Lab - Limiting Reactant and Percent Yield

Purpose

-To determine the theoretical and experimental yields of a single replacement reaction.
-To determine the limiting reactant from experimental data
-To determine the percent yield in a chemical reaction

Procedure

1) Read the entire lab and construct a data table to record the data.
2) Weigh out approximately 12.5 g of copper (II) sulfate and record the exact mass. Place the copper (II) sulfate in a 250 mL beaker.
3) Using a graduated cylinder, measure out 50.0 mL of distilled water, and then add the water to the 250 mL beaker of cupric sulfate.
4) On a piece of weighing paper, mass out close to 3.00 g of iron filings. Record exact mass and set aside until Step 8.
5) Using a ring stand setup, heat the copper sulfate and water. DO NOT BOIL THE SOLUTION!
6) To help dissolve the copper sulfate crystals, stir with a glass stirring rod.
7) When all the crystals are dissolved, stop heating.
8) While stirring, carefully add the iron filings to the hot copper sulfate solution. When all the iron has been added, let the solution sit for 10 minutes to allow it to react. Stir it occasionally and record any observations. Weigh a piece of filter paper. Record mass in data table.
9) When the 10 minute reaction time is up, fold the filter paper so it sits in the funnel which sits in a 250 mL Erlenmeyer flask. Carefully pour the solution through the funnel paper. Use small amounts of water to wash the copper into the filter.
10) While the solid is still on the filter paper, wash it 3 times using distilled water. Simply pour small amounts of distilled water over the solid filter.
11) Carefully take the filter paper out of the funnel and place the filter paper on a paper towel and allow to dry overnight..
12) Weigh the filter paper containing the dry copper metal. Record the mass in the data table.

Data Analysis (Show all work ; include units on all answers)

1) Calculate the moles of copper (II) sulfate used.
2) Calculate the moles of iron used.
3) Write a balanced equation for this single-replacement reaction. (Iron (II) sulfate will be one of the products.)
4) Using the mole ratio from the balanced equation, calculate the theoretical mass of copper (yield) that would be formed from this amount of iron.
5) Using the mole ratio from the balanced equation, calculate the theoretical mass of copper (yield) that would be formed from this amount of $CuSO_4$.
6) Calculate the mass of copper formed in the reaction using the measured mass of dry copper.
7) Calculate the percent yield of copper.

Conclusions

1) How would your experimental value for moles of copper formed be affected by the following situations?
a) If 15 g of copper (II) sulfate were added to water instead of 12.5 g copper (II) sulfate?
b) If the solid copper product was not dried thoroughly ?
c) If 5 g of iron were used instead of 3 g iron?

2) Which reactant is limiting? Which reactant is in excess? What observation indicates this to be true?
3) Calculate the mass of iron (II) sulfate that could be obtained in your reaction.
4) If you were in charge of a chemical plant, suggest one practical consideration that would help you to decide which reactant should be the limiting reactant?
5) For your error analysis, suggest several possible ways you might be able to increase the percent yield.