Experiment 1

Scientific Measurements and Errors: Determination of Density of Glass

Purposes

This experiment has three purposes:

1. Making a number of measurements, including length, weight, and liquid volume determinations.
2. Determining variations of measurements of the same items by multiple students.
3. Optional exercises include determining standard deviations (variabilities) of measurements, and determining density of glass by measurement of mass and volume of shards.

Equipment and Supplies

1. Plastic scale or ruler with numbered inch and millimeter scales.
2. Plastic protractor calibrated in 1-degree increments as a minimum. Increments should be numbered.
3. Electronic or triple beam balance with readability to at least 0.01 g; readability to 1 mg would be better.
4. Glass transfer pipettes to deliver 10 mL.
5. Disposable aluminum (60 mm × 15 mm) or plastic weighing dishes able to contain 20 to 40 mL of liquid.
6. Glass graduated cylinders of 25- or 50-mL capacity graduated in 1-mL increments; graduations of 0.5 mL would be better.
7. Deionized or distilled water.
8. Assorted beakers: 100 mL, 25 mL, etc.
9. Glass shards from sides and bottom of a broken bottle; shards should be 1 cm × 1 cm in size.

10. Tape measures: 12-ft divided into numbered 1/16 in. increments; 25- or 50-ft divided i numbered 1/8 in. increments.

Procedure

Part I: Measurements

Employing a scale and protractor, measure the sides of the structure shown in Figure 1.1 to nearest 0.5 mm. Measure angles A and B to the nearest 0.5 degree. Record the data and the identify number or letters of your scale and protractor below. (Your instructor may instruct you to rec the data on a blackboard or on the class data sheet on page 7.)

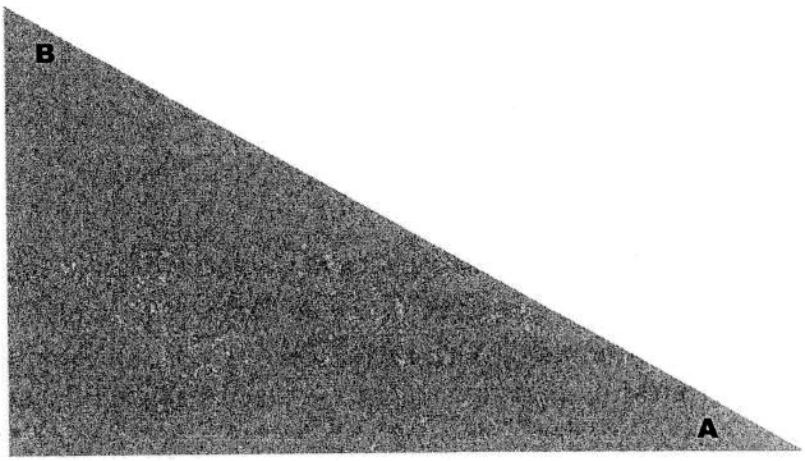

FIGURE 1.1

Calculate the average of two of your classmates' measurements recorded on the blackboard or data sheet using the following equation:

$$\bar{x} = \Sigma x_i / n$$

where $\bar{x}$ = average, x_i = total sum of all data points, and n = number of data points.

Employing the 12-ft tape, measure an object designated by your instructor (e.g., a desk or blackboard) to the nearest 1/16 in. and record the dimensions below. Employing a longer tape, measure a larger area designated by the instructor. Record the dimensions. Calculate the average of the measurements made by all students in your class.

Optional Exercise: Variability and Standard Deviation

Determine the variability of these measurements by calculating the standard deviation of each measurement by using the following equation:

$$S = [\Sigma (x - x_i)_j^2 / n - 1]^{1/2}$$

Your instructor will explain how to perform the calculation manually and the meaning of standa deviation. Other equations that calculate standard deviation are valid and may be used. You m use a scientific calculator.

Part II: Weighing and Volume Calculations

Obtain an item or items from the instructor and weigh it or them to the nearest division readal on your balance. Record the weights and note brief descriptions of the items and their weights the data sheet. Calculate the class average weight for each item.

Obtain a weighing boat and weigh it. Pipette two or three 10-mL measurements of water into boat. Reweigh the boat. Determine the weight of the water by subtracting the weight of the bc Record your data below.

Assuming water has a density of 1 g/mL, calculate the volume of water transferred.

$$\text{Density } (\rho) = (\text{mass in g/volume in mL}) \qquad (1$$

Calculate percent error.

$$\text{Percent error} = \text{mL of transferred water} - \text{volume from pipetted water/mL of transferred water} \times 100 \quad (1.2)$$

Calculate the average mL transferred by each 10 mL pipette operation. Record the percent error and average mL below.

Optional Exercise: Calculating Density of Glass

Obtain, clean, and dry a few pieces of broken bottle glass. Obtain a graduated cylinder (Figure 1.2 shows a 25-mL cylinder with an English/metric ruler) and fill to approximately half its volume with water. Record the volume to the nearest 0.1 mL. Weigh one or more pieces of glass totaling 3 to 6 g to the highest readability. Carefully place (do not splash) the glass pieces into the graduate. Record the new volume. Determine the volume change ($V_{end} - V_{start}$), which is the volume of the glass (V_{glass}). Read the meniscus (Figure 1.2). Record your data below.

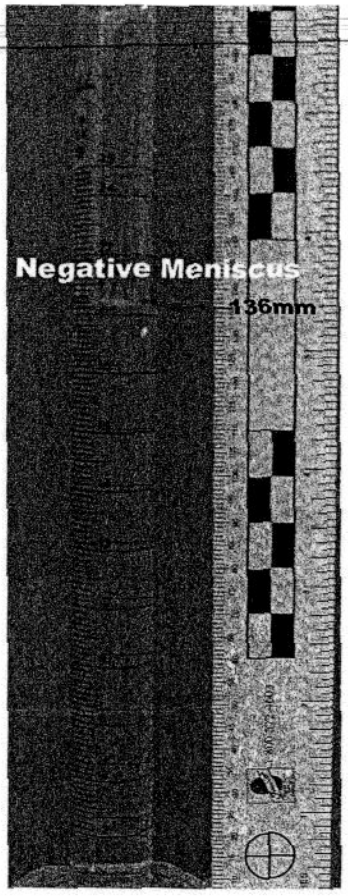

FIGURE 1.2

Calculate the density of the glass:

$$\rho = mg/VmL$$

Data Form

Use the data form on the next page to record the figures from your work and your classmates' as per your instructor's directions. Transfer the appropriate data to the report section that fo the data sheet.

EXPERIMENT 1 DATA SHEET

NAME_____ DATE_____

Enter measurements in the proper spaces. Note equipment identification in parentheses (e.g., for Side 1: 22.5 mm (B)). Enter measurement/weight data on the lines next to your student number. Enter your classmates' data on the lines next to their numbers.

Student #	Side 1	Side 2	A	B	Desk	Floor	Weights			Eq. 1.3*	Eq. 1.4**
							A	B	C		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

* Equation 1.3
Weight in grams of pipetted water/No. of mL of pipetted water.

** Equation 1.4
Density of glass = mass in grams/volume in mL.

Report

Document the following in your report:

1. Length and angle measurements

2. Class averages and standard deviations

3. Weight determinations

4. Average volume of water transferred

5. Percent error

6. Density of glass

7. Class averages for weights of objects A through C

8. Percent error for water weight, transfer experiment

9. Short narrative of what you learned from these exercises