TEACHERS GUIDE

LED ARRAY
ITEM # 3559-90

OPTICS - LIGHT AND COLOR

This LED Array is a simple device that can be used in any level of classroom to introduce the electromagnetic spectrum, demonstrate the properties of light, and/or as an integral part of students individual investigation of the properties of light.

Materials

- Black Electrician's Tape
  - Useful for blocking some of the LEDs on the LED Array
- Diffraction Gratings
- Prism and White Light source
- Geissler Tubes

Goals & Objectives

See page 8 for Next Generation Science Standards (NGSS)

INTRODUCTION

What does it do and what scientific principles can be shown:

- Color mixing properties of light
- Properties of light - Reflection, Absorption, Transmission
- Electromagnetic Spectrum - Visible Range

This LED Array is a simple device that can be used in any level of classroom to introduce the electromagnetic spectrum, demonstrate the properties of light, and/or as an integral part of students individual investigation of the properties of light. Early classrooms should focus on utilizing this device as an aide to investigating the properties of light. High school or advanced classrooms should focus more on the mathematical relationships between wavelength, frequency, and speed of light as well as the applications/use of the properties of light in communications technologies (fiber optics) or astronomical methods of observation (spectroscopy).

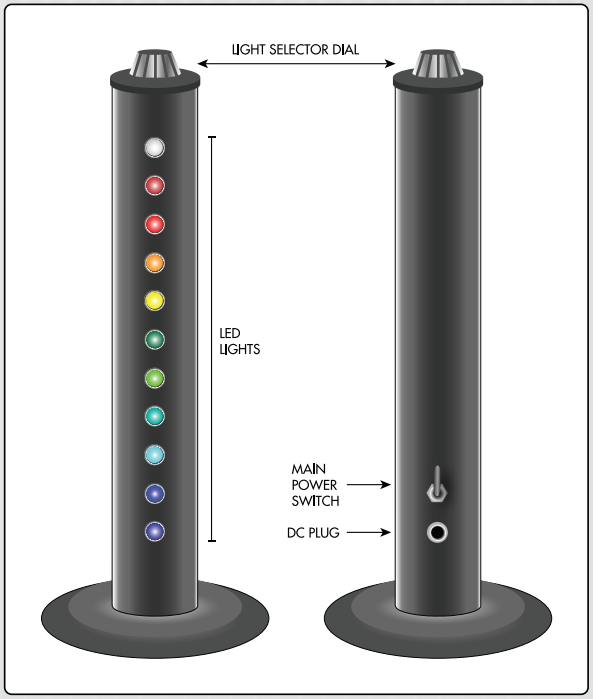
How It Works

The LED array is a solidly constructed device made of metal that displays 11 differently colored LEDs. Each LED is labeled with a color as well as a wavelength that corresponds to each of the colors of light. The colors displayed by the device from top to bottom are:

- White
- Deep Red 640 nm
- Red 626 nm
- Orange 604 nm
- Yellow 590 nm
- Green 570 nm
- Bright green 525 nm
- Turquoise 505 nm
- Blue 470 nm
- Deep blue 455 nm
- Violet 400 nm

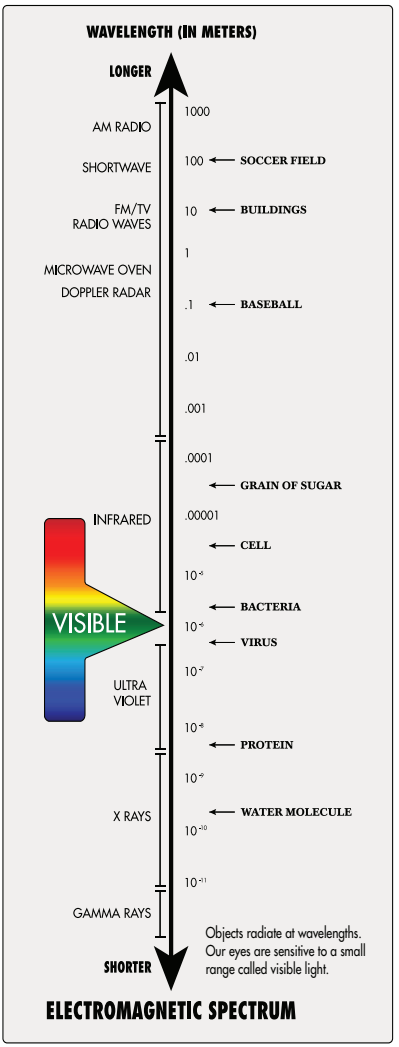
The Light Selector Dial on top of the device can be rotated to individually select one LED at a time or there is also an option to display all of the LEDs at the same time. The Main Power Switch and location for plugging in the AC Adaptor are found on the back of the device.

The components of the device can be seen in the diagram to your right:



ACTIVITIES

1 Displaying the LED Array and showing the different colors of light add up to White light.



a Connect the LED Array to a wall outlet with the 5V AC Adaptor and turn on the Main Power Switch on the back of the LED Array.

b Make sure that the LEDs are facing a white wall and turn off the classroom lights.

c Use the Light Selector Dial to switch between different light colors, being sure to announce to students the different colors of light with their respective wavelengths.

d Use the Light Selector Dial to turn all of the LEDs on at the same time. There should be a section of the wall that appears white due to the combination of all of the colors from the LEDs.

e With all of the LEDs turned on, place an object between the LED Array and the wall so that some of the colors are blocked. This should produce a variety of colored shadows in the shape of the object that was placed in front of the LED Array.
*To make the variety of color combinations less complex, black electrician's tape is useful to block all of the LED lights except for Red, Green, and Blue. This will help to make the differently colored

ACTIVITIES

Activities continued

shadows more prominent/distinct as well as reducing the complexity of the color combinations.

f The following are some questions that can help get students thinking about what they are seeing:

- What color appears when all of the light is shined onto the wall and nothing is blocking the light?
- What causes the differently colored shadows when something blocks the light?
- What combinations of light colors make: yellow, magenta, cyan, etc.?
- What combination of lights need to be blocked to make a black shadow?

g Have the students create a model or drawing to help explain why differently colored shadows appeared. The model/drawing should help students to describe the phenomena and also predict a variety of resulting colors from combined colors of light.

The image below shows the variety of colored shadows when all LEDs are blocked except for Red, Green, and Blue.

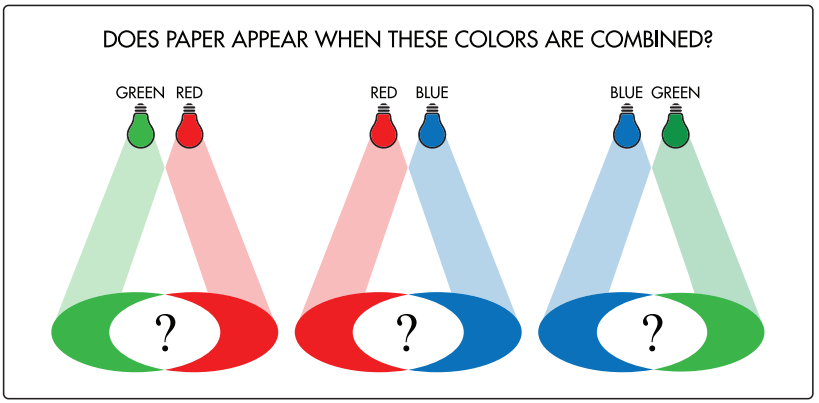
ACTIVITIES

Activities continued

Color Addition Rules

(Example of a mathematical Model)
R+G+B=W , R+G =Y, R+B=M, G+B=C
R=Red, G=Green, B=Blue, W=White, Y=Yellow, M=Magenta, C=Cyan

Example of a graphical model



2 **White light can be broken up into different colors of light.**

a Gather a white light source and a prism or a classroom set of diffraction gratings.

b Shine the white light through the prism and show that the white light is made of up many colors of light. OR Display the white light and have students look at the white light source through the diffraction gratings. Through the diffraction gratings, there should appear to be multiple images of the light source with each image showing a different color.

3 **Extension/Application: How are these properties of light useful in the real world?** Fingerprints of Stars → Geissler/Spectrum Tubes

Materials needed:
- A variety of Spectrum Tubes
- Diffraction Gratings or Spectrometers

ACTIVITIES

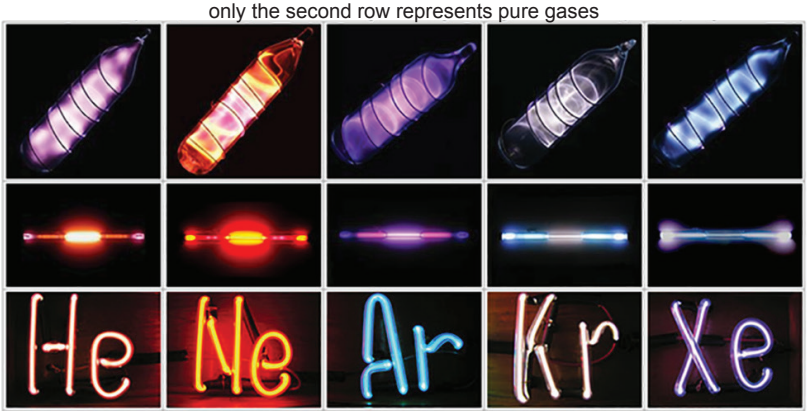
Activities continued

Light emitted from stars can be used like fingerprints to help identify what elements stars are made up of. Relate this back to demonstration that shows the color mixing properties of light. While a star may appear to be white, light blue, or red these colors are actually a result of a combination of many different colors (wavelengths) of light. When elements get hot enough they give off different color combinations of light, which are called Emission Spectra. So to determine what a star is made up of, we only have to figure out what combinations of the light from different elements would combine to make the star appear as it does.

a Set up a variety of Geissler/Spectrum Tubes to show that different gases give off different colors of light.*Be sure not to keep spectrum tubes on for a long period of time. These typically require high voltage to display and are not designed to be on for a long period of time.

b Have students look at each of the spectrum tubes with their eyes. What color do the gases appear to be? The students should then look at the lit up tubes through a spectrometer or diffraction gratings. They should see multiple images of differently colored tubes which should correlate with the emission spectra for each of the gases. An example of some different spectrum tubes and their spectra is shown below.

Colors and spectra (bottom row) of electric discharge in noble gases, only the second row represents pure gases



Helium Neon Argon Krypton Xenon

Next Generation Science Standards

Students who demonstrate understanding can:

1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

HS-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength,and speed of waves traveling in various media.

HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Standards Key

K = Kindergarten
3 = 3rd Grade
(numbered by grade)
MS = Middle School
HS = High School
PS = Physical Science

Sources

Color Addition Demonstration:
http://www.physicsclassroom.com/class/light/Lesson-2/Color-Addition

https://www.exploratorium.edu/snacks/colored-shadows

Emission Spectra - The Fingerprints of Stars
http://faculty.sdmiramar.edu/fgarces/labmatters/instruments/aa/AAS_Theory/AtomicLineOrigins.htm

https://www.boundless.com/chemistry/textbooks/boundless-chemistry-textbook/periodic-properties-8/variation-in-chemical-properties-70/the-noble-gases-group-18-330-1854/