Electron Arrangements in Atoms (Quantum Mechanical Model of the Atom part II)

The quantum mechanical model describes the probable location of electrons in atoms by describing:

-Principal energy level

-Energy sublevel

-Orbital (in each sublevel)

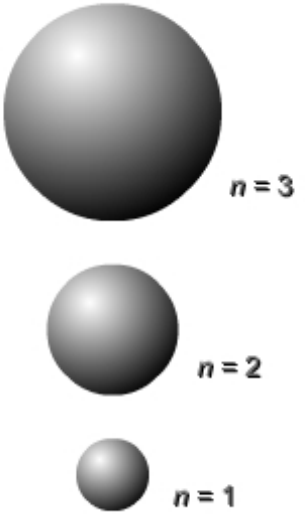
-Spin

Principal Energy Level (n)
-"shells"

Indicates the relative size and energy of atomic orbitals.

n=integers: n= 1, 2, 3, etc.

- As n increases:
  - > orbital becomes larger
  - > electron spends more time farther away from nucleus
  - > atom's energy level increases



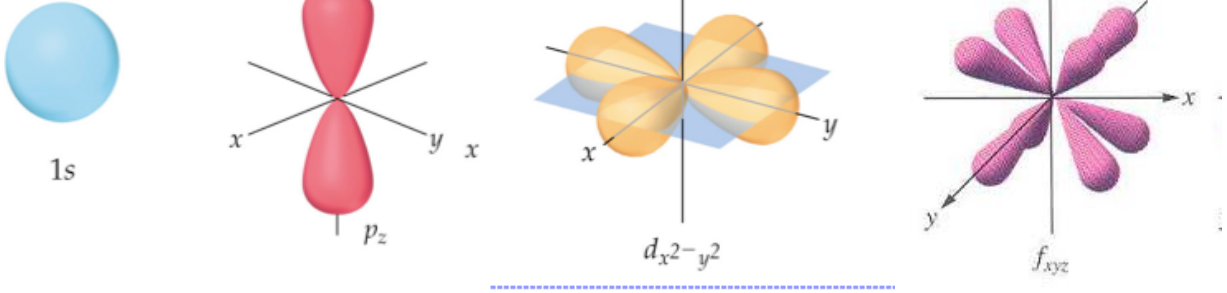
As the principle quantum number *n* increases, the size and energy of the orbital both increase, but the shape remains essentially the same.

http://www.chem.ox.ac.uk/vrchemistry/Machinery/html/page02.htm

Energy sublevel

Principal energy levels are broken down into sublevels.

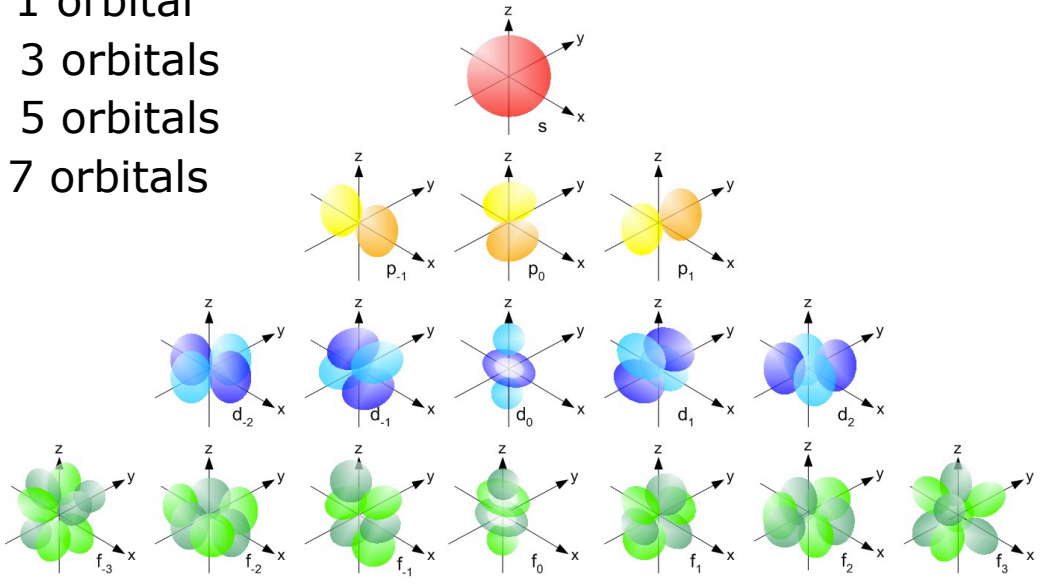
- Sublevels define the orbital shape (s, p, d, f)
  - > n=1, 1 sublevel (s)
  - > n=2, 2 sublevels (s, p)
  - > n=3, 3 sublevels (s, p, d)
  - > n=4, 4 sublevels (s, p, d, f)



Orbitals (in each sublevel)

Each sublevel has a different number of orbitals.

- s: 1 orbital
- p: 3 orbitals
- d: 5 orbitals
- f: 7 orbitals

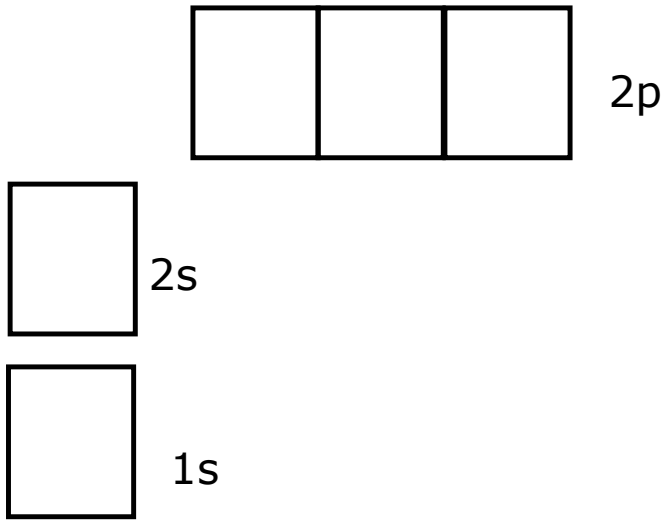


http://edtech2.boisestate.edu/lindabennett1/502/Periodic%20Table%20e%20config/electron%20configuration.html

Spin

Electrons act like they are spinning on an axis

- Generates a magnetic field
- No two electrons in the same orbital can have the same spin



Summary:

TABLE 5.1 Sublevels of the first four energy levels

Principal energy level	*Sublevel*	*Number of orbitals in sublevel*	*Total possible occupying electrons*	
1	*s*	1	2	
2	*s*	1	2	8
	p	3	6	
3	*s*	1	2	18
	p	3	6	
	d	5	10	
4	*s*	1	2	32
	p	3	6	
	d	5	10	
	f	7	14	

In each principal energy level, there are n^2 orbitals.

In each principal energy level, there are a maximum of $2n^2$ electrons.

Electron configuration notation:

List all sublevels in order of filling.

Example:

Na:

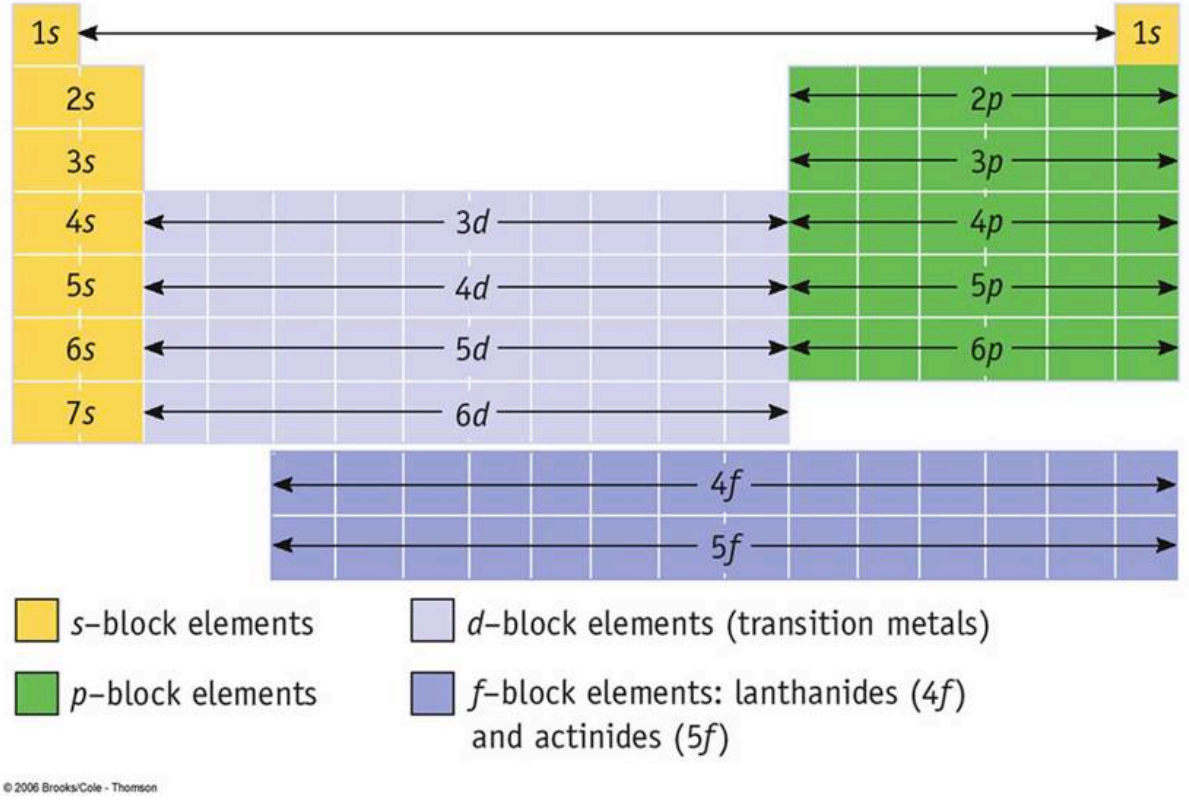
Noble-gas notation:

Like a short cut! Put noble gas of previous period (row) in brackets, and then write electron configuration for for the energy level being filled.

Example:

The Periodic table is organized into 4 blocks.

The 4 blocks correspond to the filling of the 4 quantum sublevels: s, p, d, f



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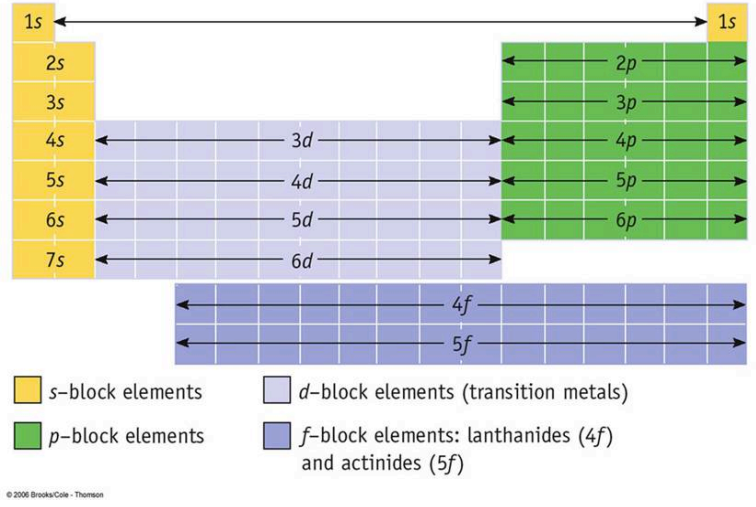

Lets practice.

Write the electron configuration and noble gas notation for:

Selenium

Argon

Boron

Manganese

Exceptions to Predicted Electron Configuration

-We follow 3 rules to fill out the electron arrangement in orbiatls:

1. Aufbau principle
2. Pauli exclusion principle
3. Hund's rule

However, some elements are exceptions:

1. Cr: $[Ar]4s^{1}3d^{5}$
2. Cu: $[Ar]4s^{1}3d^{10}$

Exceptions to Predicted Electron Configuration

- Electron filling is out of order for groups 6 and 11
  - > s electron moves to the d sublevel in order to half fill or completely fill the d sublevel
  - > Half or completely full sublevels are more stable and therefore, at a lower energy level

Valence Electrons

-Electrons that are in the highest principal energy level of an atom

*electrons in outermost orbitals

*Usually s or p orbitals

-These electrons are involved with forming chemical bonds.

Which electrons are the valence electrons in:

Selenium

Argon

Boron

Manganese

Electron-dot diagram or electron-dot structure

Consists of-

1. Element's symbol: Represents nucleus and inner-level electrons (core electrons, or non-valence electrons)

2. Dots representing the atom's valence electrons

-Place dots one at a time on 4 sides of symbol before pairing.

Example:

Chlorine

Practice

Write the electron configuration notation, noble gas notation, and electron-dot diagram for

Carbon

Titanium

Silicon

Iodine

Zirconium