Unit 3 Pre-Lab: Copper Collection

A typical high school generates a considerable volume of waste copper(II) sulfate solution each year. Due to the toxicity of this compound, it must be treated to remove the copper(II) ions prior to disposal. One way to do this is to convert the copper ions into elemental copper by reacting them with a reactive metal.

It is your job as a group to create a procedure for removing copper(II) ions from solution. Your group will be assigned one of the following metals to precipitate the copper out: aluminum, magnesium, iron, zinc

You must complete this pre-lab before starting the lab. 1 Pre-Lab is to be submitted per group. Check with the teacher when done.

1. Our group was assigned this metal:
2. Theoretically, is the metal you were assigned able to precipitate the copper out of solution? Explain (you may need to refer to Unit 2).
3. Write the chemical equation(s) for the reaction of your assigned metal with the copper(II) sulfate. **If your metal is multivalent, write an equation for each of the oxidation states.**
4. For your above equation(s), which of the reactants should be the limiting reagent and which should be the excess reagent? Explain your answer. Remember, the goal of this lab is to precipitate out **all** the copper(II) ions in solution.
5. What physical property is an indicator of copper(II) ions in solution? What should happen as the copper(II) ions are removed (precipitated out).
6. Based on your equation(s) and the excess reagent, what should be left in the beaker when all the copper(II) ions are used up?
7. How do you think the the metal you were assigned compare to the metals assigned to other groups in terms of how effective it is in removing the copper(II) ions?
8. Should the amount of water in the solution affect the amount of solid copper produced? Explain.
9. How could you prepare your metal to make sure the reaction will occur? Is there anything you could add to the solution?

**Calculations:**

To create the copper(II) sulfate solution, you will be adding about 3.00 grams of solid copper(II) sulfate pentahydrate to 100 mL of water.

1. Calculate the number of moles of copper(II) sulfate that will be in the solution.
2. Calculate the molarity (molar concentration) of the copper(II) sulfate solution.
3. What mass of metal should you add to the solution to make sure all the copper(II) ions are precipitated out? Show calculations.

*Make sure each member of your group has a copy (or picture) of this pre-lab to help when writing the actual lab!*

Unit 3 Lab: Copper Collection

**A. Purpose:** Create and test a procedure to precipitate copper(II) ions out of a copper(II) sulfate solution.

**B. Hypothesis:**

*[Summarize your procedure for precipitating copper(II) ions out of the solution using the assigned metal. Predict how effective it will be and possible reasons for error]*

**C. Materials:***[Add anything else you used that isn’t listed here]*

|  |  |
| --- | --- |
| * \_\_\_ g of \_\_\_\_\_\_ *[assigned metal]* * 3.00 g of copper(II) sulfate pentahydrate crystals * 250 mL beaker * Stirring rod * Electronic balance * Weighing paper | * Filter paper * Filter funnel * Erlenmeyer flask * Distilled water * Distilled water bottle |

**D. Procedure:**

1. All of the materials were collected at a lab bench.

**Preparation of the copper(II) sulfate solution**

1. 100 mL of distilled water was added to the 250 mL beaker
2. Approximately 3.0 g of copper(II) sulfate pentahydrate was measured on the electronic balance using weighing paper. The exact mass was recorded in the observation table.
3. The copper(II) sulfate pentahydrate crystals were added to the water. The solution was stirred until the crystals were dissolved. Observations were recorded.

**Removal of copper(II) ions from solution**

1. The ***assigned metal*** was prepared to be added to the copper(II) sulfate solution. Observations were recorded.
2. The correct amount of ***assigned metal*** was measured on the electronic balance. The exact mass was recorded in the observation table.
3. The ***assigned metal*** was added to the solution. Observations were recorded. The solution was stirred until the reaction was complete.
4. A piece of filter paper was weighed using the electronic balance. The exact mass was recorded in the observation table.
5. The piece of filter paper was folded as shown by teacher and placed in the filter funnel in the erlenmeyer flask.
6. The solution was filtered into the erlenmeyer flask. Distilled water was used to clean out the beaker and was filtered.
7. Any excess ***assigned metal*** was removed from the filter paper and was rinsed with distilled water through the filter.
8. The ***assigned metal*** was dried and weighed using the electronic balance. The exact mass was recorded in the observation table.
9. The filter paper was spread out on a paper towel, labelled with the names of the group, and left to dry overnight. The remaining aqueous solution was labeled.

**Finding the mass of the copper**

1. Once dry, the mass of the filter paper and copper residue was measured and recorded in the observation table.
2. The filter paper and copper residue were disposed of as instructed by the teacher.

**E. Observations**

*Table 1: Recorded Masses*

|  |  |
| --- | --- |
| ***Substance*** | ***Mass (g)*** |
| Copper sulfate pentahydrate crystals |  |
| ***Assigned metal*** |  |
| Filter paper |  |
| Excess ***assigned metal*** |  |
| Dry filter paper + copper residue |  |

*Table 2: Observations*

|  |  |
| --- | --- |
| ***Substance*** | ***Observations*** |
| Copper(II) sulfate solution |  |
| ***Assigned metal*** after preparation |  |
| When the ***assigned metal*** was added to the copper(II) sulfate solution |  |
| Comment on the speed of reaction (approximately how long did it take?) |  |
| Excess ***assigned metal*** |  |
| Solution after copper residue filtered out |  |
| Copper residue |  |

**F. Analysis:**

*[Complete the following questions. Include the question in your answer. Provide experimental evidence for each answer. Cite any external sources, including the textbook.]*

1. Calculate the theoretical mass of copper that should have been recovered from the experiment based on the amount of copper(II) sulfate used. Include the balanced chemical equation for the reaction.
2. Calculate the mass of solid copper recovered from the experiment.
3. Calculate the percentage yield of the experiment. Give this value to the teacher once it has been calculated so other groups can compare their values.
4. Describe at least 3 reasons that may have caused the yield to be greater or less than 100%. Be specific.
5. Explain how the appearance of the copper(II) sulfate solution changed over the course of the reaction. What caused this change?
6. What was left in the aqueous solution after the copper was filtered out? Do some research to find out if this solution safe to dispose of down the sink.
7. Compare your % yield to the yield of other groups. Which metal do you think is the most effective at recovering the copper(II) ions based on the % yield and speed of reaction?

**G. Conclusion:**

*[Summarize your results, compare them to your hypothesis, discuss the experimental error and suggestions for how you could improve the experiment if you or someone else were to repeat it]*

**H. Works Cited**

[1] *[List any additional resources used]*

**Marking Scheme**

*Professionalism /5C*

*B. Hypothesis /4C*

*C. Materials /1C*

*D. Procedure /1C*

*E. Observations /17C*

*F. Analysis /2T /1T /1T /3T /3T /3T /3T*

*G. Conclusion /6T*

*Total: /28T /19 C*

*Comments:*