

DETERMINING THE DENSITY OF LIQUIDS AND CONSTRUCTING A DENSITY COLUMN

An important physical property is density; defined as the mass of a sample divided by the volume it occupies (equation 1). The density of a liquid is usually reported as g/mL while the density of a solid is usually reported as g/cm^3 (note that $1\text{ mL} = 1\text{ cm}^3$).

$$(1) \quad \text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

To determine the density of a liquid, a known volume of the liquid is weighed. The mass of the sample is then divided by volume. Determining the density of solids is somewhat more complicated. Although the mass can be measured easily, the volume of the solid must be determined by displacement of a liquid (water).

Another method for determining the relative density of a solid is to use a density column. A density column can be made from liquids of different densities layered on one another. Density columns are useful for determining the relative density of plastics, powders, and small samples. Such columns in industrial use can determine density with a precision of + or - 0.0001 g/mL.

PROCEDURE:

Your instructor has provided a variety of labeled liquid substances of which you are to determine the density of each using the method described below. *Be sure to record these substances, your procedure, and data in your log book.* Once you have determined the density of each liquid, you will then construct a density column of 5-6 of the liquids which will provide a good range of densities. You will use your density column to determine the relative densities of small solid objects that will be gently dropped into this column. The solid objects will sink through liquids of lesser density, be suspended within liquids of the same density, and float on liquids of greater density. You will only be able to determine the range or relative density (i.e. greater than or less than; greater than X but less than Y).

In order to determine the accuracy of your results, you will take larger samples of the same solid objects and determine the density of each by the displacement method, compare your results and determine your percent error with known values.

Determining the Density of a Liquid

1. Weigh a 10 mL graduated cylinder. Record the mass in grams.
2. Place 10 mL of the liquid in the graduated cylinder. Record the volume of the liquid.
3. Weigh the graduated cylinder with the liquid in it. Record the mass in grams.
4. Subtract the mass of the empty cylinder from the mass of the cylinder containing the liquid to determine the mass of the liquid.
5. Apply equation 1 to determine the density of the liquid.
6. Pour the liquid into the waste receptacle provided by the instructor.
7. **Completely clean and dry out the graduated cylinder before you reuse it for any of the other liquids.**
8. Repeat the above steps for the other liquids.

Constructing the Column

1. Place equal volumes (10-20 mL) of the liquids you have selected in order from most to least dense.
2. Pour the densest liquid into a 100 mL graduated cylinder.
3. Gently pour the next densest liquid on top of the densest liquid. Pour the liquid slowly down the side of the cylinder. Do not pour so that the less dense liquid is splashed into or disturbs the liquid beneath it as you will not get good layered bands.
4. Repeat the above steps with the remaining liquids making sure that your least dense liquid is added last.
5. Sketch and label your results in your log book. Your density column should look somewhat like the diagram below.



Determining the Relative Density of Small Objects

1. Take a sample of each of the solids provided. Record.
2. Place one into your density column and observe where it stops sinking. Record by sketching its position in the layer in which it stopped. What is its relative density? Record.
3. Repeat for each of the remaining objects.
4. When you are finished, dispose of your waste in the receptacle provided by your instructor and thoroughly clear the equipment you used and put it away.

Determine the Density of Solid Objects by Displacement

1. Take a larger sample of each of the objects you placed in the density column.
2. Record the mass in grams for each and record this data.
3. Determine the volume in cm^3 for each by the displacement method and record this data.
4. Use equation 1 to determine the density of each and record.
5. Compare the density values of these objects you obtained by the two different methods. Record your observations.

Determining Percent Error

1. Determine your percent error for substances used by using the following formula and the accepted values provided by your instructor. Record all your calculations.
2. Percent Error = $\frac{\text{Accepted value} - \text{your obtained value}}{\text{Accepted value}} \times 100$

Questions

1. How did the densities of the solid objects compare using the density column and the displacement method?
2. Which method had a smaller percent error? Explain why you think one may have been more accurate than the other.
3. If you had a limited sample of the evidence found at a crime scene (a solid substance), which method would you choose to use and why?