Ay 10 - Section Worksheet 1
Blackbody and Emission Line Spectra

In today's worksheet we will look at examples of blackbody and emission-line spectra with a diffraction grating - a simple device that breaks light into its component colors, allowing us to "see" spectral features.

PLEASE only hold the diffraction gratings by the white border; the oils on your hands and fingers will clog the tiny slits on the clear part, thus rendering the grating useless!

Blackbody Spectrum

First, look through the diffraction grating (make sure to keep it oriented so that you can read the words on the white part of the grating) at the ordinary incandescent lightbulb. You should see a horizontal band of color some distance off to the side of the object.

1. Sketch this band as best you can in the box, indicating the order and sizes of the regions of the different colors and label the color of each region.

2. Translate this sketch into a *rough* diagram of wavelength versus intensity. Make sure that your graph has intensity increasing upward and wavelength increasing to the right.

3. Briefly explain why the bulb looks white.

Emission Spectra

Next, we will look at the spectra of a few different elements using the arc lamp, a simple device that passes an electric current though a gas-filled tube. (This is how a neon sign works and neon is one of the elements we will investigate.) Sometimes seeing these lines can be a bit tricky - if you have difficulty, try holding the lens closer to your eye and/or getting closer to the source.

4. In the area below, write the name of the element on each line and make a quick sketch of the positions and colors of the brightest spectral features. (You can also just describe the spectral features qualitatively: "lots of red lines", *etc.*). Also note the overall color of the glowing tube to your eye (without the grating).

   (a) Element: Overall Color:

   (b) Element: Overall Color:

   (c) Element: Overall Color:

   (d) Element: Overall Color:

5. Your GSI will now place a tube inside the lamp that contains a different element than the ones you've just seen, but is still listed on the page of spectra. Guess which one it is! How did you decide?

The Spectrum of Hydrogen

Hydrogen is the most abundant element in the cosmos (∼70% of all normal matter), and also the easiest to understand - it has only one proton and one electron. Thus, we will investigate how it produces emission lines in further detail.

6. Sketch the emission lines of hydrogen in the box. (HINT: There should be four lines that you can see, but one is very faint!)

7. Again, translate this into a rough wavelength-intensity diagram.

8. What color was the gas tube (to your eye, without the grating)? What colors were the brightest lines? How do you resolve this discrepancy?

A diagram of the hydrogen atom is shown in Figure 1. The numbered circles designate the individual energy levels; their distance from the nucleus (darkened circle in the middle) is approximately indicative of their energies. As it turns out, the spectral lines you saw moments ago correspond to the transitions 3→2, 4→2, 5→2, and 6→2.

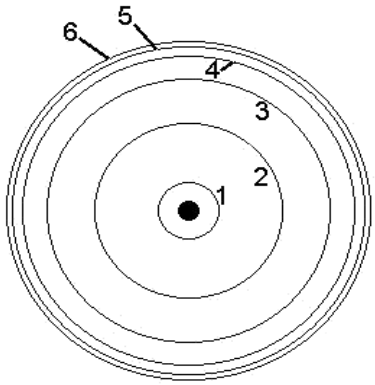

Figure 1: A simplified hydrogen atom.

9. Knowing what you know about the relationship between color, wavelength, and energy, which transition corresponds to which spectral line? (Label the lines in your wavelength-intensity diagram above).

10. Why don't you see any transition lines to the ground state (level 1) in the spectrum?

11. Why don't you see any transition lines to level 3?