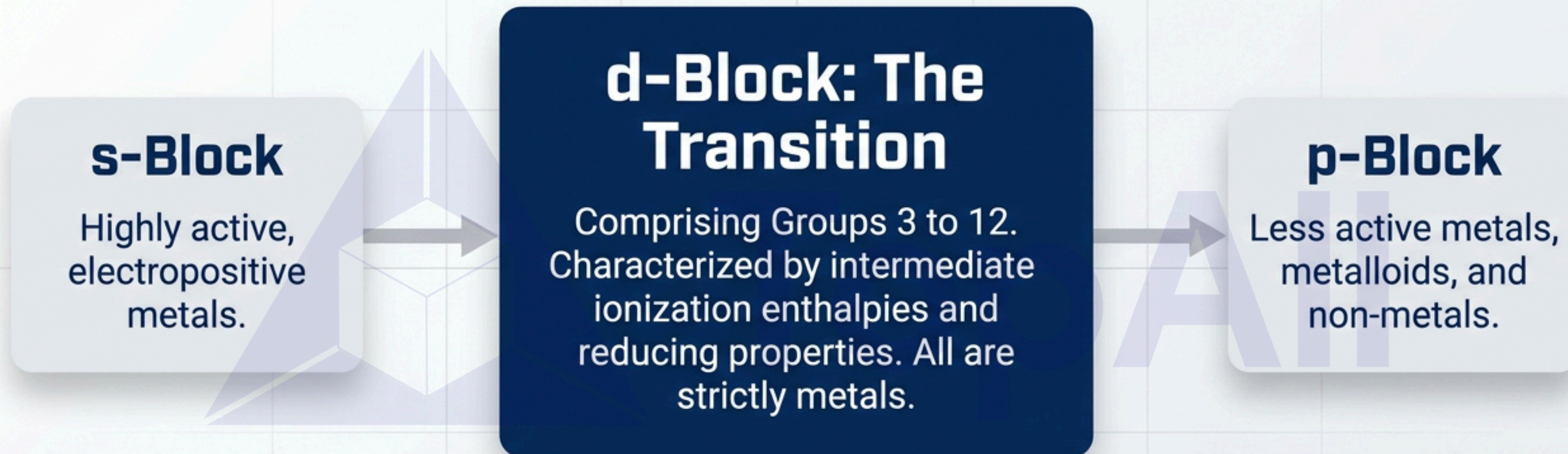


Transition Elements: The Metallic Bridge

Understanding the Architecture and
Chemistry of the d-Block

Groups 3–12

The Metallic Bridge



They take the familiar name 'Transition Elements' because their properties form a gradient bridge between the highly reactive s-block and the chemically diverse p-block.

The Defining Configuration

Inner Shell Filling

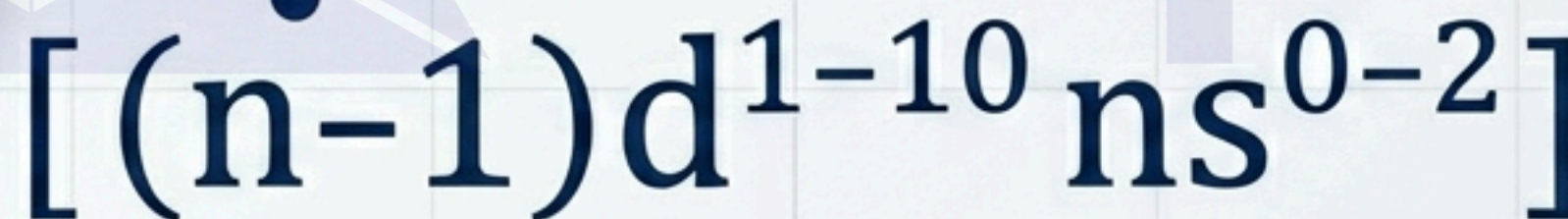
The defining trait of d-block elements: electrons are added sequentially to the inner d-orbitals, rather than the outermost shell.

The d-Orbital

Capable of holding up to 10 electrons. The progressive, partial filling of this specific orbital drives their unique chemical behavior.

Outer Valence

The outermost s-orbital typically holds 1 or 2 electrons.



Exception: Palladium (Pd) completely empties its s-orbital to achieve stability, resulting in $4d^{10}5s^0$.



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Manifestations of the d-Orbital



Variable Oxidation States

Because the energy levels of the $(n-1)d$ and ns orbitals are so close, electrons from both shells can participate in chemical bonding.

Result: A single element can exist in multiple stable valencies (e.g., Fe^{2+} and Fe^{3+}).



Coloured Ions

Partially filled d-orbitals allow electrons to easily jump between closely spaced energy levels within the same shell, absorbing specific visible light wavelengths.

Result: Transition metal compounds are famous for forming brilliant, vibrantly colored aqueous ions.

Magnetism and Reactivity



Paramagnetism

The progressive filling of the d-orbital often leaves single, unpaired electrons. The presence of these unpaired electrons causes the elements to be weakly attracted to external magnetic fields.

Result: As the number of unpaired electrons increases, the magnetic moment of the element increases.



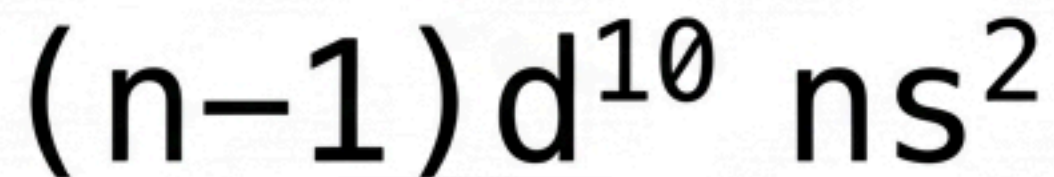
Catalysis

Their defining ability to adopt multiple oxidation states allows them to easily form temporary bonds and act as intermediate electron carriers in chemical reactions.

Result: Transition metals are heavily utilized as ideal industrial catalysts, providing active surfaces that accelerate reactions.

The Exceptions: Zn, Cd, Hg

Group 12 Anomalies



The “Why”

Zinc, Cadmium, and Mercury possess completely filled inner d-orbitals in both their ground states and their common oxidation states.

The “Result”

Because the d-orbital is totally “locked” and full, these elements cannot exhibit the electron mobility that defines true transition metals.

✗ No variable oxidation states ✗ Mostly colorless ions ✗ Not paramagnetic

D-Block vs. Group 12 Exceptions

Property	Typical Transition Metal (e.g., Fe)	Group 12 Exception (Zn, Cd, Hg)
d-Orbital	Partially Filled	Completely Filled (d^{10})
Oxidation States	Variable (Multiple)	Fixed (Usually +2)
Aqueous Ions	Coloured	Colourless
Magnetism	Often Paramagnetic	Diamagnetic (Not Paramagnetic)

While geographically located in the d-block, Zn, Cd, and Hg are chemically distinct. Their completely filled d-orbitals prevent the electron mobility that defines true transition elements.



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