MISSION PREP

A Teacher's Activity Guide

Another in the Series of
Challenger Learning EdVentures
from

Electromagnetic Spectrum

Background

Galaxies, stars, and most of the planets in our Solar System are too far away for humans to visit. So astronomers, engineers, and other types of space scientists have to be clever to learn more about these celestial objects. Scientists have done just this by studying the light, or radiation, that comes from these objects.

Although we cannot see them, visible light comes in tiny waves, similar to waves of water. The hills and valleys are called crests and troughs. The distance between two crests is called the wavelength. Visible light waves are millions of times shorter than water waves. Not all waves are the same size; some are shorter and some are longer. We see these different *wave lengths* as colors. Sunlight may appear to be colorless white light, but it really is a mixture of many colors, or wavelengths of light. You can see some of these colors when a rainbow appears in the sky after rain. Sunlight passes through the raindrops and is bent, or refracted, depending on the wavelength of the light. The colors in a rainbow range from long to short wavelengths in the following order: red, orange, yellow, green, blue, and violet, with violet having the shortest wavelength and red the longest.

Wavelengths longer than red, or shorter than violet, cannot be seen with the human eye. Those wavelengths that are slightly longer than red light make up infrared radiation, which is the kind of radiation predominately emitted by warm objects, such as planets or people. Other wavelengths that are longer than the visible spectrum include microwaves and radio waves. The wavelengths that are shorter than the visible spectrum include ultraviolet, X-ray, and gamma rays. The shorter the wavelength, the more energy the wave has. All of these wavelengths are part of the electromagnetic spectrum; however, only a small portion of the spectrum is visible.

When you look at sunlight through a prism or diffraction grating, the resulting spectrum of light is unique to sunlight. Different types of light like neon and fluorescent light result in different spectra because of the different gases present. Likewise, galaxies and stars are composed of different elements so their spectra reflect the types of gases present in those objects.

Skills

- Observation
- Data interpretation
- Comparing and contrasting
- Recording data

Objectives

Students will:

- Observe that light can be separated into a color spectrum.
- Use a diffraction grating to separate light into a color spectrum.
- Compare and contrast light sources.

Overview

Students will use a diffraction grating to separate light into a color spectrum, then build a pinhole tube with grating on one end to observe four different light sources. They will record their observations and compare and contrast the results to draw conclusions about the light sources.

Key Question

Is all light the same?

Key Concepts

- Sunlight is made up of a spectrum of colors.
- Different types of light have different spectra, each unique like a person's fingerprint.

Materials & Preparation

- 1 2.5-cm square of diffraction grating per student
- 1 Paper towel tube per student
- 1 Small piece of aluminum foil per student
- Pins (enough for students to share)
- 1 Small index card per student

- Clear tape
- 1 Pair of scissors per student
- 1 Rubberband per student
- Crayons - red, yellow, purple, blue, green, orange
- 4 light sources including: an overhead projector (incadescent), fluorescent light, neon light, or halogen

1. Order diffraction grating from a science catalog.
2. Cut the grating into 2.5 cm squares.
3. Collect paper towel tubes several weeks in advance of the activity in order to accumulate enough for each student.
4. Acquire the light sources from home, hardware stores, or specialty stores.
5. Be sure to make a pinhole tube at home and try out the activity before doing it with students so you know how the diffraction grating works and what the spectrum looks like for each one.

Management

Use one class to construct the pinhole tubes. In the second class, focus on studying spectra from different light sources.

Reflection & Discussion

1. Why do you think different types of light have different spectra?
2. How can scientists use spectra to learn about stars and galaxies?

Transfer & Extension

1. Experiment with different methods of splitting light into component colors. A slit instead of a pinhole, a prism, soap bubbles, and water can also be used to diffract light. Compare and contrast the results.
2. The Sun emits radiation other than the visible spectrum. Can you identify other types of radiation? Is all radiation safe for humans? How can we experience it? What other parts of the spectrum do astronomers and space engineers use to study the universe?

STUDENT WORKSHEET

Electromagnetic Spectrum

Student Procedures

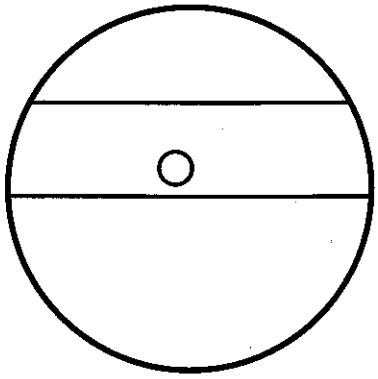
1. Take the index card. Mark a square 2 cm in length at the center of the card. Cut the square out folding the card in half if you need help starting.
2. Carefully tape the piece of diffraction grating to the card.
3. Attach the card to one end of the paper towel tube, centering the grating in the middle of the hole. Tape two sides of the card in place. Carefully cut straight lines into the card so that it will bend to fit around the tube. Tape the rest of the card firmly in place.
4. Carefully cover the other end of the paper towel tube with the aluminum foil, stretching the foil tightly across the tube hole. Use the rubberband to hold the foil in place.
5. Take the pin and gently poke a small hole in the center of the foil. Be careful not to rip the foil.
6. Your teacher will direct you to point the tube toward four light sources and look through the diffraction grating. *Do NOT look directly at the Sun.* This can lead to permanent eye damage!
7. Record what you see on the worksheet as accurately as possible.
8. Why do think the spectra are different?

STUDENT WORKSHEET

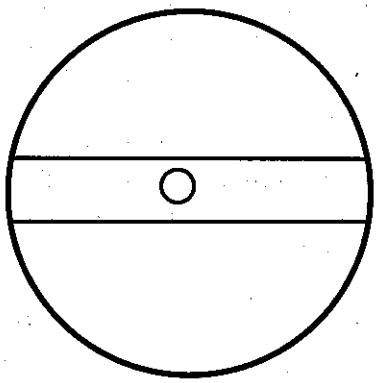
Electromagnetic Spectrum

Rotate the diffraction grating until you see color on the left and right of the light source. Draw the colors in the order you see them on both sides of the light source with crayons. Allow the colors to touch the top edge and bottom edge of the guidelines shown below. The small circle in the center represents the light source.

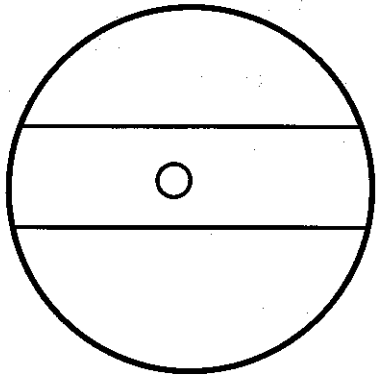
Light Source 1: _____



Light Source 2: _____



Light Source 3: _____



Light Source 4: _____