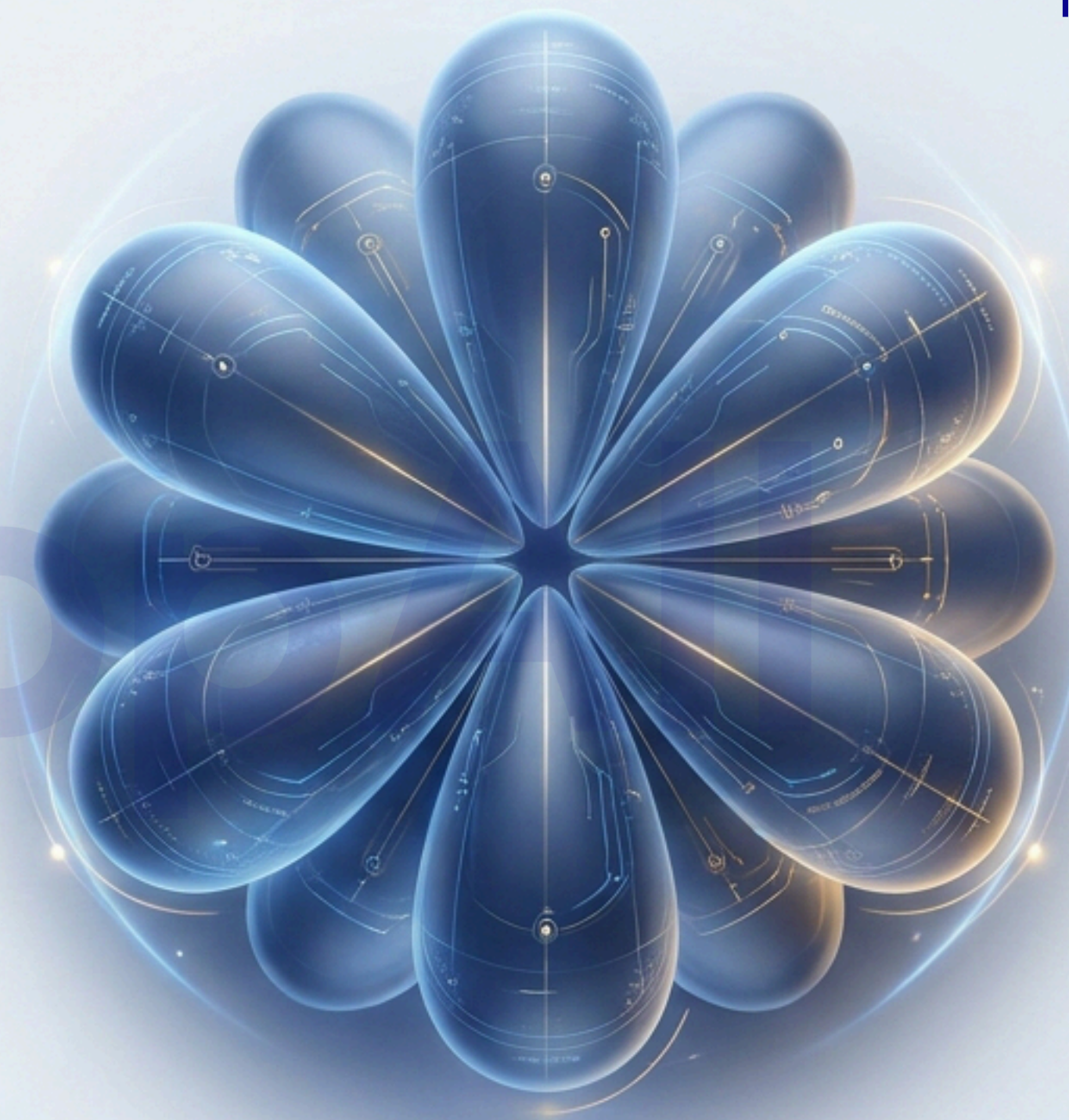


## Unit 4: The d- and f-Block Elements

# 4.5.1 Electronic Configurations of Lanthanoids

Mastering 4f Orbital Filling,  $\text{Ln}^{3+}$  Trends, and Key Exceptions for NEET/JEE.



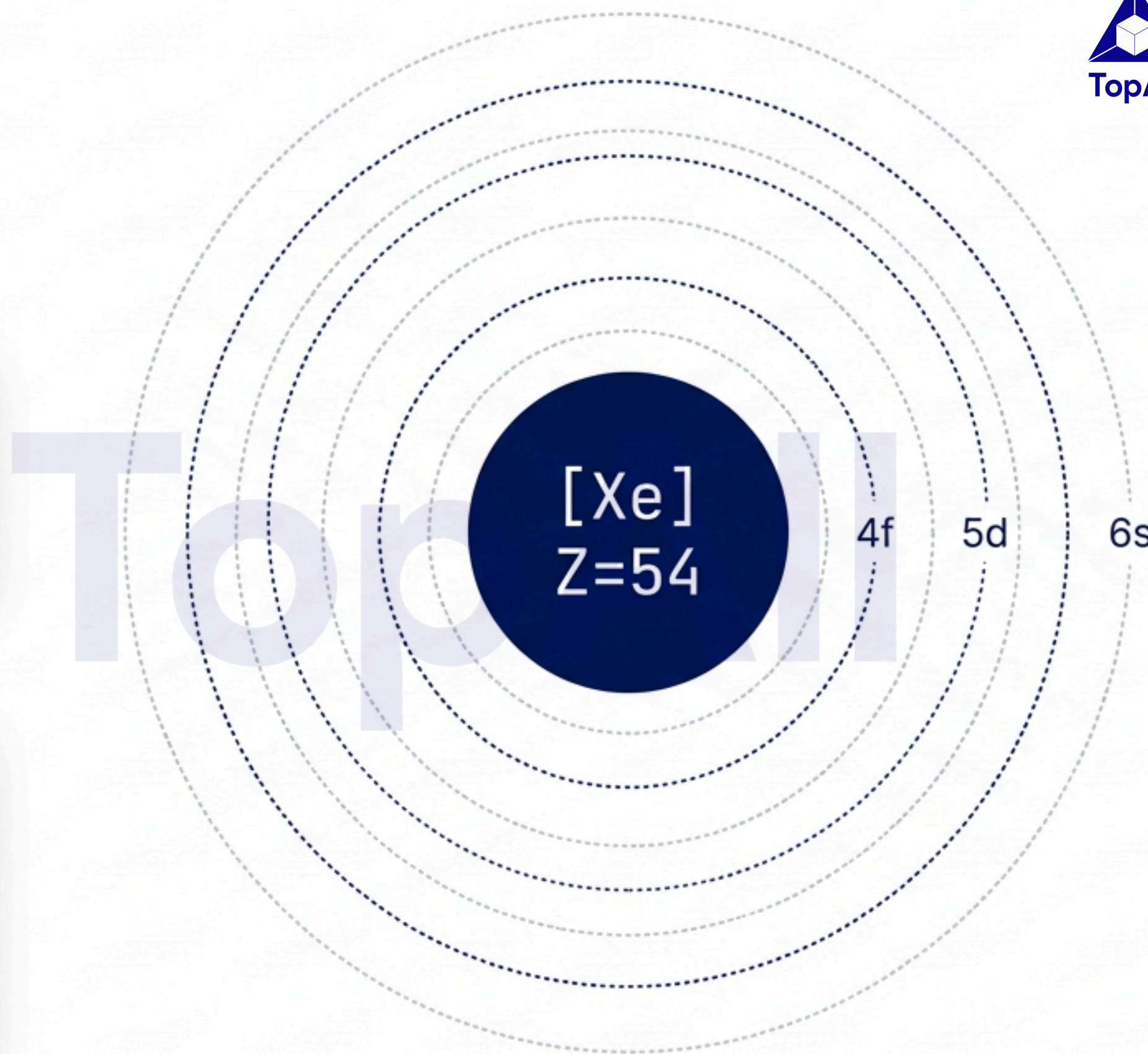
# The Foundation: The Xenon Core

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$   
 $3d^{10} 4p^6 5s^2 4d^{10} 5p^6$

## Insight Badge



By locking away 54 electrons in a completely inert configuration, the chemical complexity is reduced to just the handful of valence electrons in the 4f, 5d, and 6s outer subshells.



# The Blueprint of Lanthanoids

## The Inert Core

54 electrons securely locked away.

## Variable Occupancy

Rarely holds more than 1 electron due to similar energy levels with 4f.

Formula Chip



## The Inner Transition Orbital

Progressively filled with electrons across the series.

## The Outermost Shell

Common to all lanthanoids; always filled first, always lost first.



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

$$E=mc^2$$



Turn theory into marks with **unlimited MCQs, smart analysis, and focused revision.**

**Practice Now**



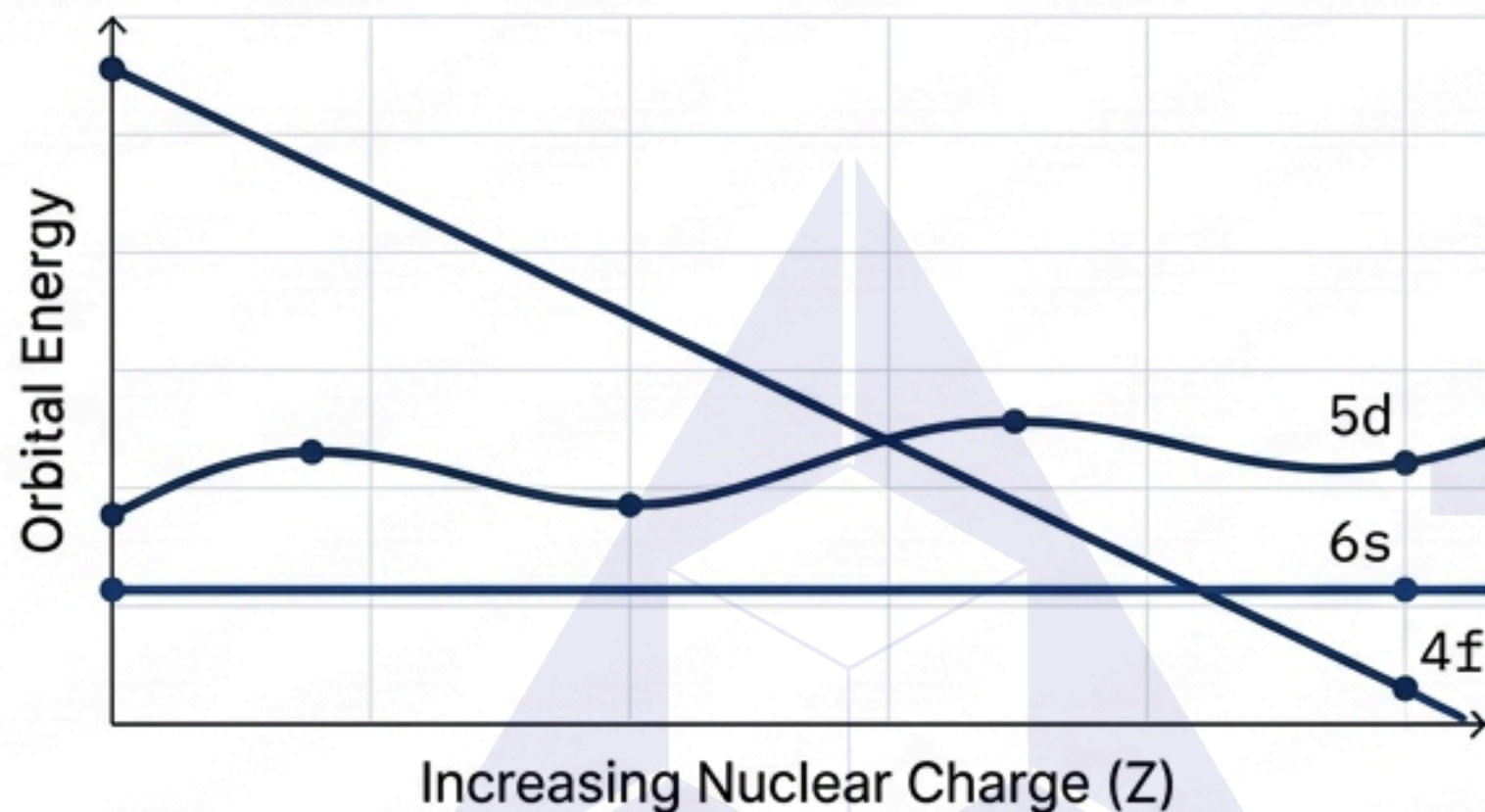
At [prep.topall.app](https://prep.topall.app)

## Key Highlights

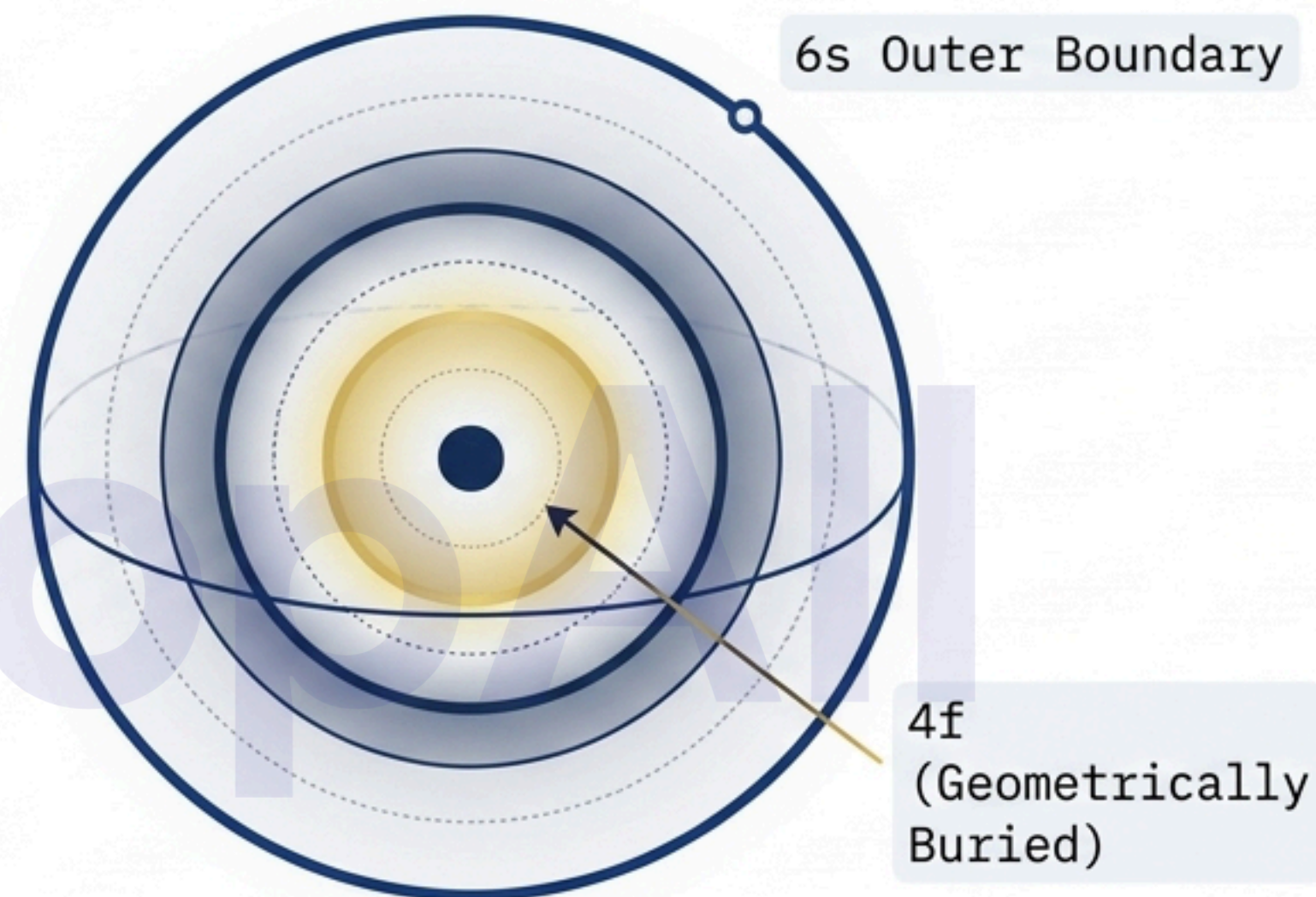
- » Free Study Material, Videos & Infographics
- » Push Your Limits with Level-Based Challenges
- » Climb the Leaderboard Among Fellow Aspirants
- » Practice Unlimited MCQs for NEET & JEE
- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



# The 'Buried' f-Orbitals



The 6s orbital is lower in energy initially (fills first). As Z increases, the 4f energy drops steeply, becoming the primary destination.

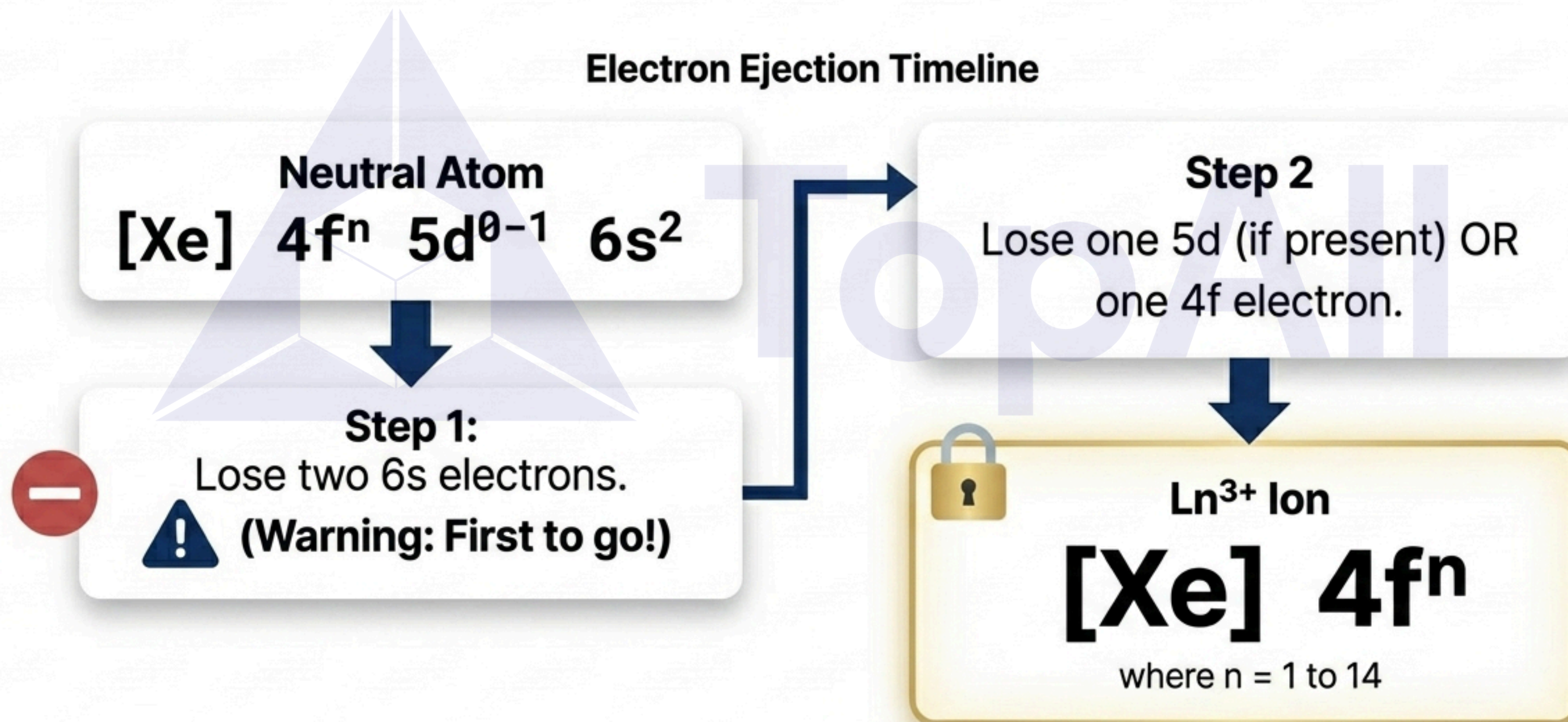


## NEET/JEE Tip

Because 4f electrons are added last but are physically buried closer to the nucleus than 5d and 6s, their poor shielding effect directly causes the Lanthanoid Contraction.

# The +3 State: Order Out of Chaos

While neutral lanthanoid atoms have irregular configurations, their **tripositive ( $\text{Ln}^{3+}$ ) ions** follow a beautifully smooth, mathematical progression.



# Exam Spotlight: Configuration Exceptions



Nature heavily favors the extreme quantum stability of exactly half-filled ( $f^7$ ) and fully-filled ( $f^{14}$ ) subshells.

## The $f^7$ Shift (Half-Filled)

Element: Gadolinium (Gd,  $Z=64$ )

Expected:  $[\text{Xe}] 4f^8 6s^2$

Actual:  $[\text{Xe}] 4f^7 5d^1 6s^2$

**Reason:** An electron shifts to 5d to preserve the extra stability of a half-filled 4f subshell.

## The $f^{14}$ Shift (Fully-Filled)

Element: Lutetium (Lu,  $Z=71$ )

Expected Pattern:  ~~$[\text{Xe}] 4f^{13} 5d^2 6s^2$~~

Actual:  $[\text{Xe}] 4f^{14} 5d^1 6s^2$

**Reason:** Retains the 5d electron to keep the 4f subshell perfectly full and maximally stable.

Don't forget **Cerium** (Ce,  $Z=58$ )! Its configuration is uniquely  $[\text{Xe}] 4f^1 5d^1 6s^2$ .

# Configuration Trend Patterns

| Z  | Element         | Neutral Atom (Ln)                                | Ln <sup>3+</sup> Ion            |
|----|-----------------|--------------------------------------------------|---------------------------------|
| 57 | Lanthanum (La)  | 5d <sup>1</sup> 6s <sup>2</sup>                  | 4f <sup>0</sup> (Empty)         |
| 58 | Cerium (Ce)     | 4f <sup>1</sup> 5d <sup>1</sup> 6s <sup>2</sup>  | 4f <sup>1</sup>                 |
| 63 | Europium (Eu)   | 4f <sup>7</sup> 6s <sup>2</sup>                  | 4f <sup>6</sup>                 |
| 64 | Gadolinium (Gd) | 4f <sup>7</sup> 5d <sup>1</sup> 6s <sup>2</sup>  | 4f <sup>7</sup> (Half-filled)   |
| 70 | Ytterbium (Yb)  | 4f <sup>14</sup> 6s <sup>2</sup>                 | 4f <sup>13</sup>                |
| 71 | Lutetium (Lu)   | 4f <sup>14</sup> 5d <sup>1</sup> 6s <sup>2</sup> | 4f <sup>14</sup> (Fully-filled) |

# 60-Second Quick Revision



## 1. General Blueprint

All chemistry happens outside the 54-electron Xenon core.



## 2. The Ejection Rule

**ALWAYS** remove 6s electrons before 4f electrons when forming ions!



## 3. Stable States

The +3 oxidation state dominates.  $\text{Ln}^{3+}$  configurations form a perfectly smooth mathematical sequence from  $4f^1$  to  $4f^{14}$ .



## 4. The Big 3 Exceptions

**Ce** ( $4f^1 \ 5d^1$ ), **Gd** ( $4f^7 \ 5d^1$ ), **Lu** ( $4f^{14} \ 5d^1$ ).  
The 5d orbital borrows an electron to maximize f-subshell stability (empty, half, or full).



# You've Learned the Theory.

## Now Let's Test It.

Reading notes gets you knowledge.

**Practicing MCQs gets you marks.**

**That's exactly what TopAll Pro is built for.**

**Try TopAll Pro Now**

### What TopAll Pro Does Differently

-  **Stuck? Snap it. Solve it. — Doubts AI**  
Photo → step-by-step solution in seconds, 24/7
-  **Your AI Coach finds your blind spots**  
Concept-level weakness detection — not just chapter-level
-  **4.5 Lakh+ questions. Never run out.**  
13× more content than any other prep app in India
-  **Build your own test in 60 seconds**  
Pick a chapter, set difficulty — AI does the rest instantly.
-  **AI Recommendation that helps you improve**  
AI Recommendation Analysis your Tests and tell you where you need to improve.



**Practice the moment you finish studying**  
Jump in while the concept is still fresh in your head

**4.5L+**  
MCQs

**1.5L+**  
Students

**AI Powered**  
In-Depth Analysis