Measurement of the density of solids

Practical question — PH3 2008 Question 3

Total	/20

INSTRUCTIONS

The candidates will be expected to determine the density of aluminium foil.

Test 1

Apparatus required:

- 1 × rectangular sheet of aluminium (cooking) foil approximately 30 cm wide and 100 cm long. 1 × metre ruler.
- 1 × digital vernier callipers [or a micrometer] of resolution 0·01 mm.
- 1 × 50 ml measuring cylinder.
- 1 × balance of resolution 0·1 g or 0·01 g.
- 1 × water bottle or beaker containing at least 50 cm3 of water.

All the above apparatus should be available to the candidate at the start of the experiment. The micrometer/vernier callipers could be shared between candidates, as could the balance.

Test 2

The apparatus is as for Test 1, except that the sheet of aluminium foil should be approximately 30cm × 80cm.

You are going to use a sheet of aluminium foil to determine the density of aluminium by two different methods.

METHOD 1

1. (a) Measure the length, l, and width, w, of the foil. Explain how you ensured your values were accurate. [3]

(b) Fold the sheet of aluminium a number of times.
Hence determine the average thickness of the foil. [3]

(c) Do you think this method of finding the thickness of the foil sheet is accurate?
Explain your answer. [2]

(d) Use the scales to find the mass of the foil. [1]

(e) Density can be calculated using the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Use your results in parts (a) – (d) to calculate the density of the foil. [2]

METHOD 2

2. Archimedes suggested a different method to find the volume. He stated that the volume of the object was equal to the volume of the water it displaced.

Fill the measuring cylinder with water up to the 30 cm^3 (ml) mark. Roll up your folded piece of foil so that it fits into the measuring cylinder and is completely covered with water.

(a) What is the new level of the water in the cylinder? [1]

(b) What is the volume of the foil? [1]

(c) Use this new value of volume to calculate the density of aluminium. [1]

(d) A result for this type of experiment can be said to be accurate if it is within 5% of the actual value. Given that the density of the aluminium you used is 2·7 g cm^{-3}, comment on the accuracy of your two results. [2]

3. State what you think the biggest uncertainty was in each experiment and say, in each case, how you could reduce it to improve your results. [4]

Method 1

Improvement

Method 2

Improvement

MARK SCHEME

Question			Marks available
1.	(a)	Repeat readings / accurate technique (1) Length and width correct [Area within 5% of centre value](1) Measurements to nearest mm with units (1)	3
	(b)	Minimum of 8 thicknesses used (1) [i.e. 3 folds] Thickness correct to 0.01 mm (1) Units (1)	3
	(c)	Larger thickness measured (1) ∴ smaller uncertainty (1) [Accept: Foil could be creased (1) ∴ larger uncertainty (1)]	2
	(d)	Mass recorded with unit [10 ± 5 g or centre value]	1
	(e)	Density correct [e.c.f.](1) with density units (1)	2
2.	(a)	Correct reading with units[m^3 or cm^3]	1
	(b)	Answer to (i) – 30 [accept – 50]	1
	(c)	Density calculated correctly [with correct units]	1
	(d)	5% of 2.7 = 0.14 g cm−3. (1) [or equivalent] Both own values correctly compared to 2.7 ± 1.4 (1) [Or for 1 mark - valid comment comparing their values to 2.7]	2