

UNIT 4 • d- AND f-BLOCK ELEMENTS

Electronic Configurations of the d-Block Elements

Understanding standard orbital filling rules, half-filled stability, and the critical anomalies of Cr, Cu, and Pd.

Core Concepts

- **The General Formula:** $(n-1)d^{\{1-10\}} ns^{\{1-2\}}$

- **Orbital Stability:** Half-filled (d^5) and fully-filled ($d^{\{10\}}$) subshells possess exceptionally lower energy and higher stability.

Mapping the d-Block (Table 4.1)

	3	4	5	6	7	8	9	10	11	12
3d Series	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
4d Series	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
5d Series										
6d Series										

The *d*-orbitals receive electrons across four long periods. The highlighted elements represent the most critical configuration anomalies.



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$$E=mc^2$$



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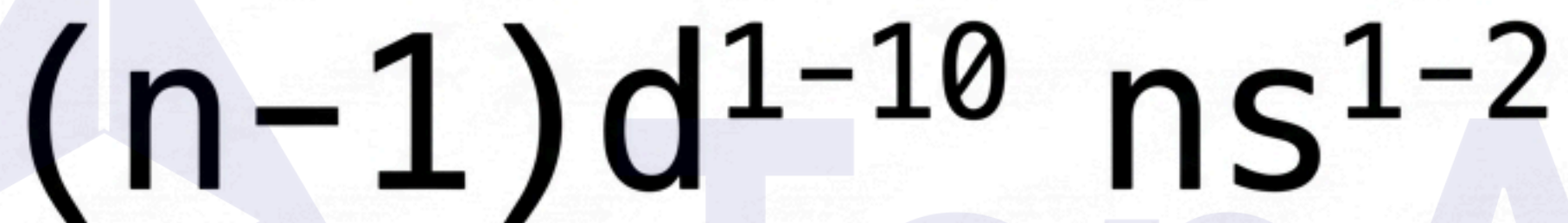
Key Highlights

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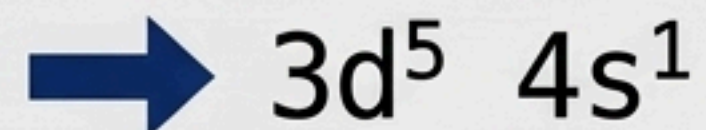


Configuration Formulas & Exceptions

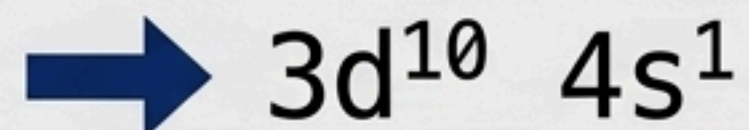
STANDARD CONFIGURATION



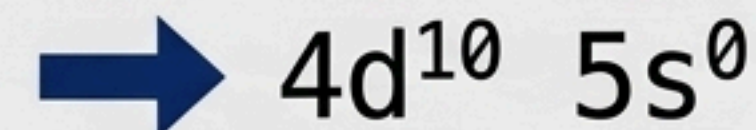
Chromium (Z=24)



Copper (Z=29)

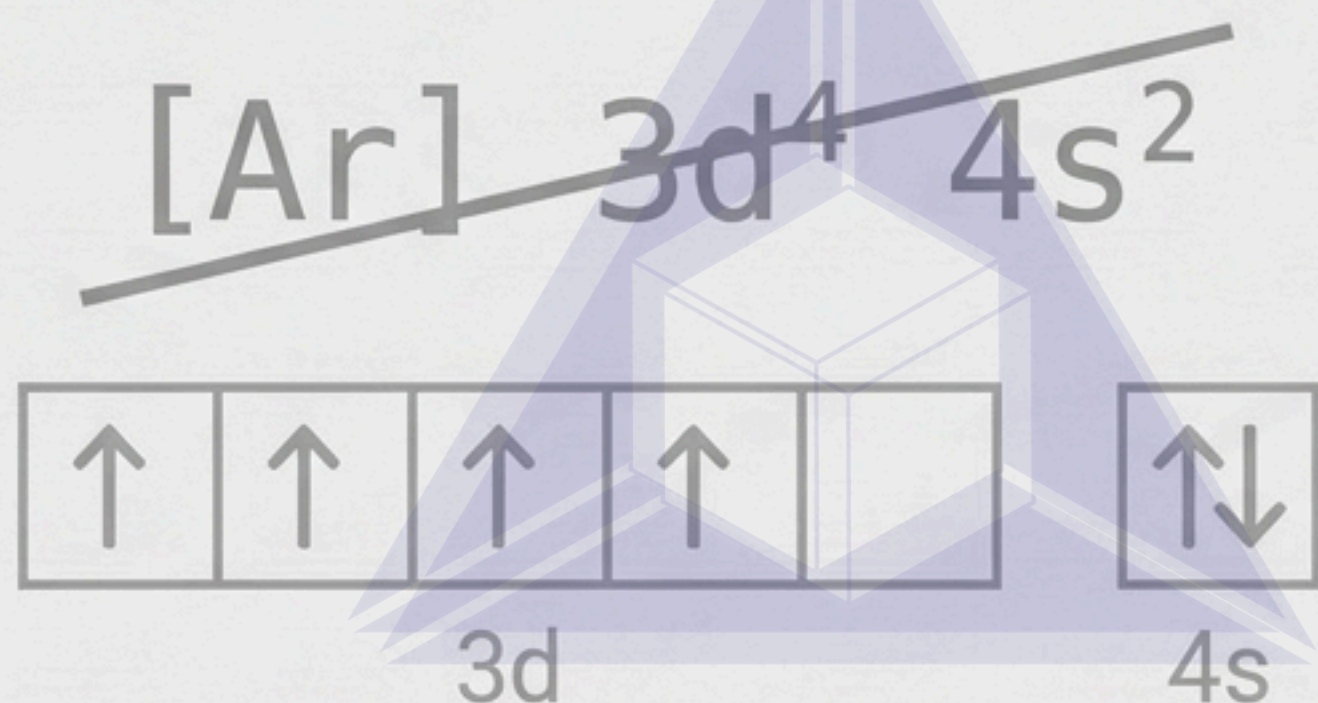


Palladium (Z=46)

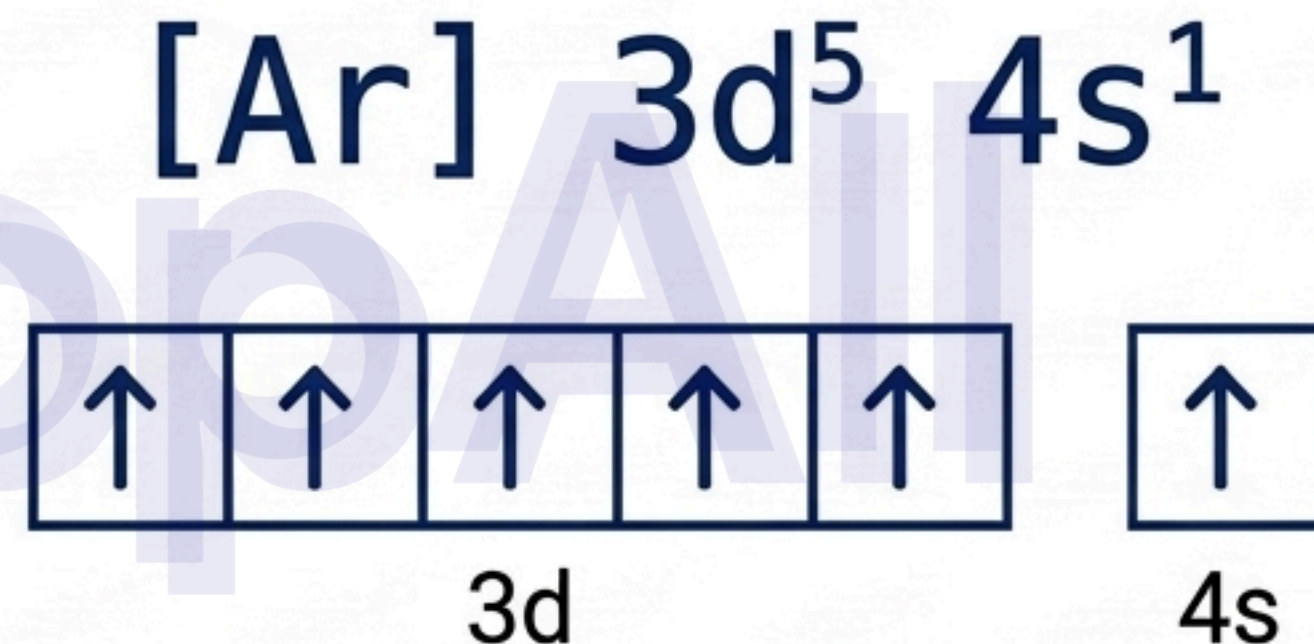


The Case of Chromium (Z=24)

Aufbau Prediction



Thermodynamic Reality



The energy gap between 3d and 4s is minimal. An electron shifts to 3d to achieve the highly stable half-filled (d^5) state.

High-Yield Exam Anomalies

Watch for this: Do not blindly apply the general formula!

Examiners routinely test the exact electron counts of the three major exceptions.

- **Trap 1:** Assuming Cr is $3d^4 4s^2$. (Reality: The stable $3d^5$ steals an s electron).
- **Trap 2:** Assuming Cu is $3d^9 4s^2$. (Reality: The fully-filled $3d^{10}$ steals an s electron).
- **Trap 3 (The Deadliest):** Assuming Pd has any s electrons. Palladium is uniquely $4d^{10} 5s^0$. The 5s orbital is completely empty!

Which of the following represents the correct ground-state electronic configuration of Palladium (Pd, Z=46)?

Option A: $[\text{Kr}] 4d^8 5s^2$

Option B: $[\text{Kr}] 4d^9 5s^1$

Option C: $[\text{Kr}] 4d^{\{10\}} 5s^0$

Option D: $[\text{Kr}] 4d^{\{10\}} 5s^1$

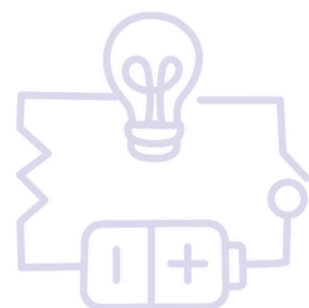
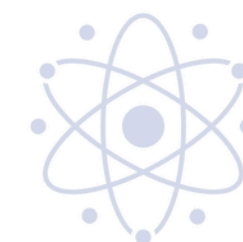
Concept Summary

- The general outer electronic configuration for transition elements is $(n-1)d^{1-10} ns^{1-2}$.
- Exceptions like **Cr** ($3d^5 4s^1$), **Cu** ($3d^{10} 4s^1$), and **Pd** ($4d^{10} 5s^0$) occur because half-filled and fully-filled d subshells provide extraordinary energetic stability, causing them to pull **electrons** from the s orbital.



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