Exploring Color: Introduction to Spectroscopy

Spectroscopy is the study of energy levels and the transitions between them. For humans, the transition of electrons between appropriately spaced energy levels gives rise to the visible spectrum of color. Because color is relatively easy for us to observe and light is relatively easy to quantify, there can be a wealth of knowledge in exploring both the qualitative and quantitative aspects of color.

Safety Notes**:** The colored solutions supplied in lab this week are all food-safe dyes dissolved in water. The guidelines given for the colored solutions you brought to lab should mean that all of those solutions are quite safe as well; however, many cleaning products can have strong odors or corrosive properties, so appropriate caution should still be exercised.

I. ***Qualitative Analysis of Color*****:**
The color of light that we perceive is determined by the wavelengths of the radiation (light) that we observe. Visible light has wavelengths from around 400nm to 700nm. Make a list of which visible color corresponds to what wavelength range. (A textbook or web search will be useful here…)
How many red light waves can fit in the 1.00cm cuvettes you will be using in lab? Yellow light waves? Purple light waves?

II. There are 3 colored solutions supplied in lab: red, yellow, and blue. Record a full spectrum of each of these solutions. For each colored solution, record the information noted in the example table below; *you do not have to print these spectra*.

Observed Color:	Wavelength Range(s) of Maximum Absorbance	Color(s) of Light Corresponding to the Wavelength Range(s) of Maximum Absorbance	Wavelength Range(s) of Minimum Absorbance (Maximum Transmittance)	Color(s) of Light Corresponding to the Wavelength Range(s) of Minimum Absorbance (Maximum Transmittance)

Is there a relationship between the ***observed color*** of the solution and the ***color of light*** being absorbed and/or transmitted in your spectra? Are the absorbed and transmitted colors related?

III. Using the red, yellow and blue stock solutions, prepare 10.mL each of green, purple, and orange solutions. Record a full spectrum of each of these solutions. For each mixed-color solution you prepare and measure, record the same information as above in a new table; *you do not have to print these spectra*.
Is there a relationship between the ***observed color*** of the solution and the ***color of light*** being absorbed and/or transmitted in your spectra? Are the absorbed and transmitted colors related?

IV. ***Quantitative Analysis of Color*****:**
Get 25mL of your favorite single-color (red, yellow, blue) stock solution from above. You will be preparing 4 diluted solutions from this stock solution using a 10.mL graduated cylinder. For the first diluted solution, dilute 8.0mL of the stock solution to 10.0mL and pour it into a large test tube. You may need to pour the solution back and forth a couple times to ensure that it is thoroughly mixed. Prepare three additional diluted solutions using 6.0mL, 4.0mL, and 2.0mL of the stock solution and diluting each to a total volume of 10.0mL. Record a full spectrum of each of these diluted solutions. For this part of the experiment, it may be helpful to click “Stop” and then “Collect” between samples so all 4 spectra are on the screen at the same time. For each spectrum, choose 3 wavelengths that have relatively high absorbance values and record the absorbance; *you do not have to print these spectra*. The 3 wavelengths you choose should all be at least 20nm apart and have to be the same wavelengths for all 4 spectra.

What are the similarities and differences between the 4 spectra of your diluted solutions? How do these spectra compare to the spectrum of your original undiluted stock solution in the previous part?

For each wavelength you chose, prepare a plot of Absorbance vs. Concentration. These series of points can all be on a single graph, but the data for each wavelength must be a separate data series.

Describe any trends you notice in your data. How could these trends be used in a quantitative analysis of a colored sample? Are the trends at different wavelengths related?

V. *What color are the samples you brought to lab?*

Record the full spectrum of each of the colored solutions that you brought to lab. If the maximum absorbance is higher than ~1.0, dilute your sample(s) until the maximum absorbance is ~1.0 or lower. ***<u>These spectra must be saved and included with your hand-in assignment.</u>*** Be sure to clean up your samples properly.

What do the spectra of your sample tell you about the dye(s) used to give your sample its color?