Module 1; Density of Solids

Directions: Answer all questions in this text document. Submit your document to be graded. You may print out this document, then hand write and scan. OR you can word process directly on this document.

Introduction

Density is the mass of an object per unit volume. It is calculated by dividing the mass of an object by its volume:

$$\text{density (d)} = \frac{\text{mass (m)}}{\text{volume (V)}}$$

A large density means that lots of material is packed into a small space. The metals known as “heavy metals” are actually just more dense than other metals. For example, the density of gold at 25°C is 19.32 g/cm^3, while that of copper is 8.96 g/cm^3. In other words, a 1 cm^3 block of gold (one of the heavy metals) weighs 19.32 g, while a 1 cm^3 block of copper weighs 8.96 g.

Every substance has a characteristic density, so density can be used to determine identify substances or establish purity. Density is constant at a given temperature; hence, the need to report temperature when you report density. Some densities are given in Table 2.1.

Density can also be used to determine measurements that are too difficult to make directly. For example, in order to measure the thickness of a thin piece of foil, you need a special instrument. However, you can also determine thickness by measuring the mass, length, and width of the foil. Using the mass of the foil and the density, you can determine the volume of the foil. V = mass /density. Then you can determine the thickness (height) since the volume, V = length x width x height. [And thus, height = V/(length X width)]

Pre-Laboratory Exercise

Complete the following exercises paying attention to units and significant figures. All answers should have three significant figures (sig. figs.) since the data provided has three sig. figs. Use one of the following formulas in each case:

D = M / V M = D X V V = M / D

1. If the mass of an unknown piece of metal is 58.0 grams and it occupies a volume of 12.9 mL, what is the density of the metal? As always when doing a calculation, first write down the formula and then plug in the numbers *with the units*. Write your answer with three sig. figs.
   Remember, Density of solids are given in g/cm^3 in table provided, so first you must convert volume unit ‘mL’ to ‘cm’ by using relationship learned in lecture in Module 1,i.e., 1cm3 =1 mL)

2. Using your answer in #1 and the information in the table below, identify the metal in question #1:

Densities of some common metals at 25°C

Metal	**Density (g/cm^3)**	**Metal**	**Density (g/cm^3)**
Magnesium	1.74	Nickel	8.91
Aluminum	2.70	Copper	8.95
Titanium	4.50	Silver	10.49
Zinc	7.14	Gold	19.32
Iron	7.87	Tungsten	19.3

3. A 105 g slab of metal is dropped into a cylinder which has 69.9 mL of water in it. The water goes up to 83.3 mL with the metal slab in it. What is the density of the metal? First calculate the volume considering the water displacement data provided. Then to solve for density: write down the formula and then plug in the numbers *with the units*. Write your answer with three sig. figs.
Remember, Density of solids are given in g/cm^3 in table provided , so first you must convert volume unit 'mL' to 'cm' by using relationship learned in lecture in Module 1,i.e., 1 mL = 1cm3)

4. Using your answer and the information in the table above, identify the metal:

5. If the slab of metal above was actually a cylinder with a 0.600 cm radius, how tall is the cylinder? To calculate this, consider the volume you calculated in the first part of #3. Since 1 mL=1cm^3, you can use the volume you calculated in #3 with cm^3 as its units so that units will cancel out correctly. Use the formula $V = \pi r^2 h$ which rearranges to $h = V / (\pi r^2)$. Round your final answer to three sig. figs. to match the measurements.

Density
Procedure and Data

Use the following link to access an online simulation. Be patient; it opens slowly. Also, you will need to use the latest version of chrome, Firefox, safari or edge. If you click on this link and see empty gray boxes labeled "introduction, compare and mystery", you will need to try a different browser. Copy and paste this link into the other browser. I suggest you use a split screen so that you can follow directions while running the experiment. Or print this document and hand write your answers; then scan and submit.

Simulation link: https://phet.colorado.edu/sims/html/density/latest/density_en.html

Part 1: Water Displacement to Measure Volume

1. Select the "**Mystery**" tile.
2. In the menu on the right, select **Set 2** Blocks.
3. Move blocks onto the scale (which is already set to zero for you) and determine the mass (place the block to center of balance). Record the mass using all digits provided by the scale.
4. Then one at a time, move them into the tank of water. Make sure the block is completely submerged and not floating to get the volume of the whole block. Record the volume of the water before and after adding the block. Use all the digits provided in the simulation. (Make sure you remove each block before measuring the next one.) Subtract to determine the volume of the block itself.
5. Calculate the density of the five blocks. Collect your data in the table below. (If you get 1 g/mL for the blocks, you probably did not submerge the block. Try again.)
6. Finally, select the "Density Table" tab in the simulator. Identify the material that makes up the blocks.

	Orange Block	Brown Block	Green Block	Pink Block	Purple Block
Mass of block in kg					
Volume of water in tank before block is added					
Volume of water in tank after block is submerged.					
Calculated Volume of block. (Show subtraction for first block. Keep same number of significant figures as measured volumes.)					
Calculated Density of block. (Show the calculation for the first block; Show the density formula, plug in the numbers with units, provide units on your final density.)					
Does the block float or sink?					
Identity of block					

Data Analysis: Consider all your data, what makes a block sink or float? Explain