## 4.2 Copper compound solubility

**Subjects:** Chemical reactions, solubility $K_{sp}$, net ionic equations

**Description:** This reaction demonstrates the difference of solubility of copper chloride in water, and then with addition of sodium hydroxide.

**Materials:**
Copper Chloride(s), $CuCl_2$‡
1 100 mL beaker
1 400 mL beaker
watch glass
spatula
stir plate*
stir bar
1M NaOH‡
wash bottle with water

*Shared item. This item is located in the top drawer opposite the chemical storage cabinets. There are other stir plates on the benchtop.

‡ Copper chloride is located in the general chemical storage cabinets. Sodium hydroxide is located in the cabinet under the hood.

**Procedure:**
1. Add some water to the 300 mL beaker and place on a stir plate with a stir bar.
2. Place some copper chloride on a watch glass.
3. Add enough water to dissolve the solid.
4. Transfer the solution to the beaker of water on a stir plate. Stir using a stir bar.
5. Add NaOH to get a precipitate of copper hydroxide.

**Discussion:**
Copper chloride is soluble in water. It dissociates as follows:

$CuCl_2(s) \rightarrow Cu^{2+}(aq) + 2Cl^-(aq)$

Adding sodium hydroxide produces a precipitate of copper hydroxide.

$CuCl_2(aq) + 2NaOH\ (aq) \rightarrow Cu(OH)_2(s) + 2NaCl(aq)$

Net ionic equation:

$Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$

Based on the solubility rules copper hydroxide is not soluble in water while copper chloride is.

The solubility product constant ($K_{sp}$) is an equilibrium constant relating the ionization products of a dissolved substance and allows us to understand why copper hydroxide is seemingly insoluble in water. $K_{sp}$ is determined experimentally by measuring the concentrations of ions in solution. Copper hydroxide does dissolve a tiny amount in pure water and an equilibrium is established. The equation for the equilibrium of copper hydroxide in water is given below:

$Cu(OH)_2(s) \Leftrightarrow Cu^{2+}(aq) + 2OH^-(aq)$

The solubility product constant, which is the product of the ion concentrations, and has been determined experimentally, is given below:

$K_{sp} = [Cu^{2+}][OH^-]^2 = 2.2 \times 10^{-20}$

$K_{sp}$ is very small meaning that copper hydroxide dissociates very little in water, while the vast majority remains a solid.

**Safety:** Copper chloride is corrosive. Sodium hydroxide is extremely corrosive and can cause severe burns. Wear proper protective equipment including gloves and goggles.

**Disposal:** Copper hydroxide in solution can be saved for demo 4.10 Hydroxide clean-up. To dispose, add some hydrochloric acid to dissolve the hydroxide and dispose in the appropriate aqueous waste container.

**References:**

1. Prof. Botch