

Making A Rainbow

Using a holographic diffraction grating and an overhead projector, you can make a rainbow in your classroom!

Materials Needed

- 1 square of holographic diffraction grating (about 4 inches on a side)
- 1 piece of poster board
- scissors
- 1 overhead projector
- 2 manila folders
- Red, green, and blue filters (Roscolux filters Medium Red (#27), Dark Yellow Green (#90), and Primary Blue (#80))
- masking tape
- 1 large white wall

What To Do:

- Using the poster board, make a frame for the square of diffraction grating. This will prevent the grating from curling. Or, you can buy a ready-made grating mounted in a glass frame from “Science First” <http://www.sciencefirst.com/> (Figure 1)

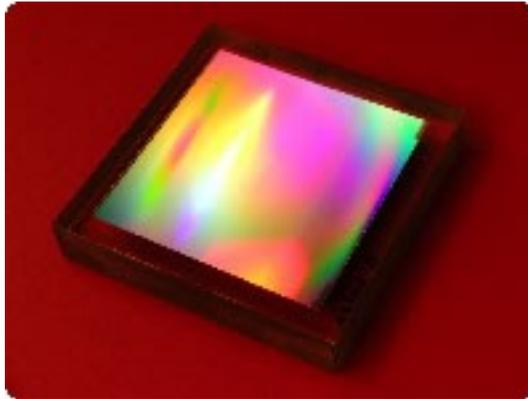
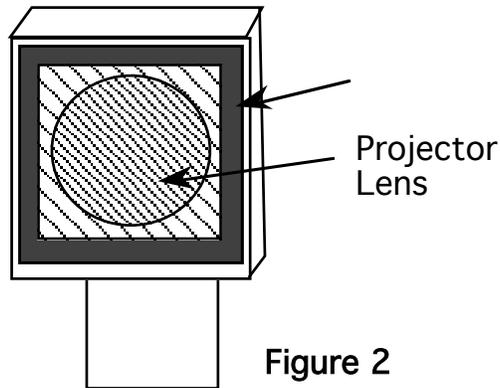
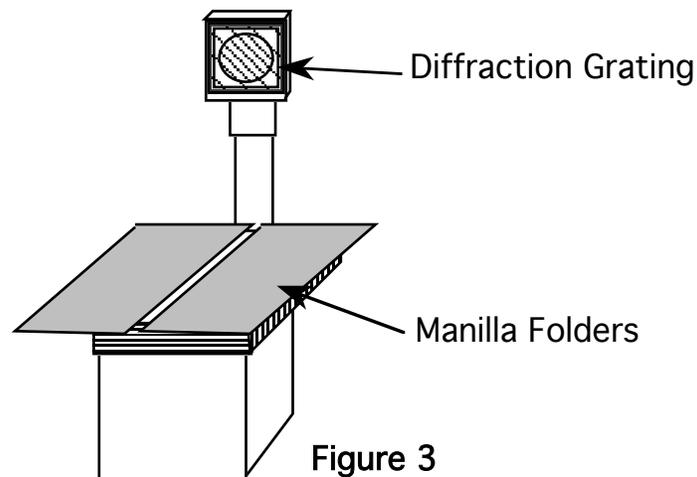


Figure 1

- Using masking tape, place the framed diffraction grating over the lens of your overhead projector (see **Figure 2**).



- Using the manila folders, cover the projection area so that only a 1 cm wide slit of light is showing (see **Figure 3**)



- Turn on the projector and project the rainbows on the wall.

Now What?

Once you have a rainbow projected on a screen, you can do lots of different experiments. What do you think the rainbow will look like through a red filter? Make a prediction and then try it by looking at the rainbow through the red filter. Do the same for the green and blue filters. Based on your observations, what do you think is happening to the light when it passes through a colored filter?

You might also want to investigate what makes an object appear red? Place a red object (like a red rose or a red ball) in the red portion of the rainbow. What color does the object appear? What color do you think the object will be if you place it in another part of the rainbow? Try it. Based on your observations, what makes a red shirt look red in white sunlight?

What's Going On?

First, why are you getting a rainbow? You probably already have experience with prisms. In prisms, light bends as it goes from air to glass. The shorter the wavelength, the more the light bends. The net effect is that the white light entering the prism breaks up into its component colors.

A diffraction grating, like the one on your projector lens, acts like a prism. The only difference is that prisms give you one rainbow while diffraction gratings can give you many more. Why is that? A diffraction grating is made of plastic or glass and has thousands of tiny lines etched on its surface. Each tiny line of the grating makes its own rainbow. As these rainbows head out to the wall, some rainbows interfere constructively while most others interfere destructively. In this experiment, you probably noticed two rainbows projected on the wall – one on the right side of the image of the white vertical slit and the other of the left side of the slit. All the other rainbows made by this grating (located even farther out to the left and right) are too dim for you to see.

The kind of grating used in this experiment is called a “holographic diffraction grating.” This kind of grating differs from the ones you have probably encountered in two ways: (1) The rainbows it makes are very bright; much brighter than those made by a regular grating. (2) You can only see two rainbows. In a regular grating you can see four or even six rainbows, but all are pretty dim compared to what you can get from a holographic grating.

This difference is because a holographic grating is manufactured very differently from a regular grating. A magnified view of the holographic grating would reveal that each line is actually a sinusoid in shape (**Figure 4**). In a regular grating, the lines would look rectangular (**Figure 5**). The sinusoidal shape bends light in way that sends most of the energy into the rainbows on either side of the slit. Very little energy is left for all the other rainbows made farther to the left and right.

Figure 4 (The Holographic Grating)

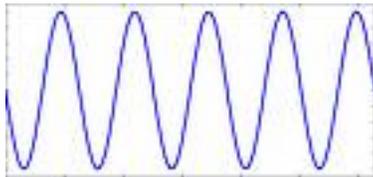
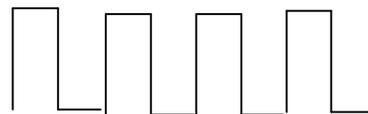


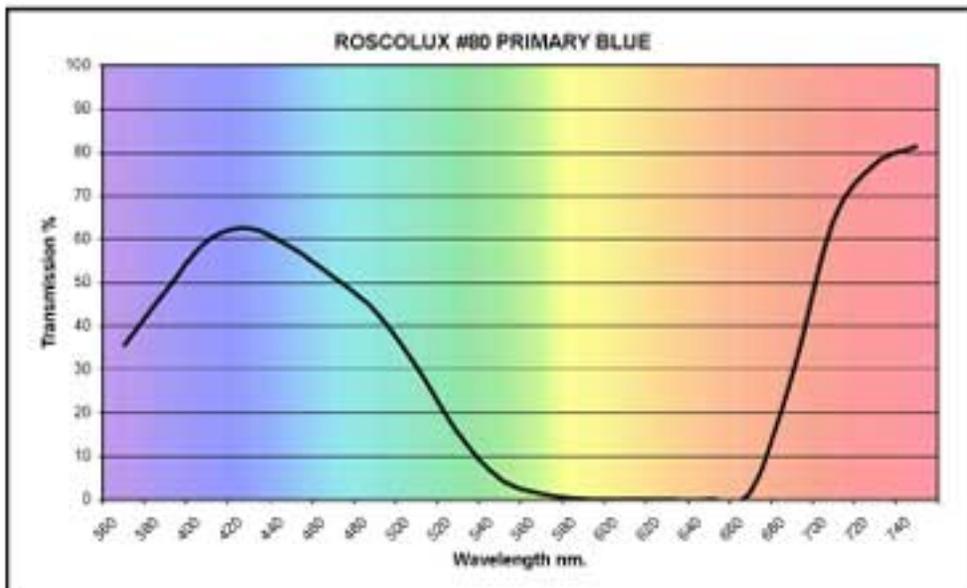
Figure 5 (The Regular Grating)



Ideas For Going Further

You can get colored gels to use as filters from a number of different sources. My favorite is Roscolux, because they have a great product and a great web site (<http://www.rosco.com/us/index.asp>). On this web site, you'll find a picture of all the colored gels they make along with the *spectrograph* for that gel (<http://www.rosco.com/us/filters/roscolux.asp#colors>). Your students can compare the spectrographs with the actual absorption features they observe when they look through the filters. Here's the company's spectrograph for "primary blue", #80.

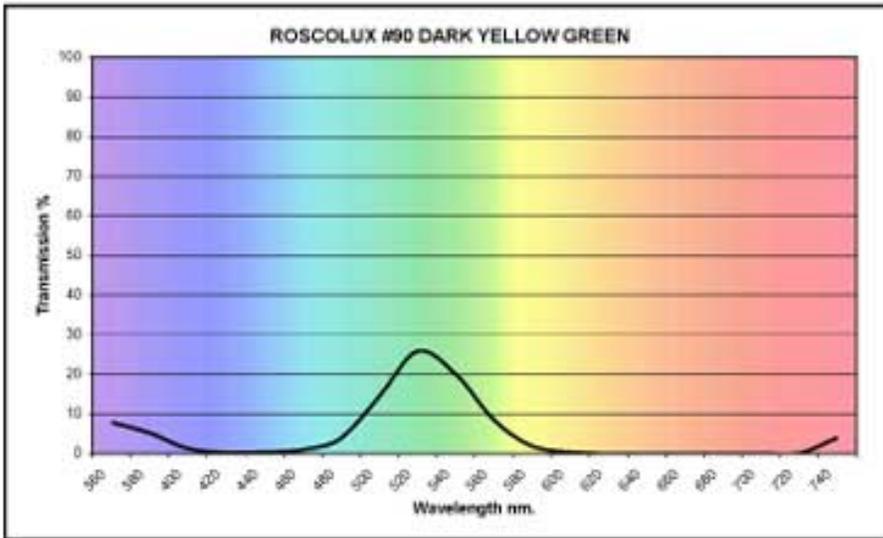
SWATCHBOOK:	ROSCOLUX
COLOR FILTER:	#80 PRIMARY BLUE
DESCRIPTION:	Color Effects Lighting Filter.
TRANSMISSION =	9% or -3.5 stop loss
MIREL SHIFT =	Not Applicable.
CC EQUIVALENT =	Not Applicable.



On the next page, you'll find the spectrographs for #27 (medium red) and #90 (dark yellow green).

SWATCHBOOK:
COLOR FILTER:
DESCRIPTION:
TRANSMISSION =
MIREL SHIFT =
CC EQUIVALENT =

ROSCOLUX
#90 DARK YELLOW GREEN
Color Effects Lighting Filter.
13% or -3.0 stop loss
Not Applicable.
Not Applicable.



SWATCHBOOK:
COLOR FILTER:
DESCRIPTION:
TRANSMISSION =
MIREL SHIFT =
CC EQUIVALENT =

ROSCOLUX
#27 MED RED
Color Effects Lighting Filter.
4% or -4.7 stop loss
Not Applicable.
Not Applicable.

