Build A Rainbow Maker and Discover What Stars Are Made Of:
Hand Held Spectrograph Construction
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Materials:
- 1 cardboard tube (toilet paper or paper towel tubes work well)
- 2 squares tin foil approximately 5 inches on a side plus some foil scraps
- 1 piece of diffraction grating, approximately 3/4 in square (can be purchased from www.sciencefirst.com, www.scientificsonline.com, and other sources)
- Tape
- Optional: colored filters (colored cellophane sold for wrapping gifts works well and can be doubled or tripled over)

Instructions:

Have fun and don’t worry. This project is extremely forgiving. None of the dimensions matter critically (not the size of the foil, the size of the grating, the size of the slit, nor the length or diameter of the tube), extra tape won’t hurt anything, and as long as the grating isn’t damaged, it can be built and rebuilt many times.

1. Cut a small hole, about 1/2 in by 1/2 in, in the middle of each of two tin foil squares. This is most easily done by folding the tin foil in half and ripping a small hole in the fold, then opening the foil back up.

2. In one piece of foil, tape the diffraction grating square over the hole, using tape along the edges. Try not to scrape the grating or put smudgy fingers on it.
3. Center (approximately) the mounted diffraction grating over the end of the cardboard tube; wrap the foil down along the sides of the tube, and tape the foil in place.

4. In the second piece of foil, we will turn the big hole into a narrow rectangular hole, or “slit.” Fold a scrap of foil in half to make a smooth folded edge. Folding the scrap over a few times is even better because it will be stiffer. Then tape down the straight edge so it covers half the hole. Do the same with a second scrap and tape it down to leave a narrow, about a fingernail’s width, slit between the pieces of foil.

5. Place the slit (gently, so it doesn’t rip or stretch) over the other end of the tube and wrap the foil along the sides. Don’t tape it down yet!

6. Look through the grating through the slit at a lamp or bright sky (not directly at the Sun!). You should see “rainbows” inside the tube but off to the sides (left and right OR top and bottom) of the slit. Gently rotate the foil with the slit and watch how the spectrum becomes narrower (so that the colors overlap more) and thicker (so the colors are more well separated). Try to find the orientation where the spectrum is thickest.
7. Tape down the slit in the best orientation. **Your spectrograph is ready to use!**

**Experiments to do with the spectrograph**

**IMPORTANT: NEVER LOOK DIRECTLY AT THE SUN!**

1. Compare the spectrum of the sky (Sun) with indoor fluorescent lighting. Notice the difference between a continuous and line spectrum. Look around your neighborhood for other kinds of lights, including Neon lights on stores and different kinds of street lights (commonly Mercury vapor, high pressure Sodium and low pressure Sodium). You will see different patterns of lines from each.

2. Note how the spectrum cuts off on the blue and red sides. Especially on the red side, it looks gradual in the spectrum. There is light you can’t see – shorter than blue (ultraviolet) and redder than red (infrared).

3. Play with putting different colors of cellophane in front of the spectrograph. You will see how they cut out different colors.

4. If the slit is narrow enough and the sky bright, you can see faint absorption lines – the Fraunhofer lines from elements in the Sun’s atmosphere. An Iron absorption line in the green is usually one of the most easily seen; look also for Hydrogen in the blue and Sodium in the yellow-orange.

5. Try making slits of different shapes and see how the grating makes a copy of the slit at every color.

**More Information About Spectrographs**

The heart of your spectrograph is the grating, which is a piece of plastic with very finely spaced grooves on it. When light hits the grooves, the different colors (wavelengths) of light go to different places and you see a rainbow. A prism of glass and water droplets after a rainstorm can similarly break up light into its component colors.

Every kind of atom produces its own pattern of spectral lines. The lines you see from fluorescent or Neon lights are like the fingerprints of the atoms in the gas inside the lights. The most common indoor fluorescent lights and bright white streetlights contain Mercury and you will see bright purple, green, orange, and red lines. Neon signs have many red lines. The element Helium was first discovered on the Sun, not on Earth, by noticing unidentified lines. Astronomers use spectrographs on telescopes to examine the light from distant stars and galaxies and determine what elements are present in them.