Blackbody and Emission-Line Spectra

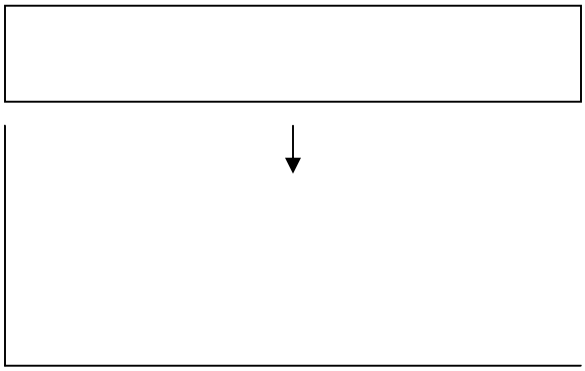
In today's exercise we will look at examples of blackbody and emission-line spectra with a diffraction grating – a simple device that breaks light into its component colors, allowing us to "see" spectral features.

Part 1 – Blackbody Spectrum

First of all, look through the diffraction grating at an ordinary light bulb (which is just a blackbody: the tiny filament inside is heated by the electric current to a temperature of about 2500 K such that it begins to glow at visible wavelengths). 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 relative arrangement and sizes of the regions of different colors.

2. Translate this into a *rough* diagram of wavelength versus intensity. Make sure you note on your graph whether you have wavelength increasing to the right or left.



3. Explain why the bulb looks white.

Part 2 – Emission Spectra

Next, we will look at the spectra of different elements using the arc lamp, a simple device that passes an electric current through a gas-filled tube. (This is exactly 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 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 brighter spectral features. (You can also just describe the elements qualitatively – "lots of red lines", etc.) Also note the overall color of the glowing tube to your eye (without the diffraction grating).

element _____ overall color _____ _____ _____

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5. Your GSI will now place a tube of unknown composition inside the lamp. Guess what it is in the tube.

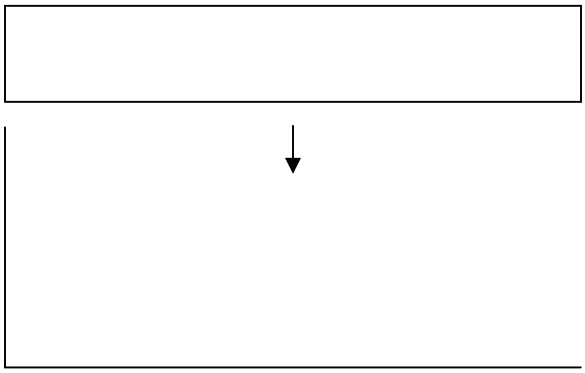
How did you decide?

Part 3 – The Spectrum of Hydrogen

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

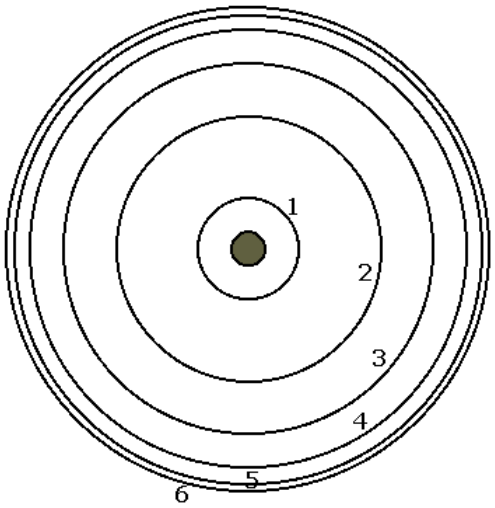
6. Sketch the emission lines of hydrogen at right. (Hint: there should be four lines that you can see, but one is very faint.)

7. Translate this into a wavelength-intensity diagram at right.



8. What color was the gas tube (to your eye)? What color were the brightest lines? How do you resolve this discrepancy?

A diagram of the hydrogen atom is shown at right: numbered circles designate the individual energy levels; their distance from the nucleus 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.



9. Knowing what you do about the relationship between color, wavelength, and energy, which transition corresponds to which spectral line? (Label the lines in the diagram in question #8.)

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

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