Periodic Trends:

In this article we summarize various trends in periodic table for main elements (1A - 8A).

Trends for the transition metals, the lanthanides, and the actinides are not included.

Sizes of Atoms and Ions: (Neutral Atoms or Ions with the Same Charge)

- ## Size increases down the group.

Reason:

As you go down a column, electrons are filling orbital farther and farther out from the nucleus.

Each row adds a new shell. Outer electrons are shielded from the nucleus by electrons in inner shells; thus they are less tightly held (in spite of the much increased nuclear charge).

- ## Size decreases across a period:

In this case electrons are being added to the *same shell*. Thus they experience little additional shielding.

On the other hand, the nuclear charge of the atom increases with the atomic number.

Thus as you go across a row, the electrons are held more tightly and the size decreases.

Iso-electronic Series.

These are series of atoms and ions in which the number of electrons is the same, but the number of protons increases with the atomic number.

In this type of series, the size of the atom decreases as the number of protons increases.

The reason for the size decrease is that more protons are pulling in the same number of electrons.

Examples include the series below in which the largest member of the series is listed first:

$$10\ e^-\ \text{series:}\ \ Ne > Na^+ > Mg^{2+} > Al^{3+}$$

$$18\ e^-\ \text{series:}\ \ P^{3-} > S^{2-} > Cl^- > Ar$$

Cat-ion Size as Compared to Parent Atom:

The size *decreases* when cat-ions form. The effect is particularly pronounced when all the valence electrons are lost and only the noble gas core of electrons remains.

For example, the Mg^{2+} ion (65 pm radius) is considerably *smaller* than the Mg atom (160 pm radius).

An-ion Size as Compared to Parent Atom:

The size *increases* when anions form.

The added electrons are going into the same shell.

They repel each other and so the size increases. Thus the Cl^- ion (181 pm radius) is considerably *larger* than the Cl atom (99 pm radius).

Ionization Energies:

The ionization energy *I* is the minimum energy needed to remove an electron from the ground state of a gaseous atom

$$A_{(g)} \rightarrow\ .\ A^+_{(g)} + e^-$$

When first electron is removed from an atom or ion this is called as first I.P value or energy of element

Additional electrons can also be removed the removal of the second electron and third electron are called as second & third I.P values of the element. Ionization is always an endothermic process

The overall trends in ionization energy are opposite to those for atomic and ionic radii.

The more tightly electrons are held, the higher the ionization energy, and the smaller the atom or ion size. Some generalities are as follows:

- **Noble gases** *have the highest ionization energies of the atoms in each row.*
- **Alkali metals** *have the lowest ionization energies of the atoms in each row.*
- *In general, ionization energies increase as we move across a Period,*

But there are a few local ups and downs. Dips occur with the loss of the first and the fourth p electron: Thus in the second row, there are dips for boron and for oxygen.

- The ionization energy decreases for atoms as you go down a column.

Higher ionization energies are always larger than lower ionization energies:

First ionization potential < Second ionization potential < Third ionization potential

A huge jump occurs in the value of ionization potential when first pull an electron out of the noble gas core.

Electron Affinity:

The electron affinity *E.A* is the energy *released* when an electron is added to a gas-phase atom (or ion) of the element.

The sign convention shows,

The process is exothermic, ΔH = -Ve, if the process is endothermic than ΔH = +Ve

$$A_{(g)} + e^- \rightarrow . A^-_{(g)} \qquad \Delta H = -Ve$$

While ionization energies are always positive numbers, electron affinities can be either positive or negative.

The halogens have the most positive electron affinities of all the elements.

Electro-negativity:

The electro-negativity is a measure of the ability of an atom to attract the shared pair of electron itself in a molecule

Elements that readily form negative ions have high electro-negativities,

While a low electro-negativity correlates with the tendency to lose electrons and form positive ions.

Values of electro-negativity ranges from a high of 4.0 for F to a lower value of 0.7 for Cs

In general electro-negativities increase diagonally from the lower left (Cs) to the upper right (F) of the periodic chart.

In practice,

Chemists use electro-negativities far more than ionization energies or electron affinities.