Emission and Absorption Spectra Lab

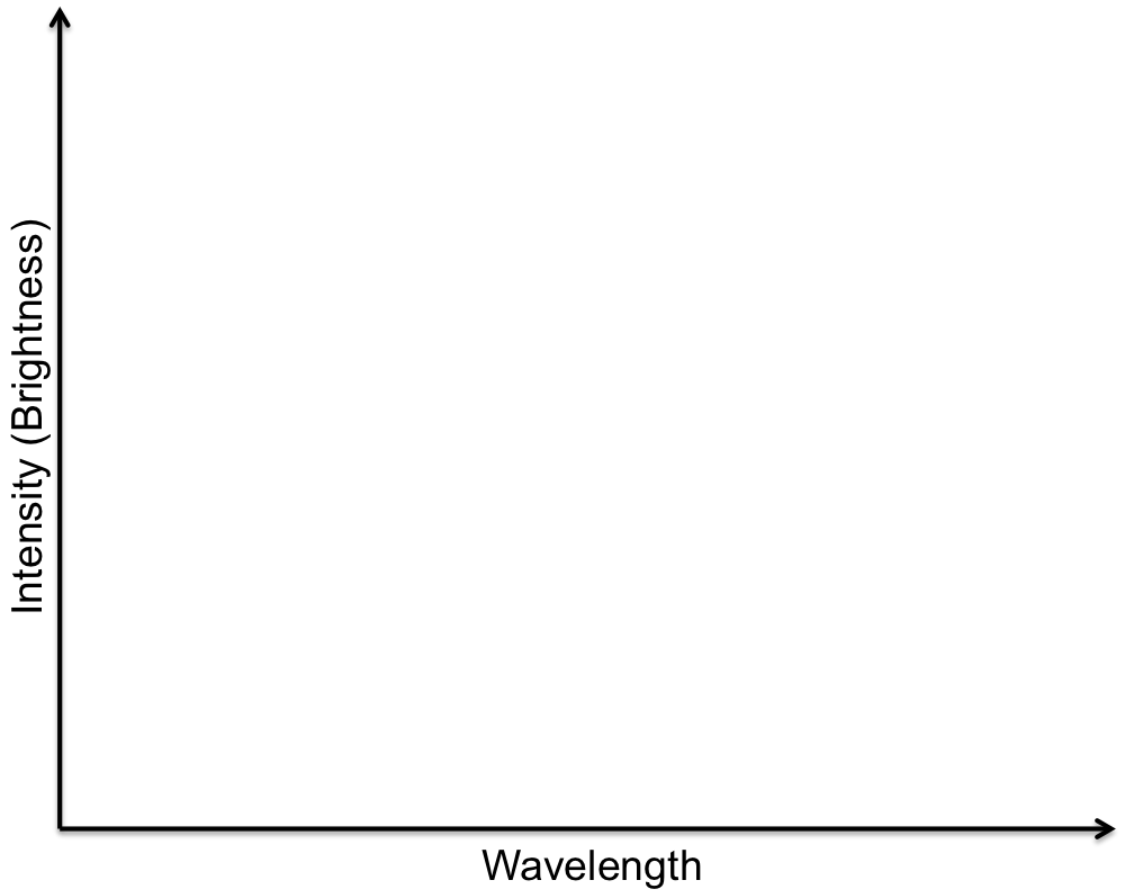
Purpose: Study various types of spectra and become familiar with how they are created.

Materials:
Spectrometer
Colored Pencils

One dimensional vs Two Dimensional Spectra
During this lab, you'll be asked to draw two types of spectra, described below.

One-dimensional spectra are those that you see when you use your handheld spectrometer. You'll use colored pencils to draw these. Draw regions darker when they appear brighter and fainter when they appear fainter.

Two-dimensional spectra are what you'll see with the digital spectrometer. They will be a graph of wavelength vs. intensity (brightness), such as shown below. Use this as a model when you are drawing spectra and making predictions for this lab.



Observation 1: Hydrogen

Your instructor will insert tube containing hydrogen gas into a power supply that will pass an electric current through the tube, exciting the hydrogen atoms and causing them to emit light. You will examine the tube with your handheld spectrometer to create a one-dimensional spectrum and with a digital spectrometer to create a two dimensional spectrum.

Answer the following questions **before** completing this observation

1. What will the spectrum of the tube look like through your handheld spectrometer.(the one dimensional spectrum). What colors will you see? Will some be brighter than others? How will it appear different from the thermal spectra you looked at last class? Write down a prediction.

2. What should the plot of intensity vs. wavelength (the two dimensional spectrum) look like for this tube?. How will it appear different from the thermal spectra you looked at last class? Draw your prediction on a chart like the one shown on the last page then write a few sentences describing why you believe that this will be the case.

3. Based on what you learned in the lecture, why do atoms emit only specific colors of light? Draw a picture to support your answer.

Now test your predictions against reality. First, just have your instructor turn the emission tube on and use your handheld spectrometer.

1. What does the one dimensional spectrum (through your handheld spectrometer) look like? Draw it with the colored pencils, then answer the following questions.
    a. Did it match your prediction? What were you right about? What were you wrong about? What (if any) false assumptions did you make?
    b. Were you able to see any brightness differences between lines? Were some more intense than others? Why or why not, do you think?
2. As you learned in the video, the visible lines in the Hydrogen spectrum are called the "Balmer" lines. There is a simple formula that describes their wavelengths. The wavelengths **in nanometers** are:

$$\lambda = \frac{109.7}{\left(0.25 - 1/n^2\right)}$$

and "n" is the number of the electron energy level where they start (they all end at n=2, which is where the 0.25 comes from $-\ 1/2^2$). The "n"s for the Balmer lines are given in the table below. Recreate this table in your lab, plug each one into the formula, and fill in the wavelength of the line in the second column. Show your work.

Energy Level	Wavelength of Photon (in nm)
n=3	
n=4	
n=5	
n=6	
n=7	

Now your instructor will do the demonstration with the digital spectrometer. Answer the following questions after the demo.

3. What did the two dimensional spectrum of the tube bulb look like? Draw it and compare it in words to your prediction. What were you right about? What were you wrong about? What (if any) false assumptions did you make? Note that in this case, you can put actual units on the axes. These will be important for later questions.
4. Remember that light that you see with your eye (visible light) has wavelengths between 400 and 700 nanometers. Draw lines marking this portion of the spectrum on your plot from #2, and label where various colors (ROYGBIV) lie within that range. Then answer the following questions
    a. Which of the lines did you see with your eye? Label the lines in your 2D spectrum with the colors you saw in the 1D spectrum. Are there lines in the spectrum that you couldn't see with your eye? What colors/wavelengths are they?
    b. Are all of the lines in the digital spectrum Balmer lines? Why or why not?

Observation 2: Helium

Compare the spectra of helium and neon.

1. Sketch both one-dimensional spectra and describe in words how they are similar or different.
2. Make a prediction for what the two-dimensional spectra will look like (for example, you might predict the relative intensities of the lines you see with your eye. How much brighter is one line than another?). Describe your prediction in words and draw it.
3. Together with your instructor, make a two-dimensional spectrum with the digital spectrometer for both bulbs. Draw them on separate charts, then compare what you saw with your predictions in words. Was your eye a good judge of the relative brightnesses of the lines?
4. How do the tubes look different when you look at them directly without your spectrometer? Based on your observation, do you think all "neon lights" contain the element neon? Why or why not?

Observation 3: Element X
Your instructor will insert a mystery element into the tube.

1. Sketch its one-dimensional spectrum after observing it with your handheld spectrometer.
2. Together with your instructor, make a two-dimensional spectrum with the digital spectrometer. Carefully identify the wavelengths of the lines.
3. Using a resource provided by your instructor, identify the element using both the one and two dimensional spectra you observed.

Observation 4: GE Reveal Bulb
Compare the spectra of a "GE Reveal Bulb" to that of a regular display case bulb.

1. Sketch both one-dimensional spectra and describe in words how they are similar or different.
2. Make a prediction for what the two-dimensional spectra will look like. Describe your prediction in words and draw it.
3. Together with your instructor, make a two-dimensional spectrum with the digital spectrometer for both bulbs. Draw them on the same chart, then compare what you saw with your prediction in words.
4. What kind of spectrum does the GE reveal bulb have?
5. Do the lines in the GE reveal bulb go all the way to zero? Why or why not, do you think?