

NAME \_\_\_\_\_ SECTION \_\_\_\_\_

PARTNERS \_\_\_\_\_ DATE \_\_\_\_\_

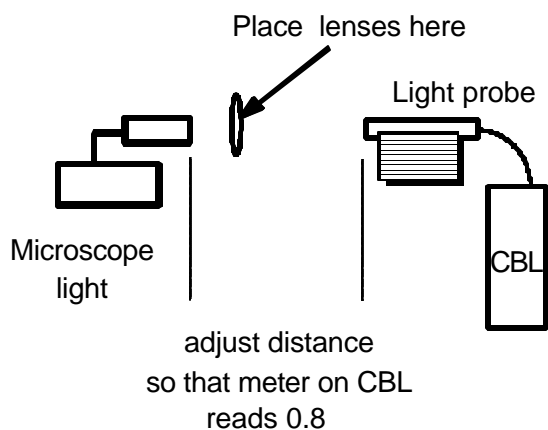
### PERFORMANCE TASK # 3

You must work in teams of three or four (ask instructor) and will turn in ONE report. Answer all questions. Write in complete sentences. You must hand this activity in before leaving today. This activity is worth 50 points.

#### Part I. Qualitative Relationships (20 pts)

In a previous lab, you considered the relationship between the appearance of a tea solution and the concentration of the solute - the tea. You were able to tell by the intensity of the color of the tea which was the weakest and which was the strongest sample. Could you tell the difference in a dark room? No. Light passes through the solutions and it is the *light* that affects your eyes and stimulates your brain and your brain then makes the decision about the strength or concentration of the tea based on the color. Your eyes and your brain may be able to distinguish among weak, strong, and medium strengths of colored solutions, but you many have difficulty distinguishing solutions that are either 10% or 15% solute as the intensity of color may be hard or impossible to distinguish.

Today you will substitute a technological device (for your eyes)- a light probe and probe meter to measure the light going through various materials.



Obtain a light probe, CBL, and light source. Connect the probe to the CBL according to your instructor's directions. Turn the light source on and shine it onto the probe. Align the light and the probe so that the light shines directly into the probe in a straight line. Hit the **ON/HALT** button and then the **MODE** button. Adjust the position of the probe so that the meter reading is close to 0.80. The meter reading is the intensity of the light beam.

**DO NOT CHANGE** the space between the light source and probe for the remaining activity, as it will influence the intensity of light hitting the probe and hence, the meter reading. It may be convenient to mark the probe and light source positions with masking tape. Record the initial meter reading.

meter reading \_\_\_\_\_

Block the light beam with your hand to verify that the CBL responds rapidly by dropping radically in value. If it does not, check with your instructor before proceeding.

1. Place a sunglass lens directly in front of the light source. What happens? Why?

meter reading \_\_\_\_\_

Is there any light going through the lens? How do you know?

Add another lens, so that you have two in place. What happens? Why?

meter reading \_\_\_\_\_

Add a third lens and note what happens.

meter reading \_\_\_\_\_

State a relationship between the amount of light absorbed by the lens material and thickness in words and as a mathematical equation.

As more light is absorbed, what happens to the amount of light transmitted (light that goes through the material)?

State a relationship between absorption and transmission in words and as a mathematical equation.

*Now let's explore how light behaves when passing through a solution.*

2. Place a bottle with only distilled water in it between the light source and the probe. What happens?

meter reading \_\_\_\_\_

Remove the distilled water bottle and place a bottle of green solution (a green solid dissolved in distilled water) between the light source and the probe. What happens? Why?

meter reading \_\_\_\_\_

If you were adjusting or standardizing a machine (to make sure the settings were all correct) before taking a light measurement through a colored solution, why might you begin by placing a sample of distilled water between the light and the probe?

Place a second bottle of green-colored solution in the light beam, in line with the first bottle. What happened? Why?

meter reading \_\_\_\_\_

State the relationship between pathlength, which is the distance light traveled through the solution, and the amount of light absorbed in words and mathematically.

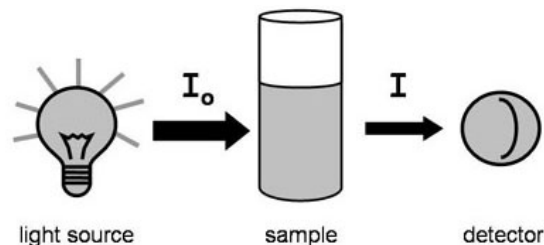
Obtain the three bottles of blue solution of varying concentrations. See if you can line them up in order from least concentrated to most concentrated just by looking at them. Place them one at a time at the same spot between the light source and the probe. Was your estimation correct? \_\_\_\_\_

How do you know if it was correct or incorrect?

State a relationship between concentration of a solution and the amount of light absorbed by that solution in words and as a mathematical equation.

## Part II. Quantitative Relationships: Using a Spectrophotometer (25 pts)

The spectrophotometer is an electronic device that can take the place of your eye and the light source with probes and the light detector. A simplified diagram of what is inside the Spec-20 looks like this:



$I_0$  is the intensity of the light hitting the sample. An added feature of the spectrophotometer is that it can select a particular wavelength of light to shine on the sample. When we used the light probes, we were using white light which contains all the wavelengths in the visible spectrum.

$I$  is the intensity of the light being transmitted through the sample, the amount of light that does not get absorbed by the sample. The amount of light absorbed by the sample will be different depending on the wavelength of light hitting the sample.

The spectrometer displays **absorbance**, which is  $-\log I/I_0$ . **Absorbance is directly proportional to the concentration of the sample.**

The samples are inserted into the machine through a covered slot on the top. The glass used to hold the sample is special optical glass (the light must go straight through the sample). It is important that these tubes be clean and free of finger prints as any marks on the tube can block some of the light and change your results. There is lens paper available for cleaning the tubes.

Only hold the tubes near the top.

**Overall Task:** There are five tubes of a given solution with the concentration in moles/liter marked on the tubes. There are also three tubes of same solution of unknown concentration.

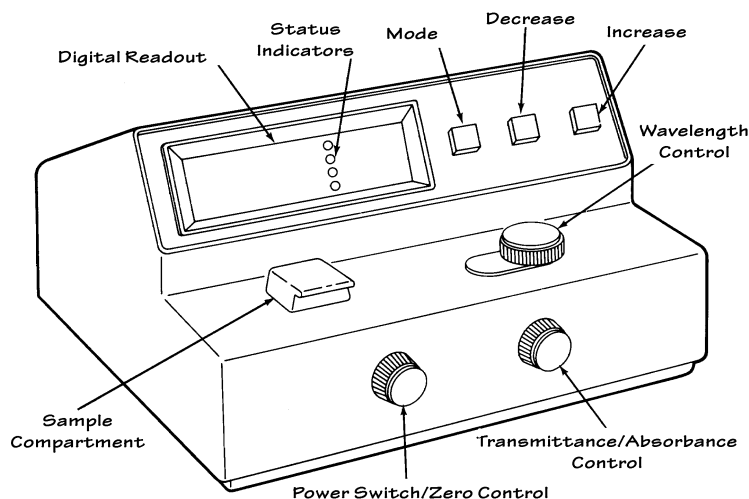
- ▶ You must find the absorbances of the five known solutions.
- ▶ Plot the absorbance versus concentration and generate the curve that describes the relationship. Answer all questions relating to the data and graph.
- ▶ Find the absorbances of the three unknown solutions from the resulting curve. (25 cr)

Since the absorbance will be different with different wavelength settings, you must first determine **which wavelength gives the maximum absorbance. When this is determined, set the spectrometer to this wavelength for the rest of the task.**

Before you start anything, locate nine sample tubes (in a rack) that contain: distilled water; 5 different concentrations of known solution; and, 3 solutions of unknown concentration (with code letters). You are now ready to begin by standardizing the spectrophotometer.

## Standardizing and Using the Spectronic 20D

Below is a schematic diagram of the Spectronic 20D.



NOTES:

- \*There are special sample tubes that must be used for the Spec 20. Be sure that any samples placed in the instrument are in these special test tubes.
- \*The sample chamber must be closed when making any measurement or adjustment.
- \*Be sure the power is on and that the instrument has had 15 minutes to warm up.

1. Set the wavelength for the measurement using the wavelength control knob on the top right of the instrument.
2. Be sure the mode is set to transmittance using the mode button.
3. With the sample chamber empty, turn the zero control (left knob on lower front) until the readout is 0% transmittance. This will correct for any stray light that may be in the chamber.
4. Change the mode to absorbance and place a tube with distilled water (or your blank) into the sample chamber. Adjust the absorbance control (right knob on lower front) until it reads 0 absorbance. This provides a control for absorbance due to the glass, water, or reagents.
5. Place your sample in the sample chamber, close the cover, and read the absorbance value from the digital readout.
6. If you are measuring the absorbance of more than one sample it is advisable to place the blank (may be distilled water) into the instrument and make any necessary adjustments between samples. If you change wavelengths YOU MUST readjust the Spec 20 with the blank before making an absorbance reading.

Set the wavelength on 400 nm to begin the standardization for today's activity.

### Determining the Wavelength of Maximum Absorbance ( $\lambda_{\max}$ )

1. Standardize the Spec-20 using the directions above. Select one of the solutions of known concentration (not the most dilute or most concentrated). Place it in the sample chamber and record the absorbance.
2. Remove the sample tube and change the wavelength to 420 nm. Repeat the standardization procedure. Place the same sample in the instrument and record the absorbance. Repeat this procedure changing the wavelength by 20 nm until you reach 600 nm.

Wavelength	Absorbance
400 nm	
420 nm	
440 nm	
460 nm	
480 nm	
500 nm	
520 nm	
540 nm	
560 nm	
580 nm	
600 nm	

The **wavelength** that produced the highest absorbance was \_\_\_\_\_ nm.

3. Set the instrument to this maximum wavelength for the rest of the procedure.

### Measuring Standards and Unknowns

1. After setting the instrument to the wavelength that produced the highest absorbance, restandardize machine and collect absorbance data for the five known samples. (Even though you did one sample before it will be more accurate if you collect all data once you have set the wavelength to the maximum). Record distilled water as an additional sample. Consider it a data point. If you correctly standardized the Spec 20, the absorbance for distilled water will be 0.

Concentration of Sample (from tube label) moles/liter (M)	Absorbance
Distilled Water 0.000M	

2. Measure the absorbance reading for the three unknown samples.

Sample Code for Unknowns	Absorbance

3. Before you plot the data, answer the following questions.

Which is the independent variable? (circle one): concentration      absorbance  
Explain why.

Therefore, which variable should be plotted on the x-axis?

What type of mathematical relationship should you expect to see when you plot the data?  
Explain why.

**Plot the data on the graph paper provided by the instructor. Draw the calibration curve that best fits the data points. Make sure the curve goes through the origin (0,0). Be sure to attach your graph to the task when you turn it in.**

Which type of relationship does the data show (circle one)?      linear      non-linear

4. Enter the data on the graphing calculator or using Excel and determine the regression equation and  $r^2$  value. If you use Excel, be sure that under Chart, Add Trendline, Options, you select the box "Set Intercept = 0". Write the regression equation in terms of the lab variables and  $r^2$  below.

regression equation \_\_\_\_\_  $r^2$  \_\_\_\_\_

5. Determine the absorbance for each unknown along the curve by interpolation on the graph and from the regression equation.

Sample code for Unknown	Absorbance of Unknown	Concentration of Unknown from Graph	Concentration of Unknown from Regression Equation

### PART III

(5 cr)

1. Summarize, in paragraph form, what you did, and what you found in **both** parts of this performance task.