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Chemistry Notes 2: Periodic Trends

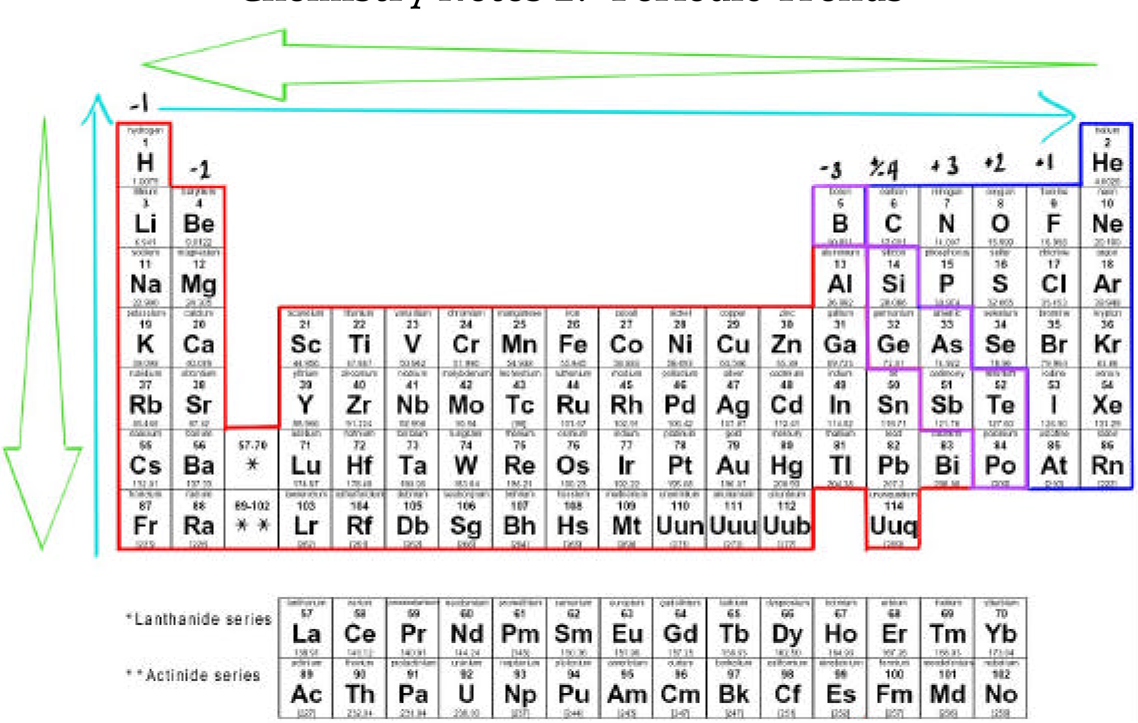

Figure 1: Green arrow represents the increase/decrease in Atomic Radius and Metallic Character. Blue arrows represent Effective Nuclear Charge, Ionization Energy, Electron Affinity, and Electronegativity.

EFFECTIVE NUCLEAR CHARGE

- The attractive force between the nucleus and the valence electron(s) of an atom
- Increases across the period
  - o The atomic number increases from left to right because of the increase of protons
  - o The increased amount of protons creates a stronger attractive force between the protons and valence electrons
  - o The number of energy levels does not change across a period – therefore there is no shielding effect that cancels out the attractive force
- Decreases down a group
  - o Core electrons repel each other, negating the effect of the increased number of protons

ATOMIC RADIUS

- Distance from the center of the nucleus to the highest energy level
- Decreases across a period
  - o Because effective nuclear charge increases across a period
  - o The attraction between the increased number of protons and electrons pulls the energy levels closer to the nucleus
  - o Therefore there is a smaller atomic radius

- Increases down a group
  - Because more energy levels are being added

IONIC RADII
- Cations
  - Smallest radius
  - Less negative charge from electrons
  - Therefore greater positive attractive force pulling the energy levels towards the nucleus
- Anions
  - Greatest radius
  - More negative charge from electrons
  - The increase of negative charge causes the electrons in the different energy levels to repel away from each other
  - Therefore greater negative repulsive force spreads energy levels apart

IONIZATION ENERGY
- Energy required to remove an electron from a gaseous atom to form a **cation**
- Depends on
  - Effective Nuclear Charge
  - Atomic Radius
  - Shielding effect
- Increases across a period
  - Due to the increase in effective nuclear charge
  - Stronger attraction between electrons and nucleus requires more energy to remove an electron
- Decreases down a group
  - Due to the increase in effective nuclear charge
  - Weaker attraction between electrons and nucleus requires less energy to remove an electron
- Formula:
  - $X_{(g)} + IE \rightarrow X^{1+}{}_{(g)} + e^-$ (Where IE is ionization energy)

METALIC CHARACTER
- Amount of electrons that need to be added
- Decreases down a period
- Increases down a group

ELECTRON AFFINITY
- Measure of the attraction an atom has for electrons other than its own
- Energy released when an electron is removed from a gaseous atom to form **anion**
- Increases across a period

  - Because non metals (right side of the PT) need to add electrons to form their stable octet
  - When atoms reach their stable octet, they release the energy that was making them unstable
- Decreases down a group
  - Because there is a greater atomic radius, so there is less of the attractive force to add electrons

ELECTRONEGATIVITY

- Measure of the attraction an atom has for electrons in a covalent bond (non metal + metal where electrons are shared)
- The measure is assigned values from 0-4
- The difference between the values of two atoms will determine what type of bond they will form
- **Note: Values are listed on the Periodic Table
  - 0 – Noble gasses
  - Less than 0.6 - Purely covalent bond
  - 0.6-1.6 - Polar covalent bond
  - Greater than 1.6 – Ionic bond
  - Example: Ga + S
    - S has a value of 2.58, Ga has a value of 1.81
    - 2.59 – 1.81 = 0.77
    - Therefore Ga + S is a polar covalent bond
- The greater difference between the two Electronegativity values of two atoms will make the bond more polar
- Increases across the table
- Decreases down the group
- Formula:
  - $X_{(g)} + EA \rightarrow X^{1+}{}_{(g)} + e^-$ (Where EA is Electron Affinity)

MULTIPLE IONIZATION LEVELS

- IE_1 is the energy necessary to remove the first electron
  - $M_{(g)} + IE_1 \rightarrow M^{1+}$
- IE_2 is the energy necessary to remove the second electron
  - $M^{1+}{}_{(g)} + IE_2 \rightarrow M^{2+}$
- IE_3 is the energy necessary to remove the third electron
  - $M^{2+}{}_{(g)} + IE_3 \rightarrow M^{3+}$
- The jumps in the IE occur because of the breaking of full octets
  - The jump in energy will occur in IE_x where x-1 represents the group number the element belongs to
      - OR
  - In group X, all the element's IE jumps will occur at IE_{x+1}
- Elements with lower IE_1 will be metals
  - Metals lose electrons, therefore less energy is required to remove them (Ionization Energy)

- Elements with higher IE_1 will be non metals
    - Non Metals gain electrons, therefore more energy is required to remove them (Ionization Energy)