5.1 Oxidation/reduction reactions involving zinc, copper, and silver

Subject: Oxidation/reduction

Description: Oxidation and reduction reactions are demonstrated using one or more of the following common reactions involving copper in zinc chloride, zinc in copper sulfate, and copper in silver nitrate.

Materials for Reaction A:
1.0 M Copper sulfate, $CuSO_4$‡
1 strip zinc metal
250 mL beaker

Materials for Reaction B:
1.0 M Zinc chloride, $ZnCl_2$‡
1 strip copper metal
250 mL beaker

Materials for Reaction C:
1.0 M Silver nitrate, $AgNO_3$‡
Coiled copper wire – heavy gauge (10 or 12 solid)
250 mL beaker

‡Solutions are located in the solutions cabinets.

Procedure A:
1. Fill the 250 mL beaker with copper sulfate ($CuSO_4$) solution.
2. Place the zinc strip in the solution and observe.
3. Over time, copper ions will be oxidized to copper metal while zinc metal is reduced to zinc ions.

Procedure B:
1. Fill the 250 mL beaker with zinc chloride ($ZnCl_2$) solution.
2. Place the copper strip in the solution and observe.
3. Over time, zinc ions will be oxidized to zinc metal while copper metal is reduced to copper ions.

Procedure C:
1. Fill the 250 mL beaker with silver nitrate ($AgNO_3$) solution.
2. Place the coiled copper wire in the solution and observe.
3. Over time, silver ions will be oxidized to silver metal while the copper metal is reduced to copper ions.

Discussion:
Oxidation/reduction reactions involve the transfer of electrons between substances. One substance will lose electrons (oxidation) that will be gained by the other

substance (reduction). The net ionic equations and half reactions for the above demos are given below:

Reaction A:
Net ionic equation: $Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$

Half reactions: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ / $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$

Reaction B:
Net ionic equation: $Zn^{2+}(aq) + Cu(s) \rightarrow Zn(s) + Cu^{2+}(aq)$

Half reactios: $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ / $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

Reaction C:
Net ionic equation: $2Ag^{+}(aq) + Cu(s) \rightarrow 2Ag(s) + Cu^{2+}(aq)$

Half reactions: $2Ag^{+}(aq) + 2e^- \rightarrow Ag(s)$ / $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

Safety: Zinc chloride and silver nitrate are corrosive and can cause skin burns. Copper sulfate can cause skin irritations. Wear proper protective equipment including gloves and safety glasses.

Disposal: Solutions and metal waste should be disposed of in appropriate waste containers. Silver metal can be reclaimed.

The reaction of copper sulfate and zinc can be saved and reused as a prop for intro to thermodynamics (per Prof. Botch)