Theater Gels

Absorption Spectroscopy

Introduction

Use this simple demonstration to show how theater gels are used to create virtually any color or shade of light based on the principles of light absorption, light transmission, and individual wavelengths of light. These gels are also a great way to incorporate or showcase an interdisciplinary application of chemistry, the use of light in theatrical productions.

Concepts

- Properties of light
- Spectroscopy
- Absorbance vs. transmittance of light

Materials

Colored solution

Theater gel, color should match that of the solution

Safety Precautions

Although this activity is considered nonhazardous, please follow all normal laboratory or classroom safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Display a colored solution and its corresponding colored theater gel. Discuss how chemists are able to analyze colored solutions based on the light absorption and transmission at specific wavelengths of light.
2. Display the full color spectrum transmission or absorption curve of the selected theater gel. Explain that the color of the solution depends on the wavelengths of visible light that are absorbed or transmitted by the solution.

Disposal

None required—save all materials for future use.

Tips

- Any colored solution can be used for this demonstration, provided that you can find a theater gel sample that approximately matches the color of the solution. Concentrated (1 M or greater) copper(II) solutions work well, and the color is fairly common.
- Ask the theater department at your school or a local college for a sample swatch wheel of theater gels, or even for the larger gels themselves. However, the swatch wheels (as shown in the video) are very convenient, and they include the full color spectrum transmission curve for each particular shade. Alternatively, a swatch wheel of theater gels may be purchased from a local theater, videography, or photography specialty store.
- If available, display a variety of colored solutions and their corresponding theater gel swatches to compare the wavelengths of light absorbed and transmitted by these solutions.
- For detailed information on the theater gels, including full spectral energy distribution curves for every color gel, visit http://rosco.com/us/filters/roscolux.asp#Colors.

Discussion

Visible light, which appears white to the naked eye, is actually composed of a full spectrum of colors, including red, orange, yellow, green, blue, indigo, and violet (ROY G BIV), in decreasing wavelength. A common method of chemical analysis of colored solutions is the use of spectral measurements in order to determine the concentration of a given solution. This can be completed either through generating a standard curve of concentration versus absorbance of the solution at a particular wavelength or through Beer's Law analysis according to the following equation (Equation 1):

$$A = \varepsilon l c \qquad \textit{Equation 1}$$

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where A is the absorbance of the solution at a particular wavelength, ε is the molar absorptivity or extinction coefficient of the solution, l is the cell path length, and c is the concentration of the solution.

In both methods, it is important to use the correct wavelength of light when making measurements with a spectrophotometer or colorimeter. This wavelength is usually determined by plotting a preliminary full spectrum absorption curve of the solution. The maximum absorption wavelength of the solution is determined, and this value is used in Beer's Law analysis to give optimal results.

In any transparent substance, the given solution appears to be a particular color, such as blue, because the solution absorbs all the wavelengths of visible white light except for blue light, which is transmitted. Theater gels can be used to demonstrate this concept. These colored lighting gels are used in theatrical productions, event production, photography, videography, and cinematography. The color gel is placed over a light, causing the light that is shone onto the stage to appear that particular color. These gels can be used to convey a certain mood based on the lighting and even to simulate sunlight, moonlight, candelight, etc. Each color gel comes with a detailed transmission curve of its individual color, as shown below (Figure 1):

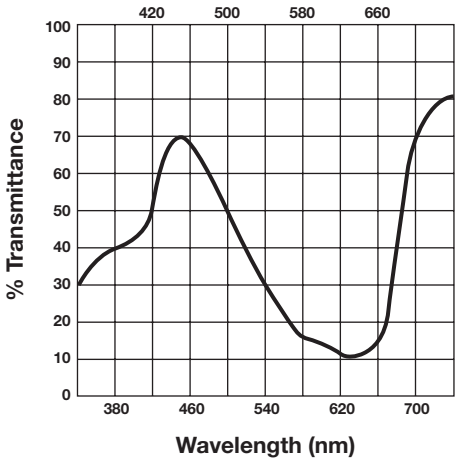

Figure 1. Full color spectrum transmission curve for a basic blue theater gel. Maximum transmittance occurs around 450 nm, while minimum transmittance (maximum absorbance) occurs around 620 nm.

This type of transmission curve can be used in the same way as an absorption curve to determine the correct wavelength to be used for a Beer's Law analysis of a solution. However, rather than finding the peak of maximum absorbance of the solution, one would instead find the peak of minimum transmittance. This peak will correspond to the wavelength at which the spectrophotometer or colorimeter should be set in order to give the best possible results, as this wavelength matches the area of visible light involving the maximum amount of energy.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Theater Gels* activity, presented by Jeff Hepburn, is available in *Absorption Spectroscopy*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.