Experiment 4

Aim

To determine the density of a non-porous solid (insoluble and denser than water) by using a spring balance and a measuring cylinder.

Theory

The density (ρ) of a given substance is the mass of its unit volume. For a substance of mass M and volume V, the density is given by the ratio:

$$\rho = \frac{M}{V}$$

Materials Required

A spring balance (0 – 500 g), measuring cylinder (100 or 200 mL), a piece of thread, water, and a small piece of experimental solid.

Procedure

1. Find the range and least count of the spring balance and the measuring cylinder (Explained in Experiment 3).
2. For finding the mass of the given solid, suspend it from the spring balance with the help of thread (Fig. 4.1). Note the reading of the spring balance.

3. Place the measuring cylinder on a horizontal surface like a table-top and fill it with water, say, up to the half of its range. Note the reading of the water meniscus as the *initial* volume.
4. Tie the given solid with a thread and lower it slowly in water in the measuring cylinder. What happens to the level of water in the cylinder? Let the solid to immerse completely in the water. Next, note the reading of water meniscus as the final volume (Fig. 4.2).

Fig. 4.1 : *Measuring of mass of solid using spring balance*

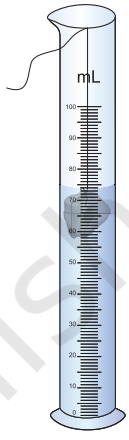

Fig. 4.2 : *Determination of volume of a non-porous solid*

5. Take out the solid from the measuring cylinder. Dry it and repeat the activity by taking different initial volume of water in the cylinder. In each case note the initial and final readings of water meniscus.

Observations and Calculations

(i) Range of spring balance = _____ g
(ii) Least count of the spring balance = _____ g
(iii) Range of the measuring cylinder = _____ mL
(iv) Least count of the measuring cylinder = _____ mL
(v) Mass (*M*) of the given solid = _____ g
(vi) Volume (*V*) of the given solid–

Sl. No.	Initial Reading of water meniscus, V_1	Final Reading water meniscus, V_2	Volume of Solid $V = V_2 - V_1$	Mean value of volume of solids
	(mL)	(mL)	(mL)	V (mL)
1.				
2.				
3.				
4.				

Density of the solid ($\rho = \frac{M}{V}$) = _____ g/mL= _____ kg/m^3

(1 kg/m^3 = 0.001g/mL.)

Results and Discussion

The density (ρ) of the given solid is _____ kg/m^3.
Find the standard value of density of the given solid and compare it with the observed result (see Appendix – B).

Precautions

- The measuring cylinder must be dry and clean.
- The measuring cylinder should be placed on a horizontal surface while reading the water meniscus.
- While observing the liquid meniscus the line-of-sight should be at the same horizontal level as that of the lowest meniscus.
- There should be no air bubble in the liquid while measuring its volume.
- The spring balance should be held verical while taking measurement.
- Before making use of spring balance it must be ensured that its pointer is at the zero mark.
- The readings of the spring balance should be noted only when its pointer comes to rest.
- The solid piece should be wiped with a dry cloth before repeating the activity.

Sources of Error

- The graduations marked on the measuring cylinder and on spring balance may not be uniform and evenly spaced.
- A spring balance is primarily meant for measuring the weight (force) of an object. However in laboratories, a spring balance is often used to measure the mass of an object. It should be remembered that the calibration of spring balance scale is done at the place of its manufacture and depends on the value of acceleration due to gravity (g) at that place. Therefore, if a spring balance is used to measure mass at any other place where the value of g is different, an error in the measurement of mass will appear.

Note for the Teacher

- The method describe above is useful for small solid objects. In case of larger objects, one should make use of an overflow can rather than measuring cylinder.
- This method is only useful for non-porous and water insoluble solid objects. Therefore it is advised to use a metallic solid.
- Some error in the measurement of volume of the solid piece may occur even if it has meagre porosity.
- The density of solid should be more than the density of water so that the solid can sink in water. If the density of solid is less than the density of water then a sinker can be used to perform the experiment.
- Earlier Experiment titled "*To determine the density of a liquid (other than water) by using a spring balance and a measuring cylinder*" also uses a spring balance. It is therefore advised that students may perorm the earlier experiment first to be aware of the instruments used in this experiment.

Questions

- Can you determine the density of a porous solid by using a spring balance and a measuring cylinder? Give reasons in support of your answer.
- How the presence of an air bubble in the liquid taken in the measuring cylinder can affect the volume of the solid?
- Density of sealing wax is 1.8 g/cm^3. Express it in kg/m^3.
- A metal cylinder is melted and the whole mass is cast in the shape of a cube. What happens to its density? Give reasons.
- At which temperature is the density of water maximum?