Notes on Ionic Compounds

**Basics:**
Ionic compounds are formed when cations combine with anions through an electrostatic interaction.

Cation – a positively charged ion, formed by loss of one or more electrons from a neutral atom or group of atoms.

Anion – a negatively charged ion, formed by addition of one or more electrons to a neutral atom or group of atoms.

Instead of forming individual molecules, ionic compounds form a crystal lattice in which the ions are arranged in a regular three dimensional array. See Figure 3.1 on p. 85 of Tro for an example.

The smallest unit of an ionic compound is referred to as a formula unit. It contains the smallest number of ions of each type needed to represent the composition of the crystal. For example, one formula unit of NaCl consists of one Na⁺ ion and one Cl⁻ ion.

**Properties:**
Ionic compounds typically have very high melting points. The higher the charge on the ions, the higher the melting point will be.

The ions in the lattice can be arranged in many different ways (called crystal packing or unit cells), and this gives different crystals different distinctive shapes.

Ionic compounds are strong electrolytes.

Electrolyte – a compound that breaks into or reacts to form ions when it is dissolved in water.

Strong electrolyte – an electrolyte in which 100% of the compound that dissolves breaks into ions. All ionic compounds are strong electrolytes. For example, if NaCl is dissolved in water, there will be no NaCl leftover; the water will only contain dissolved Na⁺ and Cl⁻ ions.

Weak electrolyte – an electrolyte in which only a small portion of the compound breaks into ions. Weak acids and weak bases are weak electrolytes. Ionic compounds are never weak electrolytes.

**Ionic Hydrates:**
When some ionic compounds crystallize, water becomes incorporated into their crystal lattices in a fixed ratio. Water molecules occupy certain specific locations in the crystal lattice. This water is called water of hydration and it must be included in the molecular formula. When weighing out the compound, the water of hydration is included in the mass that is weighed out, so it must also be included in the molar mass when converting between mass and number of moles.

Water of hydration is included in the molecular formula by placing a · after the formula of the ionic compound followed by $X \text{H}_2\text{O}$, where $X$ represents the number of water molecules incorporated in the crystal per formula unit of the compound. To name an ionic hydrate, give the name of the ionic compound followed by $\text{xxxhydrate}$, where $\text{xxx}$- is a number prefix to indicate the number of water molecules in the formula.

For example, calcium sulfate dihydrate has the formula $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$. This means that for each formula unit of CaSO₄ there are two water molecules in the crystal.