Electronic Structure of Atoms

- Electrons in an atom are found "zipping" around the nucleus to which they are attracted. These electrons are found "zipping" around in certain areas or orbitals.

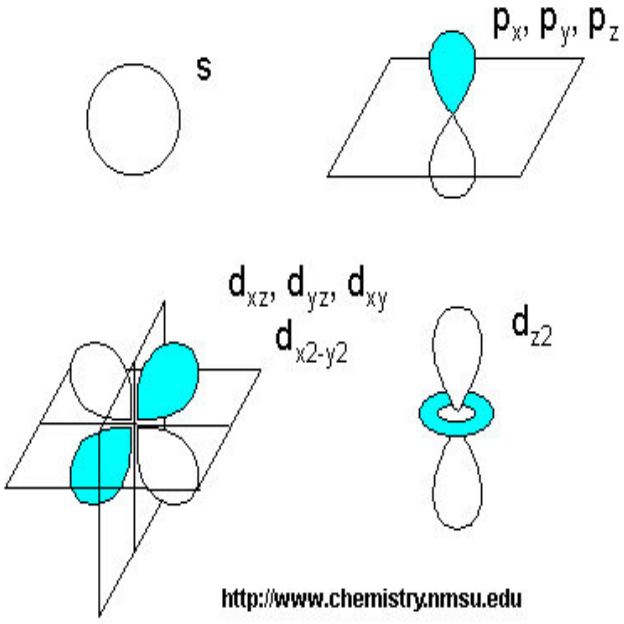
- When an atom is hit by light or other energy it reflects this energy back. If this energy that is reflected is run through a prism the energy will be split into different color bands. These bands are called a "line spectrum". These bands are created as different colors of light have different amounts of energy. Atoms will reflect back different colors depending on the type of atom. Each atom has a different amount of electrons that are in different orbitals around the nucleus. It is the number of electrons and which orbital they are in that causes the unique bands of colors.

- An _____ is the region of space around a nucleus where electrons are found. There are many orbitals for each atom.

- A _____ is the set of orbitals occurring at the same energy level.

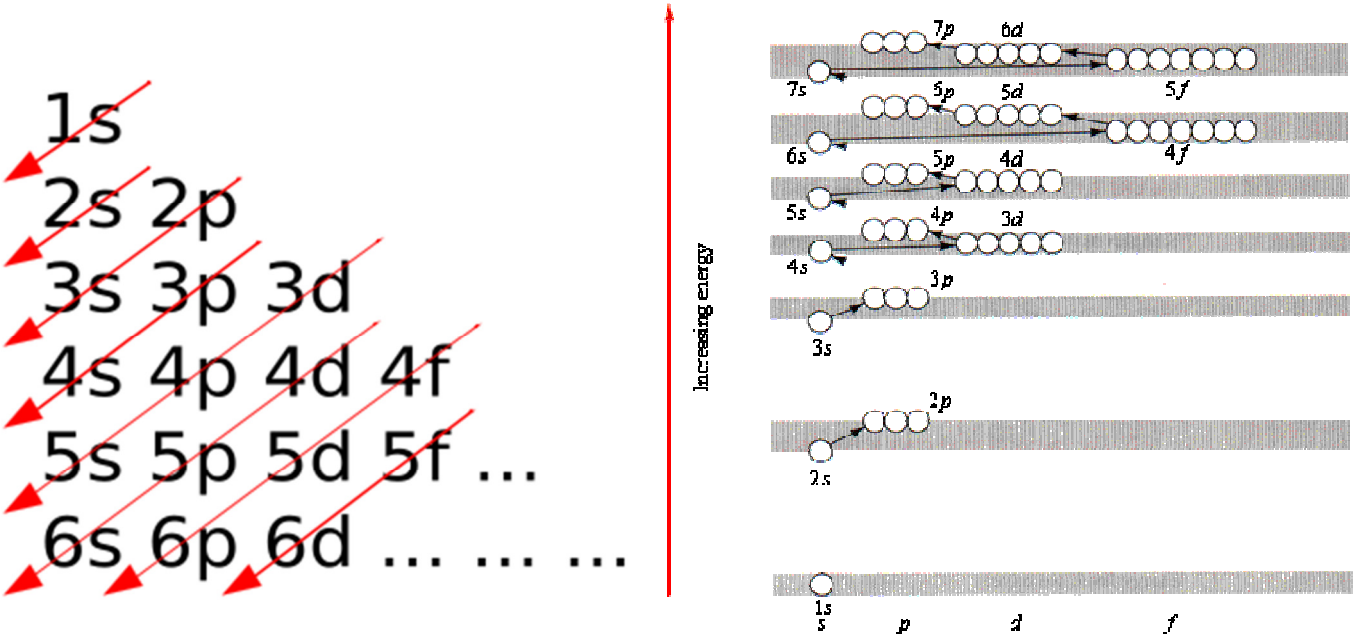
- A _____is a set of orbitals of the same shape (type).

- Each orbital has a different shape and has been designated a letter so we can describe which orbitals have electrons in them for a given atom. The four types are s-type, p-type, d-type and f-type. Each of these orbital shapes may exist at increasing levels of energy.



- As we move from left to right on the periodic table the number of protons and electrons increases by one each time. Where these electrons will be found around the nucleus follows 3 rules;

1.) Aufbau Principle - electrons are always added to the lowest energy levels first. Once these energy levels are full then the electrons will fill higher levels.



2.) Pauli Exclusion Principle – a maximum of 2 electrons can fit into each orbital. To fit into the same orbital (remember - like charges repel) the electrons must spin in opposite directions. This is called 'spin pairing' or just 'paired' for short. Thus there is a maximum of:

2 electrons in an s-type subshell	◯
6 electrons in a p-type subshell	◯◯◯
10 electrons in a d-type subshell	◯◯◯◯◯
14 electrons in a f-type subshell	◯◯◯◯◯◯◯

3.) Hund's Rule – electrons occupy equal-energy orbitals so that a maximum number of unpaired electrons results. This rule helps with p and larger subshells like so. Using Hund's rule we would place 1 electron into all three orbitals of the p subshell before spin pairing each orbital to fill the subshell with 6 electrons. Remember electrons have a like charge and as such will not share an orbital (be close together) unless they need to.

- All of this information allows us to track where the electrons for each atom are found. This is called the electron configuration.

Ex.1 –

Ex. 2 –

Ex. 3 –

- If we follow this pattern using the chart above for something like fluorine which has 9 electrons we would get $1s^2 2s^2 2p^5$.

- The picture of the periodic table on the bottom of your handout shows where the outermost electrons are filling for each area of the periodic table.

Core Notation

- Chemists love short cuts as we are inherently lazy. So, they came up with a short form for writing electron configurations. This short form is called core notation.

- Core notation is writing the electron configuration starting from the nearest NOBLE GAS ("core") that is lower than the element being written and doing electron configuration for the "outer" electrons only.

Ex.1 – Aluminum → standard electron configuration = Al ($1s^2 2s^2 2p^6 3s^2 3p^1$)

"core" "outer"

→ core electron configuration = Al ([Ne] $3s^2 3p^1$)

core outer

Ex. 2 – Rubidium standard =

core =

- A half-filled or filled d-subshell has extra stability. As such, atoms will cheat. If they have 4 or 9 electrons (both are 1 short of half or full) in the d-subshell they will steal an electron from the s sub-shell and put it in the d sub-shell. Chromium and copper do this. Let me show you.

  Cr ([Ar] $4s^2 3d^4$) is one short of having half of the d-subshell full.

  Cu ([Ar] $4s^2 3d^9$) is one short of a full d-subshell.

  Below is what copper and chromium really do. The above is NOT CORRECT!!!!

  Cr ( ) is now half-full in the d-subshell and more stable.

  Cu ( ) is full in the d-subshell and more stable.

Ion Core Notation

- Ions have less or more electrons than the neutral atom. To write electron configurations then we need to add or remove electrons properly to the notation.

  1.) Negative ions (anions) – add electrons to the last unfilled subshell.

  2.) Positive ions (cations) – electrons are removed following this order from first to last

  p-electrons → s-electrons → d-electrons

  Ex. – Tin = Sn ( )

  Tin^{2+} = Sn ( )

  Tin^{4+} = Sn ( )

- Valence electrons are the electrons in the outermost subshells that are able to take part in chemical reactions.

- In electron configuration notation the valence electrons are the electrons found in the OUTERMOST s-type and p-type subshells or d-type and f-type WHEN THEY ARE UNFILLED ONLY!!!