

# IONIZATION ENERGY

In contrast to EA, the ionization energy of an element is the energy it takes to *remove* the outermost valence-shell electron from the atom — that's the easiest electron to remove.

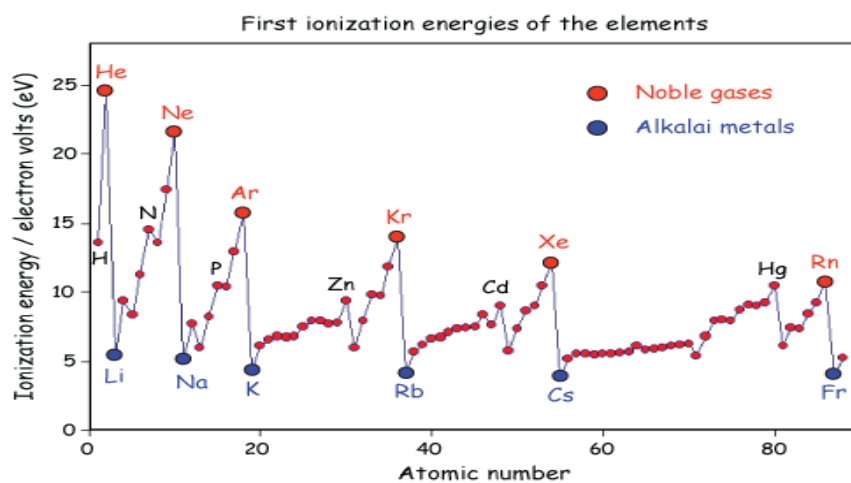
Strictly-speaking, we should say "first ionization energy" because there are also second, third ... and so on ionization energies, the energy required to remove the second electron, the third, and so on. We'll concentrate here on the first.

You might want to think back to our study of electrons and the **photoelectric effect** to help you understand ionization energy. For example, if we perform experiments in which we fire a laser at, say, a beam of gas-phase atoms, there is a threshold frequency (remember that frequency is directly proportional to energy) of light that will detach an electron. No lower energy will get the job done, and with higher frequency light, the electron will just speed away faster after it detaches from the atom.

As you might expect, the first ionization energy follows the electronegativity and electron affinity trend, except that the noble gases fit right in this time; they have the *highest* ionization energies. The tighter an electron is held, the more difficult it is to remove.

In the figure below, the ionization energies (in units of electron-volts, eV) are plotted against atomic number of the elements. Notice that ionization energy increases across each period of the table, culminating with the noble gases, which bind that last electron the most tightly. Notice that the alkali metals (Li, Na, K, Rb, Cs and Fr) are the easiest to ionize, and recall that these atoms mainly exist as +1 cations.

Notice also that there are some other "islands" of stability. Nitrogen (N) and phosphorus (P) have half-filled valence p-subshells, which appears to make them a bit more stable than their near-neighbors on the periodic table. Likewise, Zn, Cd and Hg all have full outer d-subshells.



Adapted from Chemistry, the Central Science, 2<sup>nd</sup> ed., Brown & LeMay (Prentice Hall)

Source: <http://www.dracruz.com/PeriodicTrends.html>