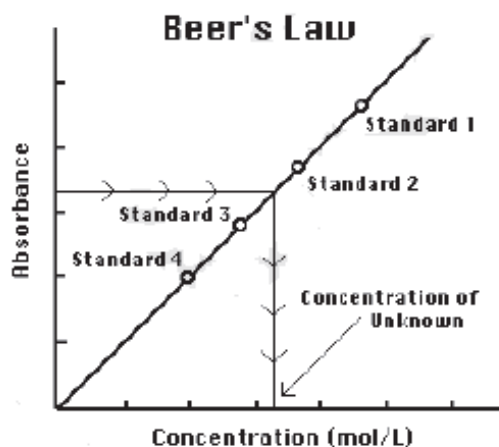


BACKGROUND

The purpose of this experiment is to determine the concentration of an unknown copper (II) chloride solution using absorption spectroscopy. The amount of light that is absorbed by a solution can be measured using a spectrophotometer. The CuCl_2 solution used in this experiment has a deep blue color. A higher concentration of the colored solution absorbs more light (and transmits less) than a solution of lower concentration. When a graph of absorbance vs. concentration is plotted for a series of standard solutions of known concentration, a direct relationship should result, as shown in the figure below:



The direct relationship between absorbance and concentration for a solution is known as Beer's law. The concentration of an *unknown* CuCl_2 solution is then determined by measuring its absorbance with the spectrometer. The concentration of the unknown can be found using the equation of the line of the Beer's law curve.

MATERIALS

Solid $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$ (170.49 g/mol) spectrometer and computer one cuvette distilled water	two 10 mL graduated cylinders Kimwipe tissues two 100 mL beakers 2 mL of CuCl_2 unknown solution	five large test tubes test tube rack one 100 mL volumetric flask stirring rod
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PROCEDURE Part I: Making the Standard Solutions

1. Obtain and wear goggles! **CAUTION:** Be careful not to ingest any CuCl_2 solution or spill any on your skin. Inform your teacher immediately in the event of an accident.
2. Produce an initial stock solution of 0.10 M copper(II) chloride by dissolving enough solid into the 100 mL volumetric flask and filling to the final volume. Once this solution is made, pour it into a beaker and mix it thoroughly.
3. Label five clean, dry, test tubes 1–5. Make 10 mL of each of the concentrations listed in the table below by diluting the correct volume of 0.10 M CuCl_2 solution with the correct volume of water in the labeled test tubes. Show all your calculations!

Data Table 1: Mixtures Used to Make Standard Solutions

Sample Number	0.10 M CuCl ₂ used (mL)	Deionized H ₂ O used (mL)	Volume of solution made (mL)	Concentration (M)
1			10.0	0.020
2			10.0	0.040
3			10.0	0.060
4			10.0	0.080
5			10.0	0.10

Calculations for Data Table 1:

PROCEDURE Part II: Calibration and Use of Spectrometer

1. Attach the SpectroVIS with included USB cable to the PC computer .
2. Search for and start the “Logger Pro 3.11” (or higher) Software.
3. Calibrate by filling a cuvette $\frac{3}{4}$ of the way with solvent (DI water) and placing it in the spectrometer (be sure the clear windows face along a line parallel to the length of the spectrometer. Click on the Experiment menu, choose “calibrate,” then follow the on-screen instructions.
4. Using your highest concentration standard solution, rinse and refill the cuvette. Place it into the spectrometer. Press the record button to obtain a full absorption spectrum of the sample. When complete, hit the stop button and a graph of absorption vs. wavelength should display on the screen.
5. Under the Experiment menu select Data collection, Events with Entry. Fill in the Column Name with Concentration and Units with M (for molarity). The instrument will ask you if you want to keep the stored data: select “Yes” in order to keep the absorption spectrum.
6. Select a wavelength where the maximum absorbance is no higher than 1-1.5. (This should happen automatically, but if not, call me over).
7. Once the device is set up, place the first solution into the cuvette and then into the instrument. Once the reading is stable, record the absorbance by hitting “KEEP” and recording the concentration. Rinse the cuvette with water, then the next solution, and continue until all of the standards have been measured. DO NOT HIT STOP until all of the standard solution samples have been measured.
8. Create a best fit line by clicking on the  icon.
9. Once you have hit STOP, obtain a sample of the unknown solution from the instructor and measure the absorbance. Take a screenshot while the absorbance of the unknown is displayed. Insert this graph/image into your lab report document in the space provided.
10. Use the equation of the best fit line to determine the concentration of the unknown solution.

Data Table 2: Absorbance of Standard Solutions

Trial	Concentration (mol/L)	Absorbance @ _____ nm
1	0.020	
2	0.040	
3	0.060	
4	0.080	
5	0.10	
6	Unknown	

Concentration of unknown	mol/L
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GRAPHS (insert below)

ANALYSIS

Graphs (these should be inserted into your lab below)

1. the absorption spectrum showing the wavelength used
2. the calibration curve (absorbance vs. concentration graph) with best fit line and equation

Use the first graph to determine which wavelength to use in the experiment. Use the second graph to find a linear best fit equation and R^2 value. Based on this equation, you should be able to find the unknown solution concentration. **Show and explain the calculations used to find the concentration of the unknown sample.**

CONCLUSION

How would the measured concentration of copper in the unknown be affected if some water droplets remained in the cuvette when filling it with the unknown sample before measuring its absorbance?