LAB # 6 : Determining Percent Yield in a Chemical Reaction

In this lab, a known mass of a copper salt ($CuCl_2$) will be dissolved in water and an excess amount of aluminum will be added to the solution. The reaction will proceed as follows:

$$CuCl_2{\cdot}2H_2O_{(aq)} + Al_{(s)} \rightarrow Cu_{(s)} + AlCl_{3(aq)} + H_2O_{(l)}$$

The mass of copper produced will be measured and then compared to the theoretical mass of copper.

Pre-lab Questions:

1. What type of chemical reaction is this? (It's actually 2 types of reactions)
2. Balance the equation.
3. You will be starting with 2.00 g of $CuCl_2.2H_2O$. Calculate the mass of copper that should be produced. This will be your theoretical yield. Show all of your steps.
4. A solution of copper (II) chloride is blue. A solution of aluminum chloride is colourless. How will you know when the reaction is completely finished?
5. "An excess amount of aluminum will be added". What do you think this statement means?

Materials:

$CuCl_2.2H_2O_{(s)}$	250 mL beaker	100 mL graduated cylinder	aluminum foil
hot plate	scoopula	evaporating dish	dropper
crucible tongs			

Procedure:

1. Mass a clean, dry evaporating dish and record its mass in your observation chart.

2. Mass 2.00g of $CuCl_2.2H_2O_{(s)}$ and record the mass in your observation chart.

3. Add the $CuCl_2.2H_2O_{(s)}$ to 50 mL of water in a beaker. Stir until it has completely dissolved.

4. Place a strip of aluminum foil into the beaker.

5. Heat the beaker **gently** using a hot plate for about 5 minutes. Do not let the solution boil.

6. When the strip of aluminum gets coated with copper remove it from the beaker and begin to extract the copper into the evaporating dish. This step is tricky. You want to collect as much of the copper that has been produced as possible. Some copper will be stuck to the aluminum foil; some will have fallen to the bottom of the beaker along with small bits of aluminum. Using tweezers, a scoopula, or anything else that you think will work to carefully separate and collect the copper.

7. While one partner is working on step #6, add a fresh strip of aluminum to the beaker and repeat step 6 as many times as necessary until all the blue colour has disappeared.

8. When all of the copper has been extracted from the solution, carefully heat the copper until it is dry. DO NOT let the copper turn black or green.

9. When the evaporating dish is cool, determine the mass of the dish and copper.

Observations:

Mass of $CuCl_2.2H_2O$: _____
Mass of evaporating dish: _____
Mass of evaporating dish and copper: _____
Mass of copper: _____

Post-Lab Calculations and Discussion Questions:

1. What is the experimental yield of copper i.e. how much copper did you extract?

2. What is your theoretical yield i.e. how much copper did you expect to extract?

3. Determine the percent yield of copper.

4. If not all of the water was evaporated in the last step, would this make the percent yield appear greater or smaller than it should have been? Show hypothetical calculations to prove your answer.

5. List two other sources of error that would have affected the experimental yield. For each, state whether it would make the percent yield higher or lower than it should have been?

6. How did you know that the reaction was really done?

7. What evidence was there to confirm that an excess amount of aluminum had been added?

8. If the experiment had been done so that there was an excess amount of copper (II) chloride in the solution rather than aluminum, what would the end of the reaction have looked like (two things)?