ORBITAL DIAGRAMS, NOBLE GAS CONFIGURATION, LEWIS DOT DIAGRAMS

Exceptions to Electron Configuration Rules- Cu and Cr

- **Copper**

Predicted: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9$

Actual: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$

- **Chromium**

Predicted: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^4$

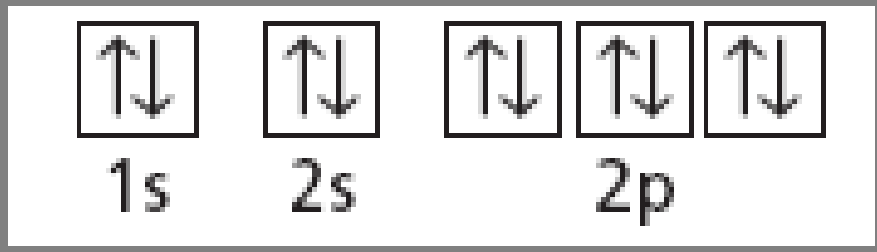
Actual: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

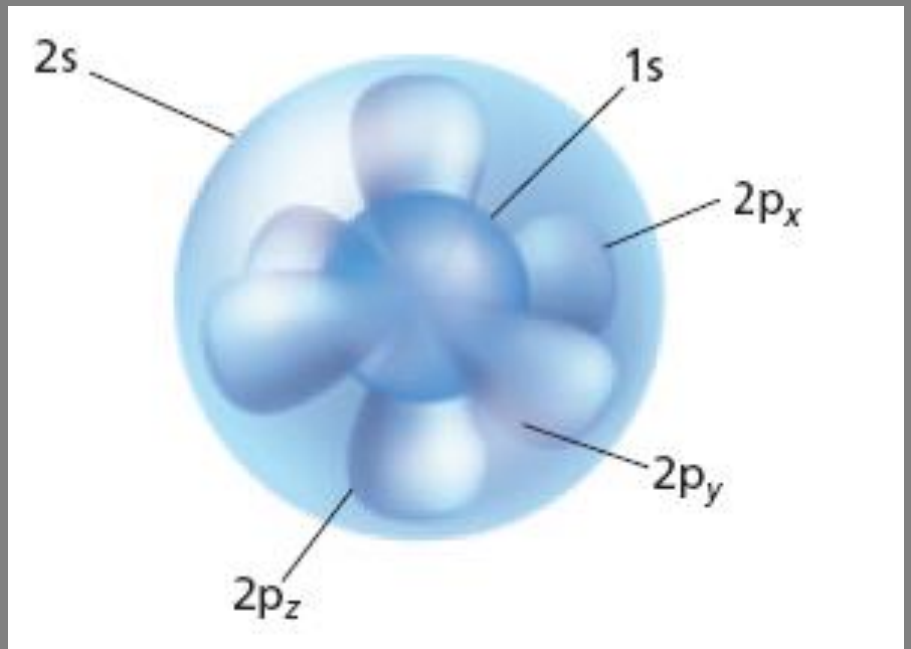
Reasons for the Exceptions

- Once we get beyond **atomic number 40**, the difference between the energies of adjacent orbitals is small enough that it becomes much easier to **transfer an electron** from one orbital to another
- It is more **stable** to have **two partially filled sublevels** than to have one completely filled and another partially filled

Electron Configuration

- Electron Configuration: $1s^2 2s^2 2p^6$
- Orbital Filling Diagram:
- Orbital image:



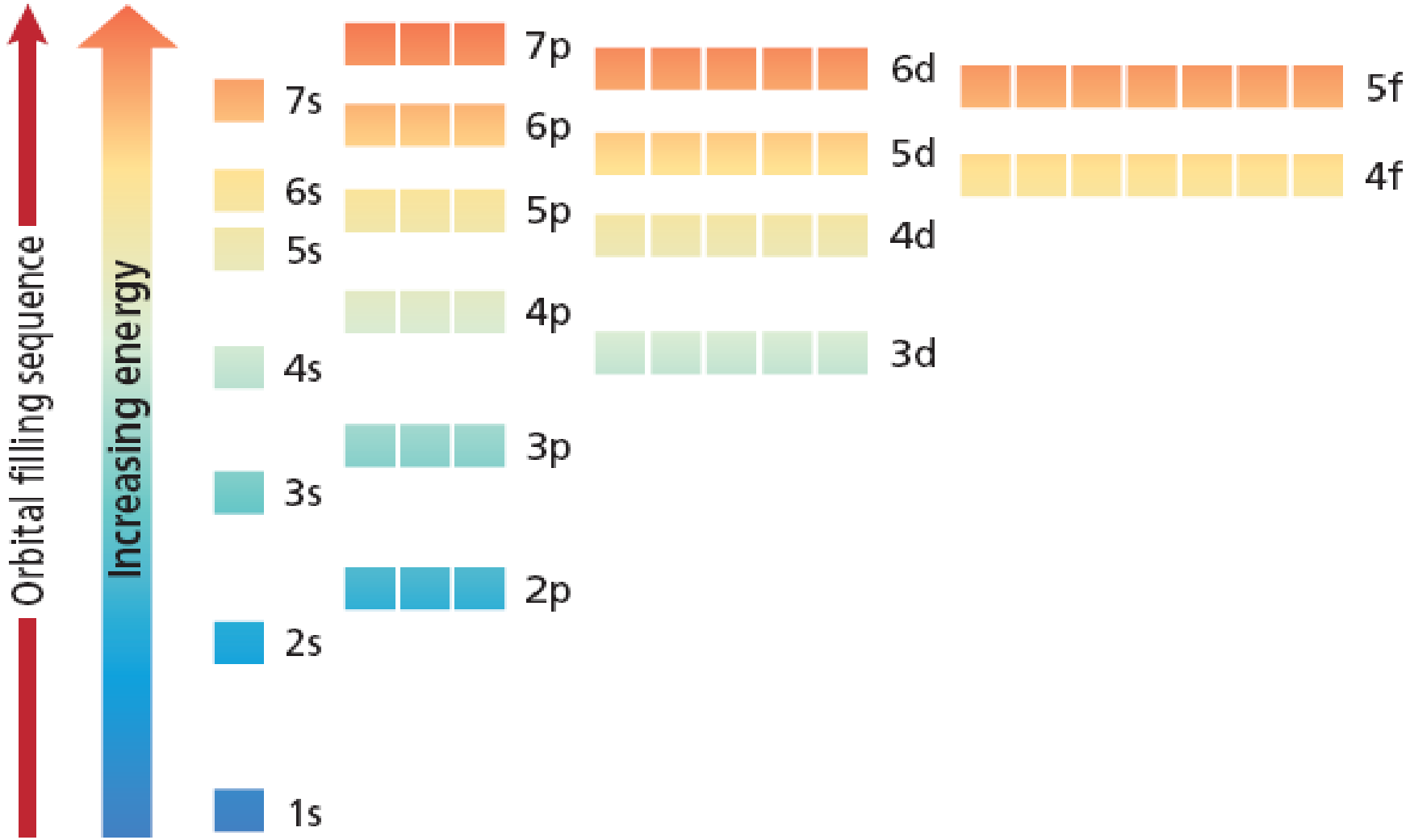


Orbital Filling Diagrams

- Each box represents an orbital which can hold a max of 2 **e-**
- **Aufbau principal** – each electron occupies the lowest energy orbital available; German for "build up"
- Electrons are notated with **an arrow**
  - **Up** arrow goes first then, **down** arrow
  - Arrows represent the **opposing spin of electrons**

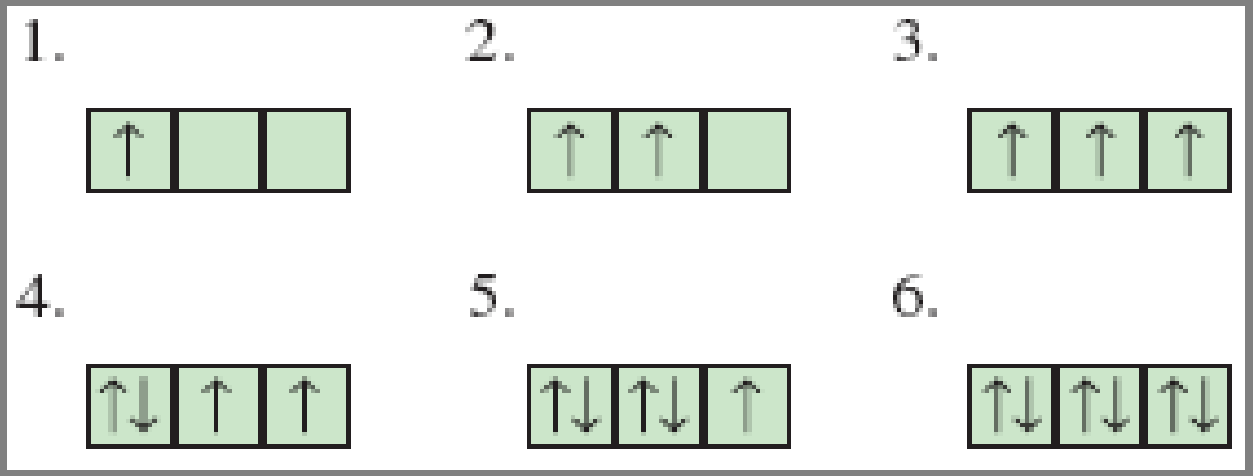
The electron as "Spinning top"

Orbital Filling Diagrams



Orbital Filling Diagrams

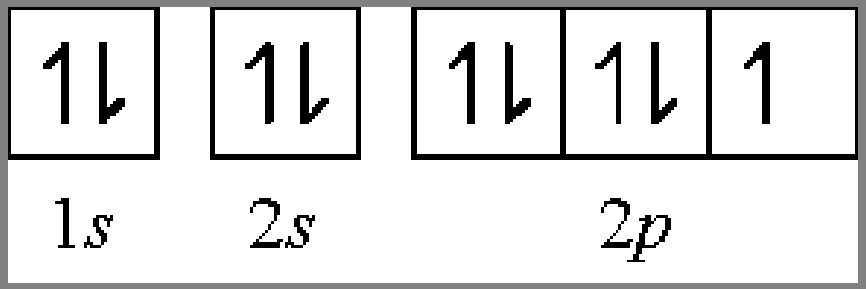
- **Hund's Rule** – when filling a sublevel, each orbital will contain 1 electron before a single orbital will contain 2 electrons
  - The three p orbitals fill in the order shown:

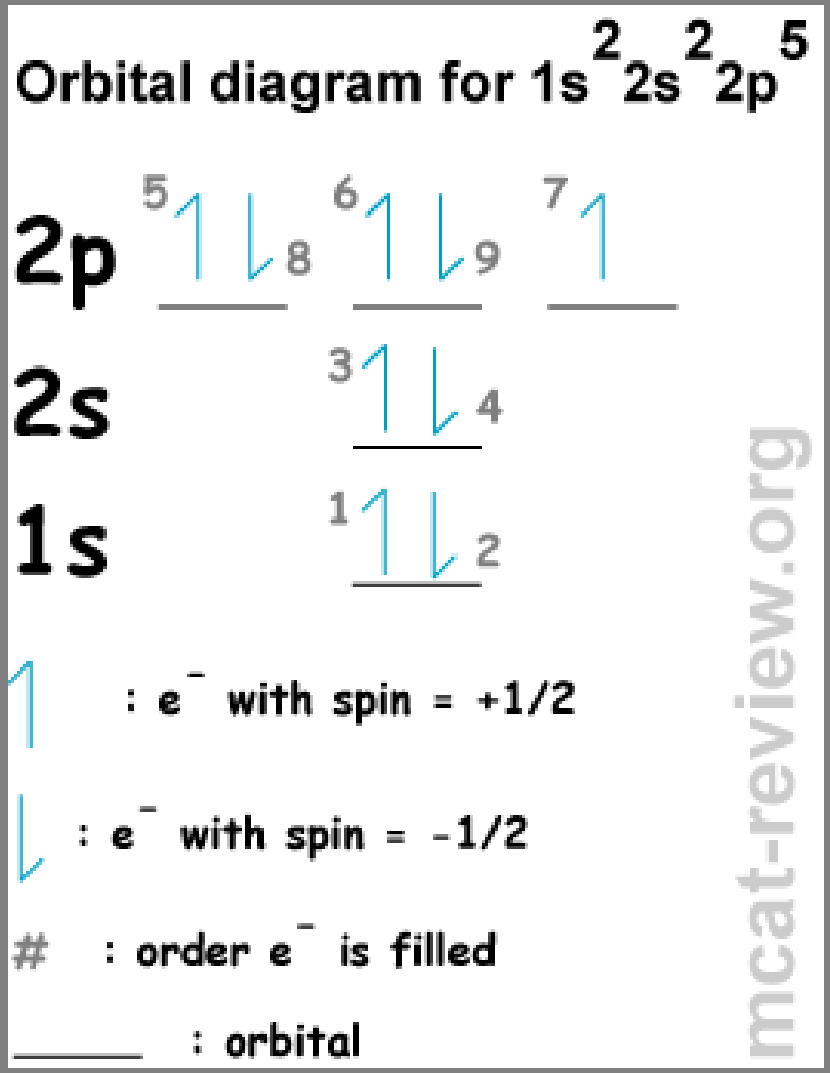


- The number of arrows must match the **number of electrons** contained in the atom

Orbital Filling Diagrams

- Electron Configuration for Fluorine
- **$1s^2\ 2s^2\ 2p^5$**

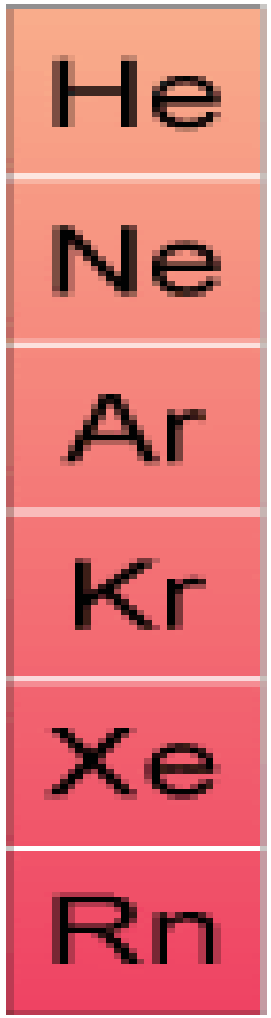




Orbital Filling Diagrams

Element	Total Electrons	Obital Diagram				
		1*s*	2*s*	2*p*		3*s*
Li	3					
Na	11					
B	5					

Noble Gas Configuration

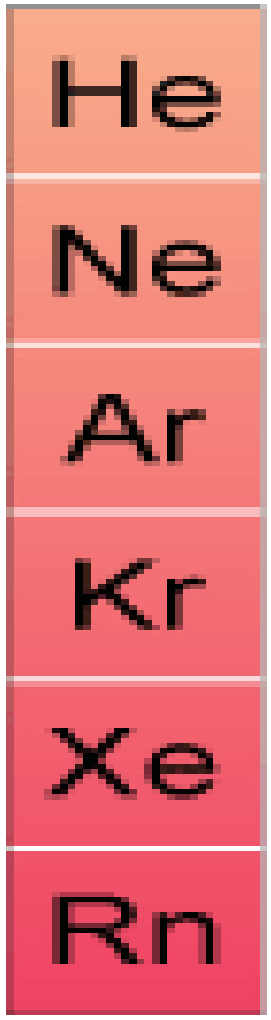


- Shorthand electron configuration
  - Give the **symbol of the noble gas in** the previous energy level in brackets
  - Give the **configuration** for the remaining energy level
- Example:

Sulfur = $1s^2 2s^2 2p^6 3s^2 3p^4$

[Ne]$3s^2 3p^4$

Noble Gas Configuration

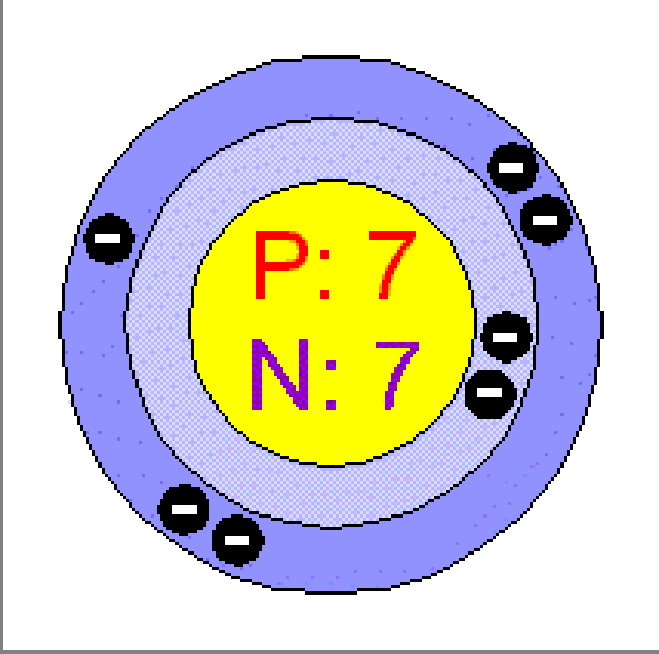


- Write Noble Gas Notation for **Ca**
  - The preceding noble gas is **Ar**
  - Use the periodic table to write the remaining configuration
  - Answer: **[Ar] $4s^2$**

- Write Noble Gas Notation for **Zr**
  - The preceding noble gas is **Kr**
  - Answer: **[Kr] $5s^2$ $4d^2$**

Valence Electrons

- Valence electrons: found in the outermost energy level (sometimes called a shell)
  - These electrons are used for bonding
- Example: Nitrogen = $1s^2$ $2s^2$ $2p^3$
  - Add up the number of e- (superscripts) in the highest energy level
  - So, nitrogen has 2 + 3 = 5 valence electrons



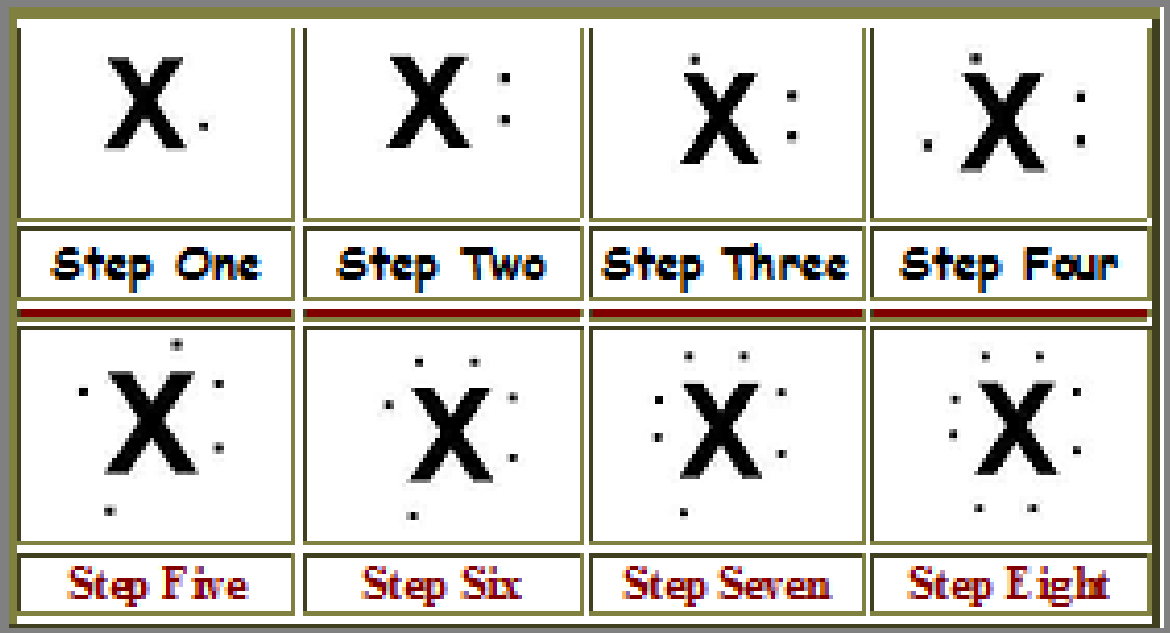
Valence Electrons

IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Li·	Be:	·B:	·C:	·N:	:O:	:F:	:Ne:

In general, the number of valence electrons of a representative element is equal to the group number

Lewis-Dot Diagrams

- Lewis Dot Diagrams are a way to represent the valence electrons in an atom.
  - Element's symbol represents the nucleus and inner-level electrons
  - Dots represent the valence electrons



Lewis-Dot Diagrams

- Dots are placed one at a time on the four sides of the symbol, then paired until all valence electrons are used…
  - Maximum of **8 electrons** will be around the symbol
    - d sublevel electrons are not valence electrons – they are in a lower energy level!

Lewis-Dot Diagrams

H		Xe	Examples: Ba In Se				He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca						