Density of Glass Fragments

This experiment will allow you to become still more familiar with the metric system and, at the same time, determine the density of some glass samples. By this means you will attempt to establish the possibility of two glass fragments having a common origin.

The procedure in Experiment 6 is more commonly used to compare the density of two pieces of glass (scene and suspect) to show that they have a common origin. However, if only one piece of glass is available (scene or suspect), a density measurement might well provide some direction regarding what type of glass to look for in order to make a comparison. The important point, however, is that this technique is not limited to glass, and it is for this reason that this experiment is included. For example, one of the authors (Meloan) was involved in a trial in which the density of the rubber covering of a truck power-steering hose was the deciding factor. The density was determined using the technique described below, with the exception that a correction for the supporting wire was made.

The density of objects is determined by measurement of the mass, volume, or loss of weight in water of the object, and then applying a mathematical relationship to arrive at a value for this property. The method for the determination of volume used in this exercise is based on a physics relationship known as **Archimedes's principle.** This principle states that an object immersed in a fluid displaces a volume of fluid equal to its volume. For example, a 1 cm cube of glass placed in water will "push aside" 1 cubic centimeter of water. Another statement of this principle is: **an object immersed in a fluid (water in this instance) is buoyed up by a force equal to the weight of the displaced fluid.** In other words, if we **assume** that a 1 cm cube of glass weighs about 2.5 g while a 1 cm cube of water weighs 1 g, when the glass cube is placed in water it will weigh 2.5 g minus 1 g, or 1.5 g. Since 1 cubic centimeter of water is equal to 1 g of water, we now have the volume of the glass.

CRIME SCENE

During a burglary, a glass object has fallen off of a table onto the floor. The floor has no carpet covering and the glass object has shattered. If the burglar was near the object when it shattered, perhaps small fragments of glass can be found lodged in his clothing, especially in the lower trouser leg areas or the soles of his shoes. A suspect is apprehended and his living quarters searched. A pair of trousers is found which does indeed have glass fragments in the fibers, and a few fragments of glass are removed from one pair of his shoes. Density determinations are to be done and an attempt made to link the pieces of glass in the trousers and shoes to the fragment collected at the scene. This, along with other physical evidence obtained, may serve to place the suspect at the scene of the burglary.

Glass from various sources, such as windowpanes, automobile headlights, bottles, and plate glass doors, all have slightly different densities. This makes it possible in some cases to help place a suspect at the scene of the crime if they have broken a glass object and if small fragments have become lodged in their clothing. The density of the glass may be only very slightly different, but careful analysis will make these differences apparent.

Forensic laboratories can analyze glass fragments as small as 1 mm wide by 3 or 4 mm long and determine their densities. Actually, for pieces that small, we suggest the procedures set forth in Experiment 7. This exercise will deal with much larger pieces of glass in order that the measuring device will require less technique. The principles are the same in both cases however, and technique is still very important. Table 3-1 gives the density for several types of glass and similar materials.

EQUIPMENT

1 Balance (±0.01 g or better) with support rack provision
8 Beakers, 250 mL (for knowns and unknowns)
1 pr Goggles, safety
1 pr Scissors
Small pieces of various types of glass
1 m String

METHOD

Obtain glass fragments from both the beakers labeled "unknown" and those labeled "known." The unknowns are numbered 1, 2, 3, and 4. The knowns are lettered A, B, C, and D. The object is to determine whether the numbered and lettered fragments have similar densities.

PART A: DENSITY MEASUREMENTS—TRIPLE BEAM BALANCE

1. Obtain a balance, a piece of string, and a 250 mL beaker.
2. Tie the string around the glass fragment, and suspend it from the pan support hook.
3. Weigh the glass fragment in air to the nearest 0.01 g, and record this value.

TABLE 3–1 Densities of Various Common Materials (g/cm^3)

Material	Density	Material	Density
Amber	1.06–1.11	Mica	2.6–3.2
Celluloid	1.4	Quartz	2.65
Bone	1.7–2.0	Beryl	2.69–2.70
Porcelain	2.3–2.5	Glass, flint	2.9–5.0
Glass, window	2.47–2.56	Diamond	3.01–3.52
Glass, headlight	2.47–2.63		

4. Place a 250 mL beaker nearly filled with water (tap water is fine) on the beaker support, and suspend the glass in the water. Adjust the glass height in the water so that it does not touch the walls of the beaker.

   Weigh the glass fragment suspended in water to the nearest 0.01 g, and record this value.

5. The density of the glass fragment is determined by the following relationship:

$$\text{Density of object} = \frac{\text{mass of object in the air}}{\text{loss of mass of object in water}}$$

6. Repeat this process for the other glass fragments you have chosen to work with.
7. Record the density of each fragment on the data sheet.

PART B: DENSITY MEASUREMENTS—ELECTRONIC BALANCE

When using an electronic balance, the glass sample is suspended over the balance rather than suspended from the balance as is the case with the triple beam balance. Consequently, the use of the electronic balance requires a small change in the calculations for this experiment.

1. Obtain a balance, a piece of fine string, and a 250 mL beaker.
2. Add a suspension support to the pan and zero the balance.
3. Weigh the glass fragment in air to the nearest 0.001 g and record this value.
4. Add the beaker support as in Step 4 of the triple beam experiment.
5. Place a 250 mL beaker nearly filled with water on the beaker support, tie the string around the glass fragment and suspend the glass in the water. Adjust the glass height in the water so that it does not touch the walls of the glass beaker.
6. Weigh the glass fragment suspended in water to the nearest 0.001 g and record this value. Convert this value to milliliters. (Recall that 1g of water has a volume of 1 mL.) This is the volume of the glass sample.
7. The density of the glass fragment is determined by the following relationship:

$$\text{Density of object} = \frac{\text{mass of object in the air (g)}}{\text{volume of the glass sample (mL)}}$$

8. Repeat this process for the other glass fragments you have chosen to work with.
9. Record the density of each fragment on the data sheet.

PART C: CLEANUP, CALCULATIONS, AND QUESTIONS

1. Return all materials to the place where you obtained them.
2. Be sure that everything is clean and dry.
3. Complete the determination by following the instructions in the data sheet and reporting your results.

4. Density of the glass fragments

A	1
B	2
C	3
D	4

Part B: Cleanup, Calculations, and Questions

1. Based on the results of this experiment, match the fragments lettered A, B, C, and D with fragments 1, 2, 3, and 4.

   A matches ________

   B matches ________

   C matches ________

   D matches ________

2. How certain are you that the fragments you have matched do have a common origin? Give your reasons.