

Chemistry Notes 10/23/13

Which is larger?

1. S or O?
 - a. S
2. H or H?
 - a. H

Ionization Energy (Ei)

- The amount of energy required to remove the highest energy electron from an isolated, neutral atom in its gaseous state
- Group 1A has the lowest Ei (meaning it's easy to remove e⁻)
 - Ei generally **increases** as you move into higher groups (nonmetals tend to gain electrons rather than lose, and vice versa for metals)
 - Ei generally **decreases** as you move down periods (electrons are further away from the nucleus)
- Irregularities:
 - Beryllium's Ei = 899.4 kJ/mol
 - Boron's Ei = 800.6 kJ/mol
 - Why does this happen?
 - Be: $1s^2 2s^2$
 - B: $1s^2 2s^2 2p^1$
 - Easier to remove electrons from higher shells
 - Nitrogen has a larger Ei than oxygen... Why?
 - N: $1s^2 2s^2 2p^3$
 - O: $1s^2 2s^2 2p^4$
 - Nitrogen has a half filled p subshell, versus oxygen which has a more unstable arrangement. In general, half-filled and fully filled electron shells are more difficult to remove electrons from.

Examples

1. Arrange Se, Cl, and S in order of increasing Ei:
 - a. $Se < S < Cl$

Removing a 2nd, 3rd, or higher electron is possible, but requires more energy

- $E_{i2} \gg E_i$
- Sodium's $E_i = 496 \text{ kJ/mol}$
 - Sodium's $E_{i2} = 4562 \text{ kJ/mol}$
 - It is ten times more difficult to remove a second electron in this situation, why?
 - Na: $1s^2 2s^2 2p^6 3s^1$
 - Have to remove electrons from a full shell
- Magnesium's $E_i = 738 \text{ kJ/mol}$
 - Magnesium's $E_{i2} = 1451 \text{ kJ/mol}$
 - Mg: $1s^2 2s^2 2p^6 3s^2$
 - Magnesium has a full shell left after removing electrons

Examples

1. Which would expect to have the higher 3rd ionization energy (E_{i3}); Be or N?
 - a. Be: $1s^2 2s^2$
 - b. N: $1s^2 2s^2 2p^3$
 - c. Beryllium would expect to have the highest E_{i3}
 - i. Have to remove electrons from a full shell in Beryllium
2. Which would expect to have the higher E_{i5} ; Ge or As?
 - a. Ge: $[\text{Ar}] 4s^2 3d^{10} 4p^2$
 - b. As: $[\text{Ar}] 4s^2 3d^{10} 4p^3$
 - i. Remove electrons from the higher shells first...
 1. The 5th electron would be removed from a full shell for Ge, whereas the 5th electron for As would be removed from a practically empty shell

Electron Affinity (E_a , or E_{ea})

- The energy change that occurs when an electron is **added** to an isolated atom in its gaseous state
 - The value is generally **negative** (energy is released)
- The more negative the E_a , the greater the tendency for the atom to accept an e^-
 - Halogens (7a) generally have the most negative value
- E_a is considered zero or greater than zero if the atom will **not** accept an electron
 - Noble Gases (8a) and Alkali Metals (2a)

Examples

1. Why does Nitrogen have a less favorable (more positive) E_a than Carbon or Oxygen?
 - a. Nitrogen has a half filled shell, which is more stable than with an extra e^-

Ionic Bonds

- Positive ions form from atoms with small ionization energies (metals)
- Negative ions form from atoms with more negative electron affinities (non-metals)