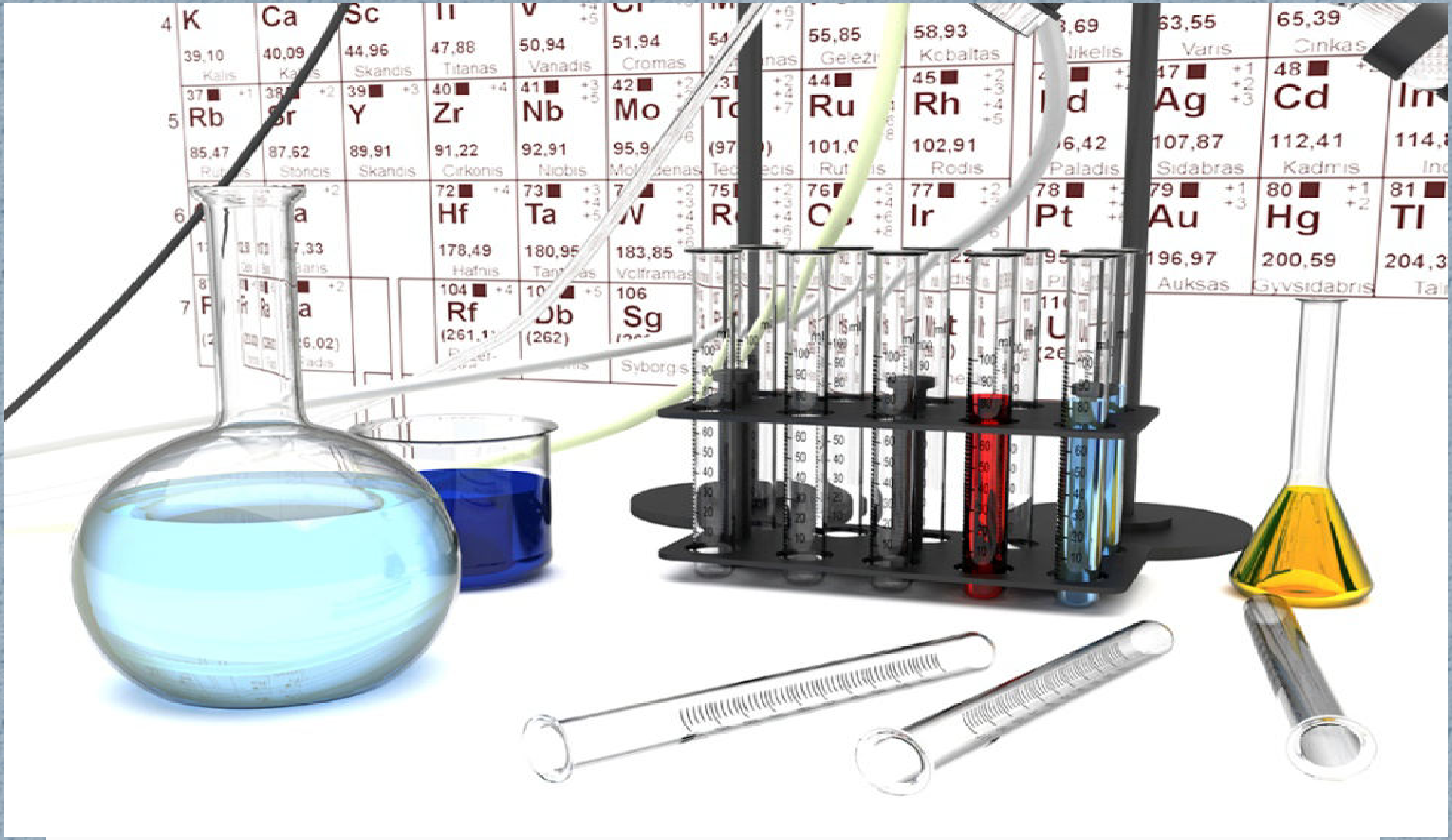
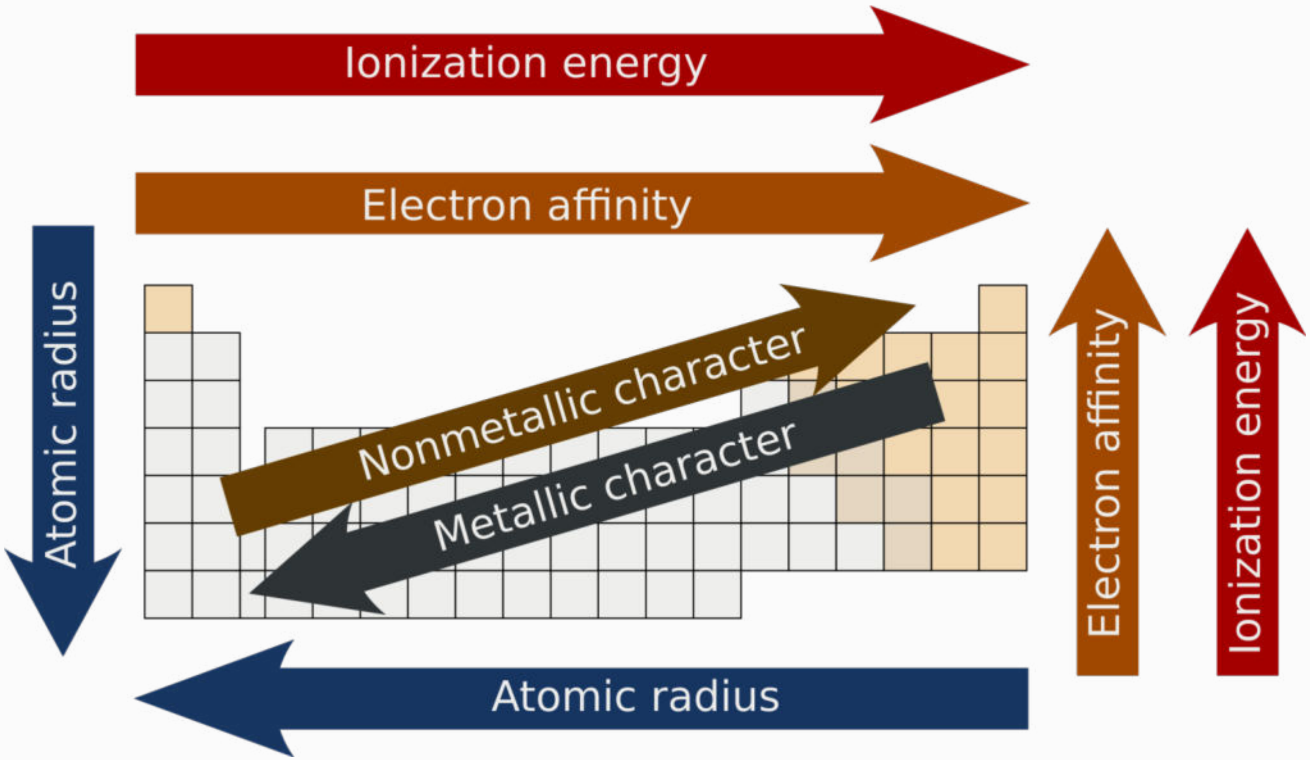


Periodic Trends

AIMES Trends

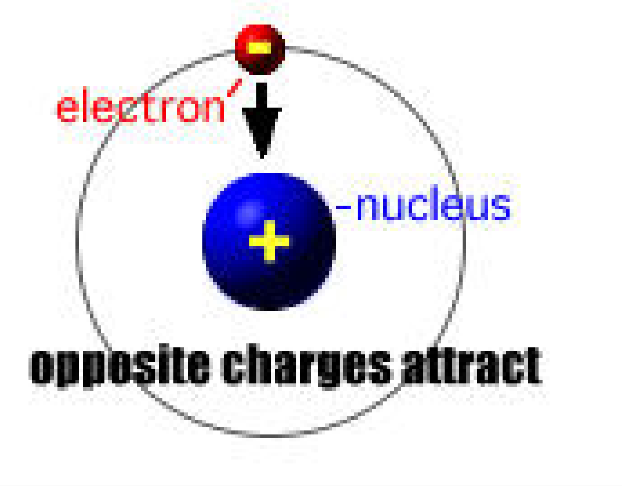
		Direction of Increase	Left to Right Across Period	Down Group
A	Atomic Radii	← ↓	decreases	increases
I	Ionization Energy	→ ↑	increases	decreases
M	Metallic Properties	← ↓	decreases	increases
E	Electronegativity	→ ↑	increases	decreases
S	Shielding	↓	stays same	increases

Direction of Increasing Trend



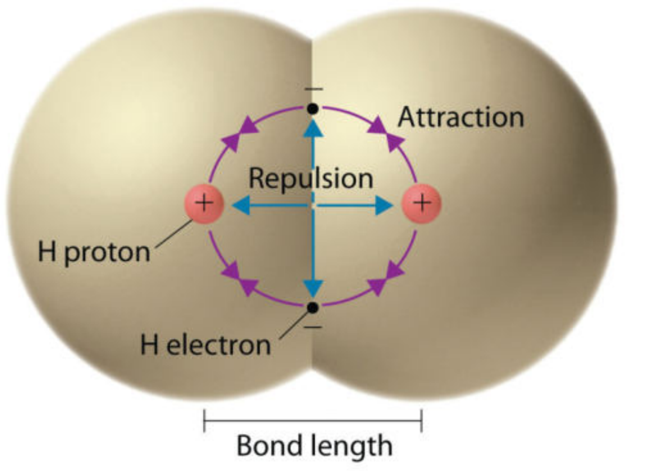
Force Determining Trends

- **Nuclear Force:** the positive protons inside the nucleus pull the negative electrons outside the nucleus in toward the center because of the magnetic rule that “opposite attract”; this is stronger than electron-electron repulsion



Force Determining Trends

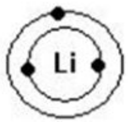
- **Electron-Electron Repulsion:** the electrons in the valence shell will repel each other and try to spread out because of the magnetic rule that says “likes repel”; this is weaker than the nuclear force



Atomic Radii

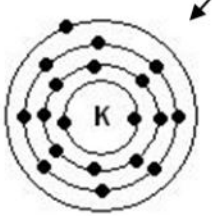
Atomic Radii – involves the size of the nucleus and electron cloud around the atom where the number of protons inside the atom equals the number of electrons outside the atom

Lithium has 3 protons pulling in 3 electrons and only 2 energy levels.



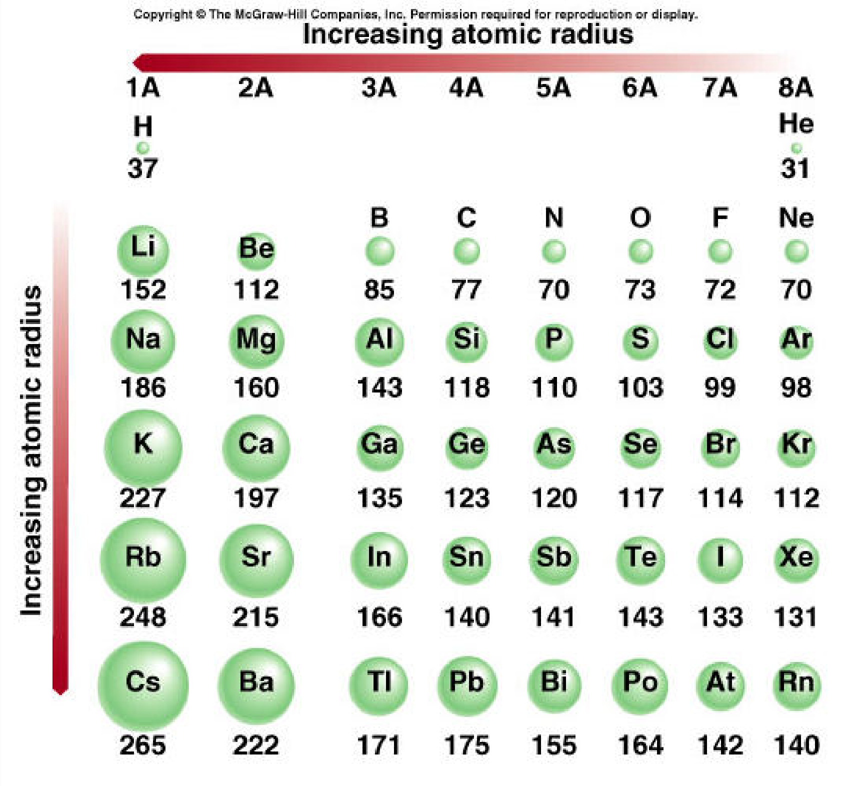
Fluorine has 9 protons pulling in 9 electrons and only 2 energy levels.

Potassium has 19 protons pulling in 19 electrons and 4 energy levels.



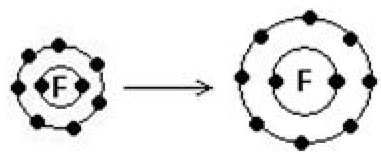
The nuclear force is pulling Fluorine's electrons in closer because there are 9 protons in the nucleus compared with only 3 for Lithium. Potassium is bigger than Lithium and Fluorine because it is in a higher energy level and has more orbitals.

Atomic Radii Trend

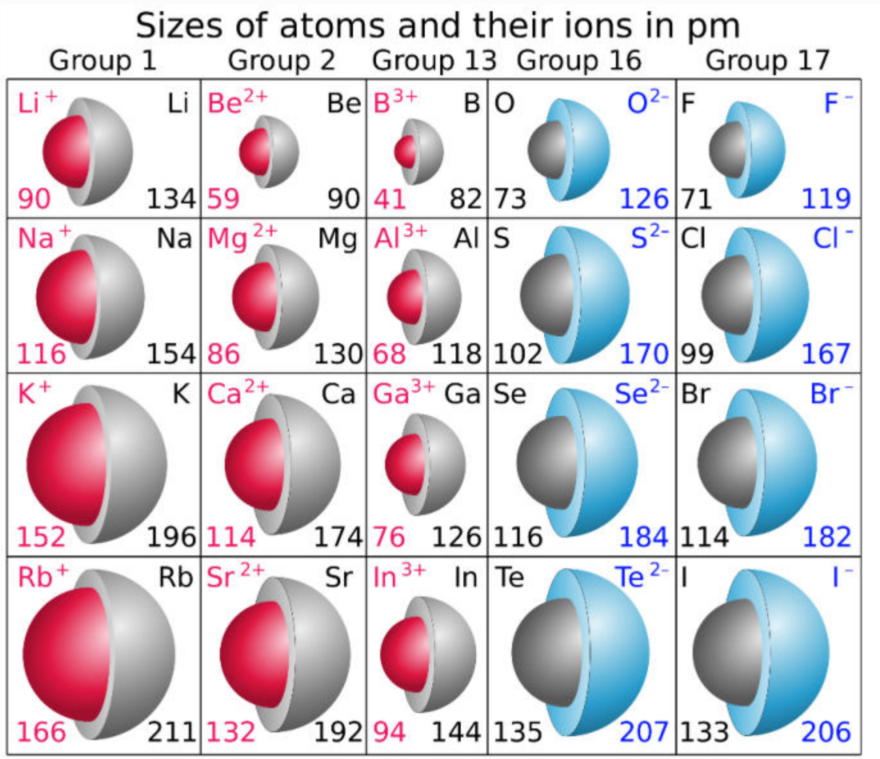


Ionic Radii

Ionic Radii - the size of the nucleus and electron cloud around the atom where the number of protons inside the atom DOES NOT equal the number of electrons outside the atom; the size pattern for Group A1 – A8 is Large, Medium, Small, Equal, Large, Medium, Small, N/A

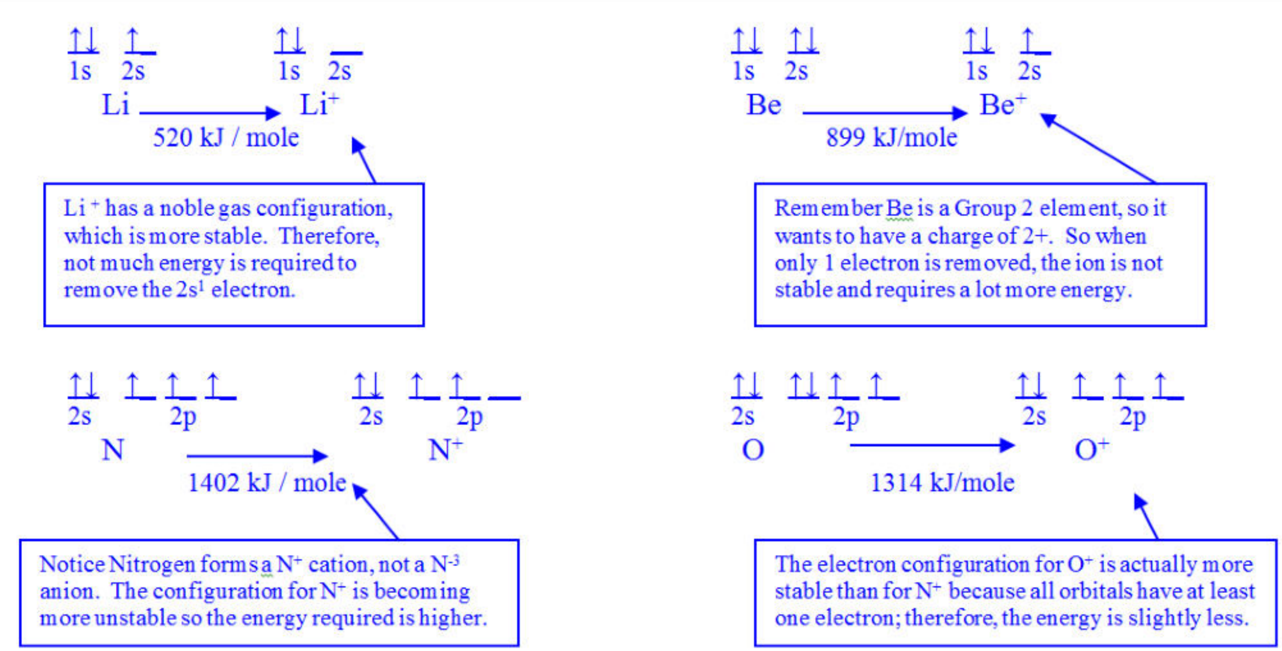
Cation	Anion
Positive ion; electron is removed	Negative ion; electron is gained
	
Li → Li^+	F → F^-
Lithium atom has 3 electrons and 3 protons; Lithium ion has 2 electrons and 3 protons	Fluorine atom has 9 electrons and 9 protons; Fluorine ion has 10 electrons and 9 protons
Cations get smaller because there are more protons pulling inward on fewer electrons.	Anions get larger because there are less protons pulling inward on more electrons.
The nuclear force is constant and the electron-electron repulsion force is decreased	The nuclear force is constant and the electron-electron repulsion force is increased

Ionic Radii Trend



Ionization Energy

Ionization Energy – the energy required to ***remove*** an electron from an atom in the gas phase; because energy is required to ionize an atom, the process will always be endothermic (+); also removing an electron always makes the atom positive forming a ***cation***



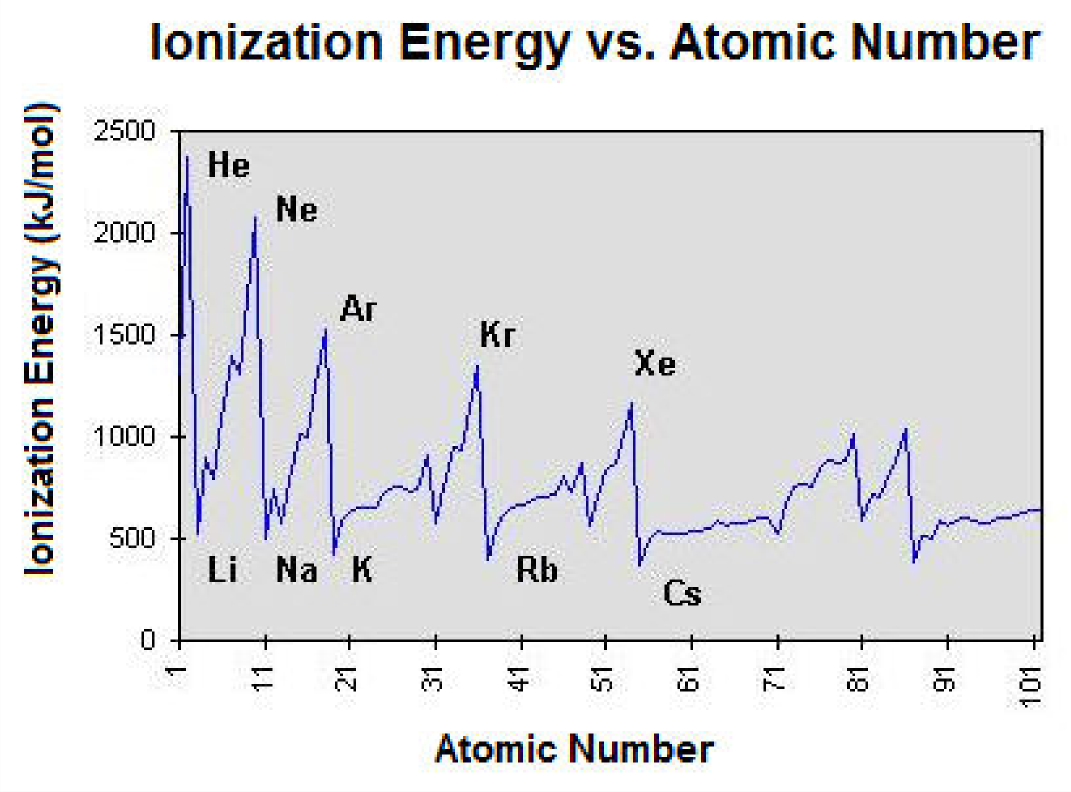
Ionization Energy

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
n = 2	Li+ 520 kJ/mol	Be+ 899 kJ/mol	B+ 801 kJ/mol	C+ 1086 kJ/mol	N+ 1402 kJ/mol	O+ 1314 kJ/mol	F+ 1681 kJ/mol	Ne+ 2081 kJ/mol
n = 3	Na^+ 496 kJ/mol							
n = 4	K^+ 419 kJ/mol							
n = 5	Rb^+ 403 kJ/mol							
n = 6	Cs^+ 377 kJ/mol							

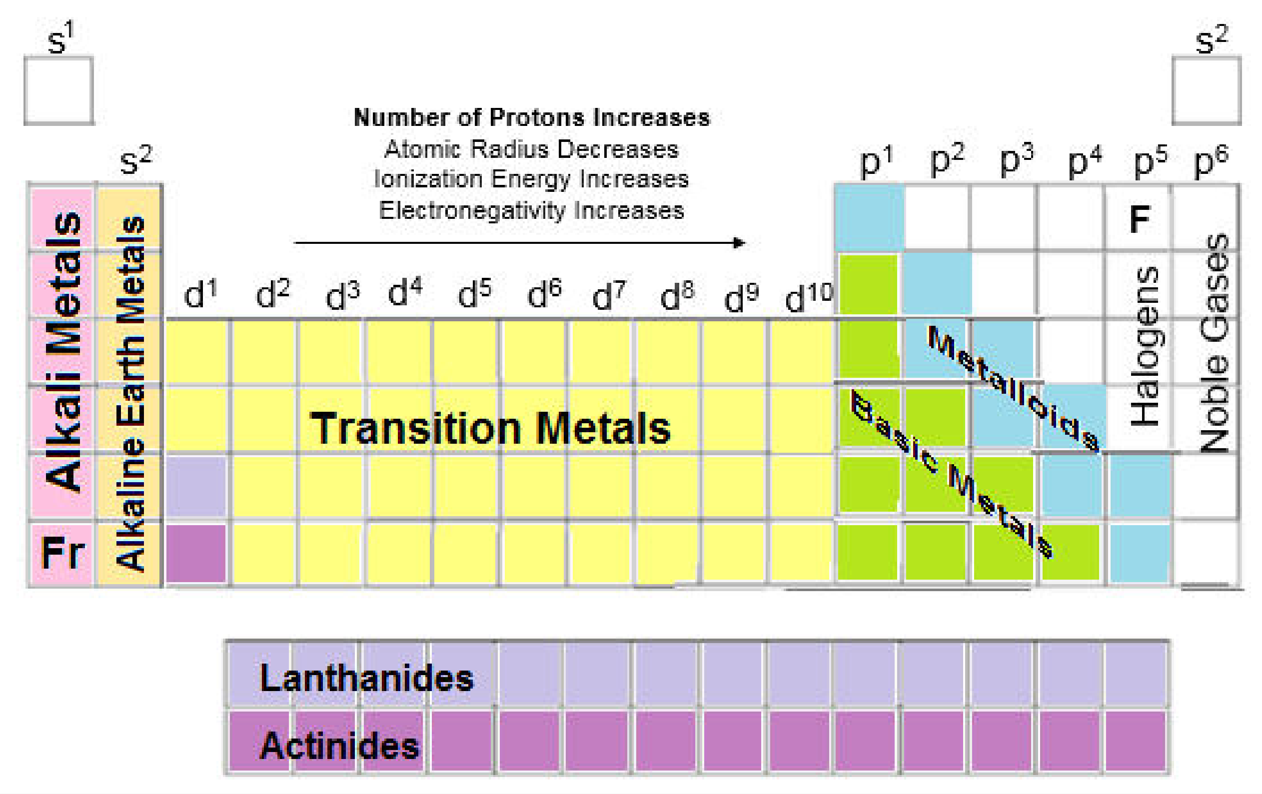
For Group 3 and Group 6 elements, more stable electron configurations are formed upon ionization; therefore, a slight dip in energy is seen in the upward trend.

For periods n = 4 and higher, the energy difference within each group is noticed less and less. This is because the inner orbitals shield the outer valence level causing the nuclear force to be less intense. Therefore, it is easier and easier to remove an electron from the valence orbital as you go down a group.

Ionization Energy Trend



Metallic Groups



Metallic Properties

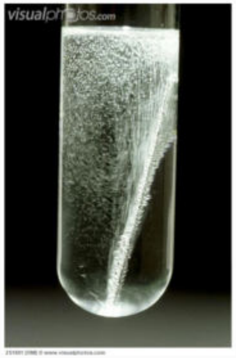
Shiny Luster

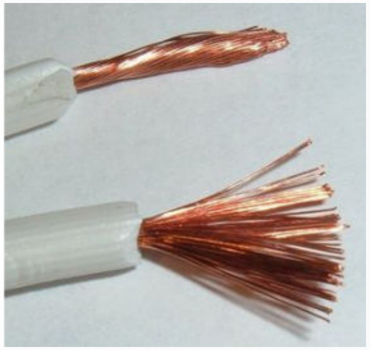
Malleable & Ductile

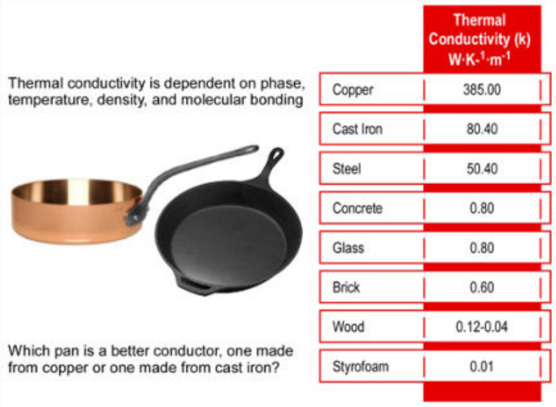
Good electric conductor

Good thermal conductor

Reacts with acids







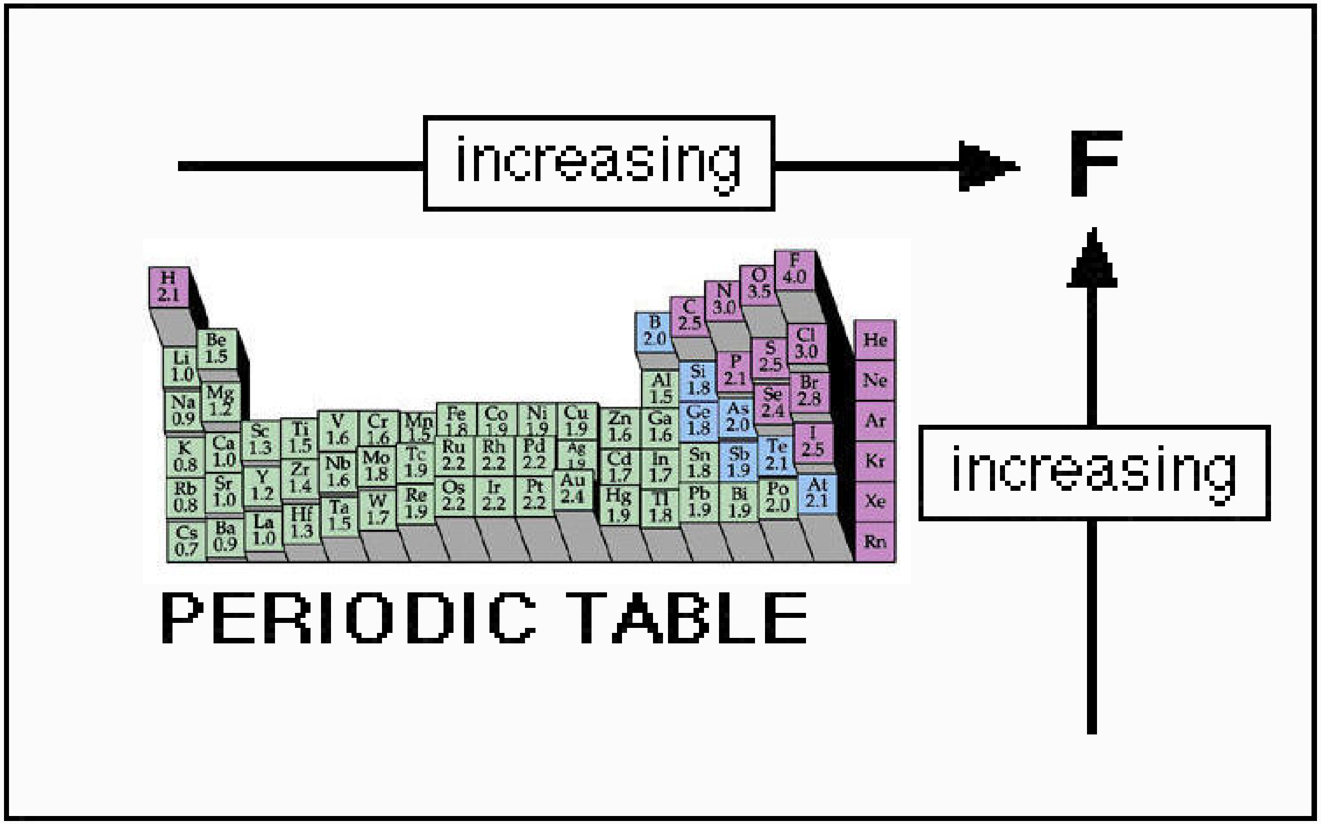
	Thermal Conductivity (k) $W \cdot K^{-1} \cdot m^{-1}$
Copper	385.00
Cast Iron	80.40
Steel	50.40
Concrete	0.80
Glass	0.80
Brick	0.60
Wood	0.12-0.04
Styrofoam	0.01

Electronegativity

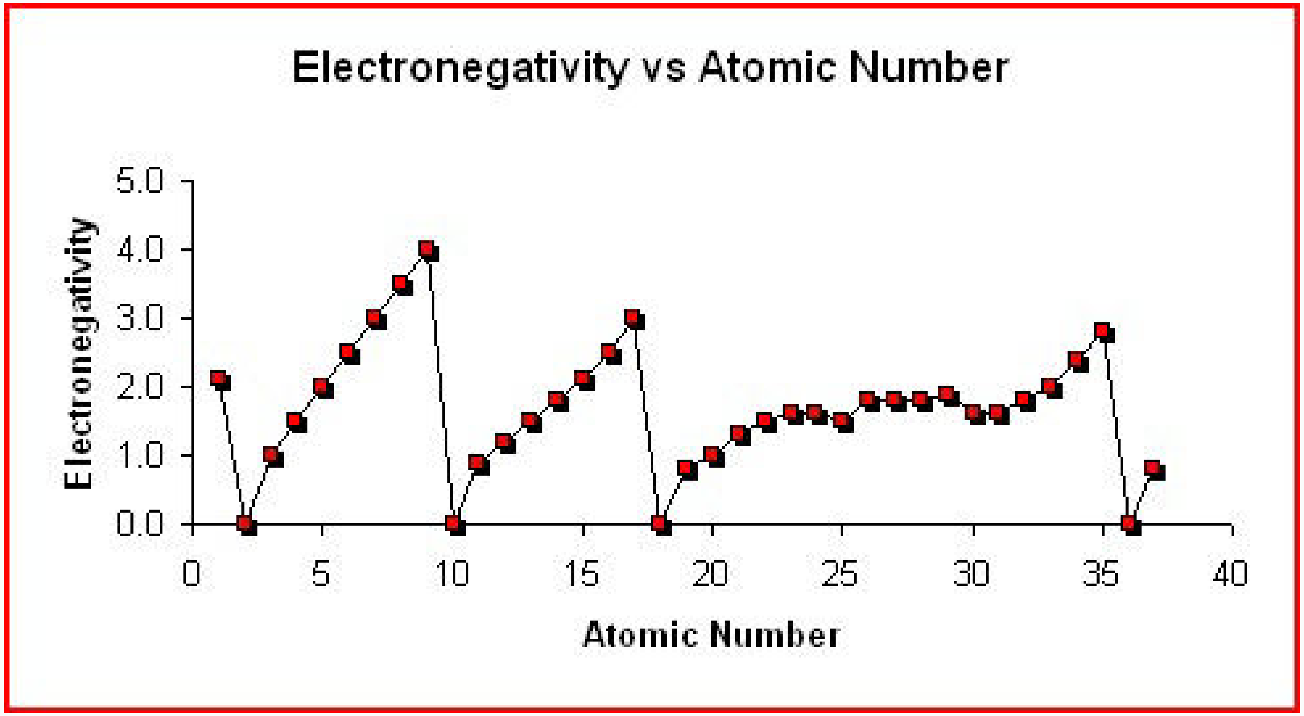
Electronegativity – a measure of the tendency of an atom to attract a bonding pair of electrons

- Gaining an electron always forms an anion
- According to the Pauling scale, Fluorine (the most electronegative element) is assigned a value of 4.0, and values range down to cesium and francium which are the least electronegative at 0.7
- If two atoms bond together, the difference in their electronegativity determines the type of bond
  - Non-polar covalent < 0.4
  - Polar covalent 0.5 to 1.6
  - Ionic > 1.6

Electronegativity Trend

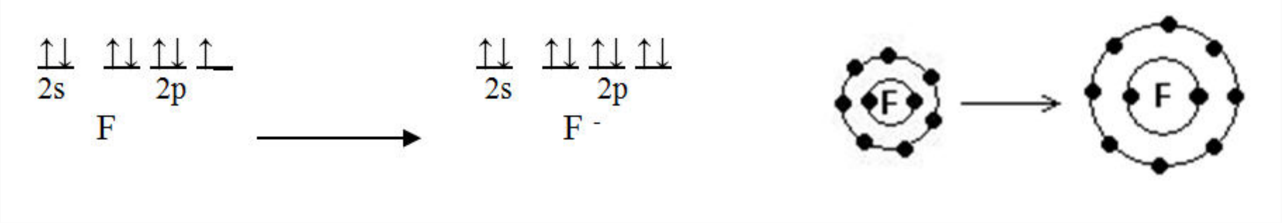


Electronegativity Trend



Flourine

- **Fluorine** is the most electronegative atom because:
  - Its configuration becomes a complete **octet** when the electron is obtained
  - It has the least amount of shielding between the nucleus and outer valence orbital.



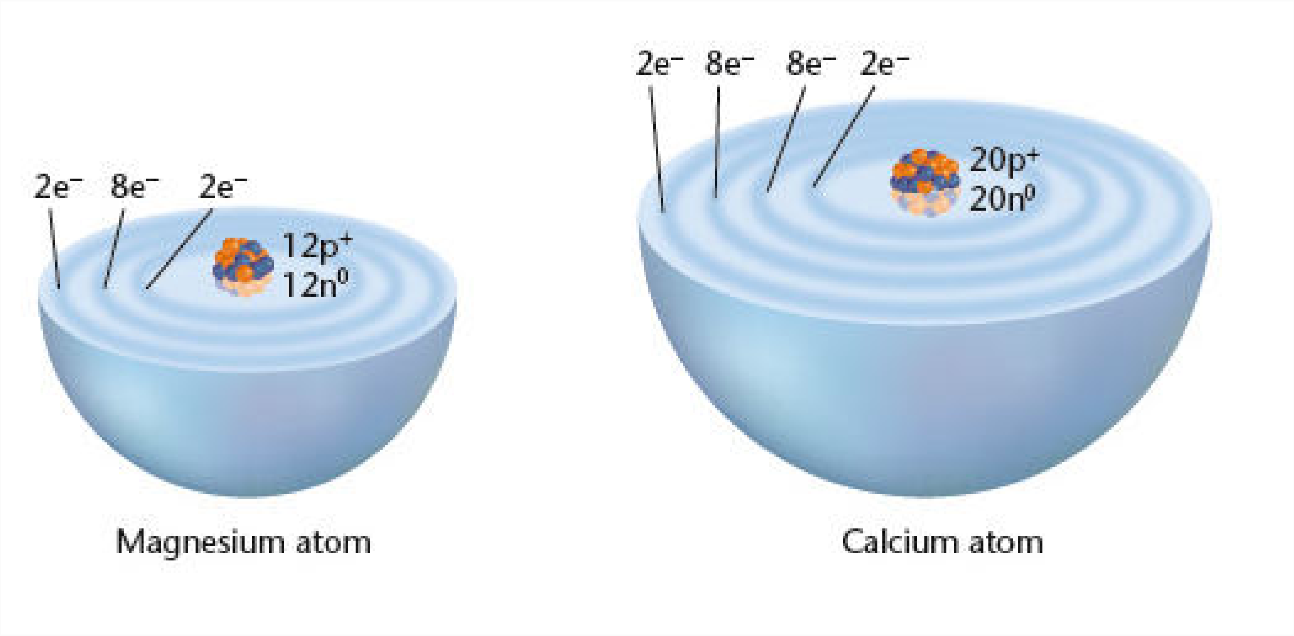
Electron Affinity

- **Electron Affinity** – the energy required for the electronegativity process in which the electron is assigned to the lowest energy unoccupied valence orbital of a gaseous atom.
- When a stable anion is formed, energy is released. The reaction is exothermic. (- ΔH)
- When an atom has no affinity for an electron (the configuration is already complete), an unstable anion is formed causing energy to be absorbed . The reaction is endothermic. (+ ΔH).
- **Electron Affinity is positive for Groups 2 and 18.**

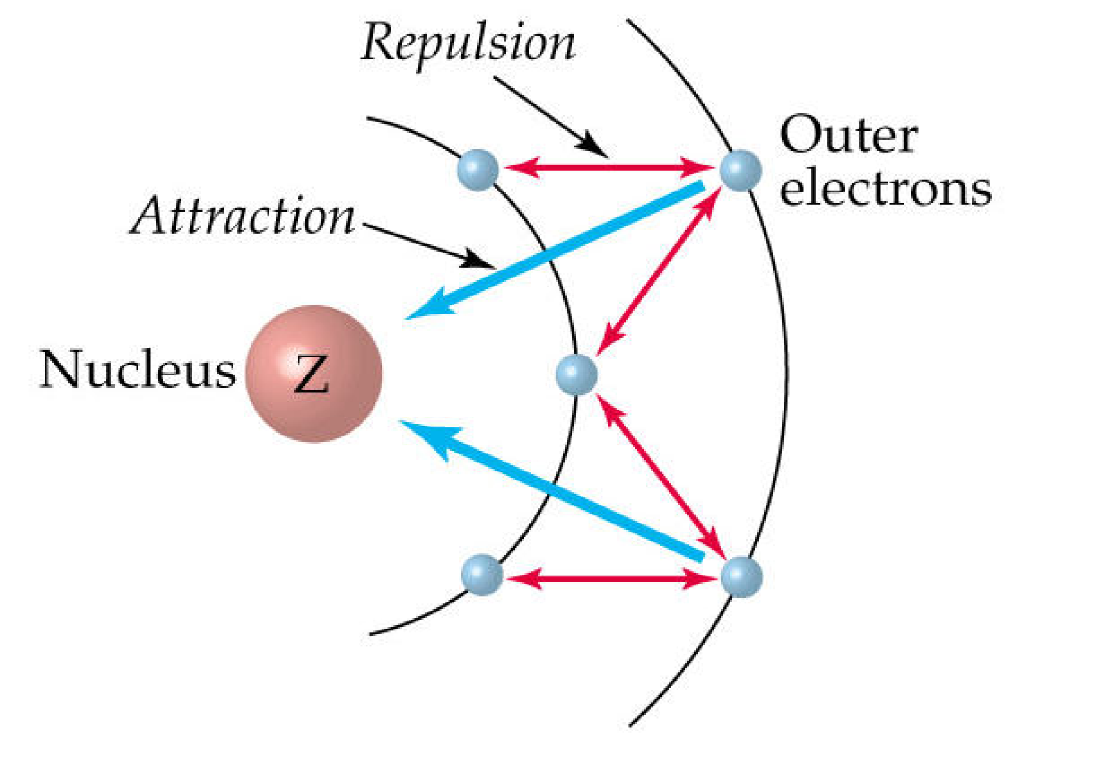
Shielding Effect

- **Shielding** refers to the number of orbitals between the nucleus and the valence orbital.
- The more innere core orbitals, the greater the shielding effect.
- The **shielding effect** interferes with the protons in the nucleus being attracted to the valence electrons in the outer orbital.
- Shielding directly effects both the nuclear force and the electron-electron repulsion force and therefore affects all the previously mentioned trends

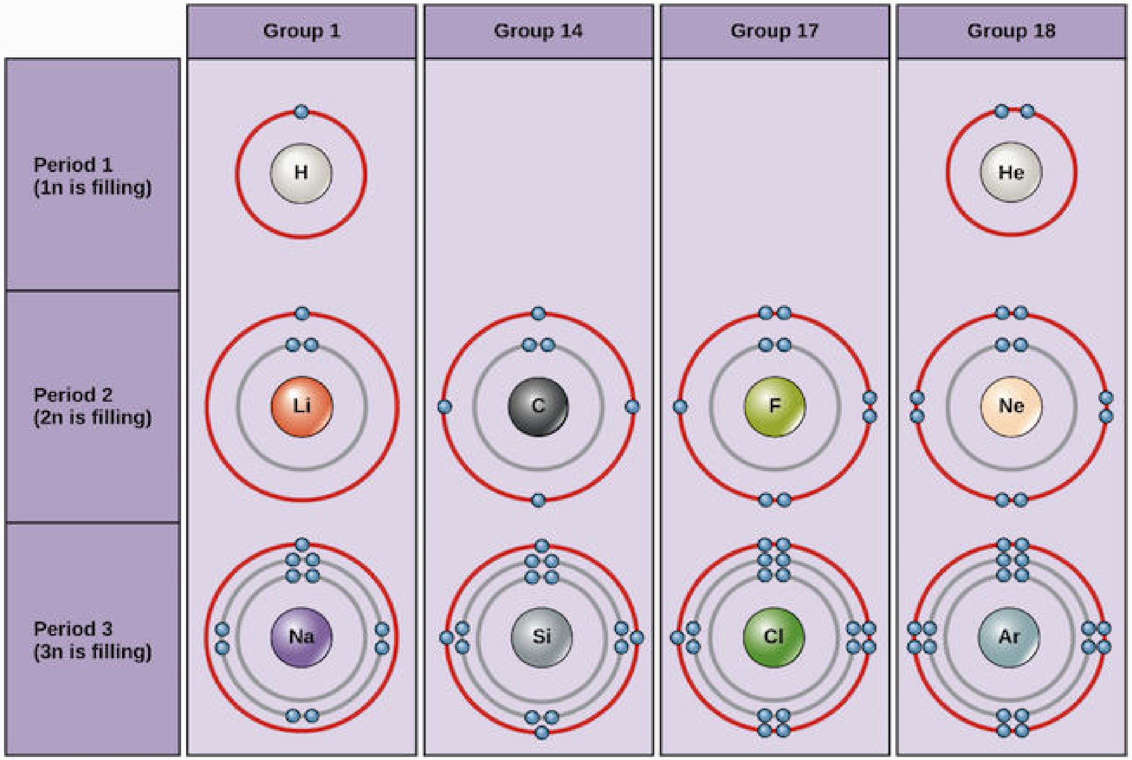
Shielding


2e⁻ 8e⁻ 2e⁻
12p⁺
12n⁰
Magnesium atom
2e⁻ 8e⁻ 8e⁻ 2e⁻
20p⁺
20n⁰
Calcium atom

Shielding

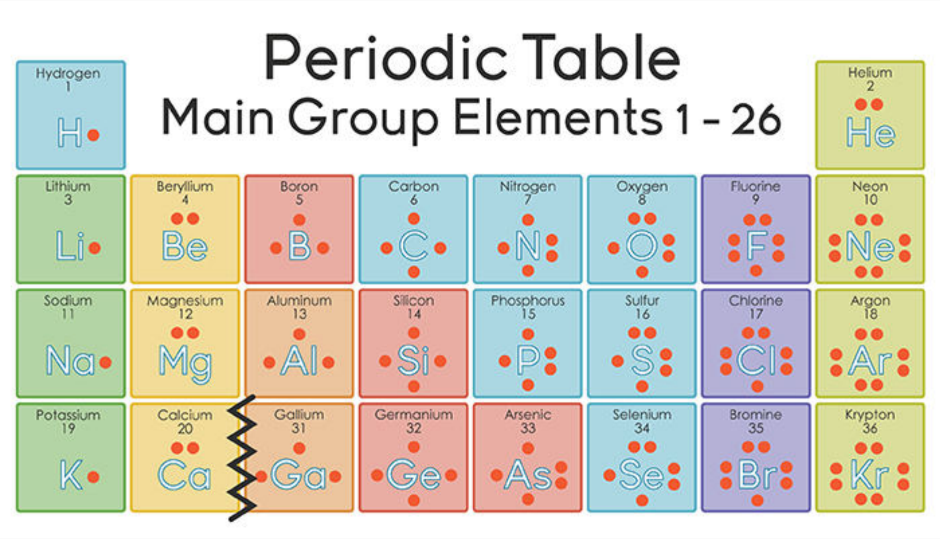


Valence Electrons

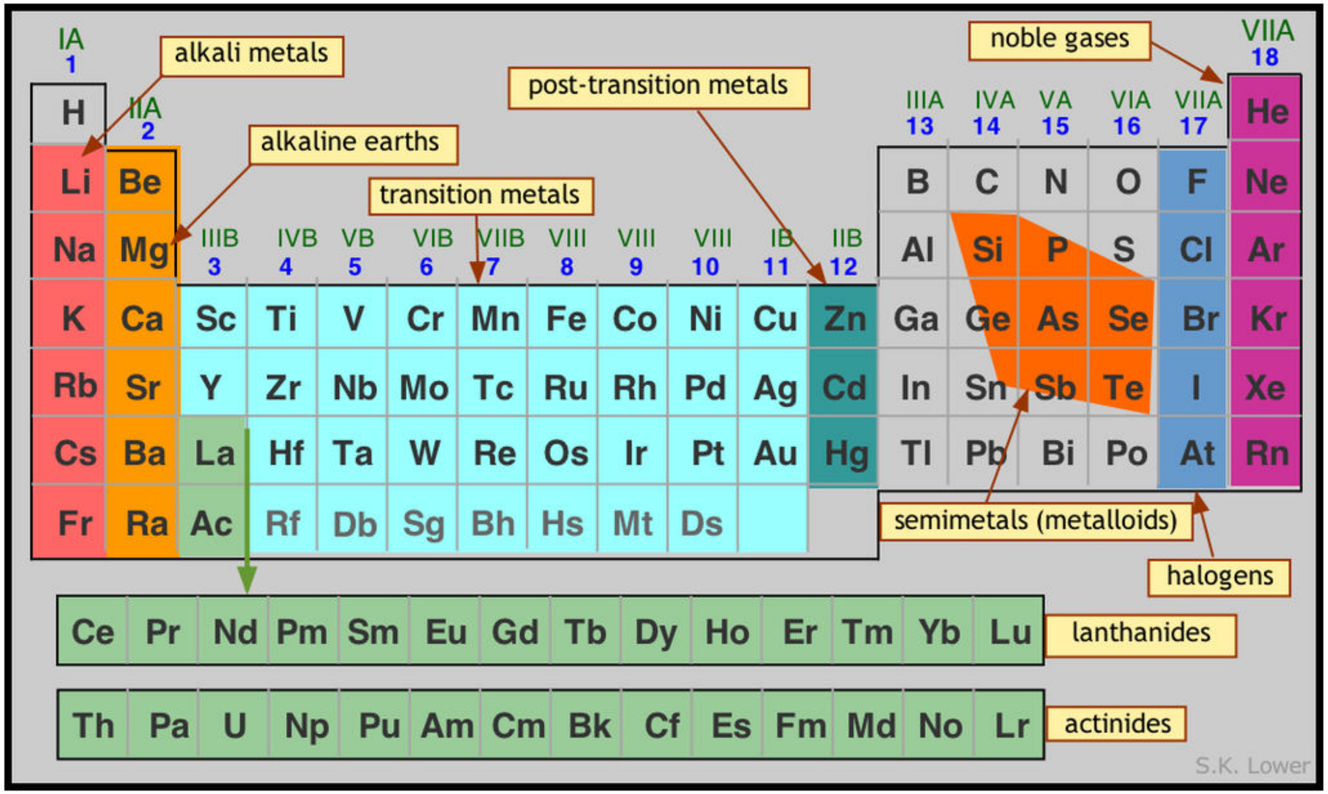


Chemical Properties

- Elements in the same group have similar chemical properties because they have the same number of valence electrons.



Periodic Groups



Periodic Table Scientists

Dmitri Mendeleev
(arranged by atomic mass)

Henry Moseley
(arranged by atomic #)