Color and Light

Spectrum Demonstrations

Introduction

Is there more to light than meets the eye? Does a green filter change white light into green light? What color of light is observed when blue and yellow filters are mixed? The answers to these questions may surprise your students. This demonstration uses a holographic diffraction grating and an overhead projector to produce a very large, very sharp rainbow of color. The large spectrum allows you to demonstrate the true nature of color and light and address common misconceptions related to the perception of color.

Concepts

- Visible light spectrum
- White light
- Color
- Transmission and absorbance

Materials

Construction paper, black, 9″ × 12″, 2 sheets
Diffraction grating, holographic, 10 cm × 10 cm
Flat-sided plastic bottle
Food dye, green, yellow, and blue
Gloves, latex, nitrile, or polyethylene
Highlighter pen, yellow
Overhead projector
Paper, white, 8½″ × 11″
Petri dishes, small, 2
Projection screen or blank, white wall
Tape
Water

Safety Precautions

The materials used in this activity are considered nonhazardous. Please follow all normal laboratory safety guidelines.

Preparation

1. Place an overhead projector 10–15 feet from a projection screen or a blank, white wall.
2. Turn the overhead projector on.
3. Using two black sheets of construction paper, form a 2-cm wide slit in the center of the stage of the overhead projector. Position the slit on the stage so that the image of the slit projected onto the projection screen is vertical (refer to Figures 1 and 2).
4. Place the holographic diffraction grating film over the lens of the overhead projector (see Figure 1). Wear gloves when handling the diffraction grating to avoid fingerprints. If the spectra are not projected to the left and right of the screen, rotate the diffraction grating 90 degrees (the alignment of the grating is important).
5. Once two bright spectra (mirror images of each other) are displayed horizontally to the left and right of the projection screen (Figure 2), secure the diffraction grating to the lens with tape. Tape only the outside edges of the diffraction grating and make sure the diffraction grating is flat.

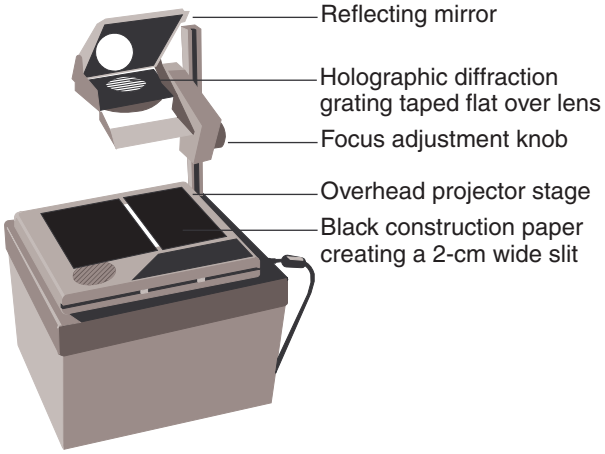

Figure 1. Overhead Projector

Publication No. 10410
031417

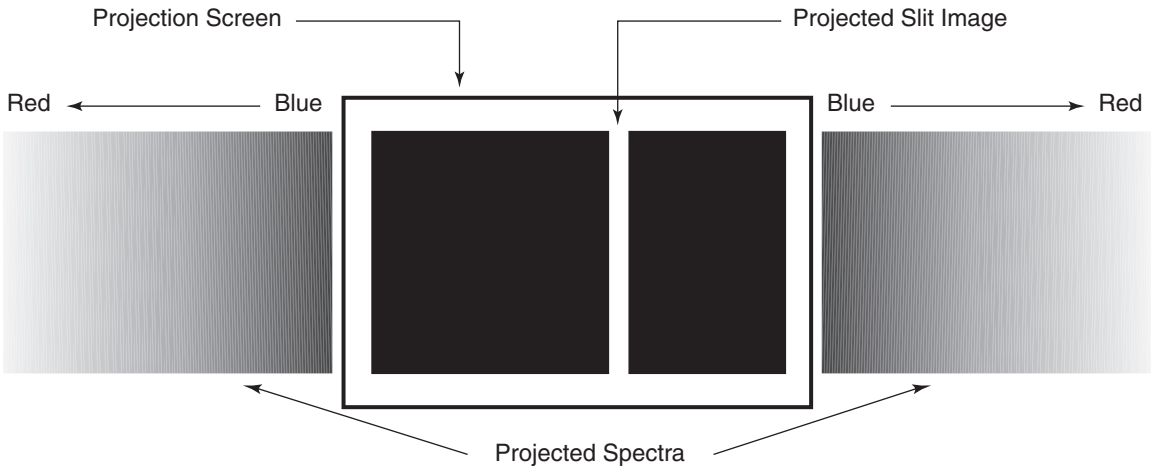

Figure 2. Projected Spectra

6. Adjust the focus of the overhead projector so the image of the slit is in sharp focus on the screen. The two spectra should also come into focus. Turn off the lights in the room and eliminate other extraneous light by closing the blinds or curtains.
7. Adjust the position of the slit so one of the spectra is in a good location to be viewed by the students. Secure the construction paper to the overhead projector with tape.
8. Perform the activities described below to demonstrate many properties of light. (All activities are best performed in a darkened room.) For additional activities, please call or e-mail Flinn Scientific to request a complimentary copy of Publication No. 6172.

Procedure

Activity 1

1. Write a message in large print with a yellow highlighter pen on a piece of white paper.
2. Hold up the paper with the message against the screen near the red end of the spectrum. The message will not be visible.
3. Slowly move the paper across the spectrum from red to violet.
4. Move the paper just past the violet end of the spectrum (into the invisible ultraviolet portion of the spectrum). The yellow highlighted will fluoresce and become visible.

Activity 2

1. Fill a flat-sided plastic bottle with water.
2. Add 20–25 drops of green food coloring.
3. Cap the bottle tightly and shake to distribute the color evenly.
4. Hold the bottle up to the screen and move it across the spectrum to see which colors are absorbed and which are transmitted.
5. Repeat steps 1–4 with other colors of food dye.

Activity 3

1. Fill two small Petri dishes slightly less than half full with water.
2. Add several drops of blue food coloring to one dish. Gently swirl to evenly distribute the color.
3. Add several drops of yellow food coloring to the other dish. Gently swirl the dish.
4. Place both dishes over the slit on the overhead projector, leaving about 2 cm in between the two dishes.
5. The spectrum will be transmitted through these “filters.”

6. Point out that the blue filter transmits only greens and blues, and the yellow filter transmits only greens and yellows.
7. Pour the yellow colored water into the Petri dish with the blue water to produce green.

Discussion

In *Activity 1*, the yellow message will show most clearly in the blue and violet range of the spectrum, but also can be seen in the invisible ultraviolet portion. Many highlighter pens will fluoresce in ultraviolet light. This clearly shows there is more to light than what is visible. In *Activity 2*, the green water acts as a color filter. The filter only transmits green wavelengths of light. All the other colors are absorbed and will appear black as the bottle is moved across the spectrum. In *Activity 3*, the common color transmitted by both the blue and the yellow filter is green, showing why mixing blue and yellow pigments produces green. Only green is transmitted by both the yellow and blue filters, all the other colors are absorbed.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
- MS-PS1 Matter and Its Interactions
  - PS1.A: Structure and Properties of Matter
- MS-PS4 Waves and Their Applications in Technologies for Information Transfer
  - PS4.A: Wave Properties
  - PS4.B: Electromagnetic Radiation

Disciplinary Core Ideas: High School
- HS-PS1 Matter and Its Interactions
  - PS1.A: Structure and Properties of Matter
- HS-PS4 Waves and Their Applications in Technologies for Information Transfer
  - PS4.A: Wave Properties
  - PS4.B: Electromagnetic Radiation

Science and Engineering Practices
- Developing and using models
- Constructing explanations and designing solutions

Crosscutting Concepts
- Cause and effect
- Energy and matter

Acknowledgment

Flinn Scientific would like to thank Doug De La Matter (retired), Madawaska Valley D.H.S., Barry's Bay, Ontario, for providing us with this "colorful" and "enlightening" activity.

Color and Light is available as a demonstration kit from Flinn Scientific, Inc.

Catalog No.	Description
AP6172	Color and Light—Spectrum Demonstrations Kit
AP1726	Microchemistry Solution Bottles, 275 mL
AP1714	Flinn C-Spectra™ Diffraction Grating
V0003	Food Coloring Dyes
AB1470	Petri Dish, Disposable, 60 × 15 mm

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.