

Periodic Trends

Periodic Law

- Properties of elements repeat themselves periodically as they are placed in order by atomic number.

Mendeleev's Periodic Table (1869)

- Arrange elements in order of increasing atomic mass.
- Arrange elements in columns so that elements with similar properties are in the same group or family.
- Ex: Cu, Ag and Au are all excellent in conducting electricity.
- Ex: F, Cl, Br, I are excellent at gaining electrons.

Moseley's Periodic Table (1913)

- Arrange the elements in order of increasing atomic number not atomic mass.
- Find 7 cases in which the current periodic table places elements in sequence according to the atomic number not atomic mass.

1st Te (52) and I (53)

Seaborg's Periodic Table (1945)

- Elements from La to Yb and Ac to No should be in a separate grouping not under the other transition elements.
- These elements are called the inner transition elements.
- La to Yb are called the lanthanides.
- Ac to No are called the actinides.

Electrostatic Force

The key to understanding the relationship between the location on the periodic table and the chemical or physical properties of elements is the electrostatic force.

Electrostatic force is the force between the nucleus and the outermost electron.

$$F = \frac{k Z q_e}{r^2}$$

F = Electrostatic Force

k = constant (ignore)

Z = atomic number (number of protons)

q_e = charge on outermost electron

r = distance from center of nucleus to outermost electron (average atomic radius)

- Electrostatic force is affected by Z and r
- As you go from left to right across a period, Z increases, and as Z increases, F increases!
- As you go down a group, r increases and as r increases, F decreases!

Across a period on the periodic table.

- The number of shells of electrons is constant.
- The number of protons in the nucleus increases, increasing the electrostatic force.

Down a family on the periodic table

The number of shells of electrons increases. This means that r, the distance between the nucleus and the valence electrons increases. This decreases the electrostatic force.

Na big F
↓
Rb small F

Atomic radius

- Atomic Radius = Radius of Atom
- Increases going down a family because the numbers of shells of electrons increases.
- Decreases going across a period because the number of protons, and therefore, the electrostatic force increases, pulling the valence electrons in.

Ionic Radius

- Ionic Radius = Radius of Ion (Atom with a charge)
- **Positive ions or Cations are generally smaller than the neutral atom.**
- As e⁻ are lost, they are lost from the outer shells. This dictates that a positive ion would be smaller than the neutral atom because there will be less repulsion between electrons.
- **Negative ions or Anions are generally larger than the neutral atom.**
- Adding e⁻ to the valence electrons will increase the repulsion force between the two. This has the effect of increasing the ionic radius.

Metallic Characteristic

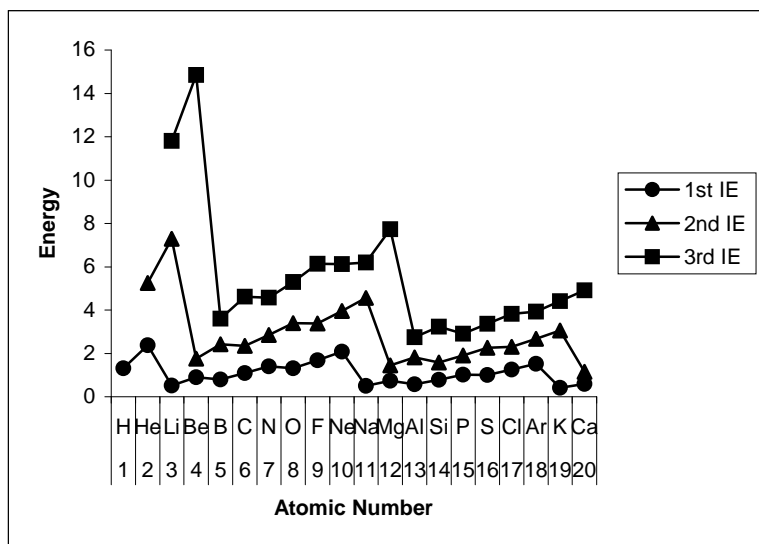
Trend follows atomic radius.

The larger atoms are the most metallic because they lose electrons more easily.

Metals are positively charged.

Ionization Energy

- The amount of energy (J) it takes to completely remove 1 mol of electrons from a mol of a gaseous element. Example: $\text{H} \rightarrow \text{H}^+ + \text{e}^-$ This reaction requires 1312 kJ/mol



- 1st IE = energy to lose the 1st e⁻ from atom
- 2nd IE = energy to lose the 2nd e⁻ from +1 ion
- 3rd IE = energy to lose the 3rd e⁻ from +2 ion
- Metal atoms lose electron(s) until they are isoelectronic with the nearest noble gas.
- Ionization Trends are generally opposite of atomic radius.
- An element with low ionization energy will form positive ions more easily than those with higher ionization energy.

Electron Affinity (honors only)

- Electron affinity is a measure of energy released when an atom gains an electron.
- Decreases going down a family because the electrostatic force is weaker.
- Increases going to the right since the electrostatic force is greater.

Electronegativity

- Electronegativity is a measure of relative pull on electrons in a bond.
- Decreases going down a family because the electrostatic force is weaker.
- Increases going to the right since the electrostatic force is greater.