Exploring Diffraction With a Spectroscope

Objective

The student will be able to see what happens to light when it passes through a spectroscope.

Science and Mathematics Standards

Science Standards

☐ Science as Inquiry
☑ Physical Science

Mathematics Standards

☐ Problem Solving
☑ Communication
☑ Connection
☐ Computation/Estimation
☑ Measurement

Theory

A spectroscope is a device that can be used to look at the group of wavelengths of light given off by an element. All elements give off a limited number of wavelengths when they are heated and changed into gas. Each element always gives off the same group of wavelengths. This group is called the emission spectrum of the element.

In the visible wavelengths of the electromagnetic spectrum, red, with the longest wavelength, is diffracted most; and violet, with the shortest wavelength, is diffracted least. Because each color is diffracted a different amount, each color bends at a different angle. The result is a separation of white light into the seven major colors of the spectrum or rainbow. A good way to remember these colors in order is the name Roy G. Biv. Each letter begins the name of a color: red, orange, yellow, green, blue, indigo, and violet. (Reference Electromagnetic Spectrum page 34.)

Materials

- spectroscope (one spectroscope for four students)
- light sources (sunlight, incandescent, fluorescent, cadmium, sodium, neon, mercury, helium, etc.) (See List of Catalogs, page 83.)
- diffraction grating
- compact disc

R	**O**	**Y**	**G**	**B**	**I**	**V**
Red	Orange	Yellow	Green	Blue	Indigo	Violet

(Students should color these boxes with their crayons.)

Procedures

Use a spectroscope and look at different kinds of light. View bulbs with different gases inside.

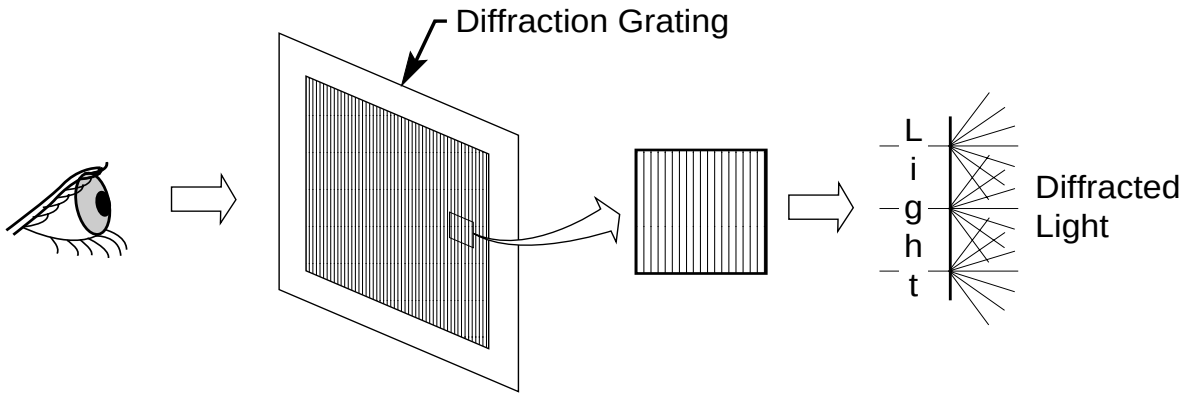
Observations, Data, and Conclusions

1. Observe each source of light. Explain what you see.
2. Observe the colors. Start with the first color on the left and list them in the table in the order that you see them.
3. When you look at the different light sources through the spectroscope, observe the stripes of color. Do they fade or blend into each other? Describe the bands of color.
4. Does each light source produce the same group of colors or spectrum?
5. Each group of colors for each different light source is called the emission spectrum for that source. How are the spectra or groups of colors alike? Different?
6. Why are the groups of color for each light source different?

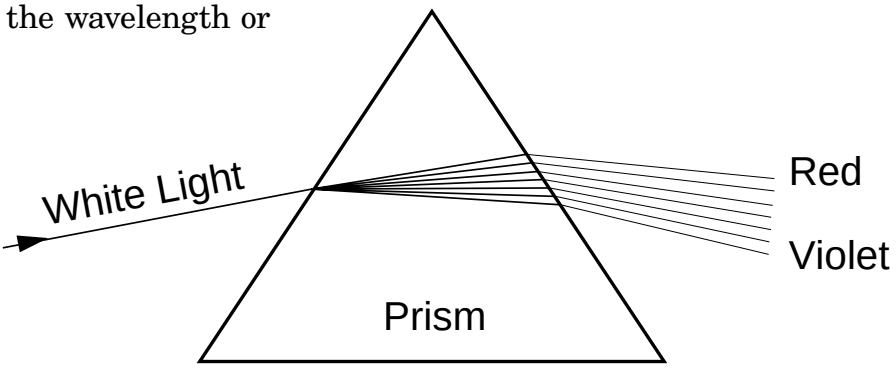
Light Source	Colors (Be Specific!)

Additional Activities

White light can be separated into all seven major colors of the complete spectrum or rainbow by using a diffraction grating or a prism. The diffraction grating separates light into colors as the light passes through the many fine slits of the grating. This is a transmission grating. There are also reflection gratings. A reflection grating is a shiny surface having many fine grooves. A compact disc makes a good reflection grating.



The prism separates light into colors because each color passes through the prism at a different speed and angle. The angles of reflection of the light, upon entering and leaving the prism, vary with the wavelength or color of the light.



The Electromagnetic Spectrum

For hundreds of years, scientists believed that light energy was made up of tiny particles which they called "corpuscles." In the 1600's, researchers observed that light energy also had many characteristics of waves. Modern scientists know that all energy is both particles, which they now call *photons*, and waves.

Photons travel in *electromagnetic waves*. These waves travel at different *frequencies,* but all travel at the speed of light. The *electromagnetic spectrum* is the range of wave frequencies from low frequencies (below visible light) to high frequencies (above visible light). (See figure below.)

The *radio wave* category includes radio and television waves. These low-frequency waves bounce off many materials.

Microwaves pass through some materials but are absorbed by others. In a microwave oven, the energy passes through the glass and is absorbed by the moisture in the food. The food cooks, but the glass container is not affected.

Like other wavelengths, *infrared* or heat waves are more readily absorbed by some materials than by others. Dark materials absorb infrared waves while light materials reflect them. The Sun emits infrared waves, heating the Earth and making plant and animal life possible.

Visible light waves are the very smallest part of the spectrum and are the only frequencies visible to the human eye. Colors are different within this category, ranging from the red wavelengths, which are just above the invisible infrared, to violet. Most of the Sun's energy is emitted as visible light.

The Sun also emits many *ultraviolet* waves. High-frequency ultraviolet wavelengths from the Sun cause sunburn.

X rays can penetrate muscle and tissue but are blocked by bone, making medical and dental x-ray photographs possible.

Gamma-ray waves, the highest frequency waves, are more powerful than x rays and are used to kill cancerous cells.

The atmosphere protects Earth from dangerous ultraviolet, x-ray, and gamma-ray radiation.

The Electromagnetic Spectrum