Emission Spectra

In this experiment, you will use a Vernier Spectrometer (V-SPEC) to measure the light emitted by selected sources. These sources can be, but are not limited to, discharge tubes, LEDs, lamps, or luminescent or fluorescent liquid solutions.

The electrons of atoms and molecules exist in specific energy states. The energy emitted by the excitation of electrons is limited to differences between these states, thus specific energies of light are emitted. The color of a glowing LED, for example, is determined by the energy of the emitted light. The energy and wavelength of the light is described by the equation $E = hc/\lambda$, where λ is the wavelength, h is Planck's constant (6.63×10^{-34} J sec), and c is the speed of light (3.00×10^{8} m/sec). If you are measuring the emission spectrum of a gas trapped in a discharge tube, only certain wavelengths of light are emitted by the gas and the "pattern" that is produced is unique for that substance.

OBJECTIVES

In this experiment, you will

- Practice measuring the emission spectrum of a source of light.
- Compare and contrast the spectra of various light sources.

MATERIALS

Vernier Spectrometer, w/o light source/ cuvette holder attachment
computer
(optional: fiber optic cable)

light sources:
LEDs
discharge tubes
lamp or flashlight

PROCEDURE

1. Use a USB cable to connect a Vernier Spectrometer to your computer. Make sure that the light source/cuvette holder has been detached from the spectrometer. (Optional) Connect a fiber optic cable to the threaded detector housing of the spectrometer.

2. Start the Logger *Pro* program on your computer.

3. In your data table, record the type of light source that you will be testing.

4. Prepare the spectrometer to measure light emission.
   a. Open the Experiment menu and select Connect Interface → Spectrometer → Scan for Spectrometers.
   b. Open the Experiment menu and select Change Units → Spectrometer: 1 → Intensity.

5. Measure the emission spectrum of a light source.
   a. **If you are not using a fiber optic cable**, place the light source near (within a few cm) the detector opening on the spectrometer. The detector opening is a round, stainless steel piece that sits in a recessed area of the spectrometer.
   b. **If you are using a fiber optic cable**, aim the tip of the cable at the light source.
   c. Click ▶ Collect. An emission spectrum will be graphed. You may have to adjust the position of the light source to get a suitable graph to appear.
   d. If necessary, move the light source toward or away from the detector so that the peak emission is less than ~1.5. When you achieve a satisfactory graph, click ■ Stop. Write down your observations of the emission spectrum in your data table.
6. To store the data, select Store Latest Run from the Experiment menu.
7. Repeat Step 5 with another light source, as directed by your instructor.
8. (Optional) Save and/or print a copy of your test results. Select Save As… from the File menu and save your experiment file.
9. Select Exit from the File menu to close down Logger *Pro*.

DATA TABLE

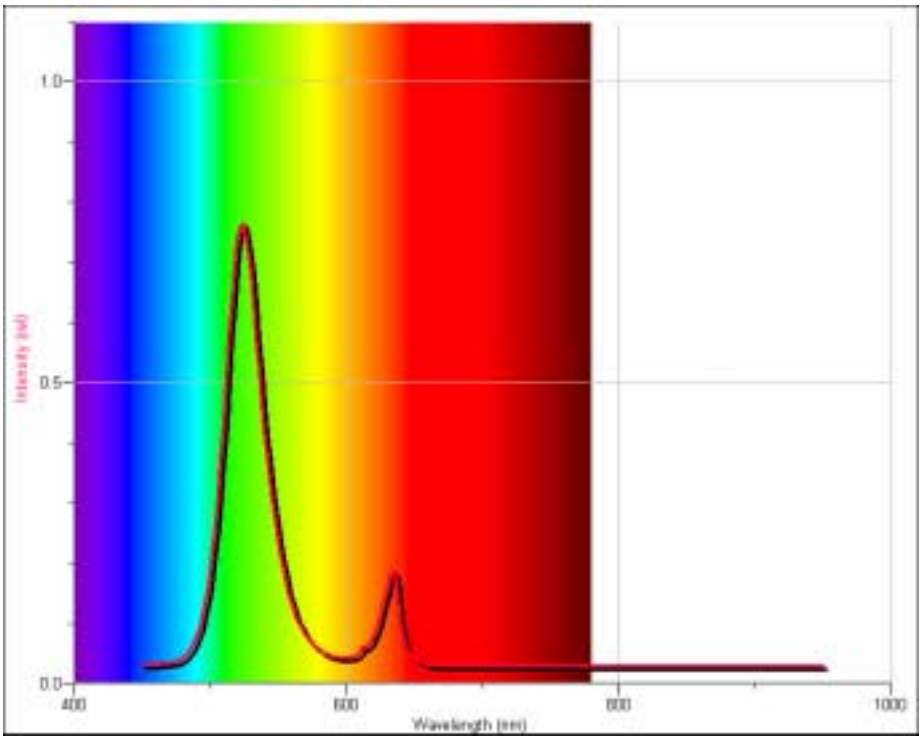
Trial	Light Source	Peaks or unique features of the spectrum
1		
2		
3		

DATA ANALYSIS

1. Describe, in detail, the emission spectrum of each light source. Emphasize the features of each spectrum that distinguishes it from the other light sources that you tested.

2. Identify the wavelengths of every peak in the graph of each light source.

3. Speculate about how the emission spectrum below might have been produced.



Teacher Information

1. Any common light source is suitable for this experiment.

2. Logger *Pro* 3.4.6 (or newer) software contains a folder with discharge tube data files. To open these files, go to the File menu and select Open. You will see the Experiment dialog box. Open the Sample Data folder. In the Sample Data folder, open the Physics folder. In the Physics folder, open the Gas Discharge Spectra folder. This folder contains eight files, seven of which are discharge tube emissions graphs.

3. The Gas Discharge folder described in #2 above also contains the graphs necessary to conduct an interesting investigation of the mercury content of indoor lighting. If you open the file entitled "office lights.cmbl", you will see the emission spectrum of fluorescent office lights. To add the mercury discharge tube graph, open the File menu and select Import From → Logger Pro File… The Gas Discharge folder will appear again; open the "mercury.cmbl" file. The data from the mercury file will be transferred to the office lights file, but it will not be graphed. Double click anywhere on the graph, choose the Axes Options tab (at the top left of the dialog box), and open "Run 1 2". Check the box next to "Intensity" and the mercury discharge data will be graphed. The two plots are red in color, unfortunately. By inserting a table and manually changing the color of one of the columns of intensity values, your graph will be easier to examine.

4. We included a few questions in the Data Analysis section of the student version as a generic starting point. Please feel free to edit or replace these questions as best fits the needs of your experiment.

5. As a good way to become familiar with this experiment, you should plan to keep a set of sample data as well as develop an answer key. It is our experience that data can vary, based on many factors, and the sample data that we have collected in testing this experiment may not be representative of your students' results.

