

Trends in the Chemical and Physical Properties of the Elements

Atomic Size

atomic radius: - increases down a group in general (outer e^- further from the nucleus as they are in higher energy levels but the effective nuclear charge does not greatly increase down a group, so e^- spread out more).
- decreases across a period in general (outer e^- are in same shell but the nuclear charge and the effective nuclear charge increases across a period, so e^- are pulled closer to the nucleus).

negative ion: - larger than corresponding neutral atom (more interelectron repulsion).

positive ion: - smaller than corresponding neutral atom (less interelectron repulsion).
{much smaller if all e^- from outer shell are removed}.

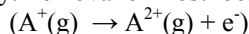
isoelectronic series (same number of electrons):

- the more positive the charge, the smaller the ion (same # e^- but different # protons; the more protons, the greater the nuclear charge and the more closely the e^- are pulled in, so the smaller the size).

Ionization Energy = - the energy required to remove the most loosely-held e^- from an isolated, gaseous atom in its ground state.

a) first ionization energy: removal of most loosely-held e^- ; ($A(g) \rightarrow A^+(g) + e^-$)

b) second ionization energy: removal of most loosely-held e^- from $1+$ ion;



greater than first ionization energy because the e^- is being pulled from a positive ion

c) etc. for third, fourth, ionization energies

- generally decreases down a group (outer e^- further from the nucleus on the average but the effective nuclear charge does not greatly increase down a group).

- generally increases across a period (outer e^- in same shell but increasing effective nuclear charge "pulls in" e^- more strongly).

- 2 major exceptions:

1. beginning of a new subshell; Group 13 or IIIA

2. onset of pairing in a p subshell; Group 16 or VIA

- generally e^- in the highest shell (largest value of n) are removed first even though they are not the "last added" in the *aufbau* process.

Example Fe: $[Ar]4s^23d^6$; Fe^{2+} : $[Ar]3d^6$; Fe^{3+} : $[Ar]3d^5$

Electron Affinity: - the energy released (usually) when an e^- is added to an isolated, gaseous atom.

- same general trends as ionization energy, but more exceptions (often nearly constant down a group).

Electronegativity: - generally increases across a period and decreases down a group.

Nonmetallic Character: - increases across a period and decreases down a group.

Metallic Character: - decreases across a period and increases down a group.