CEAC 103
GENERAL CHEMISTRY

Experiment 2
Stoichiometry: The Reaction of Iron with Copper(II) Sulfate

Purpose: To enhance the understanding of stoichiometry, a reaction between iron and copper (II) sulfate solution will be conducted. This will help you to differentiate limiting and excess reactant in a chemical reaction. Finally the theoretical and percent yield of this reaction will be calculated.

Theory

Stoichiometry is the measurement of quantitative relationships in chemical formulas and equations. In this experiment stoichiometric principles will be used to obtain the appropriate equation between the reaction of iron metal and copper(II) sulfate solution. After the reaction is taking place, the formation of metallic copper, which is seen precipitating as a finely divided reddish-orange powder will be observed. This reaction is one of the example of single substitution reaction in which one element "displaces" from a compound by another element. The element which has ability of displacing other element from compound is said to be "more active" than the displaced metal. In this experiment, iron is more active than copper.

Two distinct forms of iron are present, namely Fe^{2+} and Fe^{3+}. Stoichiometric principles will be used to determine which reaction is more dominant compared to other one by examining the reaction between iron and copper (II) sulfate solution. If Fe^{2+} is formed, then **equation (1)** is dominant, while **equation (2)** will be selected if Fe^{3+} is formed. This can be determined

according to mole ratio of copper to iron. If the moles of copper is equal to the moles of iron, then equation (1) has taken place. If you obtain 1.5 moles of copper per mole of iron, in this case equation (2) should be selected Find out which equation is corresponding to the results of the experiment you have done.

Equation (1) $Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$,

other representation is $Fe\ (s) + Cu^{2+}\ (aq) \rightarrow Fe^{2+}\ (aq) + Cu\ (s)$

Equation (2) $2\ Fe\ (s) + 3\ CuSO_4\ (aq) \rightarrow Fe2(SO4)_3\ (aq) + 3\ Cu\ (s)$,

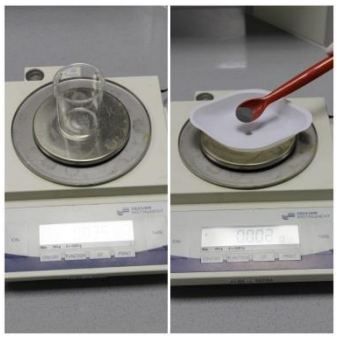
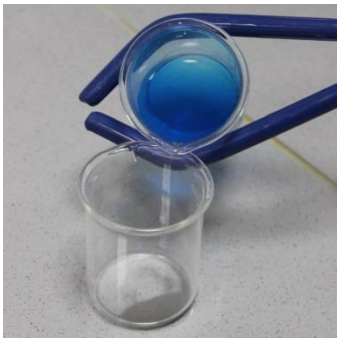
other representation is $2\ Fe\ (s) + 3\ Cu^{2+}\ (aq) \rightarrow 2\ Fe^{3+}\ (aq) + 3\ Cu\ (s)$

To the known amount of iron, excess of copper (II) sulfate solution will be added. The purpose of using excess solution is owing to provide the complete reaction of iron. The metallic copper produced will be weighed after washing and drying processes and these weighings will be used to calculate the moles of iron used and the moles of copper formed.

Materials

Fe powder	Acetone	Glass stick
Cupper (II) Sulfate ($CuSO_4$)	Beaker	Bunsen burner

Procedure

The Reaction of Iron with Copper(II) Sulfate	
1. Weigh a dry and clean 100 or 250 mL beaker and record the weight of it onto your data sheet. then, accurately weigh 1.00 gram of iron powder into this beaker. Do not exceed 1.01 grams.	
2. Measure 30 mL of 1.0 M $CuSO_4$ solution by using a graduated cylinder. Pour this solution into another beaker, and heat gently to almost boiling.	
3. Slowly add hot $CuSO_4$ solution to the beaker that contains the iron powder. Stir the mixture a few times until completeness of the reaction. You should see copper forming. When the reaction has finished, allow the copper product to cool.	
4. Then carefully decant the liquid from the copper into the waste container. Be careful not to lose any copper	

5. Add about 10 mL of distilled water to the solid copper and swirl to wash any remaining ions from the copper. Decant the wash water from the copper and add 10 more mL of distilled water, swirl and decant again. Wash copper particles finally with several mL of acetone (**CAUTION**- Acetone is very flammable). Swirl and allow to stand a few minutes. Decant off the acetone.	
6. The acetone readily dissolves the water and helps the removal of it from the medium. Swirl the beaker gently on low heat flame. Copper product should be spread in a single layer on the bottom of the beaker. Grinding of aggregates with a spatula makes the copper easy to dry. Be sure not to remove any copper from the beaker.	
7. After drying, allow copper to cool and weigh the beaker plus copper to calculate the mass of copper formed. Record the mass on your data sheet. Finally, calculate the moles of iron used and the moles of copper formed to determine which reaction of iron is taking place, reaction (1) or reaction (2).	

DATA SHEET

Stoichiometry: The Reaction of Iron with Copper(II) Sulfate

Student's Name : Date:

Laboratory Section/Group No :

Assistant's Name and Signature:

Data and Calculations

Mass of empty beaker :

Mass of iron used :

Moles of iron used :

Mass of beaker plus copper :

Mass of copper formed :

Moles of copper formed :

Moles of Cu divided by moles of Fe :

Reaction Equation :

Limiting Reagent :

Theoretical and Percent Yield :