

## 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),  $\text{CuCl}_2^\ddagger$

1 100 mL beaker

1 400 mL beaker

watch glass

spatula

stir plate\*

stir bar

1M  $\text{NaOH}^\ddagger$

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.

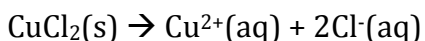
‡ Copper chloride is located in the general chemical storage cabinets. Sodium hydroxide is located in the cabinet under the hood.

**Procedure:**

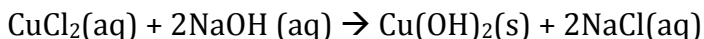
1. Add some water to the 300 mL beaker and place on a stir plate with a stir bar.
2. Place some copper chloride on a watch glass.
3. Add enough water to dissolve the solid.
4. Transfer the solution to the beaker of water on a stir plate. Stir using a stir bar.
5. Add  $\text{NaOH}$  to get a precipitate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

**Discussion:**

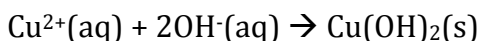
Copper chloride is soluble in water. It dissociates as follows:



Adding sodium hydroxide produces a precipitate of copper hydroxide.

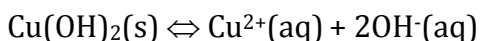


Net ionic equation:



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:



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

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

$K_{sp}$  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