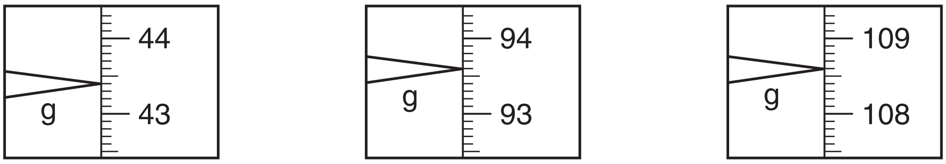
1 A student does an experiment to find out what happens when sodium chloride is dissolved in water.
She measures 50 cm^3 of water into a weighed beaker and adds some sodium chloride crystals. Then she stirs the mixture to make the sodium chloride dissolve. The diagrams, Fig. 6.1, show the balance readings for the three weighings.



mass of beaker

mass of beaker + 50 cm^3 water

mass of beaker + sodium chloride solution

Fig. 6.1

(a) Record the balance readings.

mass of the beaker = ... g

mass of the beaker + 50 cm^3 water = ... g

mass of the beaker + sodium chloride solution = ... g

[3]

(b) (i) Calculate the mass of the sodium chloride solution.

mass of sodium chloride solution = ... g

[1]

(ii) Calculate the mass of the sodium chloride crystals.

mass of sodium chloride crystals = ... g

[1]

(c) The student pours the solution into a measuring cylinder. The scale of the measuring cylinder is shown in Fig. 6.2.

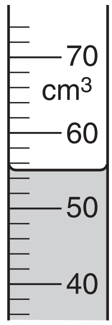


Fig. 6.2

What is the volume of the solution?

.... cm^3 [1]

(d) Which of the experimental results in **(a)**, **(b)** and **(c)** must the student use to calculate the **density** of sodium chloride solution?

....

....[1]

(e) The student wants to do an experiment to find the volume of the solid sodium chloride crystals. The teacher tells her that sodium chloride will not dissolve in hexane, an organic liquid.

Explain how she can use hexane and a 50 cm^3 measuring cylinder to find the accurate **volume** of 15 g of sodium chloride crystals.

....

....

....

....[3]

MARKING SCHEME

(a) 43.4 g, 93.6 g, 108.6 g
(max 1 if the readings have been "inverted" but otherwise correct)

[3]

(b) (i) 108.6 - 43.4 = 65.2 g (ecf)

[1]

(ii) 108.6 - 93.6 = 15 g (ecf)

[1]

(note: if the mass of salt is found by subtracting the mass of water (50g) from 65.2, the answer is 15.2)

(c) 55 cm^3

[1]

(d) (c) and (b) (i) (both correct)
accept (b) and (c) if mass and volume are mentioned (or D = M/V)
(accept 65.2g and 55cm^3 or 65.2/55 = 1.19 g/cm^3)

[1]

(e) Place hexane in measuring cylinder to a known volume (1) (weigh out 15g sodium chloride) and add to the hexane (1) note the new volume and subtract (1)
Use of displacement can and measuring cylinder correctly described can get full marks

[3]

Total 10 marks

2 A student read that an object floats in water when its density is less than that of water.

When the density of the object is just greater than that of water, it will sink. When the mass in g of a vessel placed in water is just greater than its volume in cm^3, it will sink, since the density of water is equal to $1\,g/cm^3$.

The student decided to test this statement by carrying out an experiment using a plastic drinking cup.

(a) To find the volume of water that the cup would hold, he filled a measuring cylinder up to the $250\,cm^3$ mark. He poured water from the measuring cylinder into the cup until it was completely full. He did not let any water spill over. Suggest a way of putting the last few drops of water into the cup so that it is full but not spilling over.

....[1]

(b) Fig. 6.1 shows the scale of the measuring cylinder after the cup was filled.

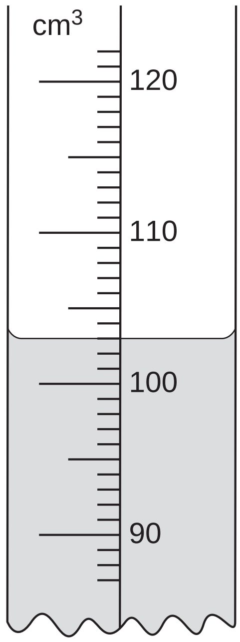


Fig. 6.1

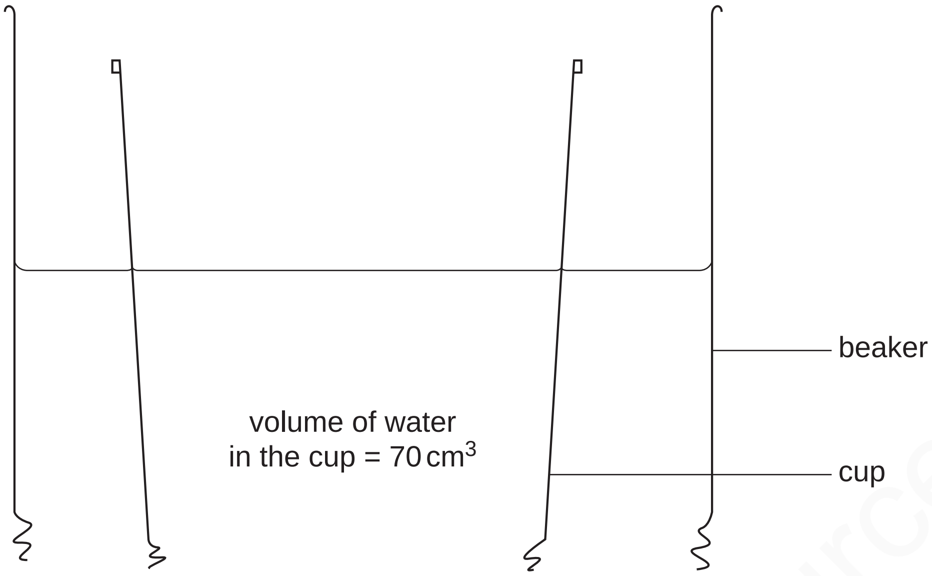
(i) Record the volume of water left in the 250 cm^3 measuring cylinder in the space below.

volume of water left in the measuring cylinder .... cm^3 [1]

(ii) Calculate the volume of water placed in the cup.

volume of water in the cup .... cm^3 [1]

(c) Fig. 6.4 shows the cup floating in the water for two of the boxes in Fig. 6.3. Measure and record the vertical height **h** each time. [2]



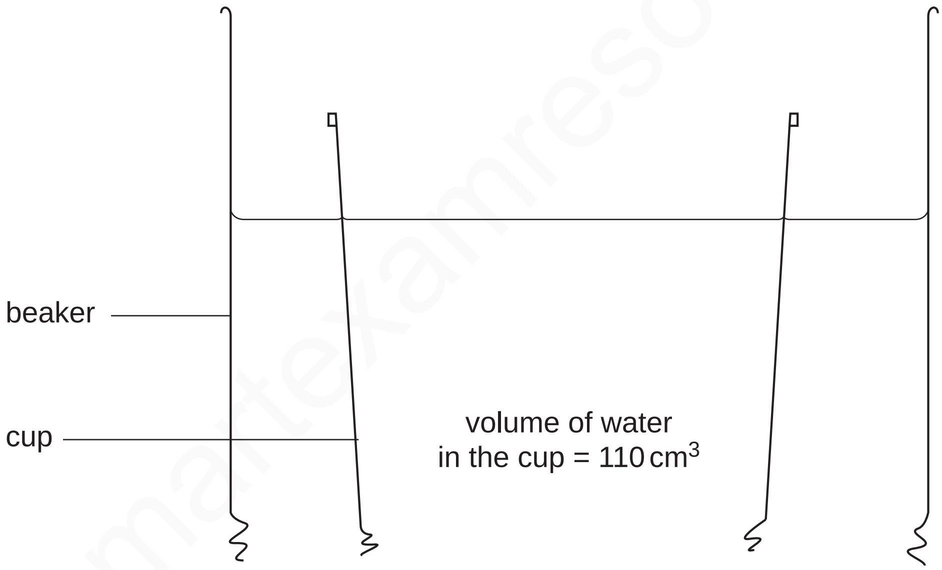
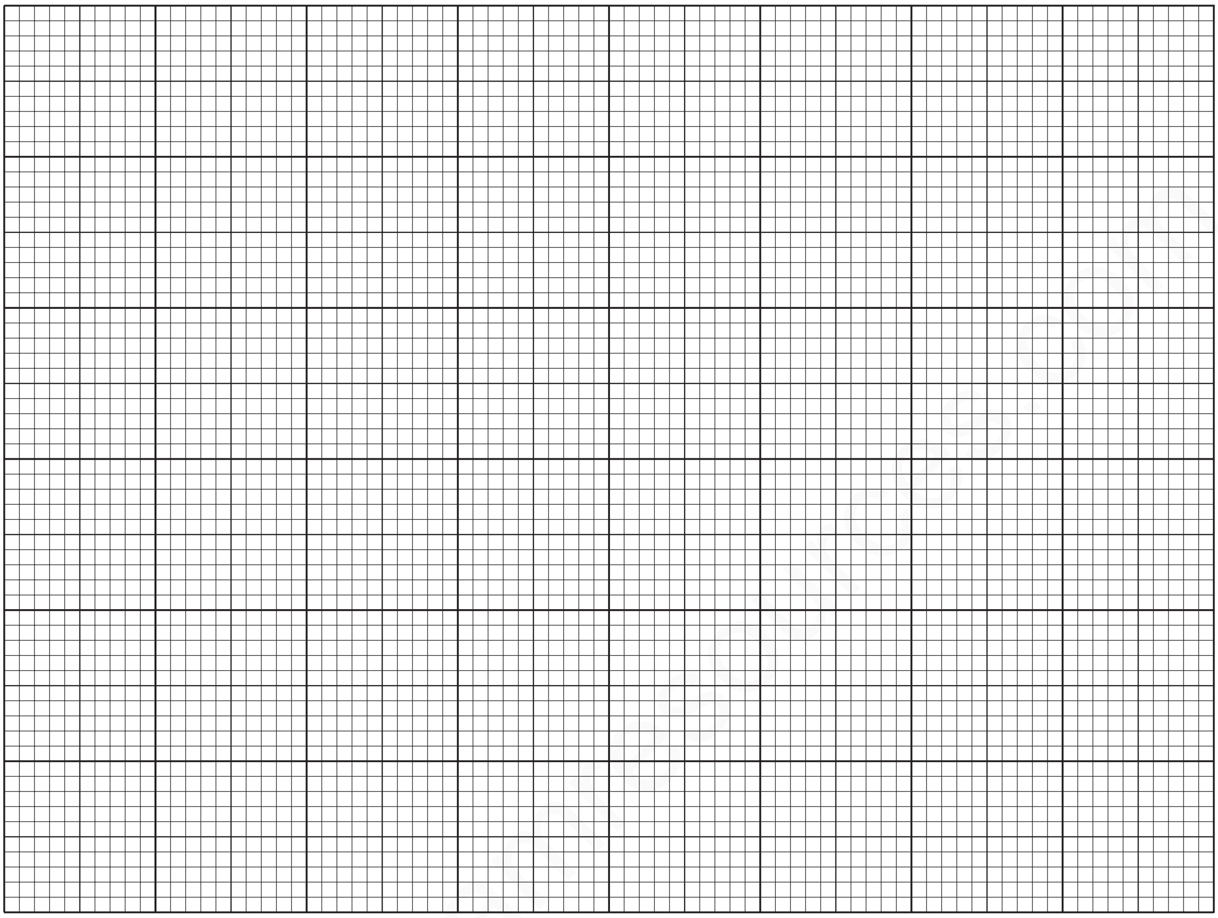


Fig. 6.4

(d) **(i)** Plot a graph of **h** (vertical axis) against the volume of water in the cup. Draw the best straight line through your points and extend it to cut the horizontal axis.



[3]

(ii) Read off from your graph the volume when **h** = 0.

volume = ...cm^3 [1]

(iii) What will happen to the cup when **h** = 0?

....[1]

(e) Did the experiment prove the statement that the student read? Explain your answer.

....

....[1]

MARKING SCHEME

(a)(i)	Use a pipette/dropper/burette	[1]
(ii)	103 (no tolerance) (1) 147 (ecf) (1)	[2]
(b)	28mm, 14mm (+/- 1 mm)	[2]
(c)(i)	correct axes labelled and scale correctly shown (1) all points from Fig.6.3 plotted correctly (1) straight line drawn extended to cut horizontal axis (1)	[3]
(ii)	From candidates' own graph (approx 147 cm^3)	[1
(iii)	it will sink OWTTE	[1]
(d)	Yes/ comparison of **(a)** and **(c)(ii)** shows that mass in cup is numerically similar to (or greater than) its volume OR No/ cup sank before its mass (g) exceeded the volume (cm^3) (depends on candidate's graph) (mark for explanation)	[1]

Total 11 marks

3 A student investigated the relationship between the deflection of a wooden ruler and the mass placed on it.
He clamped a wooden metre rule to the bench so that 700 mm of it extended beyond the edge of the bench. See Fig. 5.1

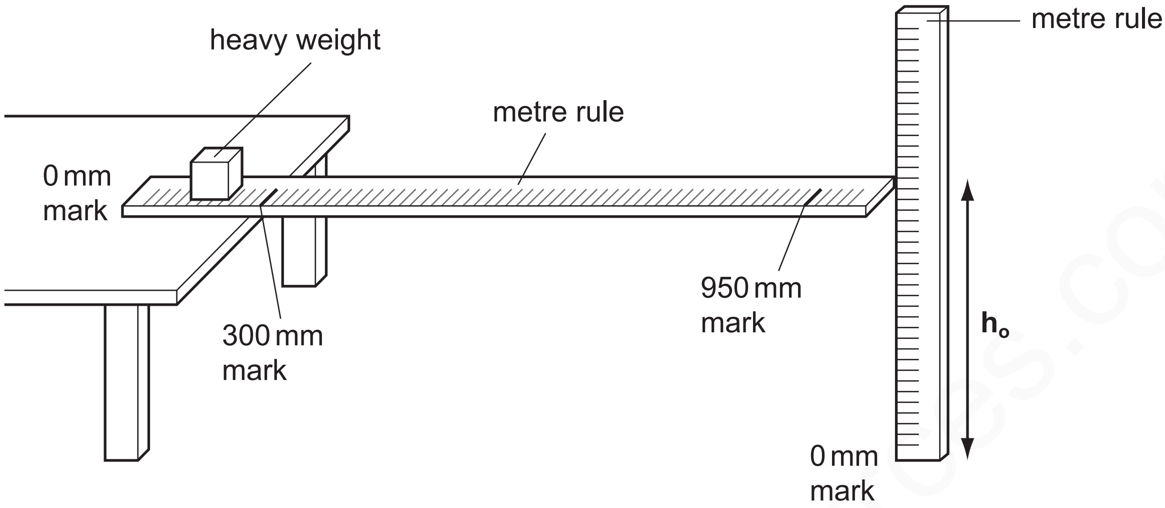


Fig. 5.1

He measured the distance, $\mathbf{h_o}$, of the end of the ruler from the floor and recorded it in Fig.5.2.
The student was given a large mass of plasticine. He divided the plasticine into five pieces roughly equal in size.

- He weighed a piece of plasticine to the nearest gram and recorded its mass, $\mathbf{m_1}$, in Fig. 5.2.
- He placed the plasticine on the 950 mm mark of the ruler. He measured and recorded the new distance from the floor, $\mathbf{h_1}$.
- He added another piece of plasticine to the first one and found the combined mass of the two pieces. He recorded this mass, $\mathbf{m_2}$, in Fig. 5.2.
- He placed the mass, $\mathbf{m_2}$, on the 950 mm mark of the ruler. He found the distance from the floor, $\mathbf{h_2}$, and recorded it in Fig. 5.2.
- The student repeated this procedure to give three more sets of readings.

mass of plasticine/g	distance from the floor/mm	deflection/mm
0	h_0 = 630	0
m_1 = 85	h_1 = 614	16
m_2 = 180	h_2 = 597	33
m_3 =	h_3 =	
m_4 =	h_4 =	
m_5 = 450	h_5 = 548	82

Fig. 5.2

(a) (i) Fig. 5.3 shows the mass of plasticine **m** and the distance from the floor **h** for the two sets of readings missing from Fig. 5.2. Read the balance windows to find $\mathbf{m_3}$ and $\mathbf{m_4}$. Read the rulers to find $\mathbf{h_3}$ and $\mathbf{h_4}$. Record these readings in Fig. 5.2. [3]

In the diagrams below, read the scale level with the **top edge** of the metre rule.

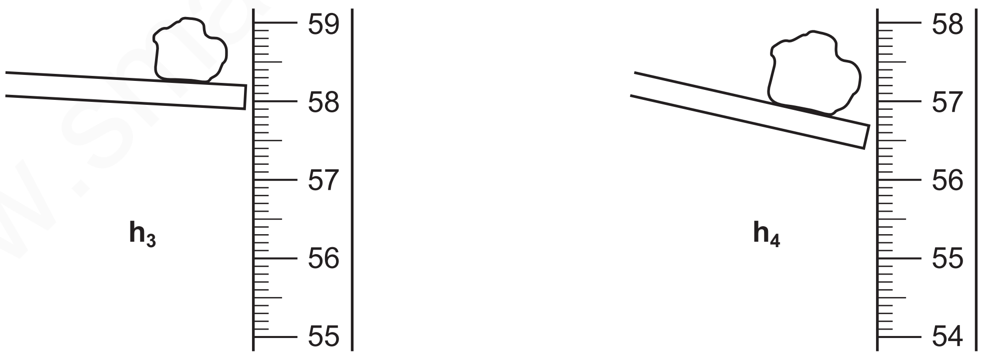


Fig. 5.3

(ii) Calculate the deflection of the ruler for the masses $\mathbf{m_3}$ and $\mathbf{m_4}$.
Record these deflections in Fig. 5.2. [1]

(b) On the grid provided, plot a graph of deflection (vertical axis) against mass of plasticine. Draw the best straight line through the points. [3]

(c) **(i)** Use your graph to find the mass of plasticine required to give a deflection of 100 mm.

.... [1]

(ii) What is the relationship between the mass added and the deflection?

.... [1]

(d) If the masses had been placed at the 750 mm mark of the metre rule instead of the 950 mm mark, what effect would this have on the measurements of deflection?

.... [1]

MARKING SCHEME

(a) (i) 260g, 350g **(1)**,
582 mm, 567 mm (+/- 1 unit) **(2)**
If height read at under-surface or mid-point of rule, 579 mm and 564 mm but **(1)** mark only.
Reject: measurements in cm **[3]**

(ii) 630 - 582 = 48, 630 - 567 = 63 mm (ecf) **[1]**

(b) labelling of axes (must include units) and choice of scale **(1)**
plotting of points all correct **(1)**
straight line passing through 0 **(1)**
(-1 mark if axes are reversed) **[3]**

(c) (i) 550 mm (or from candidate's own graph) **(1)**

(ii) mass is proportional to the deflection (the word proportional must be used) or a calculation to find the mathematical relationship between mass and deflection, stated as equation or ratio **(1)** **[2]**

(d) The deflections will be smaller OWTTE **[1]**

[Total: 10]

4

A student is given some plasticine (modelling clay) by his teacher. He is told to find the density of the plasticine by two different methods.

Method 1

The student tries to make the plasticine into a cube. He measures the cube so that he can calculate its volume.
Then he weighs the cube of plasticine on a balance.
He calculates the density using the mass and volume.

(a) (i) Fig. 2.1 shows one face of the cube of plasticine. As accurately as you can, measure one side of the face of the cube to the nearest millimetre. Use this measurement to calculate the volume of the cube in cubic centimetres.

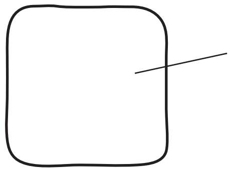


Fig. 2.1

length of one side of the cube = ... mm

length of one side of the cube = ... cm

volume of the cube = ... x .... x .... = ... cm^3 [2]

(ii) The student puts the cube onto a balance. Fig. 2.2 shows the window of the balance. Read and record the mass of the cube.

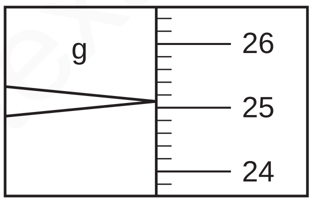


Fig. 2.2

mass of the cube = ... g [1]

(iii) Use the answers to **(a)(i)** and **(ii)** to calculate the density of the plasticine in g/cm^3.

density of plasticine = ... g/cm^3 [1]

Method 2

The student finds the volume of the plasticine by the displacement method. Then he weighs it using a metre rule. He calculates the density of plasticine again.

(b) The student puts 100 cm^3 of water into a measuring cylinder. Then he places the plasticine into the water. Fig. 2.3 shows the new level of water in the measuring cylinder.

(i) Read the level of water in the measuring cylinder. Then calculate the volume of the plasticine.

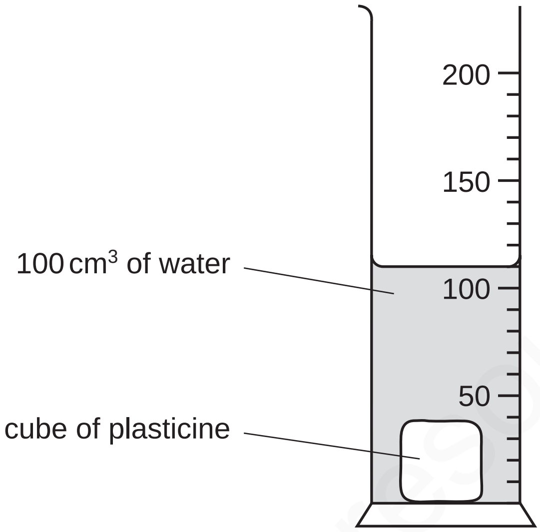


Fig. 2.3

water level in the measuring cylinder = ... cm^3

volume of the plasticine = ... cm^3 [1]

The student hangs a 50 g mass on a metre rule at the 30 cm mark. He hangs the plasticine on the other end so that the rule balances.

(ii) Use Fig. 2.4 to calculate the distances of the plasticine and the 50 g mass from the pivot.

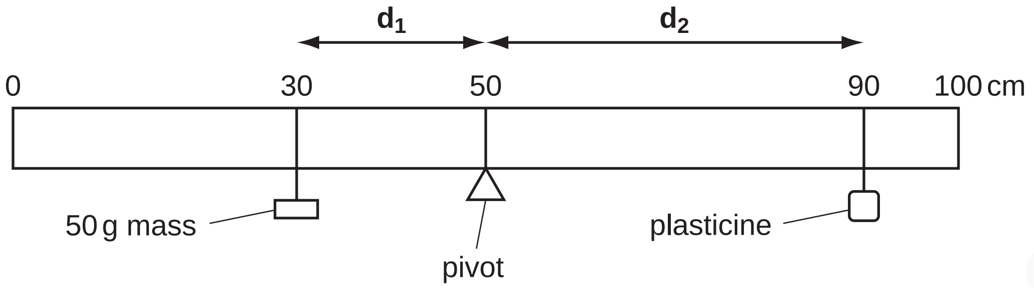


Fig. 2.4

The distance $\mathbf{d_1}$ of the 50 g mass from the pivot is .... cm

The distance $\mathbf{d_2}$ of the plasticine from the pivot is .... cm [1]

(iii) Use the following equation to calculate the mass of the plasticine.

$\mathbf{d_1}$ x 50 = $\mathbf{d_2}$ x mass of the plasticine

mass of the plasticine = ... g [1]

(iv) Calculate the density of the plasticine using your answers to **(b)(i)** and **(iii)**.

density of plasticine = ... g/cm^3 [1]

(c) Which measurement of volume, **(a)(i)** or **(b)(i)**, is more accurate? Give a reason for your answer.

....

....

.... [2]

MARKING SCHEME

(a) (i) 21 mm (+/- 1 mm), 2.1 cm^3 (both needed for the mark)
volume correctly calculated 9.3 cm^3 (e.c.f) (second d.p.not needed) **[2]**

(ii) 25.1 g (+/- 0.05 cm^3) **[1]**

(iii) 25.1/9.3 = 2.7 g/cm^3 (e.c.f.) **[1]**

(b) (i) 110 cm^3, 10 cm^3 (both needed for mark, no tolerance) **[1]**

(ii) 20 cm, 40 cm (reject answers stated the wrong way round)
both needed for the mark. **[1]**

(iii) 50 x 20 = mass x 40, (e.c.f.)
mass = 25 g (e.c.f.) (1) **[1]**

(iv) 25/10 = 2.5 g/cm^3 (e.c.f.) **[1]**

(c) EITHER method 2 is more accurate because the cube in method 1 is not accurately formed (1) so measurement of the side is inaccurate (1)
OR the scale of the measuring cylinder used in method 2 is not fine enough (1) so accuracy of measuring volume is low (1) therefore method 1 is more accurate

N.B. Note that the 2 marks can be awarded if an inaccuracy is referred to

if the candidate claims that e.g. 'finding the volume by displacement is more accurate' then award 1 mark maximum

(no mark for an answer without a reason) **[2]**

[Total: 10 marks]

5 A student must find the internal diameter of a large test-tube, shown in Fig. 6.1.
He is told to carry out the procedure shown below.

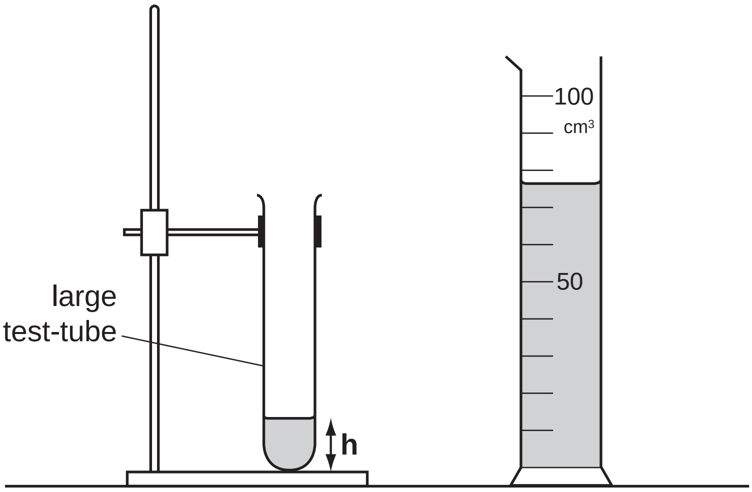


Fig. 6.1

Procedure

- Fill a measuring cylinder with water to the 100 cm^3 mark.
- Pour water from the measuring cylinder into the test-tube until it is about one-fifth full.
- Find the vertical height, **h**, of the water in the test-tube and record it.
- Record **V**, the volume of water remaining in the measuring cylinder.
- Add about 10 cm^3 of water to the test-tube. Record the new height **h** and the volume **V**.
- Repeat until there are 5 sets of readings in the table.

(a) Fig. 6.2 shows the heights of water in the test-tube and the corresponding volumes of water remaining in the measuring cylinder, for the missing readings of **h** and **V**, in Fig. 6.3.

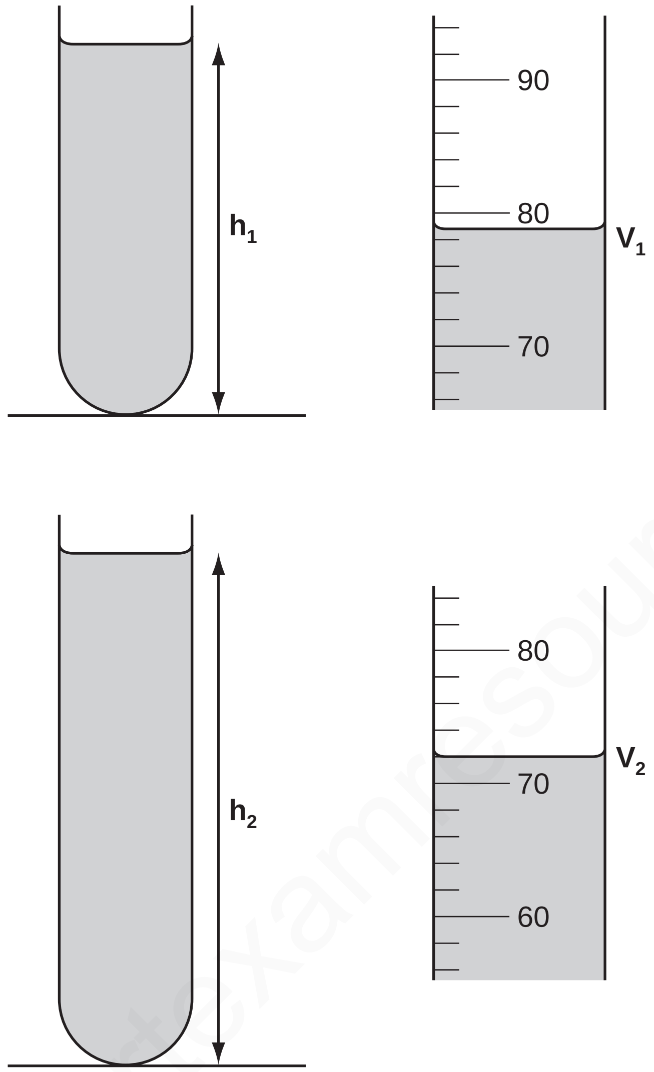


Fig. 6.2

(i) Use a ruler to measure h_1 and h_2 to the nearest millimetre and record the values in Fig. 6.3. [2]

(ii) Read the values of V_1 and V_2 to the nearest cm^3 and record them in Fig. 6.3. [2]

(iii) Complete the third column of Fig. 6.3. [1]

height **h** / mm	volume **V** / cm^3	(100 - **V**) / cm^3
25	89	9
h_1 = ...	V_1 = ...	$(100 - V_1)$ = ...
h_2 = ...	V_2 = ...	$(100 – V_2)$ = ...
93	60	40
113	51	49

Fig. 6.3

(b) On Fig. 6.4, plot a graph of (100 - **V**) against **h**.
Draw the best straight line through the points. [2]

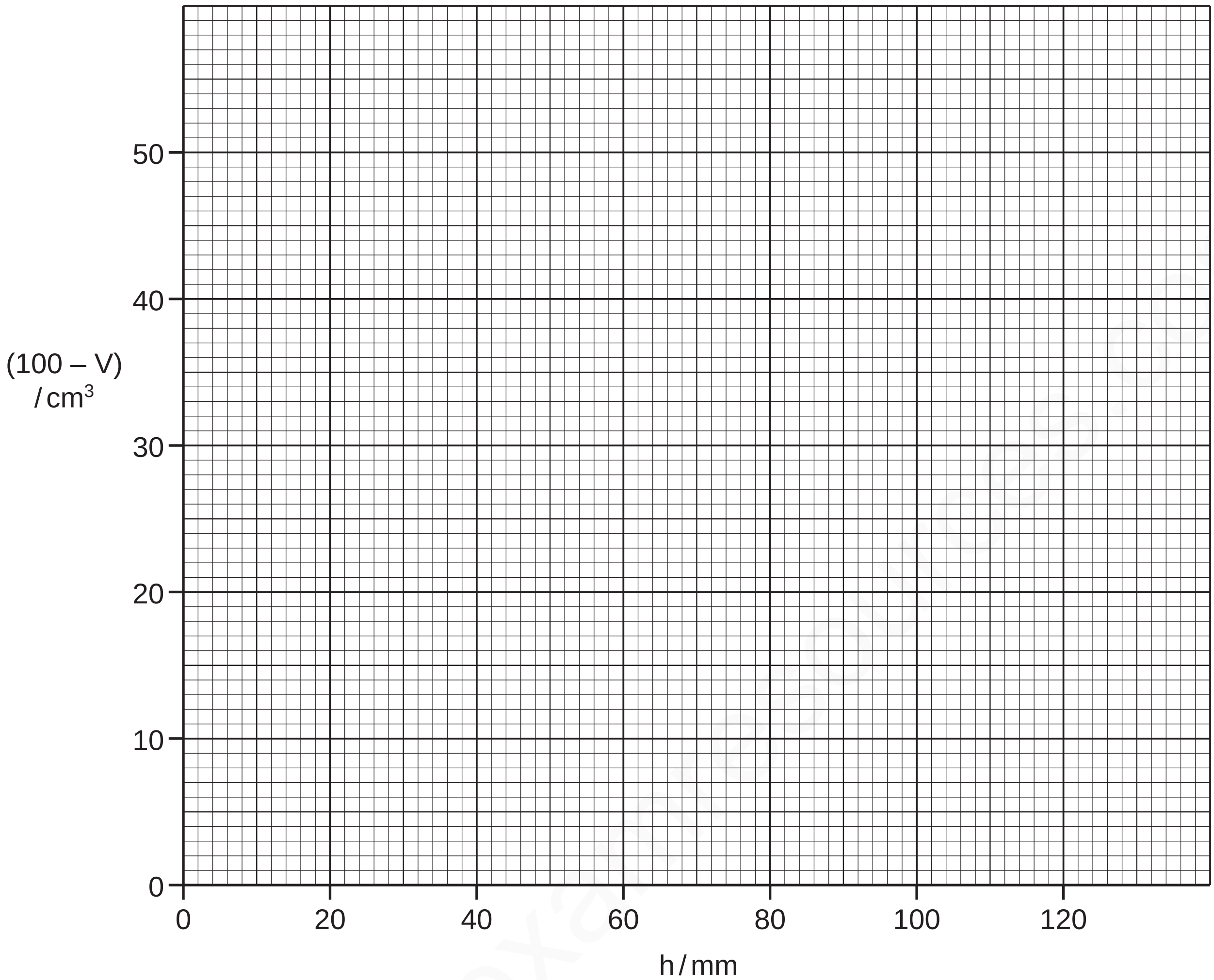


Fig. 6.4

(c) **(i)** Use your graph to find the volume, $\mathbf{V_w}$, of water between **h** = 30 and **h** = 100 mm.

Show on your graph how you did this.

$\mathbf{V_w}$ = ... cm^3 [2]

(ii) Calculate **d**, the internal diameter of the tube, using the equation

$$\mathbf{d} = \frac{\sqrt{\mathbf{Vw}}}{0.24}$$

d = ... mm [1]

MARKING SCHEME

(a)	**(i)** 49, 68 +/- 1 mm		[2]
	(ii) 79, 72 (no tolerance)		[2]
	(iii) 21, 28 (e.c.f) (both correct)		[1]
(b)	points correctly plotted (allow one error) +/- 1 cm^3 / 1 mm	(1)	
	straight line drawn (ignore error if not passing through (0,0))	(1)	[2]
(c)	**(i)** correct lines or marks shown on graph	(1)	
	about 31 cm^3 (answer from candidate's graph)	(1)	[2]
	(ii) about 24 mm (e.c.f)		[1]

[Total: 10]

6 A student did an experiment to find the density of salt solution. He floated a test-tube containing sand, in water and then in the salt solution. This is shown in Fig. 4.1.

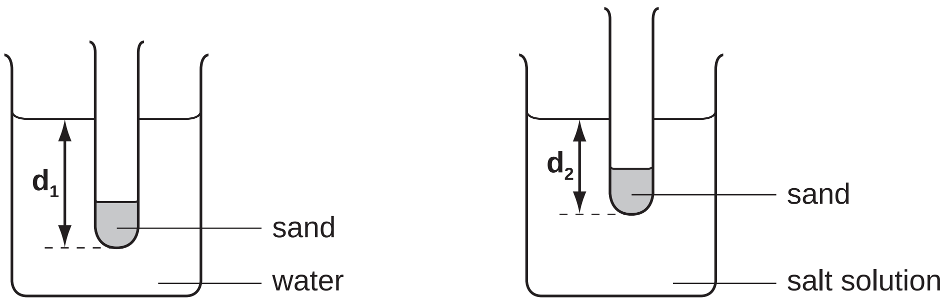


Fig. 4.1

- He placed dry sand in the test-tube and floated it in water. He measured the depth $\mathbf{d_1}$ from the water surface to the bottom of the tube. He recorded this in the first row of Table 4.2, **experiment 1**.
- He placed the same tube in the salt solution and found the depth $\mathbf{d_2}$. He recorded this in the first row of Table 4.2.
- He emptied some of the sand out of the test-tube and found $\mathbf{d_1}$ and $\mathbf{d_2}$ again, **experiment 2**.
- He emptied out more of the sand and found another set of readings for $\mathbf{d_1}$ and $\mathbf{d_2}$, **experiment 3**.

Table 4.2

experiment number	depth $\mathbf{d_1}$ in water / millimetres	depth $\mathbf{d_2}$ in salt solution / millimetres
1	104	86
2	85	70
3		

Fig. 4.3 shows the tube floating in water and in salt solution for **experiment 3**. The student has placed a ruler graduated in millimetres next to the tube.

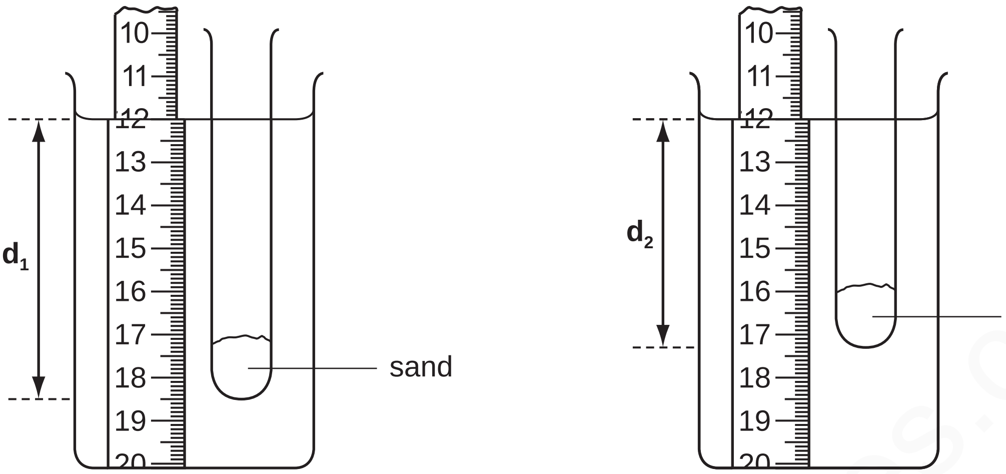


Fig. 4.3

(a) (i) Briefly explain why the ruler appears larger when viewed through the side of the beaker.

....

.... [1]

(ii) Use the scale of the ruler to calculate the depth $\mathbf{d_1}$ for the tube floating in water.

Record the value in Table 4.2.

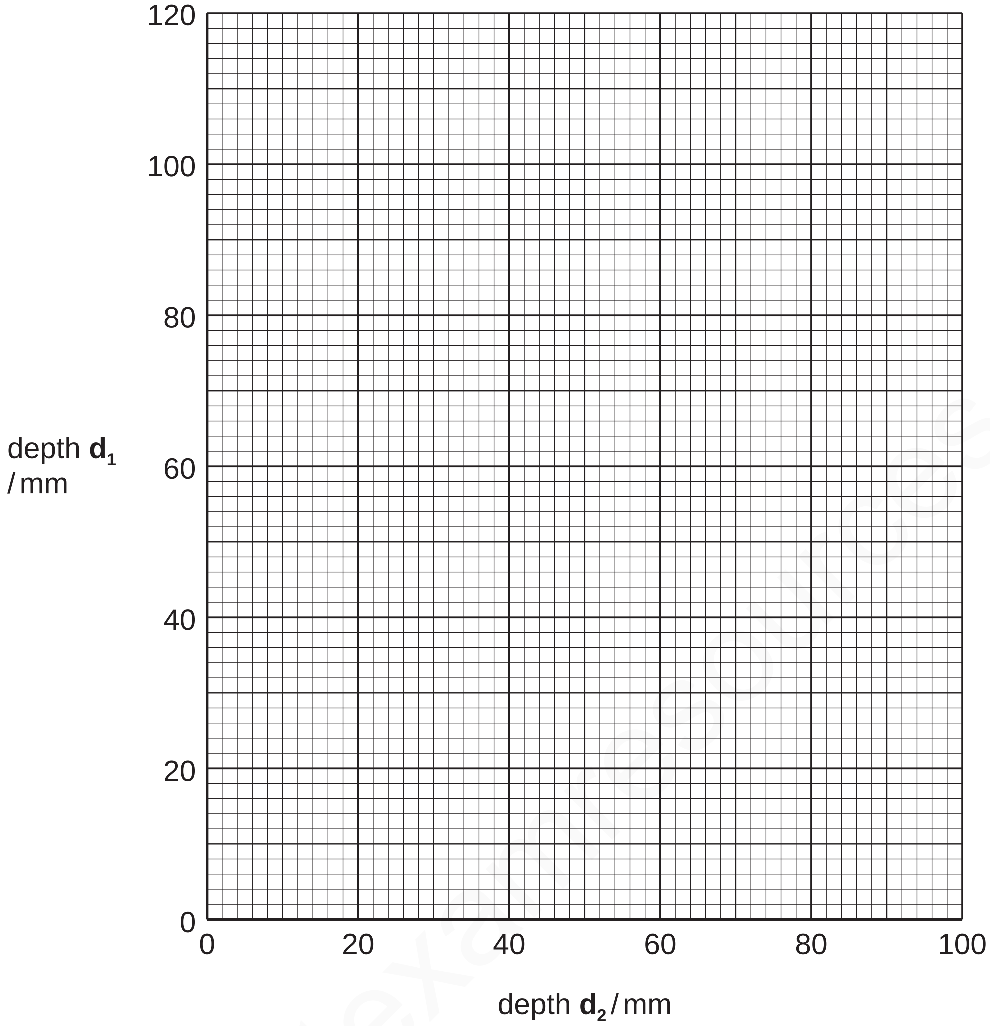
depth $\mathbf{d_1}$ = ... mm [2]

(iii) Use the scale of the ruler to calculate the depth $\mathbf{d_2}$ for the tube floating in salt solution.

Record the value in Table 4.2.

depth $\mathbf{d_2}$ = ... mm [1]

(b) On the grid below, plot the values for $\mathbf{d_1}$ from Table 4.2 (vertical axis) against $\mathbf{d_2}$. Draw the best straight line and extend it to pass through the point (0,0).



[2]

(c) Calculate the gradient of the line, showing on your graph the values you use to do this. The gradient is numerically equal to the density of the salt solution in grams per cubic centimetre.

gradient = ... [2]

(d) Describe another method for finding the density of a liquid using a pipette or burette, a beaker and a balance.

....

....

....

....

.... [2]

MARKING SCHEME

(a) **(i)** light is refracted (bent) at curved surface / beaker (and water) act as a lens / OWTTE ; [1]

(ii) 18.5 – 12 ;
= 6.5 cm (65 mm) (correctly recorded) ;
(± 1 mm)
(allow correct answer for 2 marks even if no calculation shown) [2]

(iii) 17.3 – 12 = 5.3 cm (53 mm) ; [1]
(± 1 mm) (award mark either for equation or for result)

(b) at least 2 points correctly plotted (e.c.f.) ;
straight line drawn passing through (0,0) ; [2]

(c) graph shows clearly the vertical and horizontal distances ;
calculation to give result (e.c.f. depends on candidate's graph but should be 1.2 ± 0.1) ; [2]

(d) measure known volume of liquid into (weighed) beaker and weigh to find mass of liquid ;
divide mass by volume ; [2]

[Total: 10]