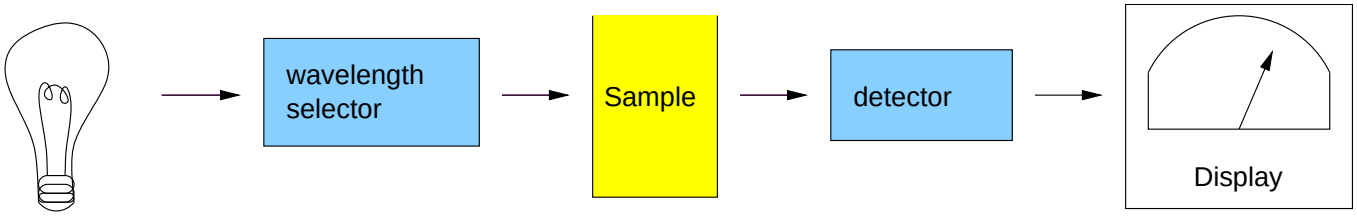
Honors 203/Chemistry 110
Laboratory 1 - Light and the Electromagnetic Spectrum

Experiment 1: Light and Color: An Introduction to Visible Spectroscopy

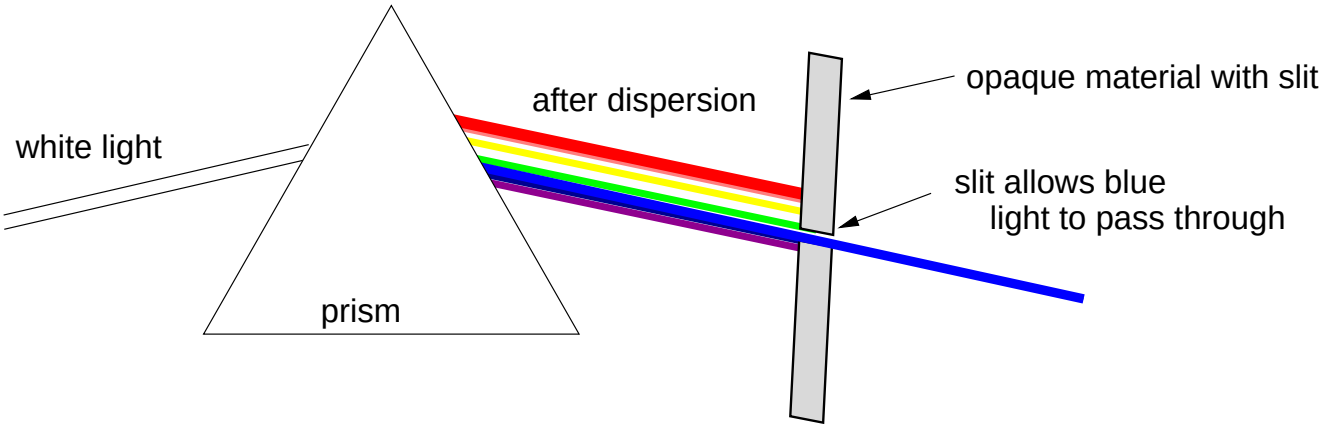
Spectroscopy is the study of the interaction of light with matter. In this experiment, we will be using a visible spectrophotometer, which allows us to measure how visible light interacts with many different substances. In particular, colored substances absorb visible light, and visible spectroscopy allows us to quantify the amount of light absorbed. Visible spectroscopy can give us useful information about the structure and properties of colored substances. More inportantly for our purposes, it can also tell us the concentrations of colored substances. Thus, if we can turn a species of interest into something colored, we can determine its concentration. In this laboratory meeting, we will familiarize ourselves with the visible spectrum and the components of a spectrophotometer.

A general scheme for the components of a spectrophotometer is below.



The first thing a spectrophotometer needs is a light source. A tungsten lamp emits light across the entire visible spectrum and is commonly used in spectrophotometers.

We often want to explore how a substance responds to a particular wavelength of light. A colored substance will interact with different wavelengths (different colors) of light differently. For example, a red substance may be very good at absorbing green light ($\lambda \approx 530\ nm$), but absorb red light ($\lambda \approx 650\ nm$) very poorly. So, we need a way to separate the wavelength of interest from the rest of the white light from the tungsten lamp. A component called a wavelength selector is used to to accomplish this. A wavelength selector selects just one narrow wavelength region out of the entire spectrum. These wavelength selectors are more technically called monochromator. A monochromator includes something that disperses the various wavelengths of light. One such device is the familiar glass prism. White light enters the prism and is dispersed, or spread out, into its various colors. A particular wavelength can then be selected by moving around an optical slit. Another common dispersion device is a grating - a piece of metal or glass with microscopic groves etched into it.



Next, the light beam passes through the sample. Some of the light may be absorbed, some may be reflected or scattered, while the rest passes through. The light transmitted is measured by a detector. The readings from the detector are processed and displayed for the user.

Because light passing through a sample can be scattered or reflected as well as absorbed, the amount of light transmitted through the sample is influenced by these factors as well. We will focus on the details of thes measurements in the next experiment. Today we will focus on the monochrometer or wavelength selector.

Experimental - Part A: Exploring the Visible Spectrum Using a Monochromator

1. Your instructor or the teaching assistant will explain how to use the spectrophotometer.
2. Take a piece of chalk 0.5 inches long and wear down one end such that a 45 degree angle remains. Place the chalk in a test tube in and put the tube in the spectrophotometer. The angled side should be pointing up.
3. Turn the wavelength selector dial to 450 nm. Look down into the test tube. Do you see a colored band of light on the chalk? If you can't, try raising, lowering or turning the test tube until you can see the band. Record the color of the light you see in the chart below, along with the wavelength.
4. Investigate the region from approximately 400 to 700 nm by varying the wavelength selector knob in 25 nm increments. Record each color in the chart its corresponding wavelength(s).
5. Explore the limits of your vision - how far can you turn the wavelength knob before you can no longer detect the light? Record both an upper and lower wavelength. (Each person should do this separately.)

Color	**Wavelength(s)**

Limits of vision (mine): upper: _____ lower: _____

Limits of vision (lab partner's): upper: _____ lower: _____

Experimental - Part B: Exploring the Visible Spectrum and Light Sources Using a Spectroscope

For this part of the experiment, we will be using hand-held spectroscopes. The instructor or TA will demonstrate how to use the spectroscope. For each light source indicate the color and appearance with the naked eye and using the spectroscope (1) indicate if the source is discrete or continuous (2) describe the spectrum of the light source and (3) list the wavelengths (for discrete sources) or wavelength range (for continuous sources) of the source.

- Sunlight:

- Fluorescent Light:

- Incandescent Light:

- LED:

- Halogen lamp:

- Candle flame:

Post Lab Questions

Please answer the following questions below:.

1. Consult your results from the experiment with the spectrophotometer and the chalk. Given your results, are the wavelength ranges associated with each color the same width? If not, which range is the widest? Narrowest?

2. Based on the prelab information given to you by the instructor and TA, hich color light has the longest wavelenght? The higher frequency? The greater Energy?

3. Compare your "limit of vision" with at least three other people in the class. What conclusions can you draw?

4. Which light sources produce a continuous spectrum? Which ones emit light in discrete wavelength ranges?

5. The TA or instructor will demonstrate the excitation of atoms via a flame. Do you think the atoms emit a discrete or continuous spectrum?