Rainbow Glasses

COLLEGE OF NATURAL SCIENCES
COLORADO STATE UNIVERSITY

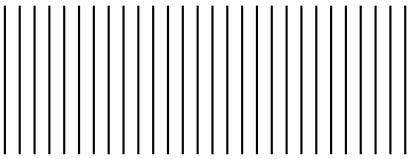
Overview

When you put on a pair of rainbow glasses and look at a light source, you see just what you would expect: rainbows! The rainbows you see are the *spectrum* of the light source.

Theory

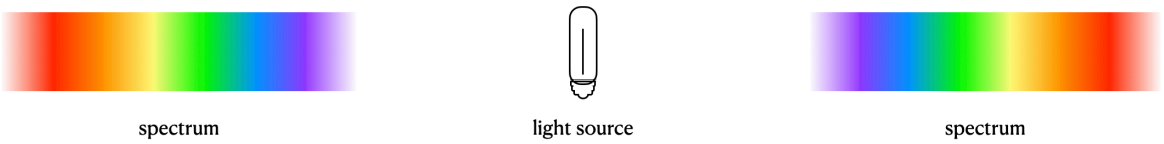
When light hits obstructions that are very small, the light can be *diffracted*. If light passes through a very narrow slit, the light will spread out as it goes through. The lenses of the rainbow glasses are plastic sheets that have very small lines inscribed on them. The lines are far too small to see, but they have an effect on the light that passes through them: They diffract it. Now, since the lines are evenly spaced, there will be another effect: The diffracted light will make an interference pattern. Light can be thought of as a wave, and so it, like other waves, it can undergo constructive and destructive interference, making a pattern of light and dark bands. A full treatment of this phenomenon is beyond the scope of this document; please consult any physics textbook for a full explanation.

Now, if the lenses in the glasses had a single set of lines spaced like this:



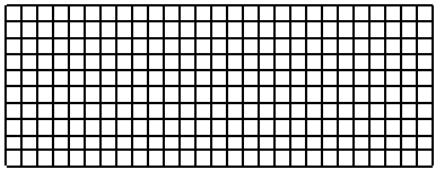
An image of an evenly-spaced set of vertical lines.

…there would be a simple spectrum of the light source. Actually, you would get two spectra, one on each side of the light source:



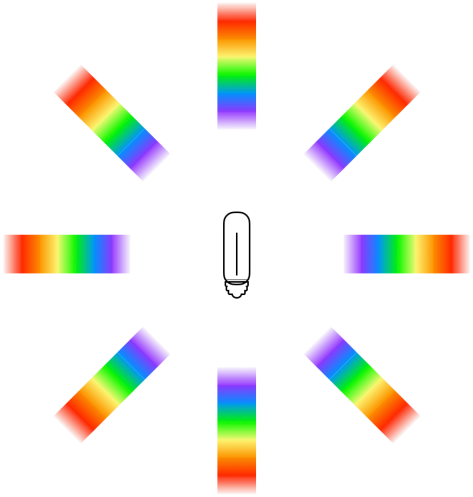
An image of a line drawing of a long-filament bulb (labeled "light source") with one horizontal rainbow spectrum to its left and a second to its right. In both spectra, the purple band is closest to the bulb and the red band is farthest.

In fact, the lenses of the glasses actually contain a grid of lines:



An image of an evenly-spaced grid of vertical and horizontal lines.

…and so you will see the usual pair of spectra, from the vertical lines, plus a set of vertical spectra, from the horizontal lines, and two "cross" spectra, from the interaction of the two! This is more complicated than what you would get with a simple diffraction grating, but it is also prettier — which is why the glasses are made this way. They are sold not as science equipment, but as "Fireworks Glasses" or "3D" glasses. The goal is to make the prettiest rainbow effect, and the grid pattern does this quite well indeed.



A line drawing of a light bulb is located at the center of this image. The same horizontal rainbow spectra as before are still present, but now there are also vertical spectra, and spectra at 45° angles extending into each quadrant. In all spectra, purple is closest to the bulb, and red is farthest.

Doing the activity

Necessary materials:

- rainbow glasses*
- variety of light sources**

*We get these from American Paper Optics.
DO NOT LOOK AT THE SUN!

In general, you don't need to do a great deal of preparation to have a very good experience using the rainbow glasses. Just hand out the glasses and let students explore! It's often a good idea to have a point source of white light (such as a single not-painfully-bright incandescent bulb) to start off. If you have old-fashioned fluorescent tubes for lighting in your classroom, these sometimes provide an interesting contrast — they often contain mercury, which (like all elements) has a unique emission spectrum. Computer and phone screens can also be quite interesting. Of course, there's one common light source you should not directly examine using the glasses…

SAFETY NOTE: Never look at the Sun! *Only eclipse glasses make it safe to look directly at the Sun. If you aren't using those, looking at the Sun (with or without rainbow glasses) can cause serious eye damage.*

You can also extend the activity by placing color filters over your white light source. The filter will "cut out" very specific sections of the spectrum depending on its color, which is an intriguing phenomenon on which to base exploration of light absorption and reflection.

Summing up

Rainbow glasses are a perennial favorite with the folks in Little Shop of Physics and the teachers we've worked with (easy, safe, cheap, educational) and with students (fun, pretty, and open-ended). If you design an interesting experiment and/or discover something exciting using the rainbow glasses, let us know!

For more information

Little Shop of Physics: https://www.lsop.colostate.edu

Colorado State University College of Natural Sciences: https://www.natsci.colostate.edu