



# Chem115 Fall 2023 - Ilana Berlin/Lab5: Synthesis of a Coordination Compound: Tetraamminecopper(II) Sulfate Monohydrate/LabReport5

Jason Cody - Sep 29, 2023, 10:23 AM CDT

## Assignment #10 - LabReport5

You cannot edit this entry after it is graded.

Description Submit before 4pm CST

I worked in a group with

The work for this assignment is in My notebook

**Grade** 9 / 10

Graded on Sep 29, 2023, 10:23 AM CDT

Ilana Berlin - Sep 25, 2023, 12:24 PM CDT

**TITLE:** Synthesis and Isolation of Tetraamminecopper(II) Sulfate Monohydrate  
**Date:** Monday, September 25<sup>th</sup>, 2023  
**Purpose:** Produce Tetraamminecopper(II) Sulfate Monohydrate from Copper Sulfate Pentahydrate Ammonia (  
**Reference:** Kotley, L. J., *Introduction to Chemistry in the Laboratory*, 20<sup>th</sup> Ed., Lake Forest College, 2023, Experiment 2A, Appendix A. (Edit the experiment title and/or appendix letter; add other references, if used, following the same format).  
**Observation and Data:** (Write your clear, concise, complete, past tense, passive voice description or narrative of the experiment as the experiment is performed. Complete unknown are used throughout.  
If needed, insert tables and edit the header: Table 1. Preparation of Standard Solutions.  
If needed, insert figures and edit this caption below the figure: Figure 1. Beer's Law Plot of 812 Standard Solutions at  $\lambda = 520$  nm. Number tables and figures in order of appearance in the report.)  
**Calculations:** (insert sample calculations here, if relevant. Otherwise, delete this section entirely).  
**Conclusion:** (review the quantitative values (percent error and/or CV) to indicate how well the goals of the experiment have been met; answer any questions in the experimental instructions, too).

ReportTemplate.docx (15.3 kB)

Jason Cody - Sep 19, 2020, 10:31 AM CDT

Now that you've mastered lab report basics, let's step it up a notch in professionalism and use a template provided by Prof. Wiser. Immediately below each of the following headings, let your cursor hover until "insert" appears and then select RichText. Then, type in your text entry. If you need to insert figures, please be sure to include a title (i.e. Figure 1: Sketch of apparatus.).

## Date and Title

Ilana Berlin - Sep 25, 2023, 12:33 PM CDT

Synthesis and Isolation of Tetraamminecopper(II) Sulfate Monohydrate

Monday, September 25, 2023

Dawn Wiser - Sep 16, 2020, 2:10 PM CDT

## Purpose

Jason Cody - Sep 29, 2023, 10:19 AM CDT

Produce Tetraamminecopper(II) Sulfate Monohydrate from Copper Sulfate Pentahydrate Ammonia ( $\text{H}_2\text{O}_{(l)} + \text{CuSO}_{4(aq)} + 4\text{NH}_{3(aq)} \rightarrow [\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}_{(s)}$ ) OK; try the subscript formatting under the A: symbol at the top of this text box (easier than tiny font). Calculate percent yield and determine limiting reagent. OK, but this would be so much better with complete sentences.

Jason Cody - Sep 16, 2020, 2:13 PM CDT

## Reference

Ilana Berlin - Sep 25, 2023, 3:37 PM CDT

Kateley, L. J., *Introduction to Chemistry in the Laboratory*, 20<sup>th</sup> Ed., Lake Forest College, **2021**, Experiment 5 Appendix D.

Dawn Wiser - Sep 16, 2020, 2:10 PM CDT

## Data and Observations

Jason Cody - Sep 29, 2023, 10:20 AM CDT

5 mL of Copper Sulfate Pentahydrate ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ ) with a concentration of 300 mg/mL was added to a 50 mL Kinmax beaker. The solution was a bright ultramarine blue liquid but the undissolved compound was a lighter azure powder. A pentahydrate is a compound with 5 water molecules attached. 4 mL of a 15 M ammonia solution was added. The solution turned dark purple and the beaker heated up (a sign of an exothermic reaction), after mixing the solution's color darkened to a deep inky purple. 8 mL of 95% Ethanol was added. The solution thinned and lightened, creating a foamy violet purple. The solution was then put on ice for around 15 minutes. As it cooled, a clear liquid rose to the top and a purple blue sediment settled to the bottom. OK. Nice observations.

The solution was filtered through a vacuum filter using a side arm flask and Hirsch funnel. The solution created a light blue filtrate left a deep blue purple solid residue in the funnel. The first wash with a solution of a 50/50 15M ammonium solution and 95% ethanol solution created a dark blue filtrate. The second wash with 6mL of 95% ethanol had a clear filtrate. The  $\text{Cu}^{2+}$  ion in the filtrate provides the blue color. Using the balanced chemical equation it is possible to isolate the theoretical amount of solid coordination compound. **No. all blue material wasn't collected on the filter.**

The petri dish (Pyrex bottom only) weighed 17.333g. The petri dish with the residue weighed 18.837g. Therefore the sediment weighed 1.504g. The reaction is limited by  $\text{CuSO}_4$ . There is more mmol of ammonium in the solution than used in the reaction. This is proven using the balanced chemical equation.

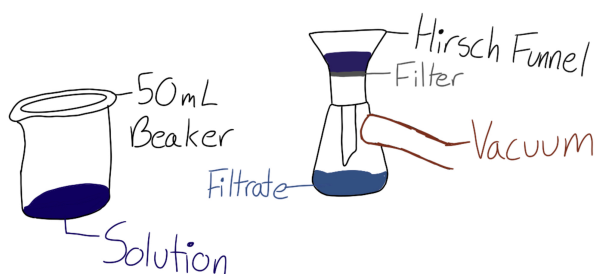


Figure 1. Vacuum Filtration Set-up

Jason Cody - Sep 16, 2020, 2:18 PM CDT

## Calculations

Jason Cody - Sep 29, 2023, 10:21 AM CDT

a) 18.837g

b) 17.333g

c) Weight of dish with residue - weight of dish = weight of sediment

$$18.837\text{g} - 17.333\text{g} = 1.504\text{g}$$

d) Molar Mass of  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$  **subscripts?**

$$63.55 + 4[14.01 + 3(1.008)] + 32.07 + 4(16.00) = 245.7$$

e)  $1.504\text{ g} (1000\text{mg}/1\text{g}) (1\text{mmol}/245.7\text{mg}) = 6.121\text{ mmol}$  of  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4 \cdot \text{H}_2\text{O}$

f) 249.7 mg/mmol

g)  $1500\text{ mg} (1\text{ mmol}/249.7\text{ mg}) = 6.0\text{ mmol}$

h) 45 mmol

i)  $6.007 \text{ mmol CuSO}_4 \cdot 5\text{H}_2\text{O} (4 \text{ mmol NH}_3 / 1 \text{ mmol CuSO}_4 \cdot 5\text{H}_2\text{O}) = 24.03 \text{ mmol}$

Percent Yield =  $100 \times \text{actual/theoretical} = \text{mmol produced} / \text{mmol possible}$

$(6.121/6.0 \text{ mmol}) \times 100 = 102\% \text{ yield OK}$

Jason Cody - Sep 16, 2020, 2:19 PM CDT

## Conclusions

Jason Cody - Sep 29, 2023, 10:22 AM CDT

The solution changed color and temperature, indicating chemical reactions occurred and new substances were formed. The final synthesized compound had a cation of  $\text{Cu}^{2+}$  **no, the coordination complex was the cation:**  $[\text{Cu}(\text{NH}_3)_4]^{2+}$  and  $\text{NH}_4^+$  **no** and an anion of sulfate  $\text{SO}_4^{2-}$ . There is one mole of hydration for each mole of coordination compound. **OK** Small amounts of product were lost at many stages, mostly through residue on equipment. The final produce in a homogenous electric purple powdery wet solid that smells like ethanol (the entire lab kind of smells like ethanol). The homogenous mixture suggest high purity. **OK**