

Name: _____

Lab Instructor: _____

PREPARATION FOR CHEMISTRY LAB: MEASUREMENT (Part II)

1. If 6.8% of the people in a room have red hair, how many redheads are in the room if it contains 250 people?
2. What units would a chemist use to report the volume and density of a rubber stopper?
3. What is the density, in g/cm^3 , of something that has a mass of 8.24 pounds and a volume of 39.7 in^3 ?
($454 \text{ g} = 1 \text{ lb}$; $2.54 \text{ cm} = 1 \text{ in}$)
4. How many mL of pure food dye are needed to prepare 258.0 mL of a 18.7% (by volume) food dye solution? You may assume that volumes are additive.
5. Using Figure 8-2 in your textbook, determine the color of the light associated with each of the four wavelengths of light used by the LabQuest colorimeter. Enter these below as well as in the table where it also occurs in the lab. ($1 \text{ nm} = 10^{-9} \text{ m}$)

| | 430 nm | 470 nm | 565 nm | 635 nm |
|-------|--------|--------|--------|--------|
| Color | | | | |

MEASUREMENT: PART II

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INTRODUCTION

Read and/or review Chapter 1, Sections 3-2.1 and 3-2.2, Figure 8-2, Appendix A-6, and the Making it Real section on Page 223 in your textbook.

The first part of this week's lab deals with the measurement of volume.

The second part of the experiment deals with density. Density can be obtained from mass and volume measurements. The density of a liquid can also be determined with a hydrometer. A hydrometer is a graduated, weighted tube that sinks in a liquid to a point determined by the density of the liquid.

In the final part of the experiment, you will make solutions of a food dye and check their concentrations with a LabQuest Colorimeter. A colorimeter is an instrument that is used to determine the concentration of a colored solution by analyzing the intensity of the color. The LabQuest Colorimeter measures the amount of light transmitted (T) through the solution. However, when determining concentration, the amount of light that is absorbed (A) by the solution is plotted as a function of concentration. The two are related by the equation:

$$A = \log \frac{1}{T}$$

You will not need to do the calculation that converts transmittance to absorbance. The LabQuest will do it for you.

The absorbance of a solution is proportional to its concentration. For example, a 50% solution will absorb half as much light as a 100% solution (in this experiment the food dye), a 25% solution will absorb one quarter as much light as a 100% solution, etc. For this experiment, all concentrations will be expressed as a percent by volume $\left[\% v/v = \left(\frac{\text{mL dye}}{\text{total mL solution}} \right) \times 100\% \right]$. This means that 100.0 mL of a 20.0% dye solution contains 20.0 mL dye and 80.0 mL water and 30.00 mL of a 15.0% dye solution contains 4.50 mL of dye and 25.50 mL of water.

PROCEDURE

A final reminder:

Throughout the semester, make written observations as you proceed with the experiments. Be aware that there may be questions at the end of the lab that depend on observations.

There is a general understanding about reading a value from a graduated device. Estimate the value to one decimal place more than the level of graduation. For example, when reading a thermometer graduated in degrees, estimate to tenths of a degree. For a ruler that is graduated in cm, estimate to mm.

VOLUME

Fill a wash bottle with deionized water (DI water) from the large container in the lab. You will need your smallest graduated beaker, a 25 mL graduated cylinder, a 10 mL pipet, and a 25 mL buret. Examine the imprinting or engraving on each of these volume measuring devices. If the measuring device is marked TD (or has a double band) it means that the device is made *to deliver* the stated volume and you should not force the release of any liquid that remains in the device. TC means *to contain* the stated volume and all contents in the device are included in the stated volume.

Determine the mass of 10 mL of DI water by dispensing measured volumes of water (using each glass device) into a tared plastic cup. Repeat this at least three times and then calculate an average mass.

DENSITY

Learn how to use a hydrometer. Use a hydrometer to find the density of water and the density of a salt solution. Pipet 10 mL of the same salt solution into a tared plastic dish or tray. Determine its mass. Calculate the density of the salt solution.

A CALIBRATION CURVE

Often, solutions of low concentration are best made by diluting a more concentrated solution (a stock solution) of the same reagent. You and your partner will prepare four solutions with assigned concentrations. To get your unknown assignment, go to the Laboratory page of our course web site that is set up on your lab computer. Enter in the appropriate information and print out the assigned concentrations.

For convenience, you will use a stock solution of a food dye in water to which we have assigned a concentration of 100.0%. The true concentration doesn't matter in this experiment. It is assumed that volumes are additive.

1. The LabQuest Colorimeter needs to be powered for about 5 minutes before using so do this step before preparing your solutions. Plug the LabQuest Colorimeter into one of the LabQuest sensor ports and turn on the instrument.
2. Obtain some of the stock solution in a large test tube (TT).
3. Calculate the volume of stock solution that you must use to prepare 10.0 mL of each assigned solution. For example, to prepare 10.0 mL of a 15% solution, you need 1.5 mL of the stock solution since 15% of 10.0 is 1.5 ($0.15 \times 10.0 = 1.5$).
4. Beginning with the most dilute solution (lowest concentration) assigned, pipet the calculated volume of stock solution into a 10 mL volumetric flask. Dilute to volume with water. Mix well and transfer into a labeled TT. Rinse the volumetric flask well and use it to make the next dilute solution. Repeat until all assigned solutions have been prepared.
5. Determine the wavelength of maximum absorbance.
 - a) Be sure one of the four green wavelength lights is on.
 - b) Only touch the ridged faces of the cuvette, never touch the clear faces. Rinse and fill one cuvette (a cuvette should be filled so that it is about $\frac{3}{4}$ full) with the blank. In this lab the blank is deionized water. Rinse and fill (about $\frac{3}{4}$ full) a second cuvette with the most dilute of the prepared solutions. **Gently blot** (don't scratch the sides of the cuvette) off any drips on the outside of the cuvette with a Kimwipe.

- c) Place the cuvette containing the blank in the colorimeter. Place cuvettes in the colorimeter so that one of the clear faces is toward the arrow at the top of the cuvette slot. Close the lid.
 - d) Using the front panel arrow keys on the colorimeter choose a wavelength. Press the **CAL** button on the front of the colorimeter. Release it when the red LED begins to flash. When the red light stops flashing, the colorimeter is calibrated and ready to use.
 - e) Place the cuvette containing the solution to be tested (not the blank) in the colorimeter. Wait for the reading to stabilize and record the absorbance of the solution at that wavelength in your lab report.
 - f) Repeat steps c, d, and e until the absorbance is recorded for each of the four available wavelengths.
 - g) The wavelength that gave the maximum absorbance is the one that will be used for the remainder of the experiment.
6. Calibrate the colorimeter. Place the cuvette containing the blank in the colorimeter set at the wavelength of maximum absorbance. Press the **CAL** button on the front of the colorimeter. Release it when the red LED begins to flash. When the red light stops flashing, the colorimeter is calibrated and ready to use.
 7. Using the stylus (never touch the LabQuest screen with your fingers): touch Sensors, Data Collection, choose Events with Entry in the Mode box. Highlight the word Event in the Name: box and replace it with Concentration. Put percent in the Units box. OK.
 8. Place the cuvette containing the prepared solution in the colorimeter. Touch the begin data collection button (triangle) on the bottom left of the screen. When the absorbance reading stabilizes, touch the **KEEP** button located just to the right of the data collection button. Don't touch the stop data collection button (square). Type in the concentration of the solution that is in the cuvette (don't include units). OK.
 9. Working in order of most dilute to most concentrated of the remaining solutions, rinse and then fill a cuvette with the solution that will be analyzed. Place the cuvette in the colorimeter. When the absorbance reading stabilizes, touch the **KEEP** button, and enter the concentration of the analyzed solution. Repeat until the absorbance of all solutions has been determined.
 10. When the absorbance of all four solutions has been determined, touch the stop data collection button (square) located on the bottom left of the screen and **save** your data.
 11. The graph (Absorbance vs. Concentration) generated should be linear and is called a calibration curve. If the four points fall on a straight line, your data are 100% correlated.

Use the LabQuest to determine the equation of the line. Check the Corr: readout on the screen. In order to get full credit on this portion of the lab, your data must be 99% correlated or better (Corr: on the screen reads 0.9900 or greater). There is no penalty for attempts to improve your results by making new dilutions and repeating the experiment as long as time remains in the lab period for you to repeat the experiment, complete the report sheet, and answer your post-lab questions.

12. Print out the calibration curve for each lab partner. Each lab report must have a LabQuest generated printout of the calibration curve attached to it.

The printout must show the graph, axis labels, the information needed to generate the equation (slope and intercept) for the line, and the correlation reading. This should all be automatically on the printout. On the footnote enter in a graph title and the names of all lab partners. Be sure that the date box is checked.

13. Delete all files before returning your LabQuest to Lab Services.

DATA AND ANALYSIS SHEET: MEASUREMENT (Part II)

Name: _____

Date _____ Lab Partner _____

VOLUME

Balance # _____ Room Temperature _____

| Measuring Device | Mass of 10.0 mL DI water | | | Average Mass |
|--------------------|--------------------------|---|---|--------------|
| | 1 | 2 | 3 | |
| Beaker | | | | |
| Cylinder | | | | |
| Pipet (Mohr) | | | | |
| Pipet (volumetric) | | | | |
| Buret | | | | |

DENSITY

Deionized water (DI water):

Which measuring device should most accurately dispense 10.0 mL of DI water? Why?

Volume of DI water dispensed: _____

Mass (average) of 10.0 mL of DI water using this measuring device: _____

Calculated density of DI water: _____

Density of DI water by hydrometer: _____

Salt Solution:

Identity of salt solution: _____

Mass of 10.0 mL of pipeted salt solution: _____

Calculated density of salt solution: _____

Density of salt solution using a hydrometer: _____

CALIBRATION CURVE

Concentration of stock dye solution: **100%**

Print out and attach the sheet of assigned concentrations (printed in the lab from the lab page of the web site) of dilute dye solutions. Each student must have a copy of the assigned concentrations attached.

Assigned concentrations of dilute dye solutions: _____ , _____ , _____ , _____

Calculate the volume of the stock solution needed to prepare 10.0 mL of each assigned solution (**show your work below**):

Enter the color associated with each of the following wavelengths into the table below and the absorbance from Step 5 at each wavelength.

| | 430 nm | 470 nm | 565 nm | 635 nm |
|------------|--------|--------|--------|--------|
| Color | | | | |
| Absorbance | | | | |

Wavelength of maximum absorbance: _____

Equation of line for the calibration curve:

Correlation: _____

Attach the calibration curve. The printout must show the graph, the information needed to generate the equation for the line, and the correlation reading. Be sure that the graph title and the names of all lab partners are entered in the footnote and that the date box is checked.

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QUESTIONS ABOUT THIS LAB: MEASUREMENT (PART II)

1. The density of a liquid is 0.462 g/mL. What is the mass, in grams, of 8.16 deciliters of the liquid?
2. A student pours a quart of water into a graduated cylinder and finds that the water occupies a volume of 0.928 L.

Using this information, how many mL are in a quart?

Using this information, how many liters of liquid would be in 33.9 gallons of the liquid?

3. The absorbance of a 100% solution (pure liquid) is 0.843. What would be the absorbance of a 41.6% solution assuming the absorbance of a 0% solution is 0?
4. Compare the density of the NaCl solution as measured by a hydrometer and as calculated from mass and volume data. Discuss why the values might be different.
5. The color of a solution is the color of the light that is transmitted or passes through the solution.
 - a) What was the color of your assigned solution? _____
 - b) You ran your experiment using the wavelength of maximum absorbance. What was this wavelength?
 - c) Compare the color of your solution with the colors associated with the four wavelengths of light available on the colorimeter. Why did the wavelength you used for your experiment give the greatest absorbance?