

## Spectroscopy of Cherry Kool-Aid Using the SpecPhone

### Materials

- Cherry Kool-Aid packets
- Deionized (DI) water
- 100mL volumetric flask
- 5mL pipettes or a graduated cylinder
- Test tubes
- Cuvettes
- Beakers
- Lint free tissue (Kim wipes)
- Spec20
- SpecPhone apparatus
- White light source (i.e. desk lamp)
- iPhone 5

### Introduction

This protocol uses a serial dilution of Cherry Kool-Aid to examine the relationship between absorbance and solution concentration. When illuminated with white light, colored samples absorb light of certain wavelengths while light of other wavelengths is transmitted through solution. When measured at the same wavelength, higher concentration solutions have higher absorbance values. Patterns like these can be observed by analyzing the resulting absorbance spectra when your dilutions are subjected to white light. The accuracy of these absorbance measurements will depend on the quality of the preparation protocol. Errors in mass or volumes will propagate to the absorbance measurement. By carefully conducting the following dilution preparation steps, the resulting absorbance spectra will accurately reflect those of the solutions.

### Sample Preparation

1. Weigh out approximately 0.2g of Kool-Aid powder.
2. Dissolve Kool-Aid in 100mL DI water in a volumetric flask.
  - a. This solution is called the “stock solution”.
3. Begin serial dilutions:
  - a. Solution A: Transfer 10mL of the stock solution to a labeled beaker or other labeled glassware for storage until use.
  - b. Solution B: Carefully using a 5mL pipette or a graduated cylinder, transfer 5mL of thoroughly mixed Solution A and 5mL of DI water to another labeled beaker.
  - c. Solutions C-G: Transfer 5mL of the previous sample and 5mL of DI water into labeled beakers, mixing before each transfer.
4. The total volume of each sample will be 5mL.

## Evaluation by Spec20

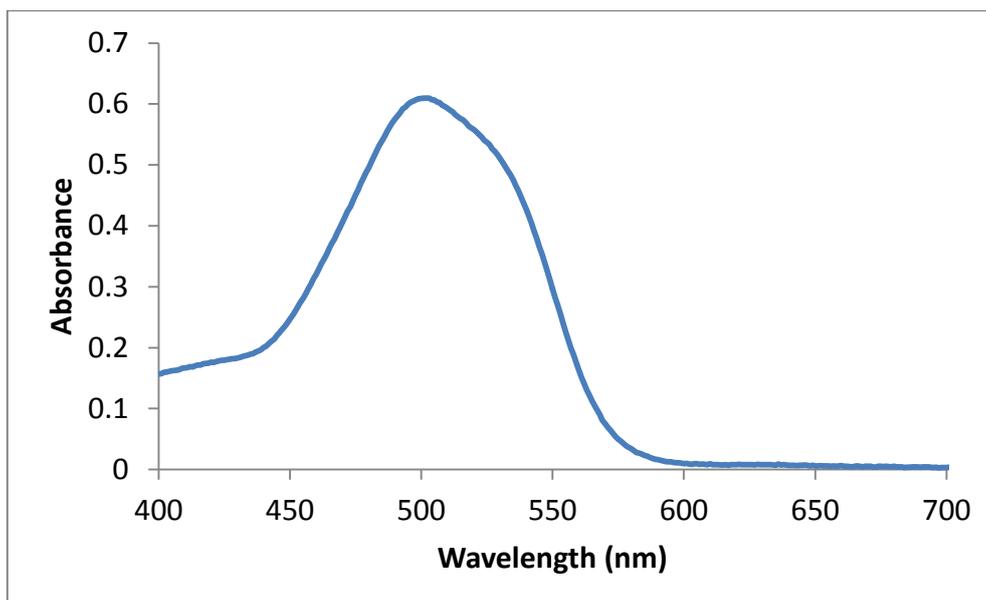
A spectrophotometer illuminates a sample with white light and measures the resulting absorbance and transmittance values without altering the solution. The amount of light that passes through the sample is measured as % transmittance (%T) and different solutions have different %T values. As less light passes through a solution, it displays a lower intensity ( $I$ ) than the intensity of light through a blank sample ( $I_0$ ). Absorbance ( $A$ ) is the value of light that instead of passing through solution is absorbed by solution and is defined by:

$$A = -\log\left(\frac{I}{I_0}\right)$$

The Beer-Lambert relationship states that the concentration of a sample is directly proportional to its absorbance values and is stated as:

$$A = \epsilon l C$$

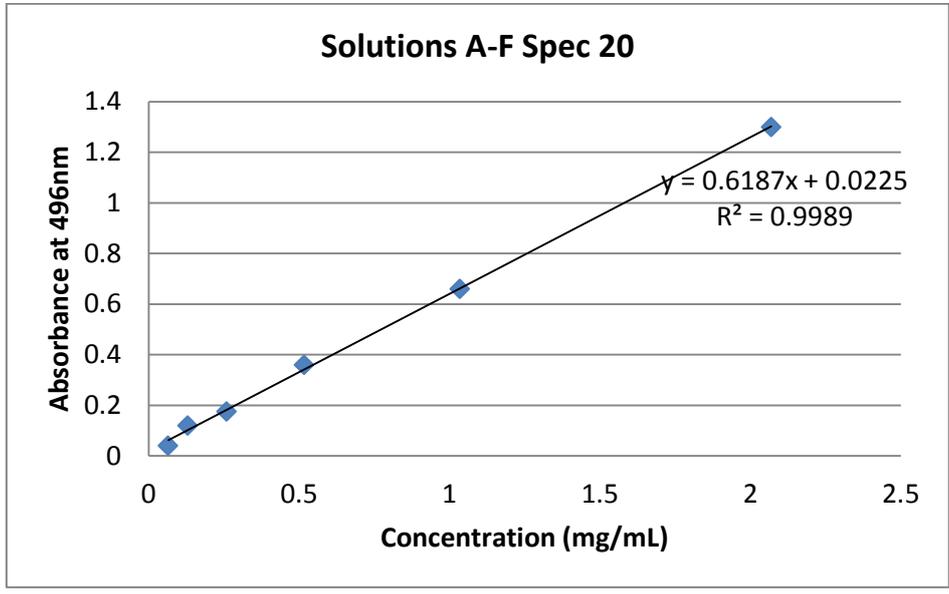
Where  $\epsilon$  is the molar absorptivity of the molecule (constant) and  $l$  is the length of sample. Absorbance and transmission are complements of each other. If a solution absorbs a particular color it will transmit the colors that are not absorbed. Therefore, a red Cherry Kool-Aid solution is absorbing light in the green region of the visible light spectrum. It turns out that wavelength most strongly absorbed by the cherry Kool-Aid is 496 nm (see plot below). This is the wavelength at which we will measure absorbance with the Spec 20.



### Procedure

1. Fill 1 test tube approximately halfway with DI water; this will be the blank.
2. Fill 7 other labeled tubes approximately halfway with the prepared solutions A-G, making sure there are not bubbles.
3. Blank the spectrophotometer using the cuvette filled with DI water: wipe the test tube with a Kim wipe and place in the Spec20, fix the dial to read 0, and remove from the spectrometer.
4. Wipe the test tube of Sample A with a Kim wipe and place sample A into the Spec20. Record the absorbance value displayed on the meter.

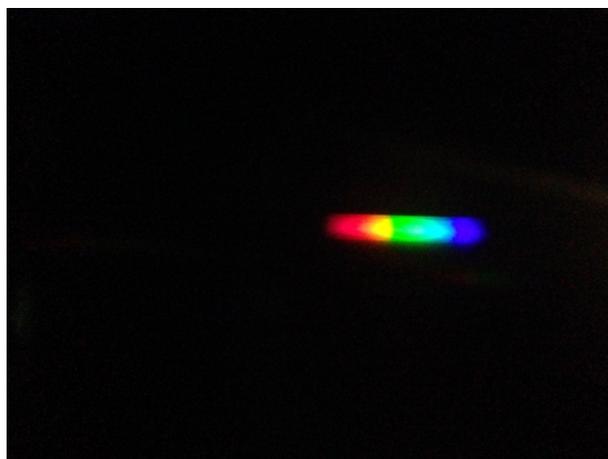
- Repeat for solutions B-G, using the cuvette with DI water to blank the Spec20 before each reading.
- Plotting these recorded absorbance values versus the concentration of the corresponding solution conveys the linear Beer-Lambert relationship



## Evaluation by SpecPhone

The SpecPhone has been designed to allow you to view the absorbance spectra to further your understanding of the properties of light and colored solutions. The light source will shine white light into the apparatus and through a slit to direct it through the sample. The transmitted light will reflect off a mirror and pass through a diffraction grating. When the iPhone is in place and the camera app is open, the diffracted light spectrum can be seen.

1. Set up the SpecPhone apparatus: tape in place on flat surface to minimize interference and fix iPhone into place on the apparatus.
2. Align the light source to project into the apparatus so that the spectrum is even across the slit. Adjust the light intensity so that none of the camera pixels are saturated using the light dimmer if available or by just moving the light source away from the SpecPhone. Once the light source is optimally aligned, do not adjust between sample readings. Minimize additional sources such as overhead lighting.



3. Fill one cuvette with DI water to be used as a blank and fill 7 other cuvettes with samples A-G.
4. Wipe the cuvette with a Kim wipe and place the blank into the cuvette holder on the SpecPhone, cover with lid to minimize outside interference from stray light.
5. Using the camera on the iPhone, take a photo of the resulting spectrum.
6. Replace the blank cuvette with the cuvette of sample A and take a photo of the resulting spectrum.
7. Repeat for samples B-G keeping the samples in order of the concentrations so that it is known which image pertains to which solution.