Representative Elements

- Atoms lose or gain valence electrons to gain a noble gas electron configuration.
  - O: 1s2 2s2 2p4
  - O\(^2-\): 1s2 2s2 2p6
  - Al: [Ne] 3s2 2p1
  - Al\(^3+\): [Ne]
  
  Al\(^3+\) and N3- are isoelectric with Ne.

- Isoelectric - same number of electrons

Transition Metals:

- Form cation by removing electrons first “s” then “d” electrons
  - Mn\(^2+\), Fe\(^2+\), Fe\(^3+\)
  - Fe: [Ar] 4s2 3d6
  - Fe\(^2+\): [Ar] 3d6
  - Fe\(^3+\): [Ar] 3d5

Lecture 3.30.17

- Same group → same # and type of valence electrons.
- Periodic law - if arrange elements by Z, their chemical and physical properties vary periodically.
- Electrons are both attracted to the nucleus and repelled by other electrons.
  - Effective nuclear charge (Z\(_{\text{eff}}\)) - “positive charge” felt by an electron.
    - Z\(_{\text{eff}}\) = Z (#pt) - # of inner core e- 
      - Z\(_{\text{eff}}\) = Z - \(\sigma\)
  - Effective nuclear charge increases as you go upper right diagonally on the periodic table.
- Atomic radius (atomic size) - one-half the distance between the 2 nuclei in 2 adjacent atoms.
○ Exactly the opposite of effective nuclear charge, and it increases as you go lower left diagonally.
○ Larger $Z_{\text{eff}}$ → stronger hold of nucleus on e- → smaller the atomic radius
○ ↓ across a period
  ■ ↑ # of protons but small shell of e-
● Put in order of decreasing atomic radius
  ○ P, Si, N
    ■ Si > P > N
  ○ C, Li, Be
    ■ Li > Be > C
● Ionic Radius
  ○ Size of an ion.
  ○ Cation (+) is smaller than the corresponding atom from which it came.
    ■ Often loses its outer shell
    ■ Nuclear charge remains the same but fewer electrons (atom shrinks)
  ○ Anion (-) is larger than the corresponding atom from which it came.
    ■ Nuclear charge remains the same but more e- (weaker so expands)
  ○ Summary: cation < atom < anion
● Comparing Ions to each other
  ○ Ions in the same group (family)
    ■ Increases down a group (if same charge)
      ● Size of shell increases as you go down a group.
  ○ Isoelectronic ions

<table>
<thead>
<tr>
<th></th>
<th>Z (#pt)</th>
<th>#e-</th>
</tr>
</thead>
<tbody>
<tr>
<td>S$^{2-}$</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Cl$^{-}$</td>
<td>17</td>
<td>18</td>
</tr>
</tbody>
</table>
Ionization energy and metallic character
  - Metallic character based on IE
  - More metallic character: more the element exhibits physical and chemical properties of metals.
  - Reactive metal → loses e- to form cation
  - Lowest IE → more metallic character

Practice Ionization Energy
  - Which has the larger 1st IE?
    - K, Ca: Ca
    - I, F: F
  - Which has the larger 2nd IE?
    - Li, Be: Li (its harder to destroy a noble gas as Li is already at its 1st IE)
    - Li+: I₂ + X⁺ (g) → X²⁺ (g) + e⁻  IE
  - Order the elements from smallest 2nd IE to largest
    - Na, Mg, Al
    - Na: [Ne]
      - Mg: [Ne] 3s²
      - Al⁺: [Ne] 3s²
    - Mg < Al < Na

Electron affinity (EA) - how strongly an atom gains electrons
  - Energy change that occurs when an e⁻ is added to a gaseous atom
    - ΔH = EA = -energy
  - EA increases as you go upper right diagonally.
  - Low EA = hard to gain e⁻
  - High EA = easy to gain e⁻

Electronegativity (EN) - the ability to attract electrons in a covalent bond
  - Closer to Fluorine, more EN.
  - EN increases as you go upper right diagonally
○ FONC BrICS PH
  Most EN    Less En
○ Noble gases aren't included: they are stable with REALLY high IE, low EA
| 3 | 1 | Trigonal planar | Bent | \[
\begin{array}{c}
\text{S} \\
\text{O} \\
\text{O} \\
\end{array}
\] | <120 |
| 4 | 0 | Tetrahedral | Tetrahedral | \[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{H} \\
\end{array}
\] | 109.5 |
| 4 | 1 | Tetrahedral | Trigonal Pyramidal | \[
\begin{array}{c}
\text{C} \\
\text{O} \\
\text{O} \\
\end{array}
\] | <109.5 |
| 4 | 2 | Tetrahedral | Bent | \[
\begin{array}{c}
\text{H} \\
\text{C} \\
\text{H} \\
\end{array}
\] | <109.5 |
| 5 | 0 | Trigonal bipyramidal | Trigonal bipyramidal | \[
\begin{array}{c}
\text{Cl} \\
\text{P} \\
\text{Cl} \\
\text{Cl} \\
\end{array}
\] | 90 Between Axial and equatorial  
120 Equatorial |
| 5 | 1 | Trigonal bipyramidal | seesaw | \[
\begin{array}{c}
\text{F} \\
\text{S} \\
\text{F} \\
\end{array}
\] | <90  
<120 |
| 5 | 2 | Trigonal bipyramidal | T-shaped | \[
\begin{array}{c}
\text{F} \\
\text{Cl} \\
\text{F} \\
\end{array}
\] | <90 |