Electrons in Atoms

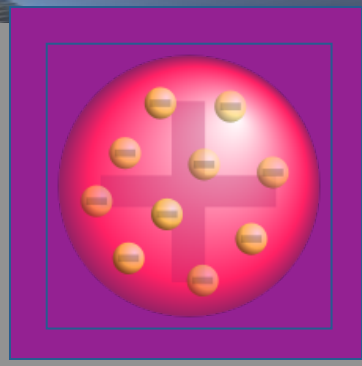
October 27, 2014

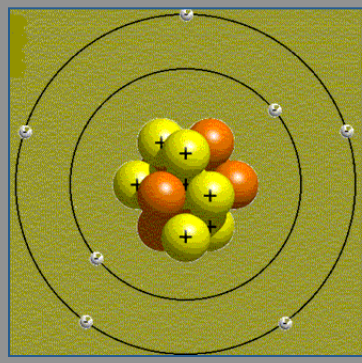
October 29, 2014

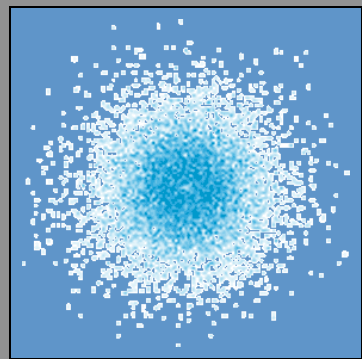
ELECTRON CONFIGURATION

Review of Atomic Theory

- **Thomson** discovered the electron
- **Bohr** determined that the electrons travel around the nucleus according to energy; electrons with lower energy are closer to the nucleus
- **Quantum Mechanical Model** says electrons orbit the nucleus in "clouds"; there is a high probability of finding them somewhere along these paths



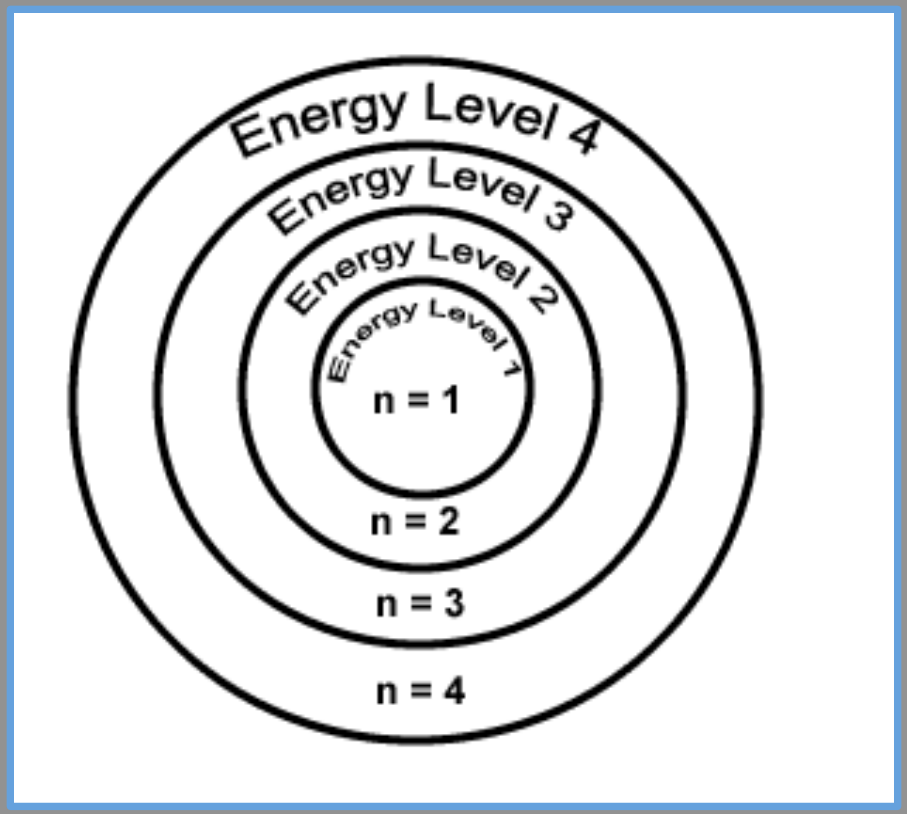




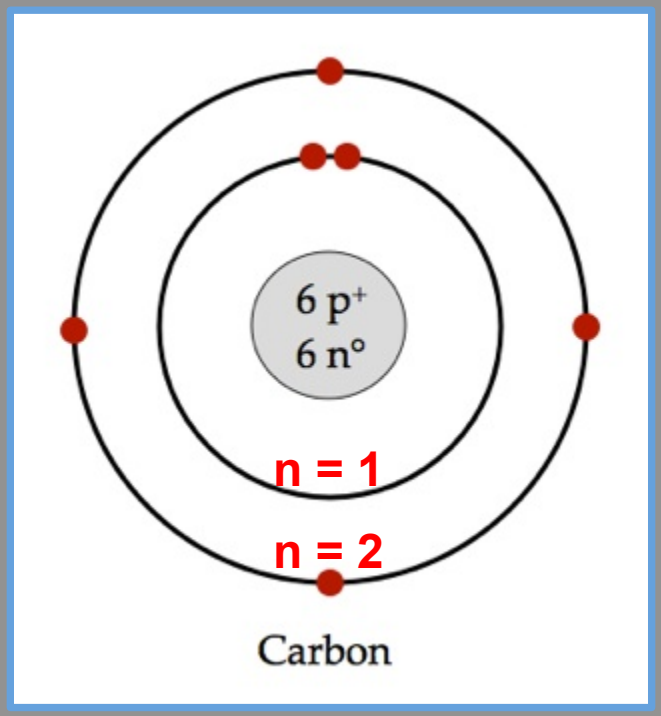
Electron Cloud

- Each **energy level** in the electron cloud model can hold a limited number of electrons.
- The lowest energy level is the smallest and the closest to the nucleus and is assigned a number of one.
  - Up to **seven energy levels have been detected**.
    - First energy level holds a maximum of **two electrons**.
    - Second energy level is larger because it is farther away from the nucleus. It holds a maximum of **eight electrons**.
    - Third energy level is larger still and holds a maximum of **18 electrons**

Electron Orbitals

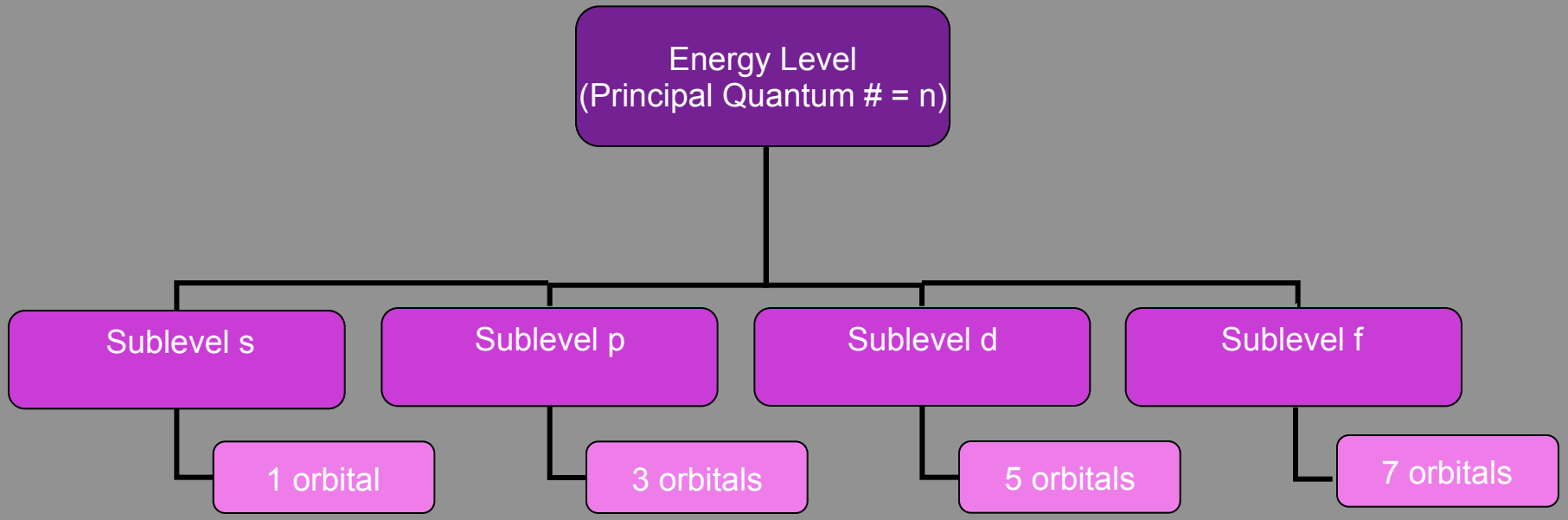


Conceptual Model of Energy Levels
Where n = energy level



Bohr Model of Carbon

Organization of Electrons



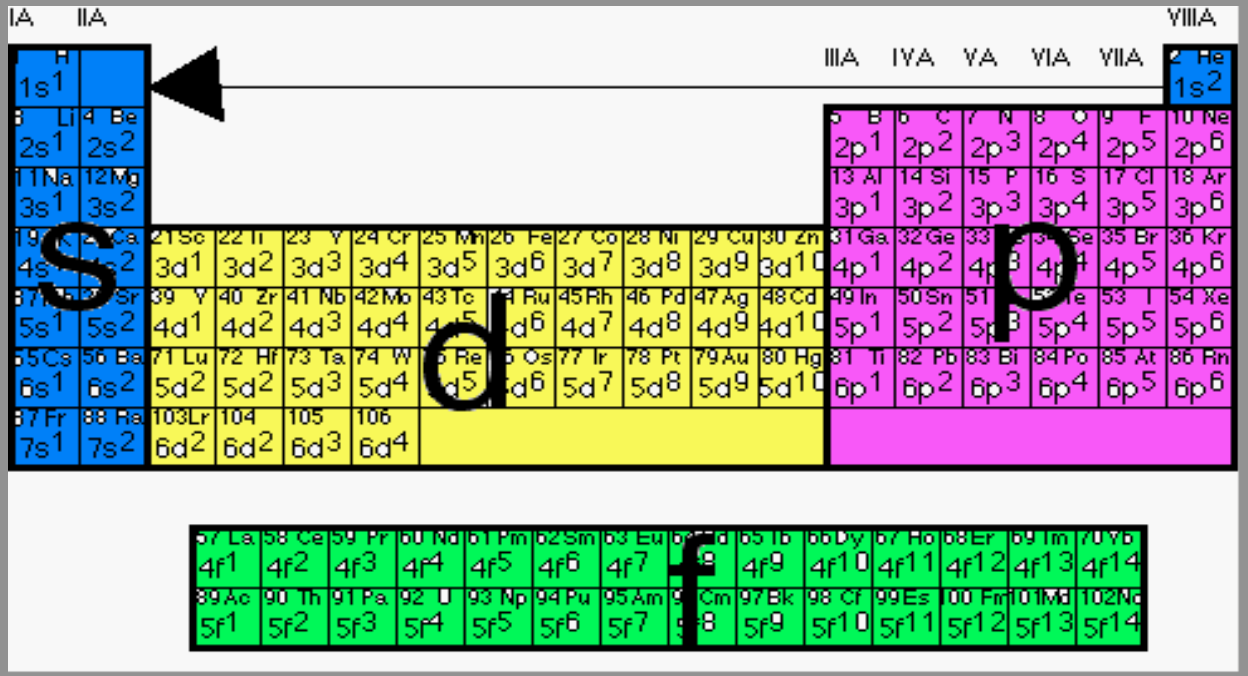
Energy Levels

- Electrons are restricted to energy levels based on the amount of **energy they have**
- Lowest energy level is assigned **#1**
- On the periodic table, each period **(horizontal row) is an energy level**

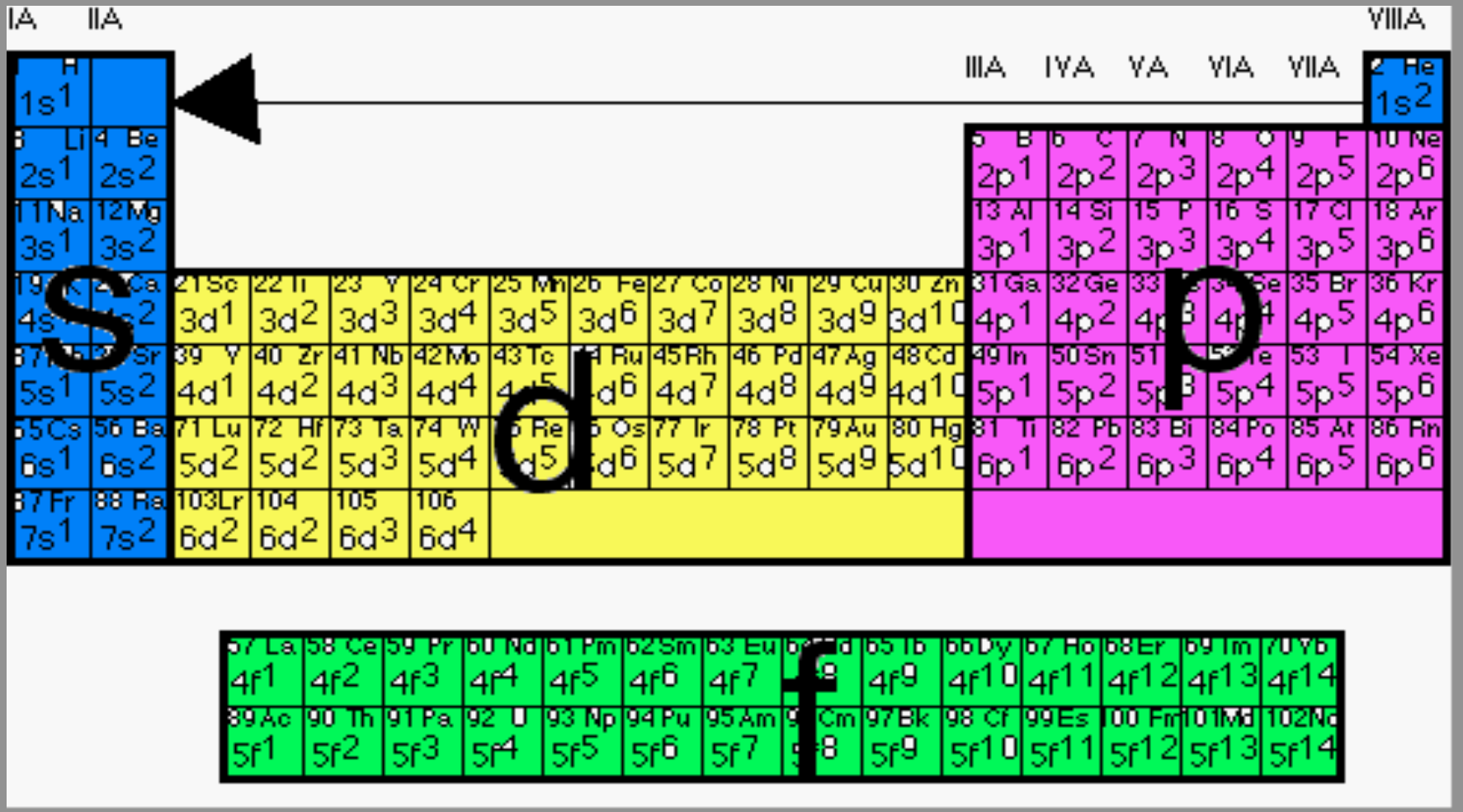
Energy Level (n) =

Energy Sublevels

- Within each energy level, there are energy **sublevels**
- The 4 sublevels are identified by a letter and listed in increasing complexity: **s, p, d, f**
- The letters stand for the way the emission lines look…
  - s = **sharp**
  - p = **principal**
  - d = **diffuse**
  - f = **fundamental**



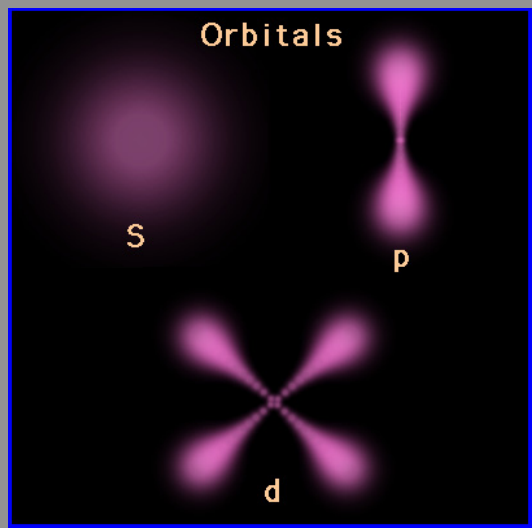
Energy Sublevels



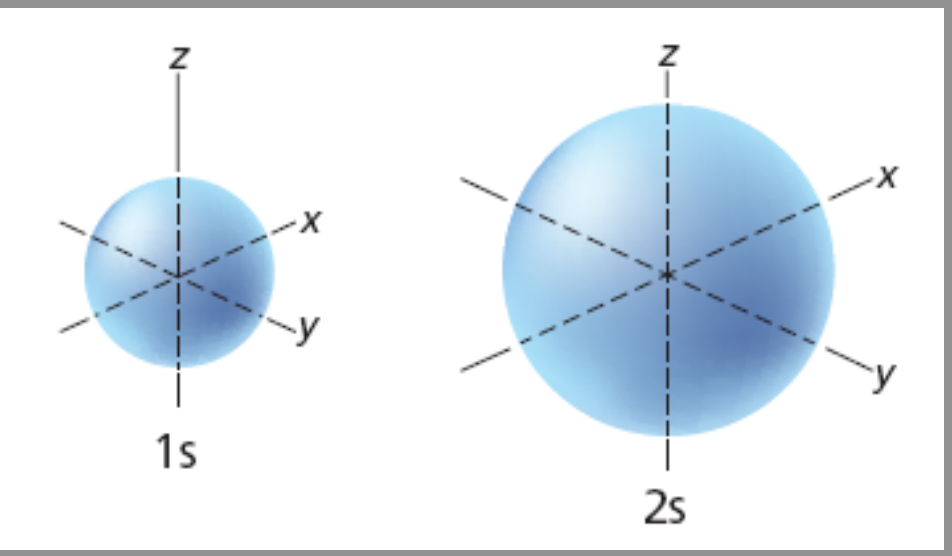
Orbitals

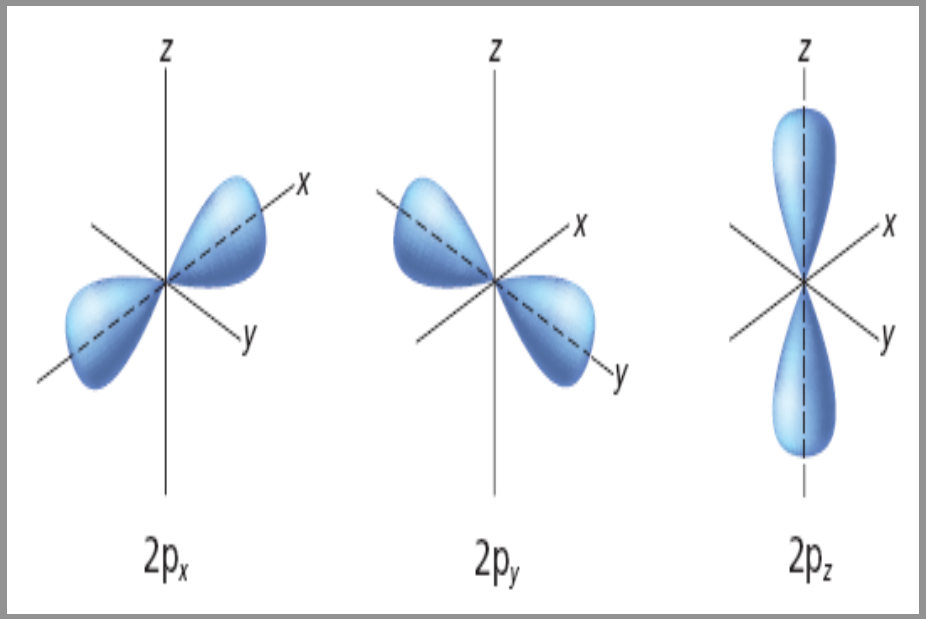
- Each sublevel contains a different # of orbitals, where the electrons are found 90% of the time
  - **Orbitals** are 3-D clouds that give volume to the atom
  - **Pauli Exclusion Principal:** Each orbital can only contain 2 electrons, which have opposing spins

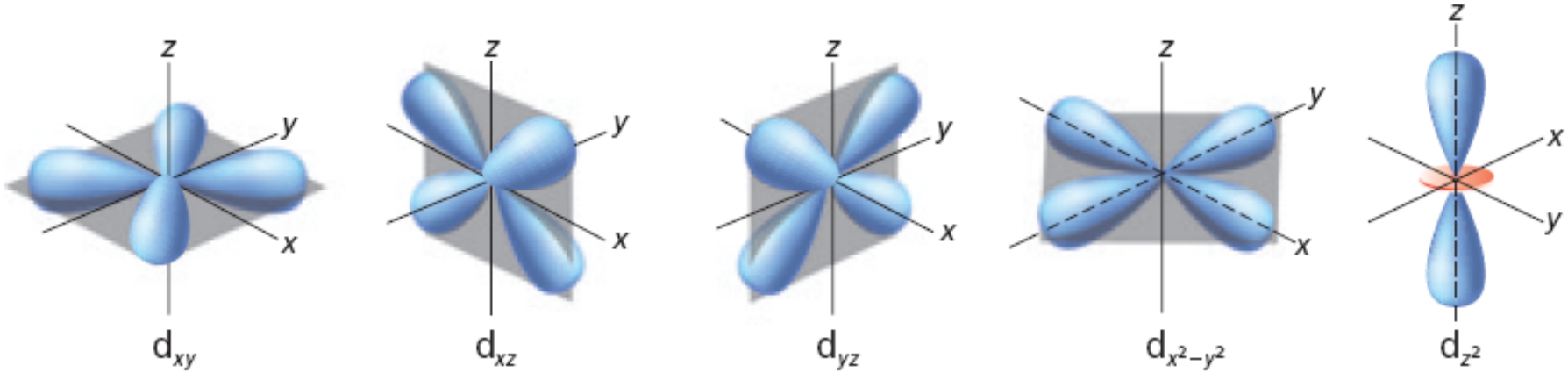
Sublevel	# orbitals	Max # e^-
s	1	2
p	3	6
d	5	10
f	7	14



Orbitals


z
x
y
1s
z
x
y
2s


z
x
y
2p_x
z
x
y
2p_y
z
x
y
2p_z


z
y
x
d_xy
z
y
x
d_xz
z
y
x
d_yz
z
y
x
d_x²−y²
z
x
y
d_z²

Locating Electrons

- There are two ways to show where the electrons are found in the atom
  - Electron configurations
  - Orbital filling diagrams

Element	Total Electrons	Orbital Diagram				Electron Configuration
		1*s*	2*s*	2*p*	3*s*	
H	1	↑				$1s^1$
He	2	↑↓				$1s^2$
Li	3	↑↓	↑			$1s^2\ 2s^1$
Be	4	↑↓	↑↓			$1s^2\ 2s^2$
B	5	↑↓	↑↓	↑		$1s^2\ 2s^2\ 2p^1$

Electron Configuration

- Shorthand method for describing the **arrangement of electrons**
- Composed of the principal energy level followed by the energy sublevel and includes a superscript with the # of electrons in the sublevel

Helium: $1s^2$

 # electrons

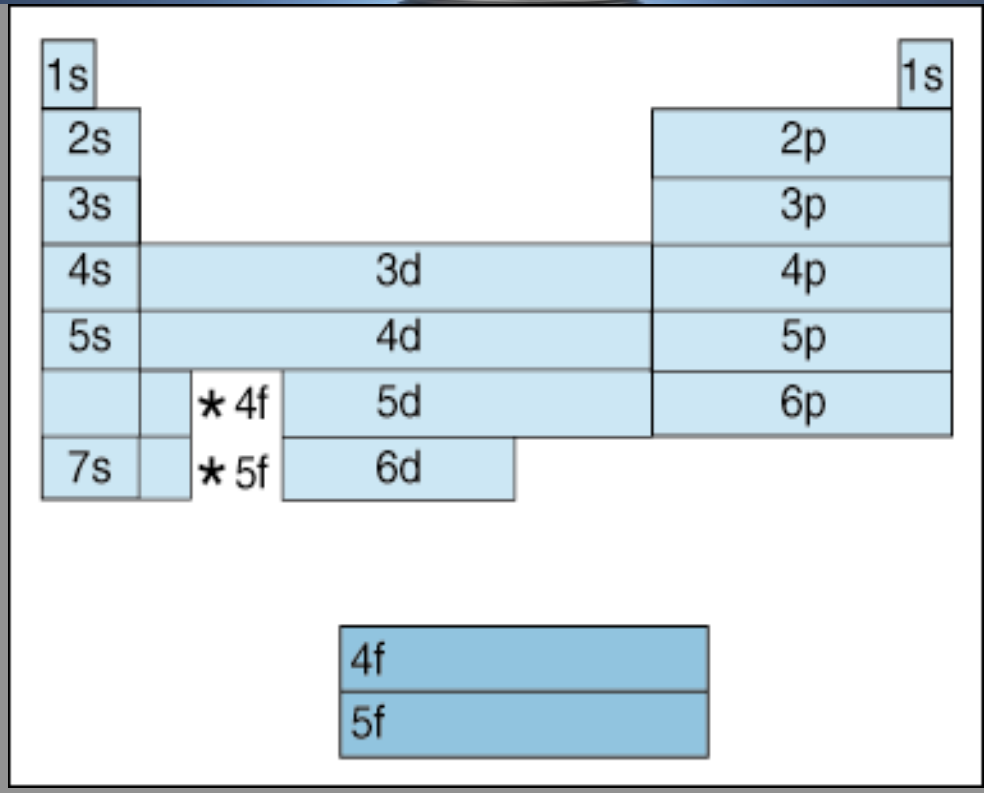
Energy Level

Sublevel

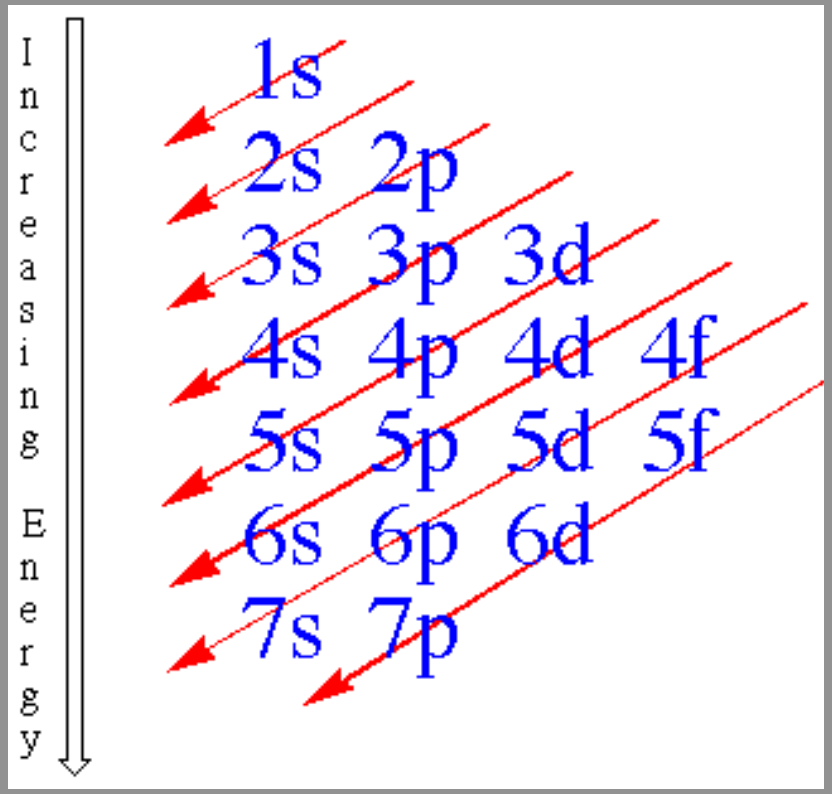
Electron Configuration

- Electron Configuration is ordered the way you read a book: from **left to right and top to bottom**

- Note that d orbital is 1 energy level behind and the f orbital is 2 energy levels behind the s & p orbitals



Electron Configuration



- Determine how many **electrons** in atom
- Fill **lowest energy** first (using Arrow Diagram)
- Stop when **sum of subscripts** is equal to electrons

The order: $1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^{10}$ $4p^6$ $5s^2$ $4d^{10}$ $5p^6$ $6s^2$ $4f^{14}$ $5d^{10}$ $6p^6$ $7s^2$ $5f^{14}$ $6d^{10}$ $7p^6$ etc.

Practice

- Hydrogen: $1s^1$
- Oxygen: $1s^1\ 2s^2\ 2p^4$
- Argon: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
- Copper: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9$