Experiment 3: Introduction to Spectroscopy

This lab will be performed in groups of 2.

Pre-lab:

Review the Balmer equation (section 2.2 in your textbook) and calculate the wavelength emitted during the following transitions: $2 \longrightarrow 1$, $3 \longrightarrow 1$, $4 \longrightarrow 1$, $5 \longrightarrow 1$, $3 \longrightarrow 2$.

Spectroscopy is the study of how light interacts with matter. In this lab you will be using two spectroscopic techniques that evaluate light in the visible spectrum. These techniques do not build on each other so you may learn them in any order.

Visible Emission Spectroscopy

1. In this portion of the lab you will examine the light emitted by various light sources using a Vernier fiber optic cable. The instructor and SIT will help you with the software.

2. Plug the SpectroVisPlus into the Computer and insert the fiber optic into the cuvette holder.

3. Open the LoggerPro software, click on Experiment, and choose Change Units → Spectometer 1 → Intensity.

4. Light sources have been set up with red, yellow, and blue light; evaluate the emission spectra of each of these and Export As csv to the Program folder.

5. Use the fiber optic cable to measure the spectra of the hydrogen and helium lamps.

6. Set up and light a Bunsen burner.

7. The first partner will make a loop of nichrome wire and heat it in the flame until hot. After you dip the hot wire into a dish of sodium chloride, salt will adhere to the wire. Now return the wire to the flame. Meanwhile, the second partner will use the fiber optic cable to obtain the spectrum of the sodium light.

8. Have the second partner briefly hold a piece of copper wire in the flame while the first partner obtains the spectrum of the copper light. (Note that copper melts quickly, so don't leave the wire in the flame too long.)

Absorbance Spectrophotometry

1. Plug the spectrophotometer into the LabQuest unit or computer. If using a computer open the LoggerPro software.

2. Fill four small beakers approximately halfway full of water.

3. To three of the four beakers add one drop of food dye: red, yellow, and blue. In the fourth beaker, you may either make a color of your choice using the first three dyes or else use a prepared dye that is some mix of the three primary colors (green, orange, etc.).

4. Make sure the Labquest/LoggerPro software is set up for Absorbance units. Blank the spectrophotometer using a cuvette of distilled water and the 'Calibrate' function on the Vernier unit or in the Experiment tab in LoggerPro.

5. Fill one of the cuvettes with a dye mixture, tap it gently to dislodge any air bubbles, and wipe off fingerprints. Place it in the spectrophotometer and measure its absorbance spectrum. If the dye is too concentrated (you'll know this because the spectrum will appear to be "cut off"), you may need to add more water to the beaker. Save the spectrum on your LabQuest or to the Program folder if you are connected to a computer.

6. Continue to take spectra for each of the other dyes. To avoid contamination, "rinse" the cuvette with the solution: fill the cuvette with the new dye; empty the dye into the waste; then refill the cuvette with the new dye.

7. Take the spectra of the commercial drinks (Koolaid, Powerade, etc.) and save these to the LabQuest.

8. If you did not directly connect to a computer, use a USB drive to save the LabQuest data to your computer.

Lab Write-up

<u>For this lab write-up, you will be doing a combined results and discussion section (which you will see in some peer-reviewed journal articles).</u>

<u>Do the following:</u>

- Use Excel to graph the spectrum of the hydrogen light. Use the Rydberg equation to figure out which transitions each line corresponds to. For example, 2→1, 3→1, 3→ 2, etc. Are some of the lines stronger than others? You probably did not observe the 5→1 transition. Why do you think it is not visible?
- Use Excel to graph the spectrum of the helium light. Although there isn't an equation like the Balmer equation for helium, speculate on what transitions the observed lines correspond to, and explain your reasoning.
- Use Excel to graph the emission spectra for each light color (blue, yellow, red) and the absorption spectra from the three dyes of the same color. What does the difference between the two tell you about the difference between absorption and emission?
- Use Excel to graph the spectrum of your "mixed" dye and compare it to the colors that were mixed to get it. (For example, if you had an orange solution, compare it to red and yellow.) Explain your observations.
- What dyes do you think were added to the commercial drinks that you analyzed? Support your hypothesis with spectral data.