



Assembly & Use Instructions -- Stanford Spectrographs

Instructions

You'll need: Spectrograph poster, diffraction grating, adhesive tape



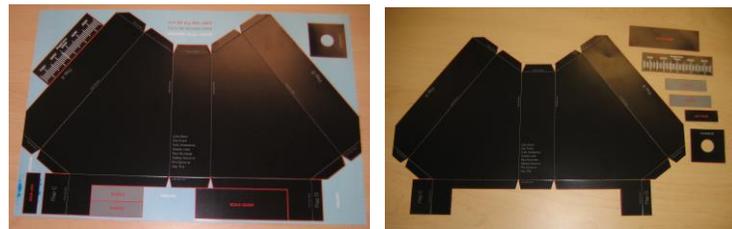
NOTE: Try not to touch the grating material, since the oils on your fingers will damage it!

1. Write your name on your spectrograph



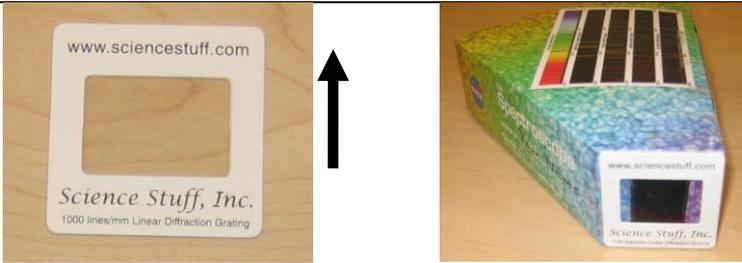
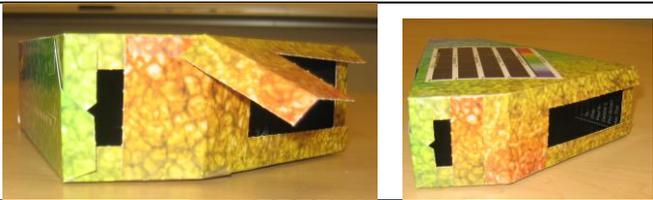
2. Punch out spectrograph on red lines.

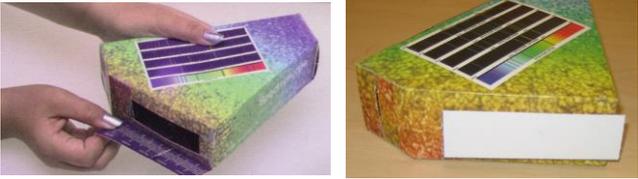
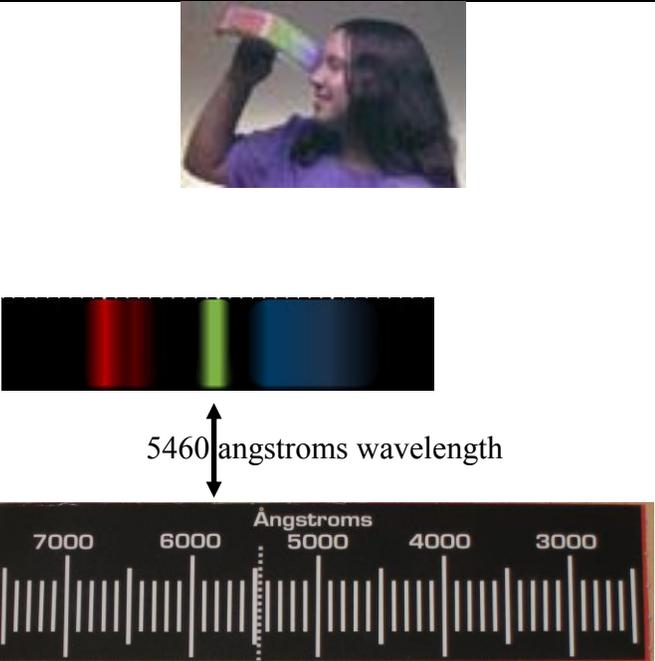
You should have 7 pieces.



3. Fold box inward on grey lines



<p>4. Tape box together at top of side (Flaps A and B) – don't tape anything else yet</p>	
<p>!!!!!!!!!!!!!!!!!!!!!!!!!!!!</p> <p>5. Tape diffraction grating onto front - LETTERING UP</p> <p>(The "Spectroscope" lettering should be UP as well)</p> <p>!!!!!!!!!!!!!!!!!!!!!!!!!!!!</p>	
<p>6. Tape eyepiece over grating -- LETTERING UP</p>	
<p>7. Tape edges of back end together</p>	
<p>8. Place "Gap Edge" piece of paper close to slit end. Measure width of slit with 2 "Slit Width" pieces</p> <p>Tape Gap Edge in place, easiest with a partner, then throw away Slit Width pieces</p>	 

<p>9. With 1 piece of tape, loosely tape, loosely tape scale over scale opening with lettering facing INWORDS and UP.</p>	 <p>(You will be moving the scale in the next step.)</p>
<p>10. Calibrate:</p> <ul style="list-style-type: none"> • Hold your spectroscope horizontal & look through the eyepiece. • Point your slit at a fluorescent tube and observe the spectrum <p>You should see some extra bright lines. Notice the bright green one - it happens to have a wavelength of 5460 angstroms. So, move your scale until the bright green line you see from the fluorescent tube lies directly over the dashed line (at 5460 angstroms) on your scale.</p>	
<p>11. After calibration, firmly tape scale in place. Trim if necessary.</p>	
<p>12. Tape Scale Cover loosely over scale ONLY ON TOP, so it can be flipped up or down</p>	

Study Light with your Spectroscope

Now use your spectroscope to examine various light sources like neon lights, mercury streetlights, sodium streetlights, even your TV. Compare what you see to the various spectra that are printed on your spectrograph. Can you identify the different chemical elements?

Background:

White light is a mixture of all colors of visible light. But not all light that appears white to the eye is made of the same mix of colors. The precise colors coming from a light source can be seen when its light is spread into a spectrum by a prism, a rainbow, or a spectroscope. With this activity, you can make your own spectroscope and see all the colors that make up the light from different sources.

Spectroscopes contain a diffraction grating that works like a prism to separate and spread out light waves according to wavelength. Our eyes see each wavelength of light as a different color. In a rainbow, or any other spectrum, the colors are arranged in order of their wavelength, with red having the longest wavelength and violet having the shortest.



The colors of the rainbow, in order, are:

red (longest wavelength)

orange

yellow

green

blue

violet (shortest wavelength)

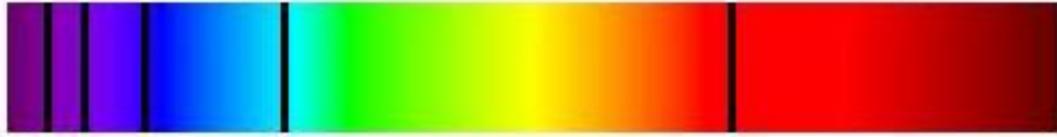


Not every color of the rainbow is always present in what our eyes see as white light. Sometimes there are extra bright colors, and sometimes there are missing colors:



The extra or missing colors tell us certain chemical elements have affected the light. Each chemical element changes the spectrum either by making certain colors brighter (emission spectra) or removing certain colors (absorption spectra). Every element has its own spectral fingerprint, and their spectral lines can be used to identify them. Here are some examples:

Hydrogen Absorption Spectrum



Hydrogen Emission Spectrum



Helium (emission)



Mercury (emission)

Astronomers and chemists study spectral lines because they contain information about the light's source. The composition of stars, nebulae, the Sun, and the atmospheres of other planets are all studied by measuring the precise colors of light they give off.

Process:

Build your spectroscope (instructions following). Afterwards, you can look at the chemical "lines" or spectra from various gases.

After you've built your spectroscope, start with looking at an incandescent light with your spectroscope. You should see something like this:



This is called a continuous spectrum, meaning that all the colors of the rainbow are present. Most objects that glow or give off light produce a continuous spectrum.

Next, point your spectroscope at a fluorescent light bulb. You should see something like this:

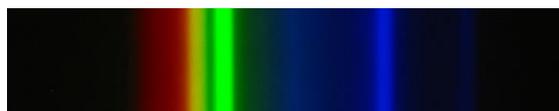


There is still a (faint) continuous spectrum. But notice the extra bright red, green, blue, and purple lines. They didn't show up in the spectrum from the incandescent light. So there is something more in the fluorescent bulb than in the incandescent one. What do you think it is?

Look back at the mercury spectrum above. It has bright red, green, and blue lines. If you compare it to what you see through your spectroscope, what do you conclude? Yes – **fluorescent lights have mercury in them!**



Fluorescent spectrum

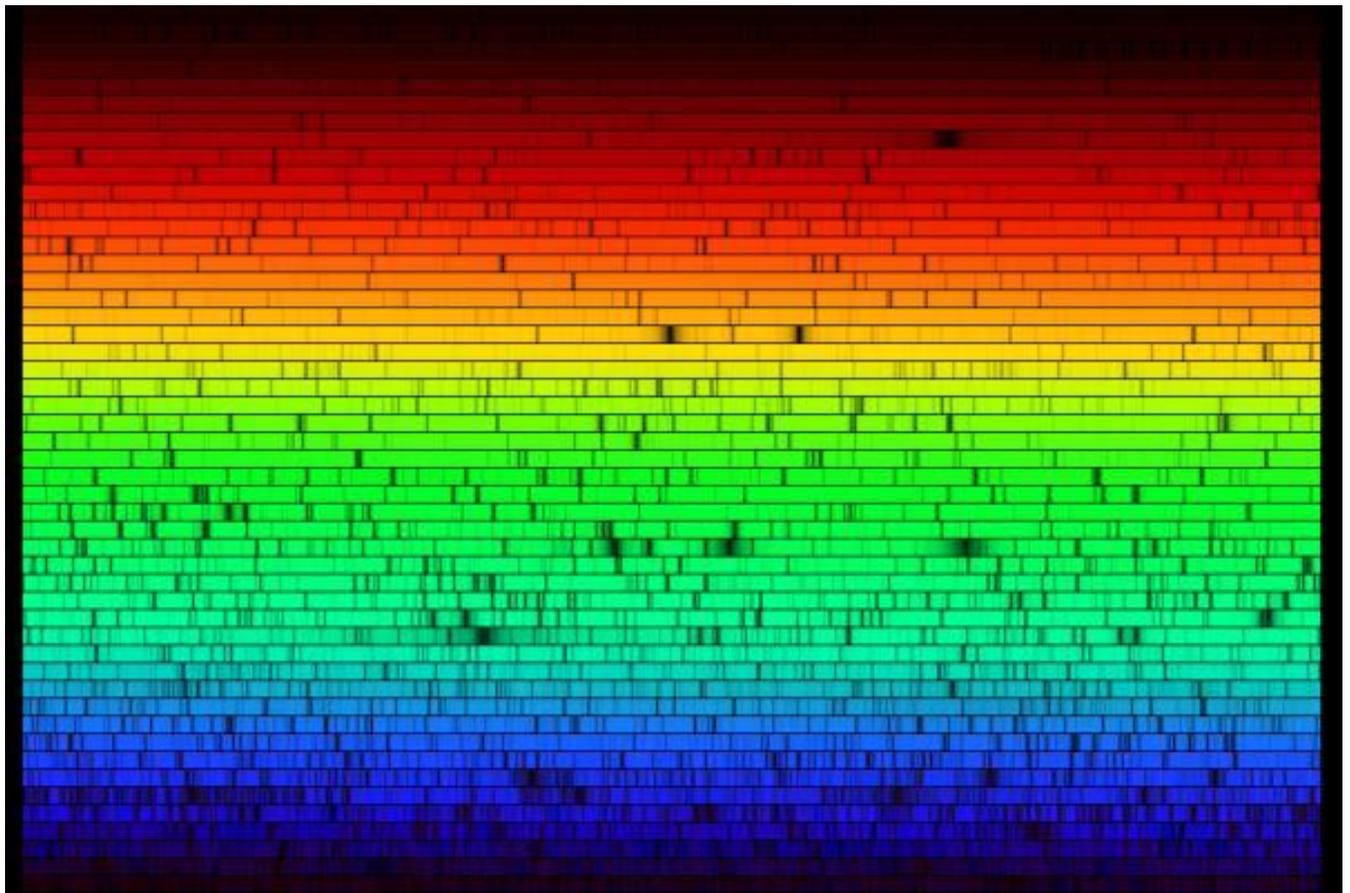
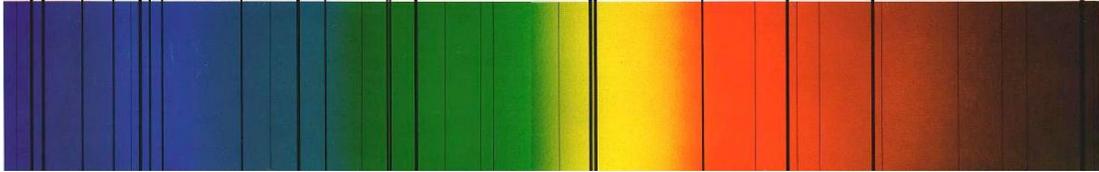


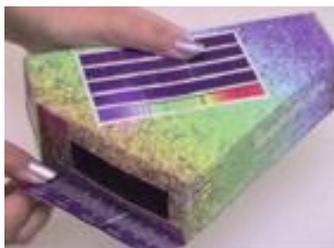
Mercury spectrum

Now, use your spectroscope to look at other gas lamps in your classroom. Then, use your spectroscope to look at neon lights, mercury streetlights, sodium streetlights, even your TV set! Compare what you see to the various spectra that are printed on your spectroscope. Can you identify the different chemical elements?

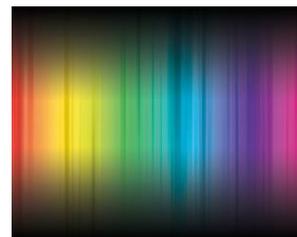
The Solar Spectrum

The Sun contains most of the chemical elements, and they show up in its spectrum (but **do NOT use your spectroscopy to look at the Sun!**). The image in the middle of this page shows the solar spectrum in some details. But it is so long that we've had to divide it up into rows for you. Think of it as one giant version of this:





Obtaining Solar Center Spectrographs and Curricula Materials



Class sets (45 each) of spectrographs and gratings are available from the Stanford Solar Center. The sets are free, but the requestor must pay for shipping. You can order spectrographs at: http://solar-center.stanford.edu/posters/posters_spec_bulk.html

Curriculum materials are downloadable from the web. See

<http://solar-center.stanford.edu/activities/cots.html>

Curriculum materials include:

Introduction to Spectroscopy	Grades 4-12	Powerpoint presentation which introduces spectroscopy and the spectrographs
Study Guide for Early Elementary	Grades 2-4	Uses gratings only; does not require spectroscopes
Study guide for Late Elementary	Grades 5-8	Requires spectroscopes
Colors of the Sun video	Grades 5-12	Video explaining the use of spectroscopy in solar observing. Produced onsite at Stanford Wilcox Solar Observatory.
Fingerprints in Sunlight presentation and activities	Grades 9-12	A Powerpoint presentation, demonstrations, and activities to be used to introduce spectroscopy to high school students. To accompany spectroscopes.
Fingerprints in Starlight presentation and activities	Grades 9-12	A Powerpoint presentation and demonstrations adapted from "Fingerprints in Sunlight" above. Designed to introduce spectroscopy into an AP Chemistry class. To accompany spectroscopes.
Colors and Motions of the Sun video	Grades 9-12	Video explaining the concepts of spectroscopy and helioseismology as related to the Sun. Produced by Jay Pasachoff.
Solar Dynamics Observatory video	Grades 9-12	A supplement to "Colors and Motions of the Sun video introducing NASA's Solar Dynamics Observatory spacecraft, on which Stanford has an instrument
Powerpoint presentation on the Sun	Grades 5-12	Set of Powerpoint slides and videos introducing solar science; does not require spectroscopes