Periodic Trends

Atomic Radius, Ionization Energy, Electron Affinity, and Electronegativity

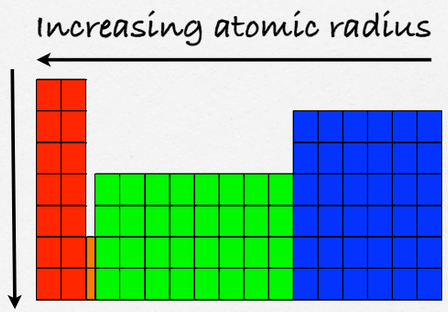
Atomic Radius

- Half the distance between nuclei of 2 atoms of the same element
- Measured in picometers (1pm = 10^{-12}m)

The Trend:

1) Decreases from left to right across a period
   - ☑ stronger pull from increasing # of protons
2) Increases from top to bottom in a group
   - ☑ Each energy level places electrons further from the nuclear pull

Follow the arrows

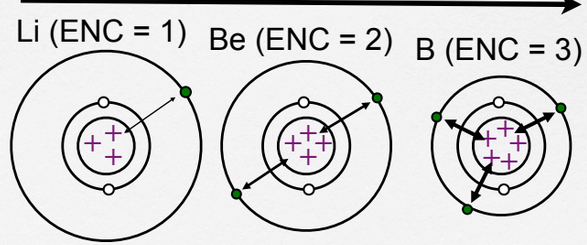


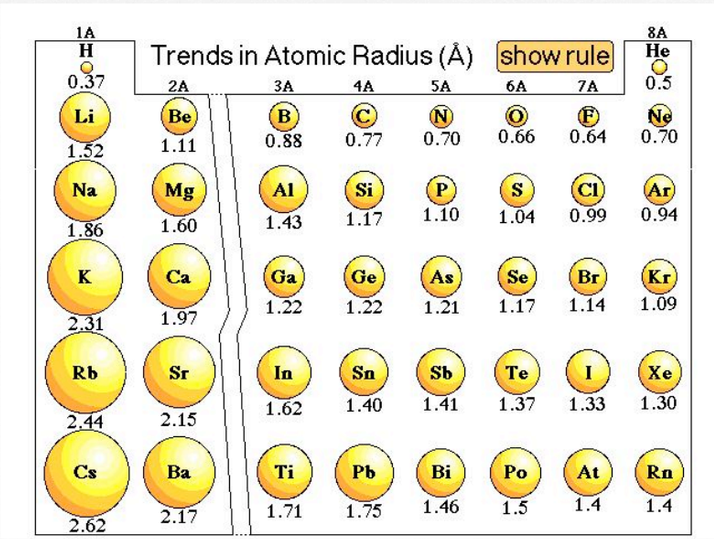
Decreasing atomic size

Effective Nuclear Charge (ENC) exerts a pull on the valence electrons

ENC = # of protons - # of core electrons

Decreasing atomic radius



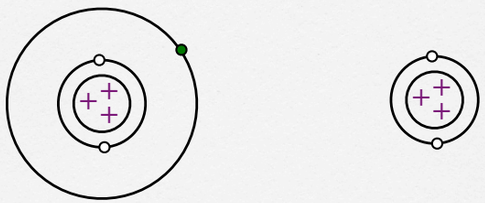


Ionic Radius

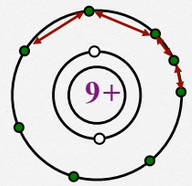
- Positive Ion (Cation):
  - Drop one energy level, therefore decreasing the radius
- Negative Ion (anion):
  - radius increases due to electron-electron repulsion

Cations: One less energy level

lithium (Li) lithium ion (Li^+)

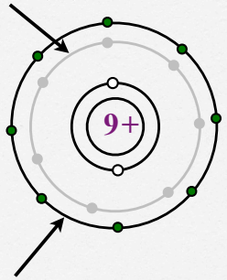


Anions: Electron-Electron Repulsion



Electron-Electron Repulsion

Therefore, Flourine (F)



Is smaller than it's ion (F^-)

Ionization Energy

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

Amount of energy required to remove an electron from the atom or ion in the gaseous state

The Trend:

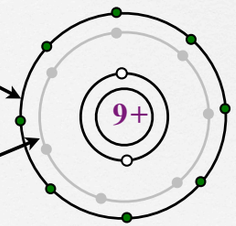
1) Decreases as you move down a group
   - ☑ further from nucleus, therefore less energy to pull it away
2) Increases from left to right across a period
   - ☑ higher ENC as we add more protons

Second Ionization Energy

- ☐ it's always harder to remove a second electron because you decrease AR as you remove the first electron = less electron-electron repulsion

from this

to this



Electron Affinity

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

- The energy change from a gaseous atom accepting an electron
- Increases as we go across a period (L to R) and decreases as we go down a group.
- Why?
  - Inversely related to atomic radius
    - Smaller radii allow the positive nucleus to attract nearby electrons

Electronegativity

- Pauling's way of combining ionization energies and electron affinity
- Increases across a period (L to R)
- Decreases down a group
- Why?
  - Again, AR. Smaller atoms have more pull on electrons = electronegative (top right: Fluorine, bottom left: Francium)

Summary

When AR Increases (down a group)

- Electrons are far from the nucleus, therefore ionization energy is LOW
- Electron affinity is also LOW, because the nuclear pull for electrons is well shielded (by distance and other electrons from lower levels)
- Electronegativity is LOW b/c the above 2 are low

Summary

When AR Decreases (across a period, L-R)

- Electrons have stronger pull from the nucleus, therefore ionization energy is HIGH
- Electron affinity is HIGH because there is little shielding from electrons – the nucleic pull is stronger
- Electronegativity is HIGH because the above 2 are HIGH

Homework

- P. 58
  - # 1 - 6 a - d
- P. 59 (sect 1.5 questions)
  - # 2 a & b
  - #3 a
  - #4
  - #5
  - #6 a - d