

General Characteristics of the Lanthanoids

Physical traits, magnetic properties, and
the chemical reactivity of the 4f series.

Defining the 4f Properties

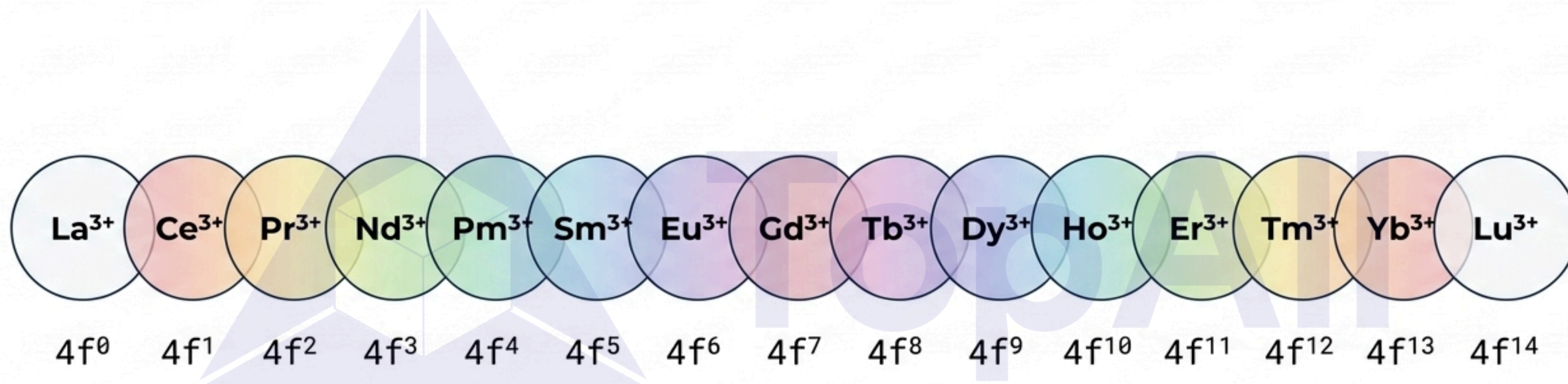
Paramagnetic Ln^{3+} Ions

Ions possessing unpaired f-electrons. Because the 4f subshell is progressively filled across the series, most trivalent lanthanoid ions are highly responsive to magnetic fields.

Colourless Exceptions

Ions lacking the ability to undergo f-f electronic transitions. This occurs only when the f subshell is completely empty or completely full.

The Ln^{3+} Spectrum



Unlike the rest of the series, the bookends lack unpaired electrons for f-f transitions.



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$$E=mc^2$$



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Chemical Reactivity and Reduction

Lanthanoids are highly electropositive metals. Early members react similarly to Calcium, while later members behave more like Aluminium.



**Standard Potential Range
(E°): -2.2V to -2.4V**

The Europium Anomaly

While the standard reduction potentials for the series are tightly clustered between -2.2V and -2.4V, one element breaks the pattern due to the extra stability of its half-filled f subshell.

$$\text{Eu}^{3+} / \text{Eu} \quad E^\circ = -2.0\text{V}$$

Formation of stable Eu^{2+} ($4f^7$ configuration) requires less reducing energy.

Exam Readiness

⚠ WATCH FOR THIS

Exactly two ions in the +3 oxidation state are colourless.

Questions often try to trick you into grouping all Lanthanoids together. Remember the visual bookends: Only **La³⁺** (empty, $4f^0$) and **Lu³⁺** (completely full, $4f^{14}$) are colourless and colourless and diamagnetic. All other +3 Lanthanoids are coloured and paramagnetic.

Summary

KEY TAKEAWAYS

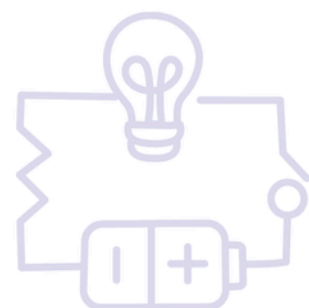
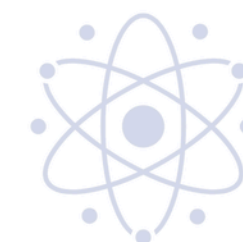
Physical Traits: Lanthanoids are silvery-white metals. Their +3 ions are predominantly coloured and paramagnetic due to unpaired f-electrons (excepting the $\text{La}^{3+}/\text{Lu}^{3+}$ bookends).

Chemical Reactivity: They are highly reactive, with reduction potentials (E°) typically between -2.2V and -2.4V, shifting from Calcium-like to Aluminium-like behavior across the series (with Eu as the notable exception at -2.0V).



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