16.5 Lewis Acid/Base reaction (Ammonia + Copper Chloride)

**Subjects:** Acids/Bases, Lewis Acid-base reactions, complex ions, equilibrium, Le Chatlier’s principle

**Description:** Ammonia is added to a solution containing copper chloride, producing the deep blue adduct. When acid is added, the reaction is reversed.

**Materials:**
- 500 mL tall form beaker
- Glass stir rod
- 1M Copper chloride (CuCl$_2$)$^\dagger$
- 1 M Aqueous Ammonia$^\dagger$
- 1 M Hydrochloric acid (HCl)$^\dagger$

$^\dagger$HCl and Ammonia are located in the cabinets under the hood. Copper chloride is located in the chemical storage cabinets.

**Procedure:**
1. Add copper chloride solution to the beaker.
1. Add some ammonia to the copper chloride solution. The solution will turn a deep blue.
2. Add the acid. The reaction is reversed.

**Discussion:**
A Lewis acid is a substance that can accept a pair of electrons, while a Lewis Base can donate a pair of electrons. Lewis acid/base reactions produce an acid-base adduct, with coordinate covalent bonds. Ammonia is a good example of a Lewis Base. It has one lone pair of electrons to donate. Metal cations can act as Lewis acids. Thus the reaction between copper (II) and ammonia is a Lewis acid-base reaction that produces a colorful complex ion with four ammonia molecules surrounding the central copper ion. The reaction is shown below:

$$\text{CuCl}_2(\text{aq}) + 4 \text{NH}_3(\text{aq}) \rightarrow [\text{Cu(NH}_3)_4]^{2+}(\text{aq}) + 2\text{Cl}^-$$

When an acid is added, the ammonia is protonated and the reaction is reversed.

**Disposal:** Make sure the solution is within the proper pH range. The solution can be flushed down the drain with water.

**References:**
1. Prof. Rotondi