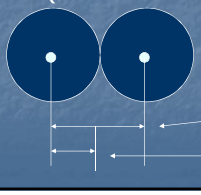
Periodic Trends

What is a trend?

- A trend is a predictable change in a particular direction.
- Trends include atomic radius (size of an atom), ionic radius, ionization energy, electronegativity, electron affinity, metallic character, melting point, boiling point, reactivity, etc.

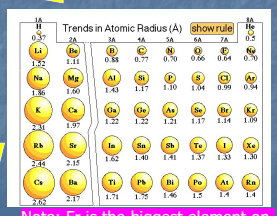
Atomic Radius
(size)

- Atomic radius is not determined by measuring the radius of one atom, but 1/2 the distance between 2 adjacent nuclei (internuclear distance)



Atomic Radii Trends

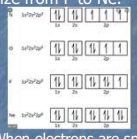
- Atomic radii decrease as you move to the right in a period because there are more protons (effective nuclear charge) to attract the valence electrons.
- Atomic radii increase as you move down a group because there are more shells (layers) and the shells shield the effective nuclear charge (protons) from attracting the valence electrons.



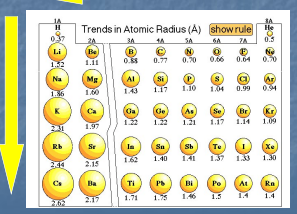
- Note: Fr is the biggest element on the periodic table! ☺

Atomic Radii Trend Exceptions

- Note the increase in size from F to Ne.

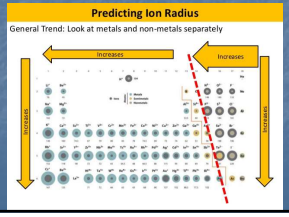


- When electrons are spin-paired, the 2 electrons in the orbital spin in opposite directions causing electron-electron repulsion which makes them not to want to attract to protons and the atom size increases.



Ions

- Metals lose valence electrons making them lose an entire shell so cations are smaller than initial atoms.
- Non-metals gain valence electrons which causes orbitals to have many orbitals with spin-paired electrons which have electron-electron repulsion causing the anions to be larger than the initial atoms.
- Ionic radii decrease across the period and increases down the group



Ionic Radius Trends

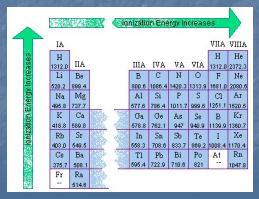
- Metals (form cations)
  - Ionic radius decreases from left to right.
  - Ionic radius increases down the chart
- Non-metals
  - Ionic radius decreases from left to right
  - Ionic radius increases down the chart
- HOWEVER:
  - Anions are larger than cations since cations lost an entire shell to become an ion
  - Decrease across the row, until you reach anions

Ionization Energy

- The ionization energy is the energy required to remove an electron from an atom or ion *(only metals want electrons removed…right?)*
  - A + ionization energy = $A^+ + e^-$
  - neutral atom = cation + electron

Ionization Trends

- Ionization energies increase to the right in a period. (more effective nuclear charge (protons) means valence electrons are more attracted and harder to remove)
- Ionization energies decrease down a group. (it's easier to remove valence electrons when there are more shells that shield the protons from attracting the valence electrons)



Ionization Energy Trend Exceptions

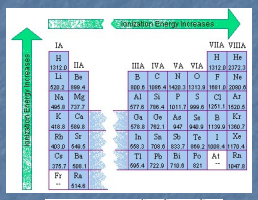
- Be→B

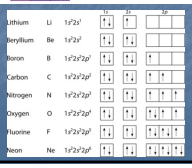
Should increase b/c more protons but decreases. Be has spin paired electrons that have electron–electron repulsion making them not as attracted to protons and easier to remove. B has a singular 2p electron that is strongly attracted to protons so harder to remove.

- N→O

Should increase b/c more protons but decreases. N has 3 singular electrons that are very attracted to protons and hard to remove. O has a 2p orbital that has electron-electron repulsion making it not as attracted to protons so easier to remove valence electrons

Do you see any other similar exceptions?





Electron Affinity

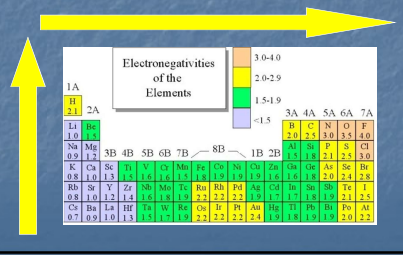
- The energy change that occurs when a neutral atom gains an electron is electron affinity *(only non-metals want electrons …right?)*
  - $A + e^- +$ electron affinity = A^-
  - neutral atom + electron = anion

Electronegativity

- Electronegativity is the measure of an atom in a chemical compound to attract electrons
- Linus Pauling created a chart of electronegativity values

Electronegativity Trends

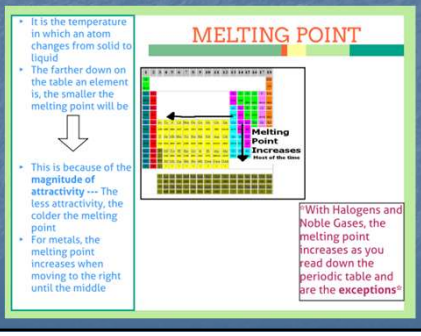
- Electronegativity decreases as you move down a group and increases across a period



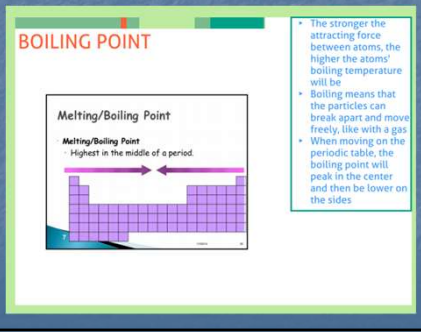
Summary of Periodic Table Trends

- Moving Left → Right
  - Atomic Radius ↓
  - Ionization Energy ↑
  - Electron Affinity ↑
  - Electronegativity ↑
- Moving Top ↓ Bottom
  - Atomic Radius ↑
  - Ionization Energy ↓
  - Electron Affinity ↓
  - Electronegativity ↓

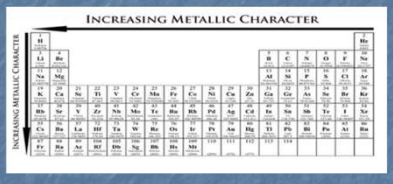
Other less common trends: melting pt.



Other less common trends: boiling pt.



Other less common trends: metallic character



The bigger the metal atom, the more the electrons in the sea of electrons are free to move around (not as attracted to protons) and the more metallic a metal becomes.

Other less common trends: reactivity