Class #5
Ions & Reactions in Solution

CHEM 107
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Ions

- **Ions**: atoms or groups of atoms with electric charge
- **Cations**: positive charge
- **Anions**: negative charge
Monatomic Cations

- Make from neutral atoms by removing electrons
- Metals, often from first 2 columns of periodic table

\[
\text{Na} \rightarrow \text{Na}^+ + e^-
\]
Monatomic Anions

- Make from neutral atoms by adding electrons
- Nonmetals, often halogens

\[
\text{Cl} + e^- \rightarrow \text{Cl}^-
\]
Polyatomic Ions

- 2 or more atoms
- Held together by chemical bonds
- Electrically charged
- Cations or anions
- $\text{NH}_4^+$, $\text{H}_3\text{O}^+$, $\text{NO}_3^-$, $\text{SO}_4^{2-}$
- See table in textbook for more

Ionic Compounds

- Anions & cations, charges balancing
- Coulomb force (attraction of opposite charges)
- Crystalline solids, high melting points.
Structure of Ionic Crystals

- In an ionic crystal, positive and negative ions are arranged in an orderly array. This is what leads to the crystalline appearance.

NaCl Crystal Structure
Ionic Compounds in Solution

- Many ionic compounds dissolve in water
- Properties in solution different from in solids
- Many ionic solutions conduct electricity

Conductivity implies free ions.
- Soluble ionic compounds *dissociate* in solution

\[ \text{NaCl(s)} \rightarrow \text{Na}^+(aq) + \text{Cl}^-(aq) \]

- Overall solution is still electrically neutral!
Chemistry in Solution

- Ionic solids usually don’t react readily with one another
- But solutions often react very rapidly
- Difference is due to the dissociation in solution

Solution Chemistry:

\[ \text{KI} + \text{Pb(NO}_3\text{)}_2 \]
Solution Chemistry:
KI + Pb(NO₃)₂
Equations?

• “Molecular Equation”

\[ 2 \text{KI} + \text{Pb(NO}_3\text{)}_2 \rightarrow 2 \text{KNO}_3 + \text{PbI}_2 \]

• Drawback is that solution does NOT contain ANY molecules of KI or Pb(NO\textsubscript{3})\textsubscript{2}

Ionic Equations

• Solutions contain free ions
  \[ \text{KI}(s) \rightarrow \text{K}^+ (aq) + \text{I}^- (aq) \]
  \[ \text{Pb(NO}_3\text{)}_2(s) \rightarrow \text{Pb}^{2+} (aq) + 2 \text{NO}_3^- (aq) \]

• Products?
  \[ \text{KNO}_3(s) \rightarrow \text{K}^+ (aq) + \text{NO}_3^- (aq) \]
  \[ \text{PbI}_2(s) \rightarrow \text{(NOT SOLUBLE)} \]
TOTAL Ionic Equation

• Show ALL ions present:
  \[ 2 \text{K}^+ + 2 \text{I}^- + \text{Pb}^{2+} + 2 \text{NO}_3^- \rightarrow 2 \text{K}^+ + 2 \text{NO}_3^- + \text{PbI}_2(s) \]
• Note \( \text{K}^+ \), \( \text{NO}_3^- \) on both sides
• “Spectator Ions”

NET Ionic Equation

• Don’t write spectators ions
  \[ 2 \text{I}^- (aq) + \text{Pb}^{2+} (aq) \rightarrow \text{PbI}_2(s) \]
• Only shows reacting ions
• Simpler looking equation; more commonly used