Pre-lab: Experiment 18 - Absorption Spectroscopy and Beer's Law: Analysis of Cu^{2+}

Format & Clarity of the Report: See lab report checklist. You are graded on how you format the lab and record your data, not just data collection.

Before class starts: Read the lab for the week carefully before you start writing your pre-lab. The purpose, introduction, and procedure are neatly written in your lab book before class starts. Keep the introduction and the purpose separate. Pre-lab questions need to be correctly answered.

Spacing: You will probably use less than 0.5 page for your purpose and 0.5-1 page for your Introduction and overview, 2-3 pages for the procedure, 1 page for the data table, 1 page for calculations, and 1 page for results table, 1-2 page for the questions, and 1-2 results/error statement. Allotting the appropriate amount of space for the lab insures lab reports stay separate. The lab book is neater and easier to read! (I have give suggestions for other allotments; look at them and use the one that makes the most sense to you.)

Purpose: Your purpose should summarize what you will be trying to determine in the lab. Although this lab has many parts, what are you ultimately determining in the lab.

Method: Give a **GENERAL** description of how to make the standard copper (II) solution in part 1, the diluted solutions in part 2, the measurements for the standard curve in part 3, and the analysis of the unknown in part 4. **Address the following in this section:** Give a brief explanation of absorbance, Beer's law, and the relationship of the parts of the equation.

Procedure:

- This is a 2-day lab.
- Make all solutions and dilutions, including the unknown solutions, on Day 1. Save these, stoppered and labeled, in your locker.
- Take all absorbance measurements on day 2.

PARTS 1 and 4:

- Transfer the solid carefully.
- Make sure that you rinse all the copper solid into the volumetric flask.
- **USE A POWDER FUNNEL TO TRANSFER THE SOLID.**

PART 2:

- Exercise care in reading the volumes.

PART 3 & PART 4:

- Make your unknown solution BEFORE reading absorbance of all the solutions.
- Use the ENTIRE contents of the vial. The mass of the contents is on the via
- Read the diluted solutions and the unknown at the same time.
- The procedure for the use of the Spectronic 20D spectrophotometers is on the website.

- **DO NOT PUT THE CUVETTES IN YOUR DRAWER.**

Qualitative Observations/Data Collections:

- **Part 1:** the formula of the solid to be used, the correct size of volumetric flask for your solution, the color of the solid.
- **Part 2:** the differences in the appearance of the various diluted solutions.
- **Part 3:** the model of the spectrophotometer, the wavelength used.
- **Part 4:** the unknown number on the vial, the appearance of the unknown, the volume of the solution made, and the mass on the vial.

Any observations, errors, or difficulties that came up when carrying out the procedure (Made the standard solution wrong, spilt some solid, missed the line on the flask, did not zero spectrophotometer.)

Data Tables (collected in the observation section):

- Well organized data tables
- Data is transferred neatly with proper significant figures and units.
- Keep sections separated
- Recorded the mass on the vial of contents, the volume of flask used for the standard solution, the volumes used to make the diluted solutions, the volume used to make the unknown, the unknown number, the absorbance of the known solutions and the unknown.

Calculations:

- Well organized calculations
- Flow of calculations is easy to follow.
- Correct significant figures and units.
- Show calculations for: the mass used for your standard solution, the concentration of the standard solutions, the concentrations of the diluted solutions, a graph of the standard data, the moles of copper present in the unknown sample, the mass of copper (II) sulfate pentahydrate in the unknown sample, the purity of the sample.

Graph:

- For this experiment, craft a well-proportioned, easy to read graph. The graph follows the standard rules of graphing as presented and practiced early in the semester.

Results Table:

- What did you determine in this lab?

Discussion/error analysis:

WHY DID I DO THE LAB?

- Re-address the purpose.

WHAT DID I DETERMINE IN THE LAB?

- Summarize your **final** data.

WHAT DID I DO IN THE LAB?

- Summarize the procedure of the lab.

WHAT DID I OBSERVE IN THE LAB?

- Summarize your observations and do not confuse observations and conclusions.

BASED ON YOUR PROCEDURE AND OBSERVATIONS, HOW DID YOU REACH THE CONCLUSION FOR YOUR UNKNOWN?

- From the observations, draw conclusions about what you observed.
- How did the concentration of the standard solutions affect the absorbance?
- How did the graph help you obtain your results?
- What did the results mean to you?
- Did the results support the purpose?

WHERE DID I MAKE AN ASSUMPTION THAT COULD LEAD TO AN ERROR?

Please analyze this as your source of error: A significant source of error in this experiment is that solid hydrated compounds are rarely pure: the compound labeled $CuSO_4 \bullet 5H_2O_{(s)}$ will also contain some $CuSO_4 \bullet 4H_2O_{(s)}$ and some $CuSO_4 \bullet 3H_2O_{(s)}$ (and other (smaller) numbers of H_2O).

a. How will this affect the initial calculated molarity of the standard Cu^{2+} solution? Explain your reasoning clearly.

b. How will this affect the concentrations of the diluted solutions?

c. Will this error affect the accuracy of the data points on the graph? Will it affect the precision of the data points on the graph (Will it cause more scatter in the points?) Explain.

d. How will it affect the slope of the line obtained? How will it affect the y-intercept of the line?

e. Unknown solution – how will this error affect the calculated M of the unknown solution – will it be too high or too low?

f. How will it affect the calculated mass percent $CuSO_4 \bullet 5H_2O$ of the unknown – too high or too low?

HOW DID IT CONNECT TO CONCEPTS DISCUSSED IN LECTURE?

- Thinking about what you learned in lecture and in the lab, do your results make sense? In other words, were there assumptions made that affected the results?
- Compare the results with theories outlined in the introduction. Do they match? Explain why they might vary.

FOR ANY STATEMENT: Submit a typed statement in 12 pt, serf font (i.e. Palatino, Garibaldi, or Times), using good grammar, syntax, and Standard English. Complete sentences are used: short well-worded sentences are better than long, poorly, worded sentences. The spelling has been checked. Questions that are presented throughout the lab can be answered in a coherent set of paragraphs, but the points must be addressed within**.** All of this was done in a manner that was well thought out, logically presented and interesting to read. The evaluation should be neatly trimmed and **GLUED OR TAPED** into your book (two copies, one original, one yellow).

(In the end, I should have a good sense of what you were looking for in this experiment, what you did and observed in the experiment, what your results were for the experiment. Think about it this way. " Oh no, I lost my report. That's okay, I can describe what I did, my results, and errors, etc., in the discussion.")

Questions:

Non- calculation answers are to be typed. Typing answers allows for a thoughtful process and assures quality and depth in the answer.

1. When preparing the standard solution in Part 1, why can't we just put the solid in the flask, fill it with water up to the mark, and then mix?
2. Why is it necessary to rinse the pipets with the solution to be used in them before using the pipets?
3. Why is it necessary to rinse out the cuvette with the solution to be used in it before making our measurements?
4. Why must we use the same cuvette for all measurements?
5. What is the purpose of "zeroing" the spectrophotometer using a "blank" solution (water)?

6. What assumptions are we making in the calculations and analysis for this lab?

7. 6.019 g of an unknown copper compound was dissolved in 100.0 mL solution. The absorbance of this solution was 0.477 at 620 nm. Use your Beer's law graph to determine the concentration of copper ions in this solution. Then determine the mass percent copper in the copper compound.