

Newton's Rainbow

Teacher Background

Sir Isaac Newton in 1666 was the first to realize that white light was a combination of all of the colors of the rainbow. His experiments with prisms led the way for other scientists to probe the secrets of the spectrum. Until Newton, prisms were regarded as little more than playthings. Newton used them to break sunlight up into its constituent colors. It's not obvious that white results from combining colors. If you take red, orange, yellow, and all the other rainbow colors of paint and mix them up, you just get a murky brown-black. But if you do the same by mixing light from red, blue and green filters, the result is white light. To prove this to your students, create a color wheel with all of the colors of the spectrum. (The Lockheed Martin/University of Montana Yohkoh spacecraft education site [YPOP] provides simple but excellent instructions:

<http://mithra.physics.montana.edu/YPOP/Classroom/Lessons/Filters/filterprint.html>)

Materials

- prism
- light source
- slide projector
- diffraction grating

Explain/Explore

On a sunny day, take a prism over to an open window and stand it on end. Manipulate it until a spectrum is projected onto a wall in the classroom. Ask students what they see. Most will tell you it's a rainbow. Ask them what they know about it. There will be a variety of answers: keep probing until someone says that the colors always appear in the same order. Why does that happen? Something must happen to the light as it passes through the prism.

Take a pencil and put it in a glass of water. Ask what happened to the pencil? They should note that it's magnified, but also that it appears to be bent. Light is bent or refracted by the water. The same thing happens with sunlight when it passes through the prism. Since each color that's "hiding" in the white light has a different wavelength, it's bent by a slightly different amount, and so is separated into the spread out rainbow which emerges.

If you want a more controlled alternative to the prism, take a blank 35 mm slide and cover it with black tape so that a slit about 3 mm across is formed. Place the slide in a projector so that the slit is vertical. Aim the projector at a screen and place a diffraction grating in front of the lens. A beautiful spectrum will be generated, guaranteed to produce gasps from even the most reluctant scholar!