Colorimetry

Absorption Spectroscopy

Introduction

Allow students to predict how the appearance of red color varies based on changes in volume and concentration.

Concepts

- Absorption spectroscopy
- Concentration
- Colorimetry

Materials

Food dye, red
Water, distilled or deionized
Beakers, 200-mL, 5
Beaker, 1-L
Light box of overhead projector
Stirring rod

Safety Precautions

The materials used in this demonstration are considered nonhazardous. Follow all laboratory safety guidelines.

Preparation

1. Add 600 mL of distilled or deionized water to a 1-L beaker.
2. Add enough red food coloring to the water to provide a definitive red color to the solution. Mix using a stirring rod.
3. Pour 60 mL of the red solution to each of the five 200-mL beakers.
4. Label the beakers 1–5.

Procedure

Part A. Volume

1. Place each of the five 200-mL beakers containing the 60 mL or red solution in a row on a light box.
2. Observe the five beakers horizontally (from the front). The solutions should all appear the same color.
3. Observe the five beakers vertically (from above). The solutions should still all appear the same color.
4. Add red solution to beaker 1 so it contains 100 mL of solution.
5. Add red solution to beaker 2 until it contains 120 mL of solution.
6. Add red solution to beaker 3 until it contains 150 mL of solution.
7. Observe all five beakers horizontally. All five beakers should appear the same color.
8. Observe the five beakers vertically. The solutions with the greater volume will appear darker.

Part B. Concentration

9. Add distilled 100 mL of distilled water to beaker 4.
10. Add 50 mL of distilled water to beaker 5.
11. View the beakers horizontally. Beaker 4 should appear the lightest in color.
12. View the beakers vertically. Beakers 4 and 5 should appear the same color when viewed vertically.

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes. All solutions used in this activity may be rinsed down the drain according to Flinn Suggested Disposal Method #26b.

Discussion

Molarity and dilution calculations show us how to prepare solutions of a known concentration. Another important problem chemists encounter in the lab is how to determine the concentration of an unknown solution. If the solution is colored, then the concentration of an unknown solution can be determined by measuring the intensity of the color. A special sensor or instrument called a colorimeter is used to measure the absorbance of visible light that gives the solution its color. Generally, the more intense the color of the solution, the greater the absorbance of light will be. In using colorimetry, it is important to remember that the color of light transmitted by the solution (the color we see) is complementary to the color of light absorbed by the solution (the color we measure). Since the color of light depends on the wavelength, the wavelength of light transmitted by the substance. Copper(II) sulfate solutions, for example, are blue. The absorbance of copper(II) sulfate solutions is measured 635 nm, corresponding to red light.

Part A of this demonstration explores the effect of volume on the appearance of color. Regardless of the volume, all three beakers appear the same color when viewed horizontally. However, when they are viewed vertically the beaker that contains the highest volume of red solution appears to be the darkest. Part B of this demonstration explores the effect of concentration on the appearance of color. When viewed horizontally the most concentrated solution appears to be the darkest and the most dilute solution appears the lightest. Conversely, when viewed vertically they appear the same color. In this experiment the human eye acts as a colorimeter. Color is a function of two factors; quantity of pigment and the length of the light path.

Reference

Cesa, I. *Solubility and Solutions*, *Flinn ChemTopic™ Labs*, Volume 12; Batavia, IL; 2003; p. 41.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Colorimetry* activity, presented by Irwin Talesnick, is available in *Absorption Spectroscopy*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Colorimetry* are available from Flinn Scientific, Inc.