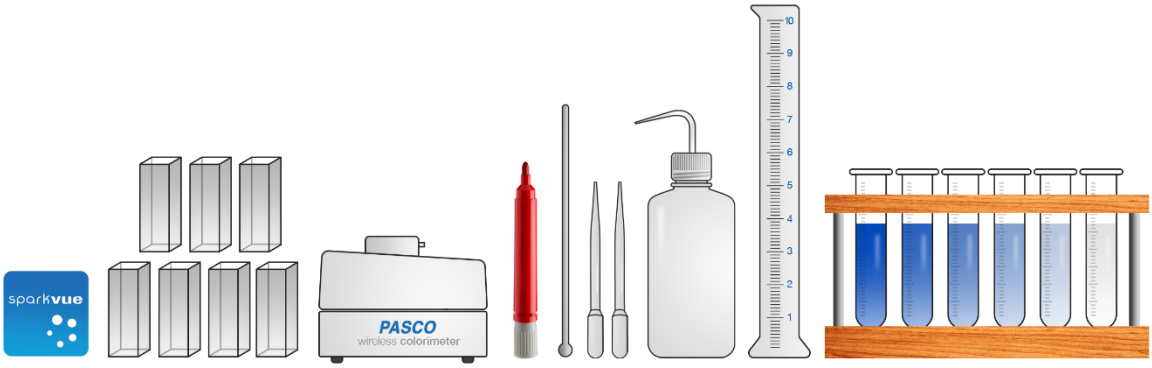
13B – SOLUTION CONCENTRATION

INQUIRY

How can you use light to determine the concentration of a solution?

MATERIALS

- Device with SPARKvue software
- Colorimeter
- Cuvettes (7)
- Wipes, lint/scratch-free for cuvettes
- Test tubes, 20 mm x 150 mm (6)
- Test tube rack
- Graduated cylinder, 10-mL
- Stirring rod
- Pipets (2)
- 0.20 M Copper(II) sulfate, 40.0 mL
- Marker
- Wash bottle with distilled water



BACKGROUND

Have you ever added more and more of a substance to solution and seen the color of the solution deepen? Analytical chemists, particularly in the agricultural and medical fields, routinely use a quantitative approach called spectroscopy to determine the concentration of solute in a solution as it relates to the color of the solution. While we can roughly tell how many substances are dissolved based on color, spectroscopy allows us to assign numbers to the dissolved substances. Beer's Law states that the absorbance of a solution (A) is directly proportional to its concentration (M). You will first determine the relationship between absorbance and molarity for a known concentration of $CuSO_4$. You will then use this relationship to construct a calibration curve. The standard curve will be used to determine the concentration of a solution of unknown molarity of copper(II) sulfate.

SAFETY

Follow these important safety precautions in addition to your regular classroom procedures.

- Wear safety goggles at all times.

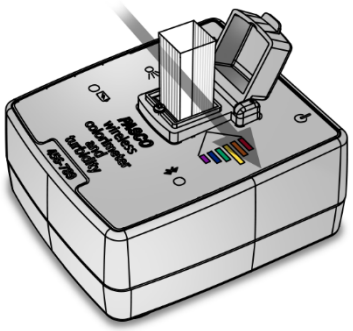
PROCEDURE

Part 1 – Known concentrations

1. Open SPARKvue.
2. Open the 13B Solution Concentration lab file in SPARKvue.
3. Use the Bluetooth icon to connect the Colorimeter.

PROCEDURE

4. Fill a clean cuvette 3/4 full of distilled water. This will be used for your reference measurement. Be sure to handle the cuvette only by its ribbed sides.



5. Calibrate the colorimeter with the cuvette containing distilled water (the water sample is called a "blank"). Orient the cuvette inside the colorimeter so the arrow shown in the diagram passes through the clear sides of the cuvette.

Note: It is important to wipe the clear sides of the cuvette before placing it into the colorimeter.

6. Obtain about 40 mL of a 0.20 M $CuSO_4$ solution.

7. Label 5 test tubes: A, B, C, D, E. Measure 10.0 mL of the 0.20 M $CuSO_4$(aq) and add it to test tube A, then rinse the graduated cylinder with distilled water. Invert the graduated cylinder and remove as much excess water as possible.

8. Label a pipet "S" for use with the 0.20 M $CuSO_4$ solution. Prepare Solution B by using pipet "S" to add exactly 8.0 mL of 0.20 M $CuSO_4$ to the graduated cylinder. Label a pipet "W" for distilled water. Use pipet "W" to add distilled water to the cylinder up to the 10.0 mL mark. Stir and transfer the solution to test tube B. Rinse the graduated cylinder and stirring rod with distilled water. Remove excess water from the graduated cylinder and dry the stirring rod.

9. Use the same method to prepare 10.0 mL of Solution C using 6.0 mL of 0.20 M $CuSO_4$(aq).

10. Use the same method to prepare 10.0 mL of Solution D using 4.0 mL of 0.20 M $CuSO_4$(aq).

11. Use the same method to prepare 10.0 mL of Solution E using 2.0 mL of 0.20 M $CuSO_4$(aq).

12. Determine the molarity for all solutions. Solution A (original solution) has a molarity of 0.20 M. For solution B (first dilution), the original molarity is M_1 = 0.20 M, and the volume is V_1 = 8.0 mL. We are solving for the new molarity (M_2). The final volume is V_2 = 10.0 mL. Record the molarities of all solutions in Table 1 on your answer sheet.

13. Label 5 cuvette caps: A, B, C, D, and E. Fill each cuvette 3/4 full with the appropriate solution and replace the cap on each cuvette.

14. Start collecting data.

15. Place cuvette A in the colorimeter. Select the check mark to record the values for the absorbance at all available wavelengths. Repeat this for each cuvette and transfer the data to Table 1.

16. Stop data collection.

17. Dispose of the pipets and the solutions in the test tubes and cuvettes according to your teacher's directions.

18. Rinse the graduated cylinder, test tubes, cuvettes, and stirring rod with distilled water.

ANALYSIS

Complete the analysis for Part 1 on your answer sheet.

PROCEDURE

Part 2 – Unknown concentration

1. Your teacher will provide you with a copper(II) sulfate solution that has an unknown concentration. If there is more than one unknown, record the solution label in Table 2 on your answer sheet.

2. Obtain 10 mL of the unknown solution of $CuSO_4$ provided by your instructor. Fill a clean cuvette at least 3/4 with this solution.

3. Go to the next page of the SPARKlab. You should see a digits display of Absorbance for all the colors of light.

4. Start data collection.

5. Find the color that matched the graph you made with known concentrations in the first part of the investigation. Record the Absorbance in Table 2.

ANALYSIS

Complete the analysis for Part 2 on your answer sheet.

QUESTIONS

Answer the questions on your answer sheet.