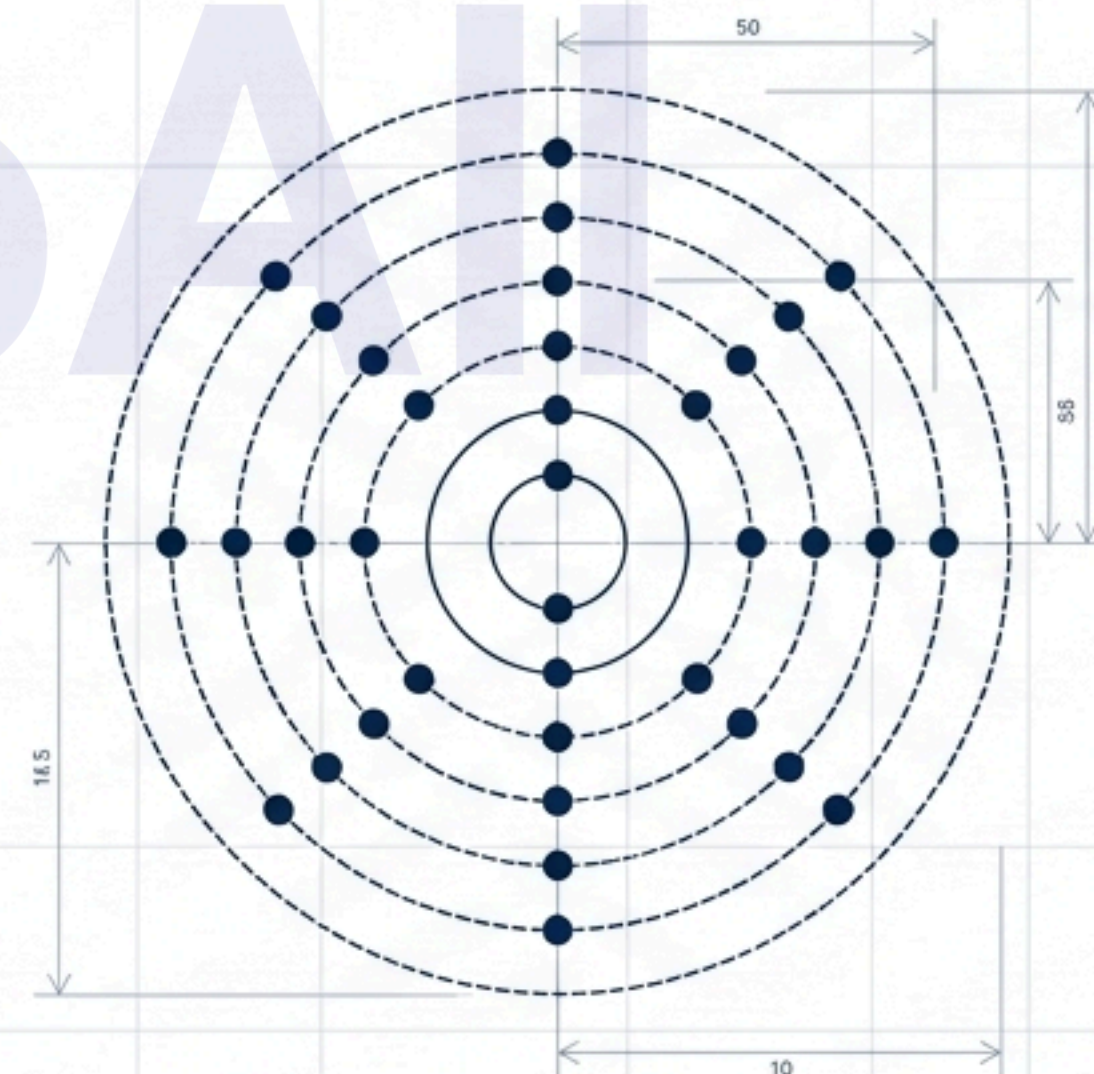


CHAPTER 2: STRUCTURE OF ATOM

ELECTRONIC CONFIGURATION

The precise distribution of electrons into the orbitals of an atom.



[Deep Navy] "The Two Languages of Configuration"



[Dark charcoal] "We represent electronic distribution using two complementary notations."

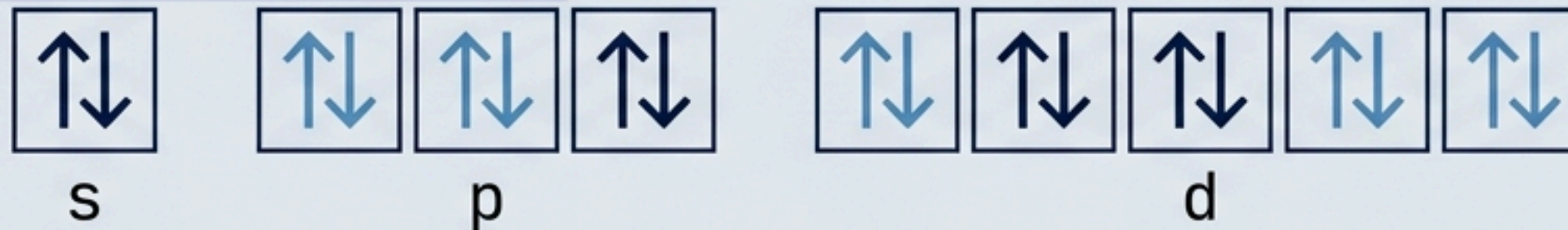
Standard Notation

$s^a p^b d^c \dots$

Quick, formulaic representation.

- Number (e.g., 2): Principal quantum number (n) / Shell.
- Letter (e.g., p): Subshell / Orbital shape (ℓ).
- Superscript (e.g., 6): Number of electrons in that subshell.

Orbital Diagram

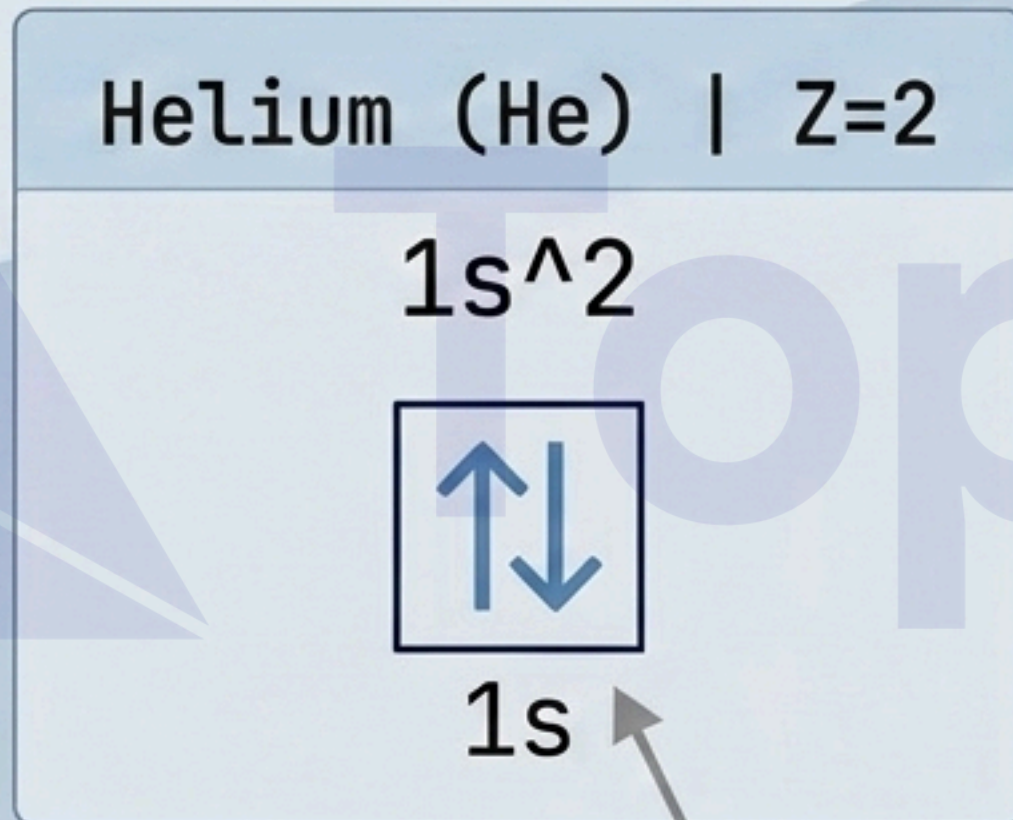
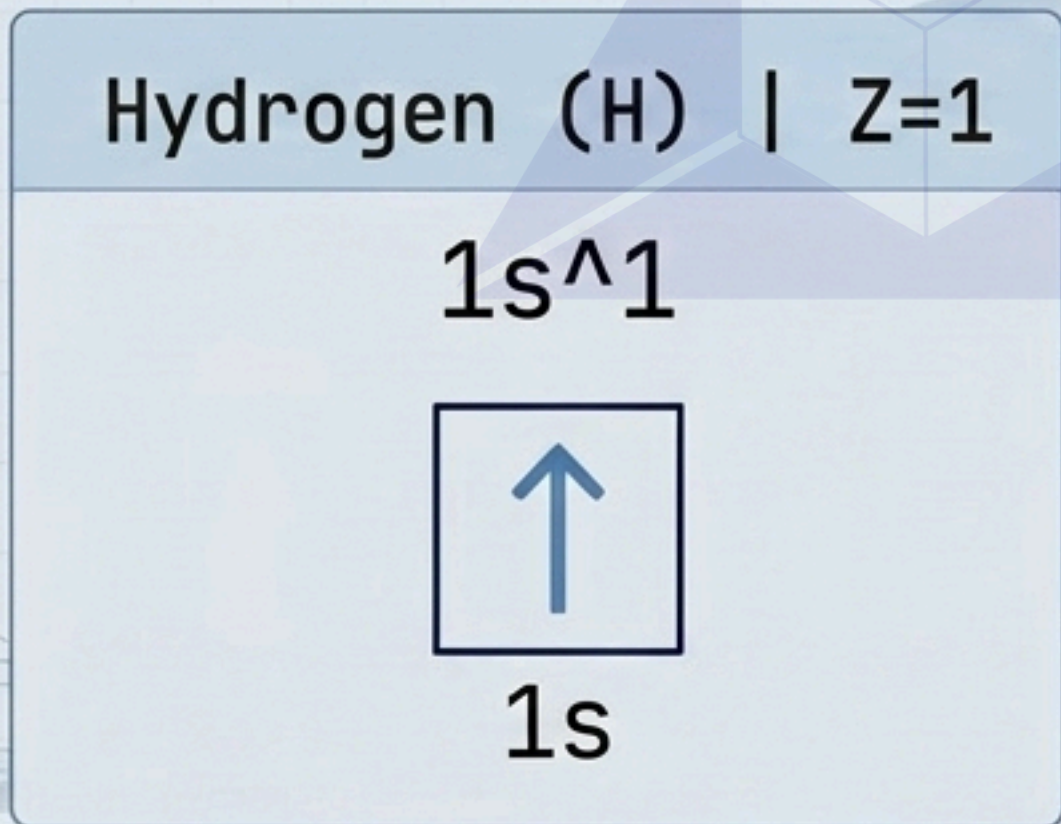


Reveals all four quantum numbers, including spin.

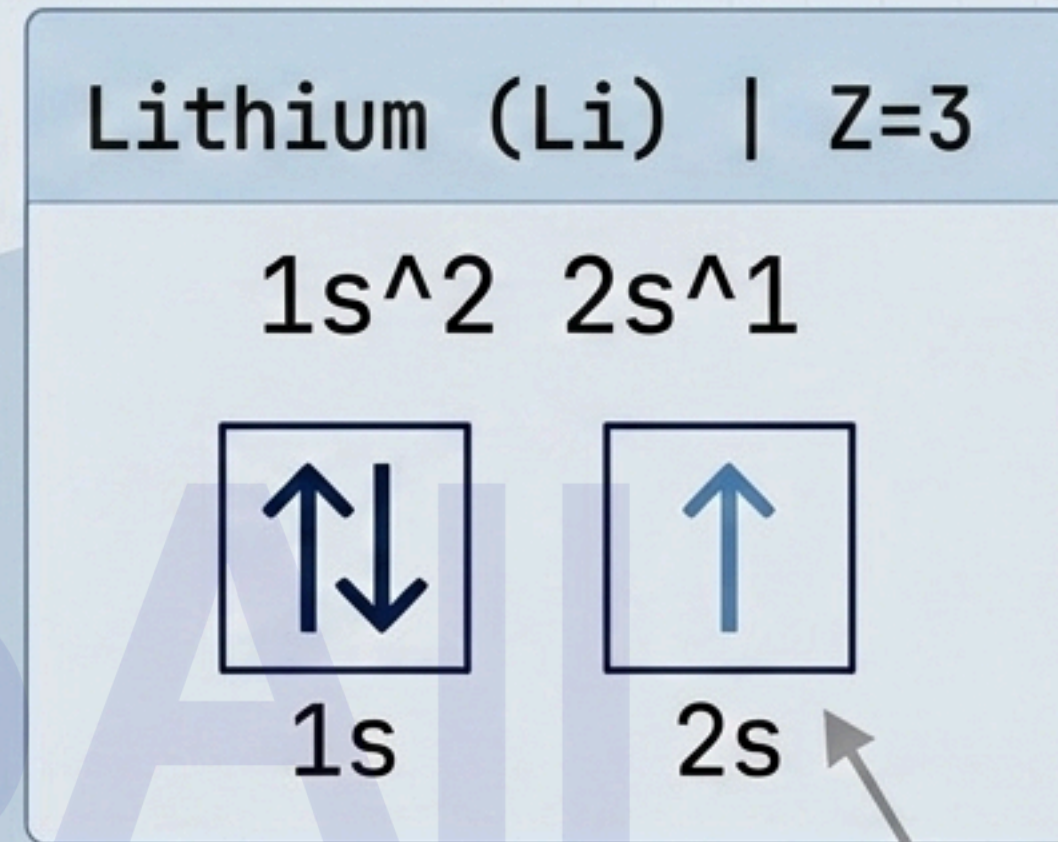
- **Boxes:** Represent individual orbitals (1 box for s, 3 for p, 5 for d).
- **Arrows:** Represent electrons.
- **Direction:** Represents opposite spin states ($+1/2$, $-1/2$).

[The Aufbau Build-Up]

[Electrons occupy the lowest energy orbitals available first.]



The second electron must have opposite spin (Pauli Exclusion Principle).



The 1s orbital is full.
The third electron must enter the next energy level (2s).

[Deep Navy] Core vs. Valence Electrons

[Dark charcoal] Not all electrons play the same role in chemical behavior.

Sodium (Na) $Z=11$



Core Electrons

- Electrons in completely filled inner shells.
- Highly stable.
- Do not participate in chemical bonding.

Valence Electrons

- Electrons in the outermost electronic shell.
- Determine the chemical reactivity and valency of the element.
- Experience less effective nuclear charge (shielded by the core).



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[Condensed Notation (The Shorthand)]

[Writing full configurations for heavy elements is inefficient.
We use Noble Gases as chemical checkpoints.]



Full Configuration of Sodium



Identify the Noble Gas Core

The inner core ($1s^2 2s^2 2p^6$) is structurally identical to Neon (Ne).

Compress



Example 2: Potassium (K, Z=19) is written as $[\text{Ar}] 4s^1$ rather than writing out all 18 inner electrons.

The Stability Exception

⚠ Caution: The Aufbau principle is a guide, not an absolute law.

In certain transition metals, the energy gap between the 4s and 3d orbitals is extremely small. An electron will spontaneously shift from the 4s to the 3d subshell if it results in greater overall atomic stability.



Why does this happen?

Configurations that are exactly half-filled (p^3 , d^5 , f^7) or completely filled (p^6 , d^{10} , f^{14}) possess extraordinary extra stability.

Two Reasons for Extra Stability:

1. **Symmetry:** A symmetrical distribution of electron clouds minimizes mutual repulsion.
2. **Exchange Energy:** Electrons with parallel spins in degenerate orbitals can exchange positions. More possible exchanges = lower energy = higher stability.

Exception #1 - Cr (Chromium): The Half-Filled Drive

Atomic Number: $Z=24$

Expected Trap

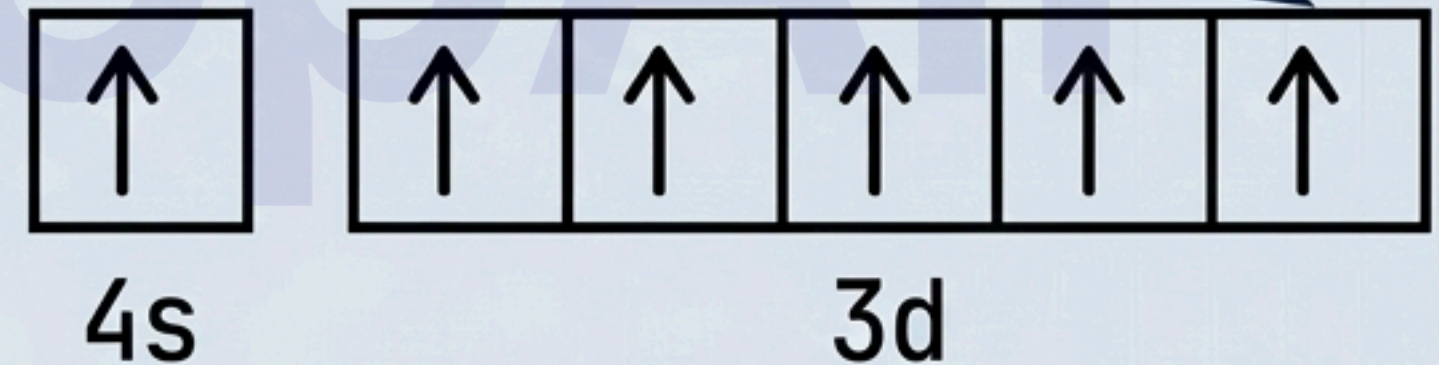
$[\text{Ar}] 3d^4 4s^2$



Missing just one electron for a highly stable, half-filled d subshell.

Actual Configuration

$[\text{Ar}] 3d^5 4s^1$



An electron shifts from 4s to 3d. The result is two perfectly stable half-filled subshells.

Exception #2 - Cu (Copper): The Fully-Filled Drive

Atomic Number: $Z=29$

Expected Trap

$[\text{Ar}] 3d^9 4s^2$



Missing just one electron for a perfectly complete d subshell.

Actual Configuration

$[\text{Ar}] 3d^{10} 4s^1$



An electron shifts from 4s to 3d.
The d-subshell achieves maximum stability by being completely filled.

The Big Picture

Why Electronic Configuration Explains Everything



Chemistry is Electron Exchange

The rich diversity of how elements react, bond, and form molecules is traced directly to the specific arrangement of their valence electrons.



The Periodic Table's True Blueprint

It dictates element placement. The periodic table is a map of electron configurations; elements with similar valence structures group together because they behave the same chemically.



Stability is the Ultimate Driver

Whether following the Aufbau principle or breaking it for symmetrical stability (like Cr and Cu), the singular goal of electron distribution is achieving the lowest possible atomic energy state.



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