Measurement Challenge

Introduction

Take the measurement challenge! Accurately estimate the length, width, and height of a small plastic block and calculate the block's volume. Then predict the mass of the block—without a balance—by using the block's known density.

Concepts

- Measurement
- Estimations and certainty
- Significant figures
- Volume, mass and density

Materials

Calculator

Metric ruler, 0.1 cm markings

Background

All measurements involve some degree of error or estimation. The measurements are based on the fact that the human eye can estimate to one-tenth of the smallest mark shown on a measuring instrument. Therefore, a ruler with only 1-cm increments shown can provide measurements that are estimated to 0.1 cm, while a ruler with 0.1-cm increments shown can provide measurements that are estimated to 0.01 cm.

In this activity, the first goal is to determine the volume of a plastic block. The volume of any regular solid can be calculated using Equation 1. The length, width, and height must be estimated using a reliable measuring instrument.

$$\text{Volume} = \text{Length} \times \text{Width} \times \text{Height} \qquad \textit{Equation 1}$$

Once the solid's volume has been calculated, the mass can be predicted using the known density value of the solid. To predict the mass, rearrange the density equation shown in Equation 2 to solve for mass, as shown in Equation 3.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \qquad \textit{Equation 2}$$

$$\text{Mass} = \text{Volume} \times \text{Density} \qquad \textit{Equation 3}$$

Success of this laboratory activity depends on the ability to take accurate measurements to make valid estimations and to apply the rules for significant figures in mass and volume (and density) calculations.

Safety Precautions

All activities in this lab are considered nonhazardous. Please follow all laboratory safety guidelines.

Pre-Lab Activity — *Length and Area*

Procedure

Reading the Metric Ruler

1. Obtain a metric ruler. Take a close look at the markings on the ruler. What is the distance between the smallest markings on the ruler?
2. It is generally accepted that scientific measurements can be estimated to one-tenth of the smallest mark on the instrument. Therefore, if a ruler has a marking every 1 cm, a person can reliably estimate to the nearest 0.1 cm. Likewise, if a ruler has a marking every 0.1 cm, a person can reliably estimate to the nearest 0.01 cm. With the metric ruler provided by your instructor, what is the most reliable estimation that can possibly be made?

3 Use the metric ruler to measure the length of the following line segments. Be sure to estimate to the hundredths place for each measurement. Be sure to include the appropriate units for length. Underline the digit that you estimated while measuring.

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Measure These Line Segments	*Measurement*
a.	_____
b.	_____
c.	_____

Applying Significant Figures in Calculations

4. Use the metric ruler to measure the length and width of each of the rectangles below. Be sure to estimate to the proper decimal place for each measurement and to include units with each measurement. Underline the digit that you estimated while measuring.

Rectangle #1	**Rectangle #2**
Length: _____	***Length:*** _____
Width: _____	***Width:*** _____

5. To calculate the area of the rectangles, multiply the length by the width. Round the area values to the proper number of significant figures. Be sure to include the appropriate units for area.

Area of Rectangle #1:_____	***Area of Rectangle #2:***_____

Experiment #1 — *Density Calculation*

Materials (for each lab group)

- Balance
- Calculator
- Metric ruler, 0.1 cm markings
- Plastic blocks, 3

Procedure

1. Obtain a plastic block from your teacher. Record the block number and color of the block in the table below.
2. Use the laboratory balance to measure the mass of the block. Record the mass in the data table.
3. Use the metric ruler to measure the dimensions of the block. Record these values in the data table.
4. Calculate the volume of the block using Equation 1 from the background information. Round the answer to the proper number of significant figures. Record the volume in the data table. Be sure to include the appropriate units.
5. Calculate the density of the plastic block using Equation 2 from the background information. Record the density in the data table. Be sure to include the appropriate units.
6. Repeat steps 1–5 for two additional blocks, being sure to obtain blocks of different colors. Record all data in the table below.
7. Check with your instructor to determine the accuracy of your measurements and calculations.

Data Table

Block Number			
Color of Block			
Mass (g)			
Length (cm)			
Width (cm)			
Height (cm)			
Volume (cm^3)			
Density (g/cm^3)			