

5.6 Reduction of Cu^{2+} by Aluminum

Subjects: Oxidation/Reduction, Net ionic equations

Description: When a ball of aluminum foil is placed in a copper solution with chloride ions, the copper ions are reduced to copper metal and a coating of copper is seen on the surface of the aluminum.

Materials:

400 mL beaker

1 M Copper sulfate‡

1 M Sodium chloride‡

Ball of aluminum foil

Stir rod

Thermometer

Optional: Vernier Thermometer and Go-Link interface. These require Logger Lite or Logger Pro software.*

‡ Solutions are located in the solutions cabinets.

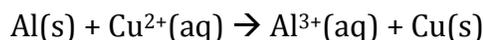
*Vernier sensors and interfaces are located in the drawers opposite the bin storage shelves.

Procedure:

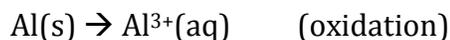
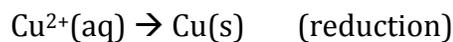
1. Add the solutions to the beaker and stir.
2. Place the foil ball into the solution.
3. Observe the copper metal forming on the aluminum.
4. Measure the temperature rise of the solution.

Discussion:

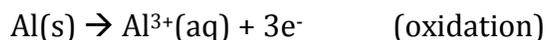
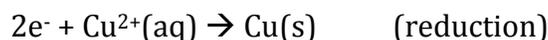
The unbalanced net ionic equation for the reaction is given below:



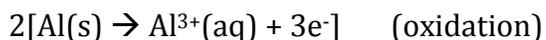
1. Aluminum is oxidized. The oxidation state increases from zero to plus three (3 electrons lost). The copper is reduced. The oxidation state decreases from 2+ to zero (2 electrons gained). The two half-reactions are as follows:



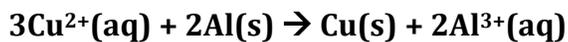
2. The reactions are already balanced for mass.
3. To balance the half reactions for charge add the appropriate number for electrons:



4. Multiply by an appropriate factor:



5. Add the half reactions to get the net ionic equation:



This reaction is exothermic and the temperature rise of the solution can be measured using a thermometer.

Disposal: Dispose of solutions in appropriate aqueous waste containers.

References:

1. J. Kotz, P. Treichel, J. Townsend. *Chemistry & Chemical Reactivity*. 7th Ed. Teachers Ed; Brooks/Cole; 2009; p. 900. Figure 20.2. Example 20.1

Note: Al foil has a coating of aluminum oxide (Al_2O_3) that protects it from further reacting. The chloride ions in the solution breach the coating, allowing the reaction to take place.