Density Identification Set

P1-1110

INSTRUCTIONAL GUIDE

Contents

Density Identification Set

- 12 different samples
- Storage block

Required for this lab:

- **Scale accurate to 0.1g (02-7500)**
- **Calculator (08-0700)**
- **Graduated cylinder (25mL works best)**
- Long, unfolded paper clip or similar wire

Background

Density can be defined simply as mass per volume. Units for density are most often found in terms of *g/mL* or *g/cm³*. One important relationship to understand before completing this lab is that $1cm^3 = 1mL$. Another concept to consider that is rather tacitly explored in this lab is the difference between mass and weight. Weight is the result of a mass being acted upon by gravity. The reason we can weigh a sample and use the measurement as mass is because gravity is a constant and will be uniform for every measurement, thus cancelling out.

Some logistical notes: using a **25 ml Polypropylene Cylinder (06-3041)** is much safer than glass since students will be dropping rather dense materials into the cylinder to measure volume. Also, a long, unfolded paper clip or some other type of wire can be used to fully submerge the buoyant samples. Students may have to be reminded how to measure volumes in a graduated cylinder from the bottom of the meniscus.

Introduction

Why don't objects that have the same dimensions always have the same weight?

Density!

Density is the way we measure the amount of matter in a certain space or volume. This is written as a very simple mathematical equation:

$$density = mass/volume$$

This gives density units of *m/v*. In this lab we will be measuring mass in terms of grams (g) and volume in milliliters (mL), so density can be written in units of *g/mL*. But it doesn't stop there! mL is a useful unit for liquids since it's very difficult to measure the dimensions of a liquid with a ruler. But with solids,

which don't fill the container they're in, cubic centimeters (cm^3) is a much more useful unit.
In this lab, we will be using a liquid (water) to measure the volume of a solid. This means our units will need to convert from mL to cm^3. Lucky for us, the conversion is a simple one.

$$1\,mL = 1\,cm^3$$

We need to do this conversion because our initial measurements will be from the displacement of liquid inside a graduated cylinder. *The volume of water moved by placing a solid into the water is equal to the volume of the solid.*

Set-Up

First, set up two tables with column headings like the ones below.

Sample	Mass (g)	Volume before (mL)	Volume after (mL)	Sample volume (mL)	Density (g/cm^3)

In the first column, write the name of the sample. For the first part of the lab, the samples will be numbered 1-12 since all of the samples are different materials and different volumes. Once you have determined each sample's mass and volume, you can identify the sample.

Data Collection

Determine the mass of each sample with a scale accurate to 0.1g. Tare the balance before taking measurements. Record the measurement of every sample in the column labeled, "mass." *Remember to always record the units of measurement!*

Determining the volume of each sample is a little more involved. Follow these steps for each sample:

1. Fill the graduated cylinder with a little bit of water (10-15mL) and record the measurement to the nearest 0.1mL. Write this number in the "Volume before" column.
2. *Carefully* place the sample in the graduated cylinder. If water splashes out, remove the sample and take a new measurement for the starting volume. It helps to hold the graduated cylinder at an angle and carefully slide the sample into the water.
3. Record the new volume of the water to the nearest 0.1mL and record this number in the "Volume after" column.

Once data have been gathered for every sample, it's time for the fun part.

Data Analysis

Since we already have the mass of each sample, we need to find the volume of each sample. To do this, subtract the numbers in the *Volume before* column from the numbers in the *Volume after* column and you have the volume of the sample. Record this new value in the "Sample volume" column.

Here's a sample table for finding the density of titanium:

Sample	Mass (g)	Volume before (mL)	Volume after (mL)	Sample volume (mL)	Density (g/cm^3)
1	13.8	9.0	12.1	3.1	

Once a volume calculation has been done for every sample, density can be easily determined. Remember the density equation? All we need to do is divide the mass of each sample by its volume and we have density!

Density of each sample should fill in the last column of your table.

Sample	Mass (g)	Volume before (mL)	Volume after (mL)	Sample volume (mL)	Density (g/cm^3)
1	13.8	9.0	12.1	3.1	**4.5**

Now compare your answers to the known values for each material and try to identify each unknown. If there are differences between your experimental results and the actual density values, explain possible sources for error.

Density ID							
Sample	Chemical name	mass (g)	volume before (mL)	volume after (mL)	sample volume (mL)	Density (g/cm^3)	Lit. Density (g/cm^3)
Rubber	--	9.7	13.0	19.3	6.3	1.5	1.1
Copper	--	44.8	11.7	16.8	5.1	8.8	8.79
Brass	--	44.8	11.5	16.9	5.4	8.3	8.48
lucite (acrylic)	Poly(methyl methacrylate)	6.3	13.5	18.9	5.4	1.2	1.18
Glass	--	11.6	9.0	14.2	5.2	2.2	2.1-2.8
Aluminum	--	18.5	11.7	18.5	6.8	2.7	2.699
teflon	Polytetrafluro-ethylene	10.5	10.0	17.5	7.5	1.4	1.1-1.45
Nylon	--	7.9	13.0	20.0	7.0	1.1	1.15
Delrin	Poly oxymethylene	9.9	11.0	18.0	7.0	1.4	1.41
PVC	polyvinyl chloride	16.0	9.0	16.5	7.5	2.1	2.2
Oak	--	4.7	11.5	19.0	7.5	0.6	0.74
Pine	--	3.6	12.0	19.3	7.3	0.5	0.35-0.5

Note: The three white plastics may be difficult to identify. The translucent white plastic is nylon, the bright opaque one is teflon, and the third is PVC.