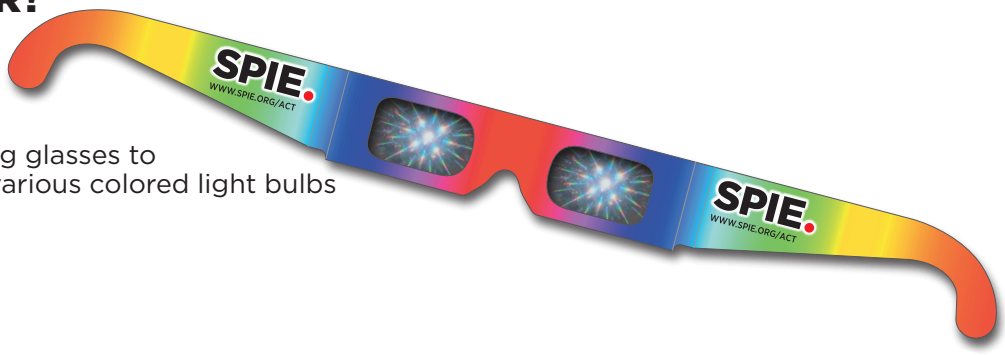
DIFFRACTION GLASSES: WHAT'S IN A COLOR?

Ages 10-14, Grades 5-8



Description:

Students use diffraction grating glasses to examine the spectra through various colored light bulbs

Materials:

- Diffraction grating glasses
- Red bulb or LED
- Blue bulb or LED
- Green bulb or LED
- White bulb

The best light bulbs for this experiment are compact fluorescent light bulbs that are often available at home improvement stores. You can also purchase LED lights online or at electronics stores; white LED bulbs tend to appear blue so they are not recommended. Note: avoid using colored incandescent bulbs because their color output is less pure.

Background and Misconceptions:

Light can be broken into component colors using a diffraction grating - waves, light, or any type of wave that goes through a narrow slit spreads out. The process that results from the wave spreading out as it goes through a narrow opening is called **diffraction**.

When we use diffraction, it is possible to see which **frequencies**, or colors of light, make up the light that you see with your naked eye. Different colors of light have different spectra. The visible electromagnetic **spectrum** (VES) is the light that makes up the colors we see. When a spectrum is present with all the colors, we call this a continuous spectrum.

If the light is from a red laser, you will see only red because lasers are comprised of exactly one frequency of light, whereas a red light bulb is not a single pure frequency. When you view a red light bulb, the diffraction grating spreads out the light and you see that red, yellow, and orange may be present in the spectrum, but not the color blue.

Continuous visible electromagnetic spectrum from white light

Teacher Guided Questions to Inquiry:

Use these questions to get the students started on their own inquiry

1. **What is a spectrum?** (colors that make up the light we see)
2. **What happens when light passes through a prism or diffraction grating?** (spreads out and you can see all the colors.)
3. **What would happen if you passed light that was only one color through a prism or diffraction grating?** (If the light were a specific wavelength, such as a laser's wavelength, you would see only one color through the diffraction grating and it would be a dot or a line. If you were looking at an LED bulb you would see a range of colors, but they would be limited to a smaller portion of the VES spectrum. For a blue bulb, there might only be colors that are from purple to light blue on the VES Spectrum. In other words, you would have a much smaller portion of the spectrum visible through the diffraction grating.)
4. **Why are colored light bulbs "colored"?** (Because they only display a small portion of the VES spectrum.)

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Guided Inquiry:

1. **Use the diffraction gratings to determine what makes up each type of light for each of the different colored light bulbs you have, including white.**
2. **What colors are hidden inside of light and how can the diffraction gratings be used to investigate the types of colors?** (When looking at a light through a diffraction grating, the light is spread out into its component colors. The component colors can tell us more about the composition of the light; for example, astronomers use light to determine which elements are present in stars. Elements such as hydrogen and helium will emit light at specific wavelengths and when these "fingerprints" of light are viewed in the star light, astronomers know the composition of the star.) Note: the spectra shown are approximate. Students may see parts of the spectra that are further to the left or right of what is depicted below.

Color of bulb or LED	Colors contained in the light	Colors shown
White bulb	All colors (red, orange, yellow, green, blue, indigo, violet)	
Red bulb or LED	Mostly red	
Blue bulb or LED	Mostly blue with some green	
Green bulb or LED	Mostly green with some blue and red	

Analysis Questions:

1. **How does the spectrum change with the different colored bulbs?** (There are different parts of the spectra that are visible, but the light that is visible always matches the color of the filter. So if I am using red, I see the red part of the spectrum.)
2. **Compare the spectrum from the white bulb to the spectrum of the red, green, and blue bulbs. When you mix the spectra of the red, green, and blue lights, why do you get the spectra of the white light?** (White light is made up of all the colors of the rainbow. Red, blue, and green contain only parts of the rainbow, but when they are combined, all the colors are also combined; therefore, they make white light).
3. **What do you think the diffraction grating glasses do?** (The diffraction gratings spread the light out so much that it is possible to see what makes up light.)

NEXT GENERATION SCIENCE STANDARD

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

PS4.B: Electromagnetic Radiation – When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light.

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