Aluminum Density Determination Set

P1-1100

INSTRUCTIONAL GUIDE

Contents

Aluminum Density Determination Set:

- 12 Aluminum rods
- Storage block

Required for this lab:

- Scale accurate to 0.1 g (02-7000)
- Calculator (08-0700)
- Graduated cylinder (25 mL works best: 06-3044)

Background

Density can be defined simply as mass per volume. Units for density are most often found in terms of *g/mL* or *g/cm*^{3}. One important relationship to understand before completing this lab is that 1 cm^3 = 1 mL. 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 polypropylene graduated cylinder is much safer than glass since students will be dropping rather dense materials into the cylinder to measure volume.

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. However with solids, which do not fill the container they are 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.

$$1mL = 1cm^3$$

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 a table 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. The samples will be numbered 1-12 since all of the samples are the same material but different volumes.

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**

Answer key:

Uniform Density		Aluminum (Al) Actual density:		2.699 g/mL	
Sample	mass (g)	volume before (mL)	volume after (mL)	sample volume (mL)	Density (g/cm^3)
1	13.9	11.5	16.6	5.1	2.725
2	14.7	8.5	14.0	5.5	2.673
3	15.6	11.4	17.0	5.6	2.786
4	16.6	8.1	14.3	6.2	2.677
5	17.3	11.6	18.0	6.4	2.703
6	18.3	11.9	18.6	6.7	2.731
7	19.0	11.6	18.7	7.1	2.676
8	19.9	11.6	19.0	7.4	2.689
9	20.6	11.7	19.4	7.7	2.675
10	21.3	11.5	19.5	8.0	2.663
11	22.5	11.2	19.5	8.3	2.711
12	23.4	10.7	19.4	8.7	2.690
				Average	2.700
				StdDev	0.035

Data Analysis

Density Identification Set (P1-1110) Students identify each of 12 different samples by determining their density. Each cylinder varies in size (volume) and density, but has the same diameter of 1/2”.

Assorted Density Block Set (P1-1010) Equal volume set. One cube each of aluminum, brass, copper, iron, lead, and zinc. 20mm cubes in storage case.

Density Rod Set (P1-1020) Use this discrepant event to test students' understanding of density, buoyancy, and thermal expansion!

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