Thermal Emission Spectra Lab

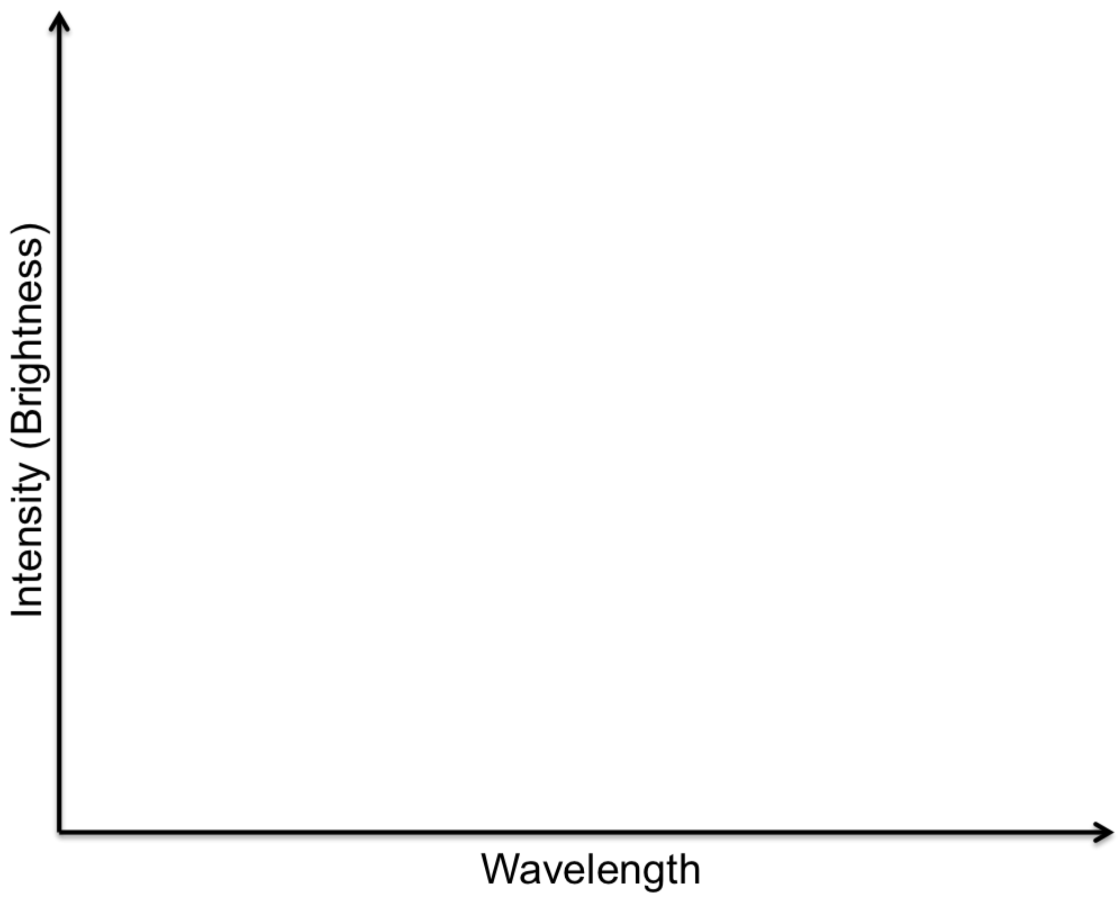
Purpose: Study various types of spectra and become familiar with how they are created.

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: Incandescent Light Bulb

Your instructor will insert an incandescent light bulb into a power supply with a dimmer switch, which allows you to vary the amount of current that passes through the bulb, changing its brightness. You will examine the bulb with your handheld spectrometer to create a one-dimensional spectrum and with a digital spectrometer to create a two dimensional spectrum.

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

1. What will the spectrum of the bulb look like through your handheld spectrometer.(the one dimensional spectrum). What colors will you see? Will some be brighter than others? Write down a prediction.

2. What should the plot of intensity vs. wavelength (the two dimensional spectrum) look like for this bulb. 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. What do you think will happen to the spectrum when the dimmer switch is turned to increase the current? Draw your predictions for a "dim" setting and a "bright" setting on another chart and then write a few sentences describing why you believe that this will be the case.

Now test your predictions against reality. First, just have your instructor turn the lightbulb 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 colors? Were some more intense than others? Why or why not, do you think?

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

2. What did the two dimensional spectrum of the light 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.
3. Draw the spectra of the bulb on "dim" and "bright" settings on a new plot (both on the same plot, but different from the plot you made in question 2). Again,

make sure to include units on the axes. Compare this to your prediction. What were you right about? What were you wrong about? What (if any) false assumptions did you make? Note that TWO observable things should have changed about the spectrum between the dim and bright settings and you should describe them both.

4. As you learned in the video, the wavelength of the peak of a thermal emission spectrum is directly related to its temperature through Wien's Law. Use this relationship (and your instructor if you need help) to calculate the temperature of the bulb on its "dim" and "bright" settings. Show your work.
5. Compare the answer that you got in #4 to the temperature of the sun. Is it similar or different? Use Wien's law to explain why this is the case.
6. 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, then answer the following questions
    a. Estimate what percentage of the total light lies in the visible regime for the light bulb. If you need some tips for how to do this well, ask your instructor.
    b. Based on this, do you think the light bulb is efficient or inefficient? Why or why not?

Observation 2: Bug light versus regular incandescent light bulb.

Compare the spectra of a regular incandescent light bulb to that of a "bug light".

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. Bug lights claim to keep bugs away from them. Given your observations of the two spectra, which range of the spectrum do you think bugs see in? Explain your answer using specific information from you observations.

Observation 3: Incandescent vs. Fluorescent

Compare the spectra of incandescent and fluorescent bulbs.

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. Did anything surprise you about these two spectra? Do they operate in the same way? Does the fluorescent light bulb have a thermal spectrum?
5. Use your observations to explain why fluorescent light bulbs are more efficient than incandescent bulbs.