Chem 1010/1800 Tip Sheet

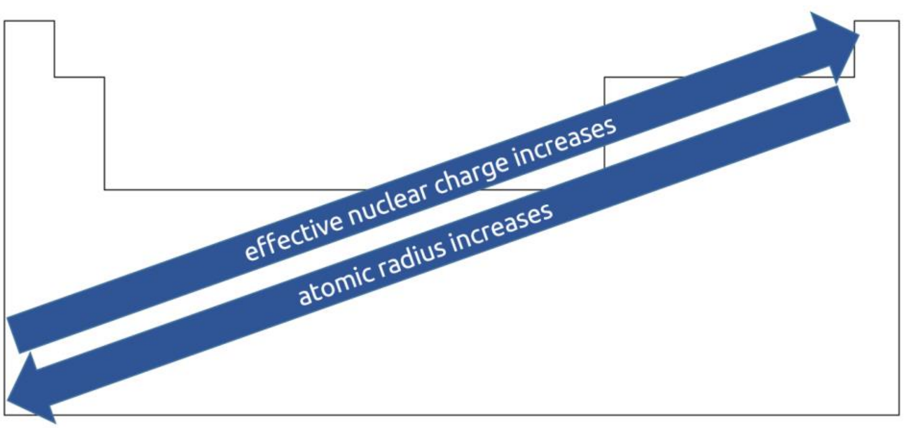
Periodic Trends

The periodic table is organized in an incredibly simple way: in order of increasing atomic number, with new rows beginning when the valence shells become full. Despite how uncomplicated this is, a vast amount of information can be inferred from the periodic table. We can use these periodic trends to predict relative atomic size, reactivity, and more – just by looking at where an element appears on the periodic table!

1) Atomic Radius and Effective Nuclear Charge (Z_{eff})

Atomic radius: a measure of an atom's size, using the distance from the centre of the nucleus to the outermost electron shell.

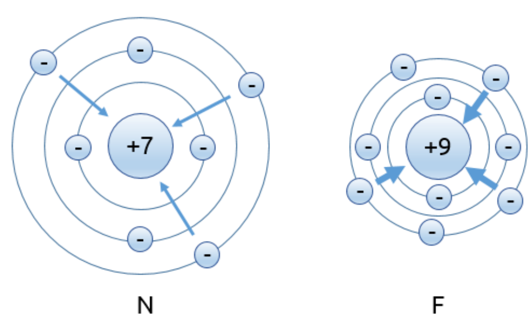
Effective nuclear charge (Z_{eff}): the net positive charge that an electron experiences from the atom's nucleus. When Z_{eff} is large, an electron will be more attracted to the nucleus, which decreases the atomic radius.



As we go up and to the right on the periodic table, atomic radius decreases while Z_{eff} increases. The two have an inverse relationship with each other, as shown to the left.

This relationship seems a bit counterintuitive, since we expect atomic size to only go up as the number of protons and electrons increase.

However, electrons are pulled more strongly toward the nucleus when there are more protons. The image on the right shows that fluorine is smaller than nitrogen despite having two more protons and two more electrons. Since fluorine's nucleus has a larger positive charge, the outer electrons are held more closely to it, which makes the atomic radius smaller.



2) Ionization Energy, Electron Affinity, and Electronegativity

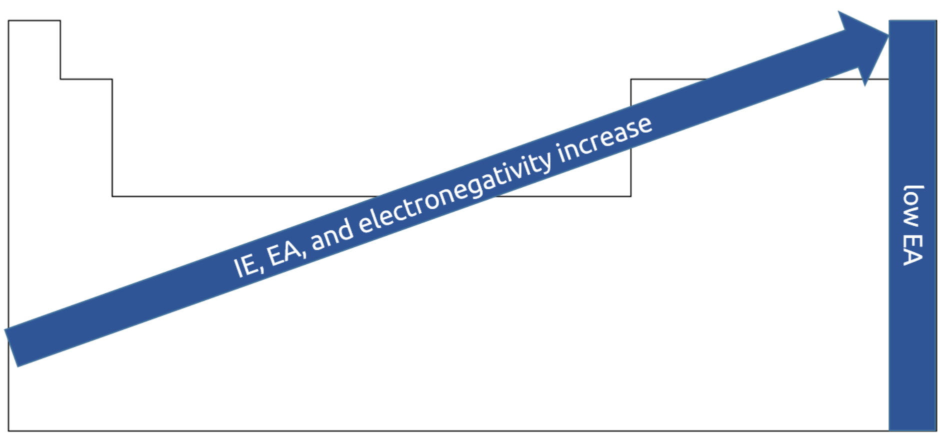
Ionization energy (IE): the energy required to remove one electron from the valence shell of a gaseous atom.

$$e.g. \qquad M_{(g)} \rightarrow M^{+}_{(g)} + e^{-}$$

Electron affinity (EA): the energy released or spent when an electron is added to a gaseous atom.

$$e.g. \qquad X_{(g)} + e^{-} \rightarrow X^{-}_{(g)}$$

Electronegativity: the ability of an atom to attract bonded electrons toward itself in a covalent bond.



When Z_{eff} is large, electrons are held more tightly to the nucleus. This makes it harder to remove an electron from the valence shell of an atom. Therefore, IE and Z_{eff} have the same periodic trend of increasing as we go up and to the right on the periodic table.

EA also follows this trend, because electrons will me more attracted to an atom with a higher Z_{eff}. However, this excludes group 18 (the noble gases), as these elements already have a complete valence shell and do not want to accept any more electrons.