FINDING INTERNAL DIAMETER

1 A student does an investigation to find an approximate value for the internal diameter *d* of a test-tube.

The internal diameter *d* is estimated by measuring the height *h* and volume *V* of water in the test-tube.

The test-tube is considered to be an approximate cylinder.

Procedure

The student:

- adds 100 cm^3 of water into a measuring cylinder
- pours some water from the measuring cylinder into a test-tube.

Fig. 6.1 shows a full size drawing of this test-tube.

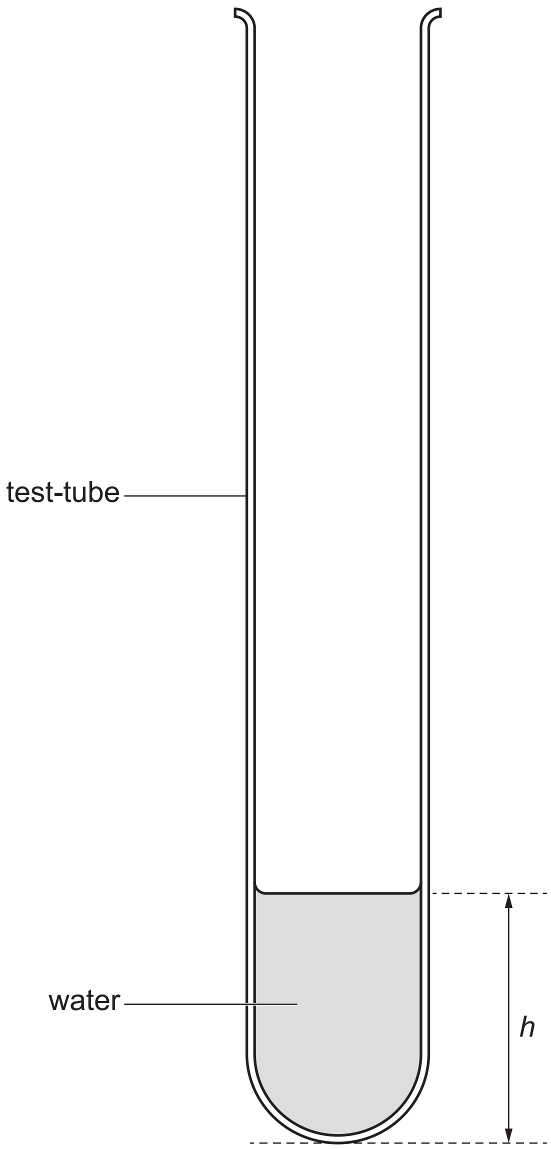


Fig. 6.1

(a) Measure the height *h* of the water in the test-tube in centimetres to the nearest millimetre.

Record *h* in Table 6.1.

Table 6.1

h / cm	*R* / cm^3	*V* / cm^3
5.8	80	20
8.9	69	31
11.5	58	42
14.3	49	51

[1]

(b) Fig. 6.2 shows the reading *R* of the water remaining in the measuring cylinder.

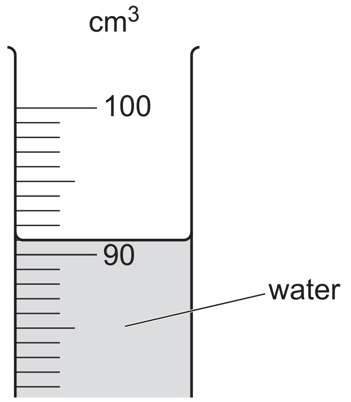


Fig. 6.2

(i) Read the measuring cylinder and record the reading *R* in Table 6.1. [1]

(ii) Calculate the volume *V* of water in the test-tube.

Use the equation shown.

$$V = 100 - R$$

Record your answer in Table 6.1. [1]

(c) Procedure

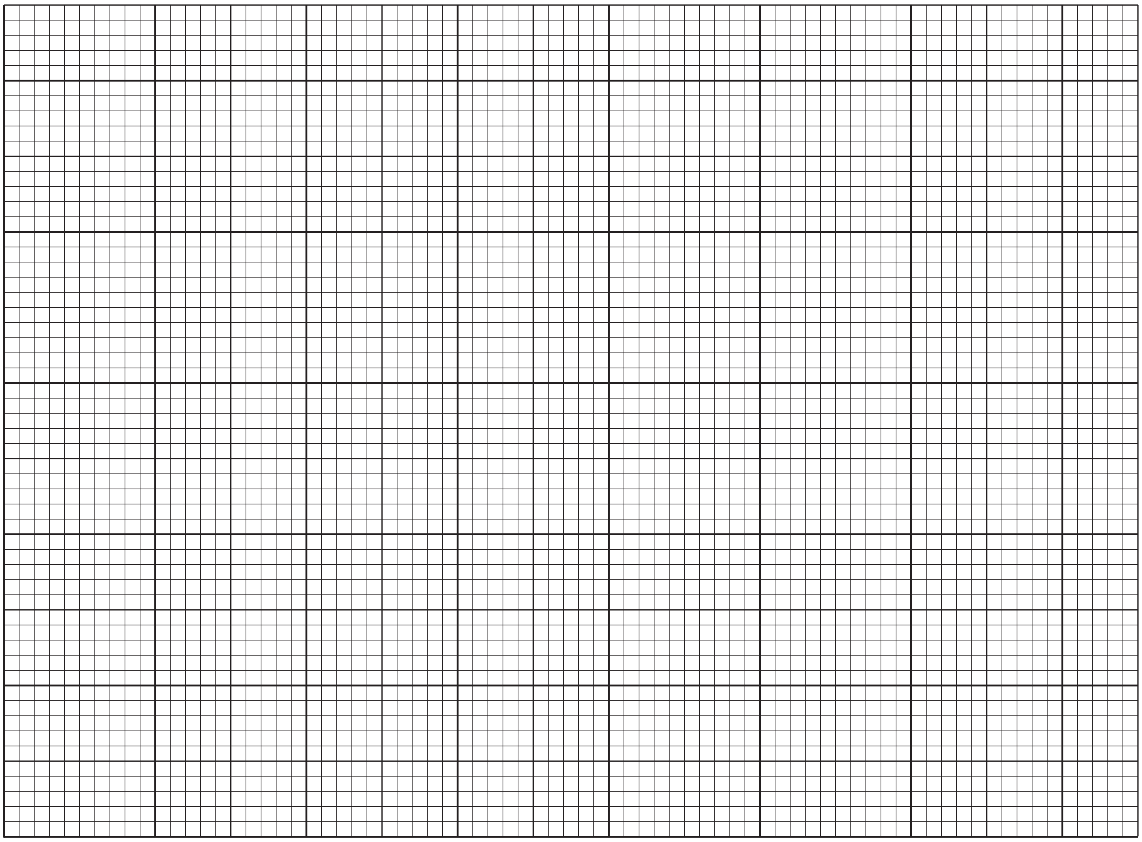
The student:

- adds more water from the measuring cylinder to the test-tube
- measures and records in Table 6.1 the new values of *h* and *R*.

The student repeats the procedure for another three more values of *h* and *R*.

The student's results are shown in Table 6.1.

(i) Plot on the grid provided a graph of *V* (vertical axis) against *h*.



[3]

(ii) Draw the best-fit straight line. [1]

(d) Calculate the gradient *m* of your line.

Show all working and indicate on your graph the values you chose to enable the gradient to be calculated.

m = ... [2]

(e) Calculate the internal diameter d of the test-tube.

Use the equation shown.

$$d = 0.59 \times m$$

d = ... cm [1]

(f) **(i)** State why the student holds the ruler close to the test-tube when measuring the height h of the water.

....

.... [1]

(ii) Suggest one other reason why your calculated value for the internal diameter d of the test-tube is only approximate.

....

.... [1]

[Total: 12]

MARKSCHEME:

(a)(i)	0.24 (A) ; 2.6 (V) ;	**2**
(a)(ii)	cells run down ;	**1**
(b)(i)	0.624 (W) ; 0.62 (W) ;	**2**
(b)(ii)	W / watt ;	**1**
(b)(iii)	current / potential difference / power decrease (as length increases) ;	**1**
(c)	(not true because) ratio *I* / *V* not constant / doubling *I* does not double *V*/as *I* increases *V* decreases ;	**1**
(d)	voltmeter in **parallel** with lamp ; variable resistor in **series** with lamp **and** circuit complete ;	**2**

2 A student investigates the alcohol content of wine.

- He places a 100 cm^3 measuring cylinder on a mass balance and zeroes the balance (so that the mass reads 0.00 g).
- He places between 95 cm^3 and 100 cm^3 of water into the measuring cylinder. This is 0% alcohol.
- He reads the mass balance, which is the mass of water. He records this mass in Table 6.1.
- He measures the volume of water and records this value, to the nearest 0.5 cm^3, in Table 6.1.
- He empties the measuring cylinder and repeats the procedure using 4%, 8%, 12%, 16% and 20% alcohol solutions.

Table 6.1

percentage of alcohol / %	volume / cm^3	mass / g	density / g per cm^3
0	99.0	99.0	1.000
4	98.5	97.8	0.993
8	99.5	97.7	0.982
12		94.6	0.980
16	97.0		0.975
20	96.0	93.0	0.969

(a) (i) Fig. 6.1 shows the volume in the measuring cylinder for the 12% alcohol solution.

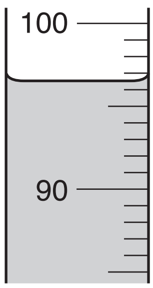


Fig. 6.1

Record this volume in Table 6.1. [1]

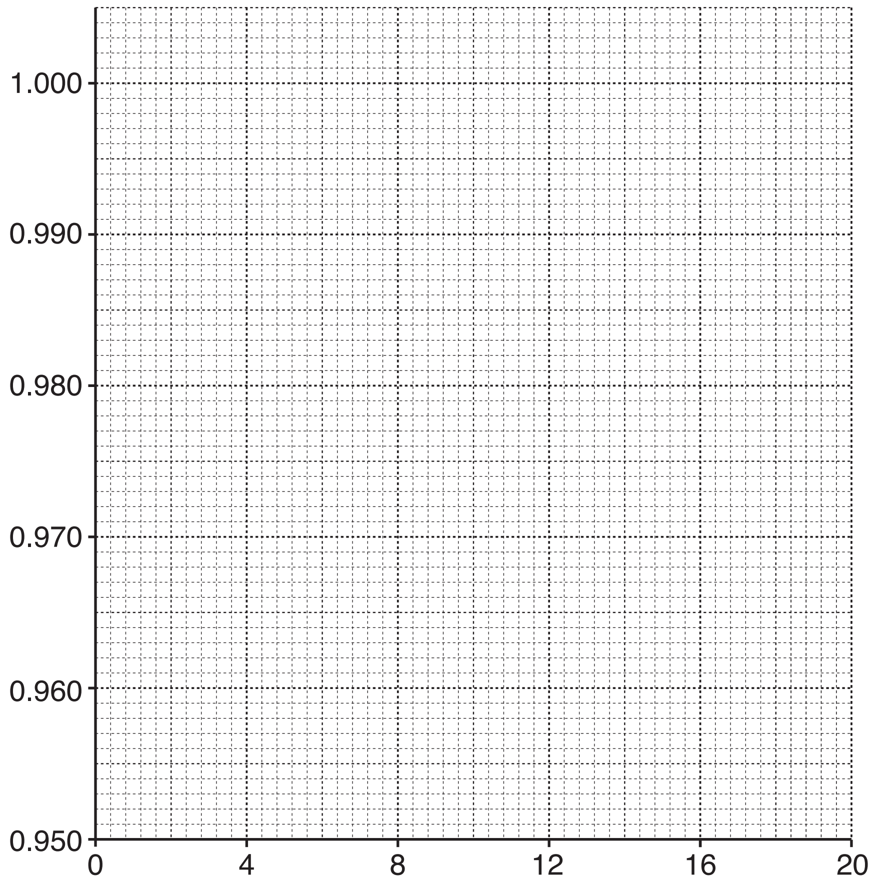
(ii) Fig. 6.2 shows the mass balance reading for the 16% alcohol solution.

Fig. 6.2

Record this mass in Table 6.1. [1]

(b) **(i)** On the grid provided, plot a graph of density (*vertical axis*) against percentage of alcohol.

Label the axes.



[2]

(ii) On your graph, circle the anomalous point. [1]

(iii) Draw the best-fit straight line. [1]

(c) Use your graph to determine the percentage alcohol content of a sample of wine of density 0.978 g per cm^3.

Show clearly on your graph how you arrived at your answer.

Percentage alcohol content of wine = ...% [1]

(d) Suggest how the student could minimise the effect of errors in this experiment.

....

....[1]

(e) The density of the alcohol solution is calculated using the formula shown.

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

Suggest **one** reason why the student added between 95 cm^3 and 100 cm^3 of the alcohol solution into the measuring cylinder rather than adding exactly 100 cm^3.

....

....[1]

(f) Some wines, for example Champagne, contain dissolved carbon dioxide which makes them fizzy.

Suggest **one** reason why the method in this experiment is **not** suitable for determining the alcohol content of Champagne.

....

....[1]

MARK SCHEME:

(a)(i)	96.5 ;	1
(a)(ii)	94.6 ;	1
(b)(i)	both axes labelled with units ; minimum 5 plots correct ;	2
(b)(ii)	point at 8% circled ;	1
(b)(iii)	best-fit line AND not including anomaly ;	1
(c)	answer from their line in **(b)(iii)** AND this marked on graph ;	1
(d)	repeat values and average / repeat to identify anomalies / repeat values to reduce effect of errors / thinner measuring cylinder ;	1
(e)	difficult to get exactly 100 cm^3 ;	1
(f)	bubbles take up volume / amount bubbles vary / bubbles change mass / difficult to measure volume ;	1

DETERMINE VOLUME OF GLASS

3 A student determines the volume of glass used to make a beaker.

Fig. 5.1 shows the external diameter *d* and the height *h* of the beaker.

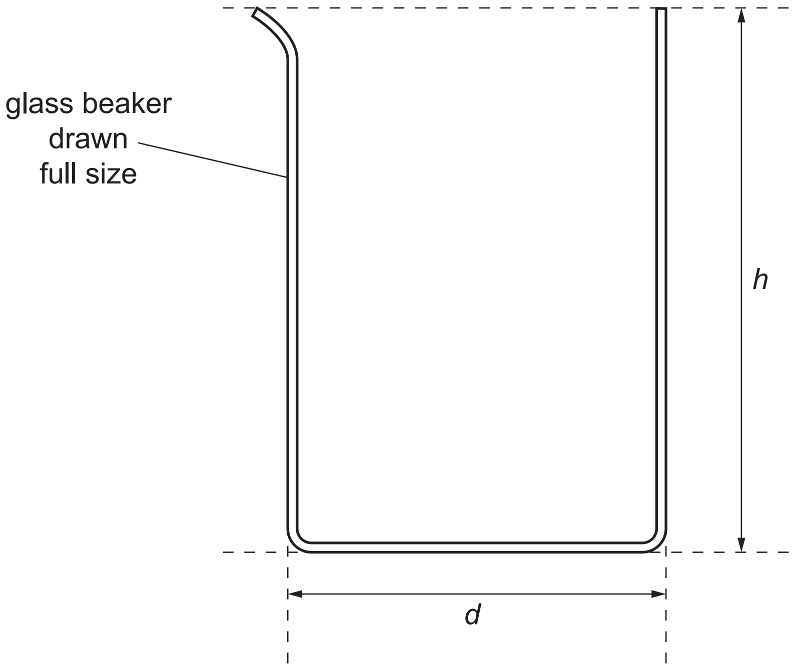


Fig. 5.1

(a) Use a ruler to measure the external diameter *d* of the beaker in Fig. 5.1 in centimetres to the nearest 0.1 cm.

external diameter *d* = ... cm [1]

(b) The student uses two wooden blocks to help obtain an accurate answer for the external diameter.

The beaker is placed between the blocks, and touching them, as shown in Fig. 5.2.

view from above

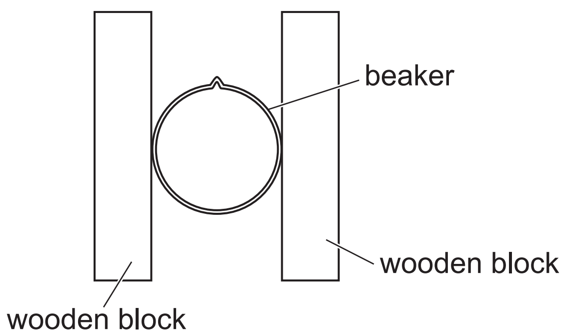


Fig. 5.2

(i) Explain why it is important to ensure that the wooden blocks are parallel to each other before measuring the diameter of the beaker.

....

.... [1]

(ii) Draw a double-headed arrow (⟷) on Fig. 5.2 to show the distance that the student measures. [1]

(c) Use a ruler to measure the height h of the beaker in Fig. 5.1 in centimetres to the nearest 0.1 cm.

height h = ... cm [1]

(d) Calculate the external volume V_{EXT} of the beaker.

Use the equation shown.

$$V_{EXT} = 0.79\,d^2h$$

V_{EXT} = ... cm^3 [2]

(e) **Procedure**

The student:

- fills the beaker to the top with water
- uses a measuring cylinder to measure the volume of water that the beaker contains.

This is the internal volume V_{INT} of the beaker.

Fig. 5.3 shows the level of the water in the measuring cylinder.

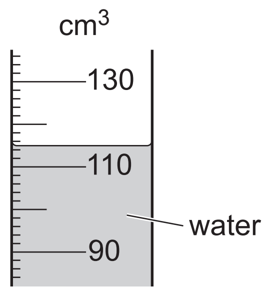


Fig. 5.3

Read the measuring cylinder and record the internal volume V_{INT} of the beaker.

V_{INT} = ... cm^3 [1]

(f) Calculate the volume V_G of glass used to make the beaker.

Use the equation shown.

$$V_G = V_{EXT} - V_{INT}$$

V_G = ... cm^3 [1]

(g) Your answer for V_G is approximate. State one source of error in measuring:

(i) the external volume V_{EXT} of the beaker.

....

.... [1]

(ii) the internal volume V_{INT} of the beaker.

....

.... [1]

[Total: 10]

MARKSCHEME:

(a)	5.<u>0</u> (cm) ;	**1**
(b)(i)	so that the distance between them is the same (at all points) / otherwise the value of *d* depends on where the ruler is placed;	**1**
(b)(ii)	correct distance indicated perpendicular to the blocks and between the blocks ;	**1**
(c)	7.2 ;	**1**
(d)	V_{EXT} = 142(.2) (cm^3) ; ;	**2**
(e)	115 ;	**1**
(f)	27 / 27.2 ;	**1**
(g)(i)	beaker not a perfect cylinder;	**1**
(g)(ii)	cannot tell when beaker is full / can overfill the beaker / water spilled (on transfer) / measuring cylinder only reads to nearest 1 cm^3 / bigger measuring cylinder should be used ;	**1**