Constructing a Density Column

An important physical property is density, defined as the mass of a sample divided by the volume it occupies (eq 1). The density of a liquid is usually reported as g/mL while the density of a solid is usually reported as g/cm³ (remember that 1 mL - 1 cm³).

$$density = \frac{mass}{volume} \qquad\qquad (1)$$

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 or some other indirect method.

Another method for determining the density of a solid is to use a density column. A density column can be made from liquids of different densities layer on one another or by mixing two liquids so a gradient is formed (with pure liquid A on top, pure liquid B on the bottom, and a changing amount of A and B in between). Density columns are useful for determining the density of plastics, powders, and small samples. Such columns in industrial use can determine density with a precision of ±0.0001 g/mL.

In this lab, a density column will be constructed using 4 different liquids. You will then drop objects into the liquid and determine the approximate density of the solid. The solid will sink through liquids of lesser density and float in liquids of greater density. You will not be able to determine the exact density, but you will know one or two limits to the density (greater than... or less than... or greater than x by less than y).

Procedure

You will be provided with vegetable oil, glycerol, water, and a saturated potassium bromide solution. You will determine the density of each of the four liquids and construct a density column.

Determining the Densities of the Liquids

(1) Weigh a 10 mL graduated cylinder. Record the mass.

(2) Place between 9 and 10 mL of the liquid in the graduated cylinder. Record the actual volume of the liquid.

(3) Weigh the graduated cylinder with the liquid in it. Record the weight.

(3) Subtract the mass of the empty cylinder from the mass of the cylinder containing the liquid to get the mass of the liquid.

(4) Apply equation 1 to determine the density of the liquid.

(5) Pour the liquid into a small beaker.

(6) Repeat for the other 3 liquids.

Constructing the Column

(1) Place the four liquids in order from most to least dense.

(2) Pour the most dense liquid into a 50 mL graduated cylinder.

(3) Pour the second most dense liquid on top of the most dense liquid. Pour the liquid slowly down the side of the cylinder. Do not pour so that the less dense liquid is splashed into the more dense liquid.

(4) Repeat step 3 for the third most dense and the least dense liquids.

Determining the Densities

(1) Take the solids available and place them one by one onto the top of the column and let them sink into the column. Draw a picture of the column and where the object remains after it stops sinking.

(2) Try to gently remove the objects with forceps.

(3) Repeat with the other object(s)

Liquid 4

Object

Liquid 3

Liquid 2

Liquid 1