IS WHITE LIGHT REALLY WHITE?

Lesson Plan. *Developed by LASER-TEC.*

"No known theory can be distorted so as to provide even an approximate explanation of the duality. There must be some fact of which we are entirely ignorant and whose discovery may revolutionize our views of the relations between waves and matter. For the present we have to work on both theories. On Mondays, Wednesdays, and Fridays we use the wave theory; on Tuesdays, Thursdays, and Saturdays we think in streams of flying energy quanta or corpuscles."

(Sir William Bragg)

As a "hook" for this lesson, use LASER-TEC diffraction glasses.

Encourage students to put the diffraction glasses on, and compare the light emitted by different light sources: LED, fluorescent, incandescent, etc. Do you see a difference between spectra of different sources? Are the same colors present from source to source? Is the intensity of the colors the same or does it vary? Is the transition between colors similar in fluorescent or incandescent sources?

Never look directly at the Sun or a laser beam!

DESCRIPTION:

In this demonstration you will observe five different color Light Emitting Diodes (LED) and an incandescent light through a diffraction grating. The diffraction grating separates all the constituent colors from each source and allows us to see the spectrum of the source. The LED colors are red, yellow, green, blue, and white. The incandescent light source is also white.

OBJECTIVES:

Upon completion of this demonstration, you will be able to:

1. Describe the color spectrum of all six different light sources
2. Identify the spectral differences of white LED and white incandescent lights
3. Explain what color or colors a red LED actually produces
4. Explain the spectral quality of yellow, green, and blue LEDs

MATERIALS:

1. LED light tower
2. Diffraction grating

BACKGROUND INFORMATION:

Light is energy in the form of electromagnetic (EM) waves. EM waves appear in a wide range of wavelengths that span from long radio waves to short wave gamma rays. The continuous range of EM wavelengths is called the electromagnetic spectrum. The term "light" is normally used when referring to EM waves that are visible to the human eye. Visible light is only a small section of EM spectrum, and its wavelengths vary between around 400 nm and 700 nm. It consists of waves with individual wavelengths that we perceive as a specific color.

THE ELECTROMAGNETIC SPECTRUM

The visible light that the sun produces appears to be white, although it is actually made of the following colors: red, orange, yellow, green,

LASER-TEC
This project is supported by National Science Foundation grant DUE-1304628.
3209 Virginia Avenue Fort Pierce, FL 34981 | 772-462-7179
www.laser-tec.org

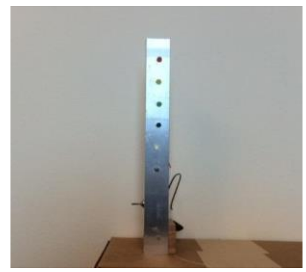
blue, indigo, and violet. The mnemonic ROY G BIV which is made up of the beginning letter from each color, is used to help remember the colors in descending wavelength order. The mnemonic begins with red (R), which has a wavelength of 700 nm, and ends in violet (V), with a wavelength of 400 nm. In recent years the color indigo has been dropped from the list because of its proximity in wavelength to violet. The mnemonic can still be useful, remembering to drop indigo form the color list. Visible light can be separated into its components by using an optical prism or a diffraction grating. In reverse, the combination, or mixing, of ROYGBIV colors will produce light that we perceive to as white. So, white is not a color, but rather a mixture of all the wavelengths of visible light.

PROCEDURE:

We will look at the lights on the light tower through a diffraction grating, which will enable us to see the constituent colors from each light source.

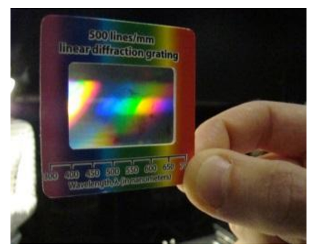
STEP 1:

Place the light tower on a table with a white background behind it, and turn the lights on.



STEP 2:

Place the diffraction grating in front of your right eye, and look at the image.



STEP 3:

Move your head towards the right until you see an image like the one on the left. This image shows the six light sources and their corresponding color spectra on the right hand side of each light. The incandescent light on the bottom has a spectrum resembling that of the white light produced by the sun. As you move up, observe the spectra of the five different LEDs and compare them to the incandescent light.

APPLICATIONS:

- Diffraction gratings are used in spectroscopy to determine the wavelength of light emitted by glowing gasses.
- In astronomy, diffraction gratings can be used to determine the wavelengths contained in the light emitted by distant stars.
- Diffraction gratings can also be used in special glasses for creating colorful visual effects.

LASER-TEC
This project is supported by National Science Foundation grant DUE-1304628.
3209 Virginia Avenue Fort Pierce, FL 34981 | 772-462-7179
www.laser-tec.org