

## Chemistry of Copper

The two most important oxidation states of copper are the +1 (cuprous) and +2 (cupric). The +2 ion is more stable and by far the most common. Commonly encountered copper salts include copper sulfate pentahydrate and copper chloride dihydrate, which have the formulas  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  and  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ . The former is pale blue in color, and the latter is blue-green in color.

Copper sulfate pentahydrate contains copper(II) in a geometry best described as distorted octahedral. The copper(II) is bound to four water molecules in a square-planar geometry and two oxygen atoms from two sulfate ions. This salt dissolves in water to produce the pale-blue  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  ion, in which two of the water molecules are less tightly held and have longer bond distances. The blue-green color of copper chloride dihydrate is due to the presence of some  $\text{CuCl}_4^{2-}$ , which is yellow in color and has a square planar geometry. Concentrated solutions of copper chloride may appear blue-green in color, but dilution results in the formation of the pale-blue  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  ion.

Addition of  $\text{NH}_3$  to solutions containing the  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  ion results in successive replacement of the first four  $\text{H}_2\text{O}$  molecules. Replacement of the fifth and six water molecules does not occur to an appreciable extent in aqueous solution, and replacement of the sixth only occurs in liquid ammonia.

