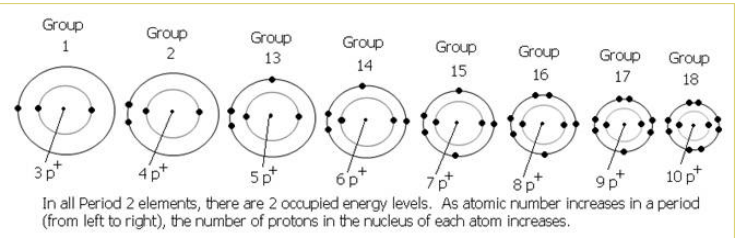
Periodic Trends

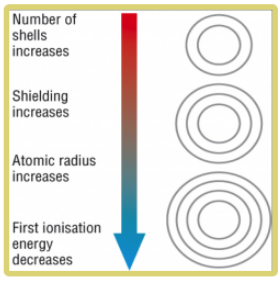
Effective Nuclear Charge-
As you go across a period (L to R) the # of proton increases; each element gains a proton. This increases the attraction of the electrons(negative) to the nucleus (positive).

The electrons get pulled closer as you go across.



In all Period 2 elements, there are 2 occupied energy levels. As atomic number increases in a period (from left to right), the number of protons in the nucleus of each atom increases.

Shielding Effect-
As you go down the groups (top to bottom),
each atom gains a new shell or energy level.
There are more shells between the nucleus and the outer electrons. The shells are further from the nucleus. The nucleus is not able to attract the electrons as strongly.



High IE - anion

Low IE - cation

Cation smaller

Less electrons

Less repulsions in e- cloud

Na $1s^2 2s^2 2p^6 3s^1$

Na^+ $1s^2 2s^2 2p^6$

anion larger

gain e⁻, more repulsions

F $1s^2 2s^2 2p^5$

F^- $1s^2 2s^2 2p^6$

Note* there are always exceptions to the trends we will cover. The noble gases specifically do not always follow the trends.

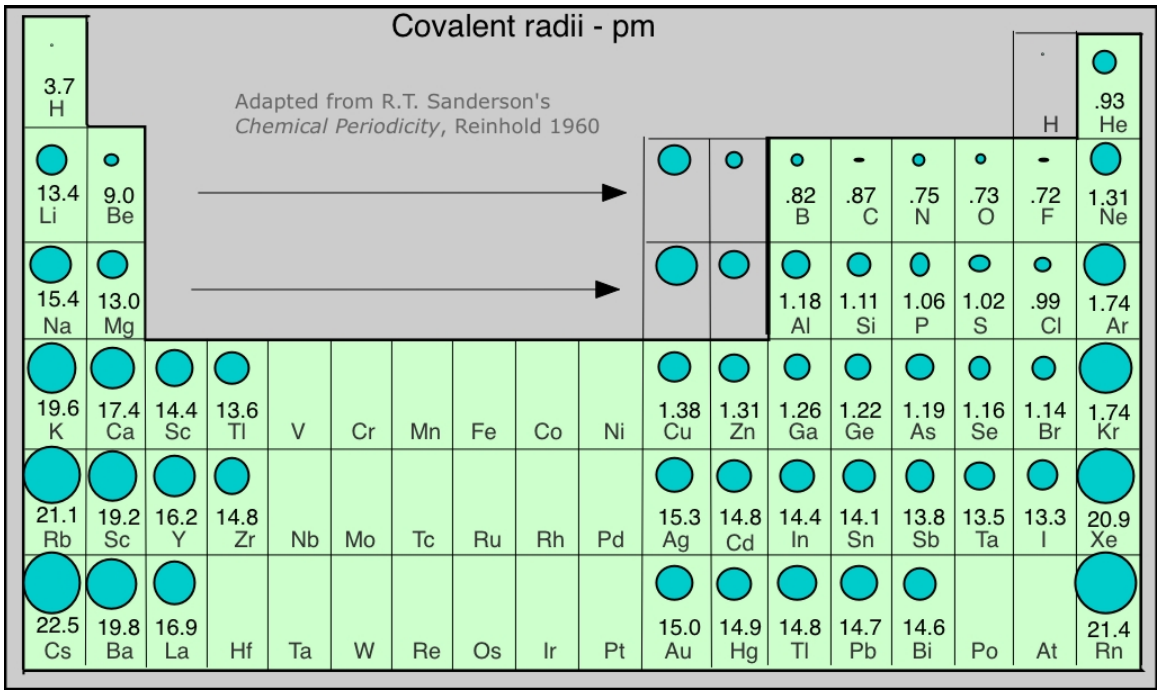
Atomic Radius- a measure of the distance from the nucleus to the outermost electron orbital.

TREND- from left to right across a period it decreases

Down a group or family it increases

WHY?

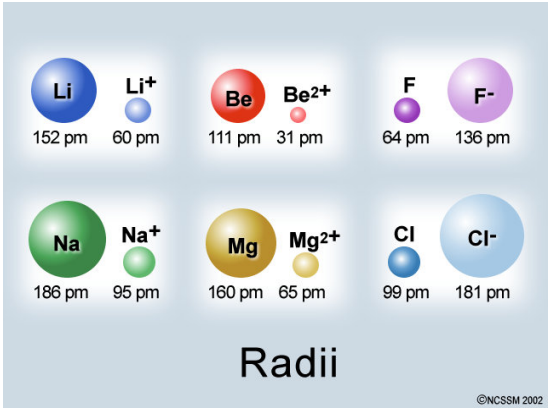
- Across a period the increase # of protons pulls the electrons closer
  Down a group the increasing # of electron shells increases the distance from the nucleus.


Covalent radii - pm
Adapted from R.T. Sanderson's
Chemical Periodicity, Reinhold 1960
3.7 H
H
.93 He
13.4 Li
9.0 Be
.82 B
.87 C
.75 N
.73 O
.72 F
1.31 Ne
15.4 Na
13.0 Mg
1.18 Al
1.11 Si
1.06 P
1.02 S
.99 Cl
1.74 Ar
19.6 K
17.4 Ca
14.4 Sc
13.6 Tl
V
Cr
Mn
Fe
Co
Ni
1.38 Cu
1.31 Zn
1.26 Ga
1.22 Ge
1.19 As
1.16 Se
1.14 Br
1.74 Kr
21.1 Rb
19.2 Sc
16.2 Y
14.8 Zr
Nb
Mo
Tc
Ru
Rh
Pd
15.3 Ag
14.8 Cd
14.4 In
14.1 Sn
13.8 Sb
13.5 Ta
13.3 I
20.9 Xe
22.5 Cs
19.8 Ba
16.9 La
Hf
Ta
W
Re
Os
Ir
Pt
15.0 Au
14.9 Hg
14.8 Tl
14.7 Pb
14.6 Bi
Po
At
21.4 Rn

Ion Size

When atoms lose electrons there is less repulsion in the electron cloud, the radius decreases. (Cations get smaller)

When atoms gain electrons there is more repulsion in the electron cloud, the radius increases. (anions get larger)

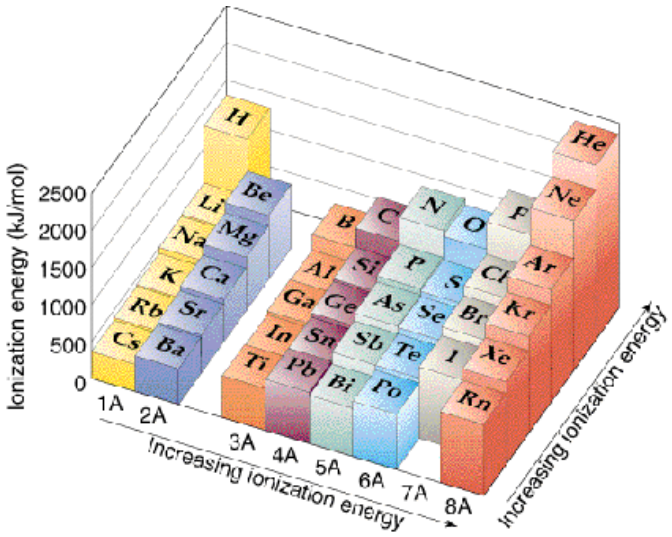


Ionization Energy -
The energy required to remove an electron from an atom.

The trend-
As you go across the period from left to right, ionization energy increases

As you go down a group from top to bottom, ionization energy decreases.
Why?As you go across the electrons are attracted more strongly to the more positive nucleus. This requires more energy to remove electrons.

As you go down the group the electron shells are further from the nucleus and are easier to remove because the nucleus has less of an attraction to the outer electrons


Ionization energy (kJ/mol)
2500
2000
1500
1000
500
0
1A
2A
3A
4A
5A
6A
7A
8A
Increasing ionization energy
Increasing ionization energy
H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
Ar
K
Ca
Ga
Ge
As
Se
Br
Kr
Rb
Sr
In
Sn
Sb
Te
I
Xe
Cs
Ba
Ti
Pb
Bi
Po
Rn

Electronegativity

The ability of an atom in a molecule to attract an electron to itself.

Trend-
As you go across a period, electronegativity increases.

As you go down a group, electronegativity decreases.

FLUORINE is the MOST ELECTRONEGATIVE ELEMENT ON THE PERIODIC TABLE!

Why?
As you go across elements get closer to having a full outer shell. These atoms really want to attract more electrons the closer they get to eight.
As you go down a group atoms have a hard time attracting electrons to themselves due to the large number of shells in the way.

Electron affinity
is the energy change when an atom gains an electron. As you go across the table this value becomes increasingly more negative. Due to energy being released.