LASER CLASSROOM

Bringing STEM to light®

BIG IDEAS

- Demonstrate the monochromatic nature of LASER light by comparing the spectra of white light and colored LEDs to that of LASER light.

WHAT YOU'LL NEED

- 1 Diffraction Grating
- Light BLOX: Red, Green, Blue
- 1 White LED
- 1 Flashlight (optional)
- 1 Red Laser Pointer
- A blank wall/screen

RELATED PRODUCTS

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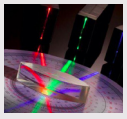
Red Laser Blox



Light Blox

Red & Green Laser Pointer

MONOCHROMATIC LASER LIGHT

Working with LASERs, it's immediately obvious that they don't behave like the light we encounter every day. What makes LASER light different from the light emitted by a normal light bulb?

WHAT IS COLOR?

Color is a property defined by the wavelength of light. Different colors of light have different wavelengths. When you look at a red object, it looks red because the object is reflecting red light.

When light consists of only one wavelength of light, we say it is monochromatic (from ancient Greek, mono meaning "alone" or "single", and chromatic meaning color).

WHITE LIGHT

So what color is the light emitted from the sun, or the overhead lights? Yellow? White? Does it even have a color?

Yes, it does! This light is called white light, and despite its name, it's actually made up of a combination of colors. White light from the sun is made up of all the colors of you rainbow, it just looks white to you when they are all together. This is why you can see all the different colors of objects when the sun shines or from the light of a flashlight. Every wavelength of light is available to be reflected or absorbed, so every color has the potential to be visible.

DIFFRACTION GRATINGS

A diffraction grating is a transparent piece of plastic mounted in a frame, as shown in *Figure 1*. What you can't see, is that the plastic is covered in thousands of tiny scratches. The scratches run from the top of the plastic to the bottom, and are parallel to one another (in the same direction,

Figure 1: Diffraction grating of the same kind as you have in your kit.

but not touching). The lines are so thin that you can fit hundreds of scratches on one mm of plastic!

When you shine a beam of light through a diffraction grating, it splits the light up into its component wavelengths. All of the different colors of light that make up the beam of light can be seen side by side, as in *Figure 2* - this is called its spectrum. But what happens if the light isn't white, but monochromatic?

Figure 2: Spectrum of white light

MONOCHROMATIC LIGHT IN REAL LIFE: SPECTROMETRY

Gases absorb light that passes through them. But they only absorb specific wavelengths, and every gas absorbs a different combination of wavelengths. If scientists know that a specific gas, and only that gas, absorbs a certain wavelength of light, they can test for that gas using LASERs. Note: again, this could be written "lasers"

Scientists can pick a laser that is a certain wavelength, or use a laser that has a tuneable wavelength and shine it through the place where they suspect the gas exists. If reflected light from the LASER returns weaker in certain areas, it means that the gas must be present, since it absorbed some of the LASER light. This technique is used in examining the Earth's atmosphere, and the atmospheres of other planets.

ACTIVITY SHEET: MONOCHROMATIC LASER LIGHT

Let's investigate one of the aspects of LASER light that makes it different from "normal" light.

- Hold the diffraction grating up to one eye.
- Hold the white Light Blox at arm's length, pointing towards your eye, and turn the Light Blox on. Don't look directly at the light; rather slightly to the left or right of the source.

What do you see? Record the order of the colors, starting from closest to the light source.

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White light is made up of a rainbow, all the colors mixed together. The order of colours are violet, blue, green, yellow, orange and red.

- Now hold the diffraction grating up to your eye and look at a flashlight, the overhead lights, or the sun.

Was the rainbow the same for all sources of white light? What do you expect to see for the colored Light Blox?

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This spectrum is the same for all white light; always in the same order.

- Repeat the process with the red, blue and green Lazr fingers.

What do the spectra (plural of spectrum) look like? Was this what you expected? Why/why not? What is colored light really made of?

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You might've expected to see only red light for the red Light Blox, blue for the blue Light Blox, etc. Actually, colored lights are not one colour at all. They consist of a spectrum of colors as well, they just have mostly the color that they look like. For example, when you look at the red Light Blox with the diffraction grating, it looks mostly red, but there is a little bit of yellow and green too. This means that the Light Blox are not monochromatic!

- Point the red LASER pointer towards a blank wall or screen, approximately 15-20 cm away from the surface. IMPORTANT: NEVER POINT A LASER AT YOUR FACE! Never look into a laser or point one at someone else's face either.

- Hold the diffraction grating about 5-10 cm from the front of the LASER, and switch on the LASER pointer.

How is this different to the colored Lazr fingers? What does this tell us about what makes LASER light special?

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Even though the LASER was split up into its components, they were all red. Unlike the red Lazr finger, which has multiple colors in its spectrum, even though it looks red, you can see only red in the spectrum of the laser. Hence, the LASER pointer consists of only one color light, i.e. only one wavelength. This is called monochromatic light.