1.4 Density

01. 0625_m20_qp_62 Q: 1

A student is determining the density of wood by two methods.

He is using the wooden rod shown in Fig. 1.1.

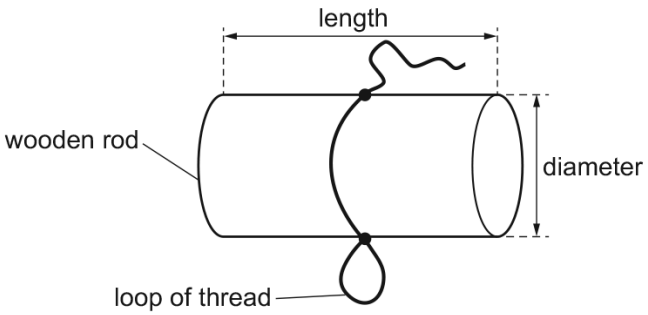

Fig. 1.1

Method 1

The dimensions of the wooden rod are shown full size in Fig. 1.2.

Fig. 1.2

(a) (i) Measure the length l and the diameter d of the wooden rod in Fig. 1.2.

l = ... cm

d = ... cm

[2]

(ii) Suggest an accurate method for measuring the diameter of the wooden rod in this experiment.
List any additional apparatus that might be required and briefly describe how you would determine the diameter.
You may draw a diagram if it helps to explain your answer.

.....

.....

..... [2]

(b) The student uses a balance to measure the mass *m* of the wooden rod as shown in Fig. 1.3.

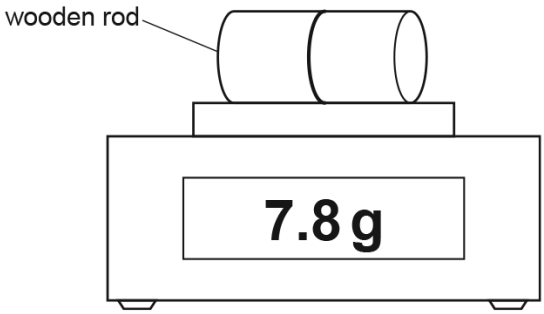

Fig. 1.3

Record the mass *m* of the rod.

m = ...g

Calculate a value ρ_1 for the density of the wooden rod. Use your values from **(a)(i)** and **(b)** and the equation $\rho_1 = \frac{4m}{\pi d^2 l}$. Include a suitable unit.

ρ_1 = ... [2]

Method 2

(c) The student pours water into a measuring cylinder as shown in Fig. 1.4.
He then floats the wooden rod in the water as shown in Fig. 1.5.

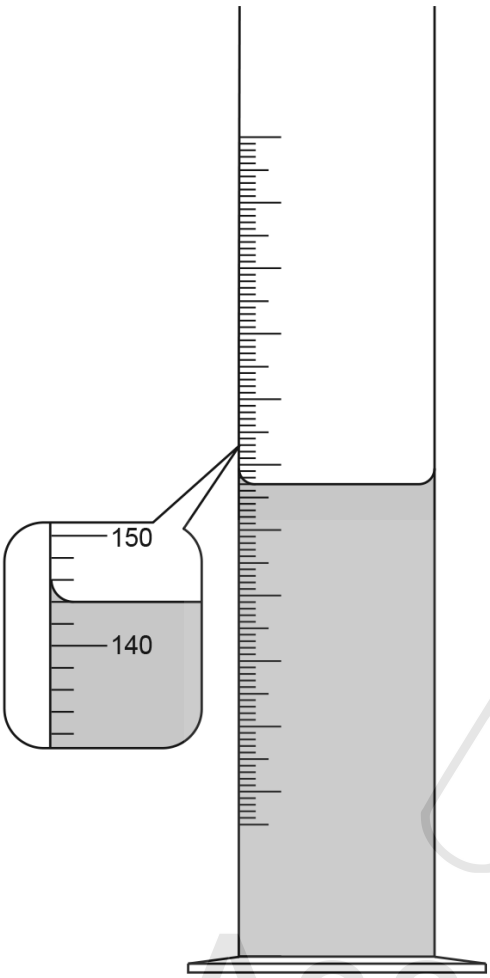

Fig. 1.4

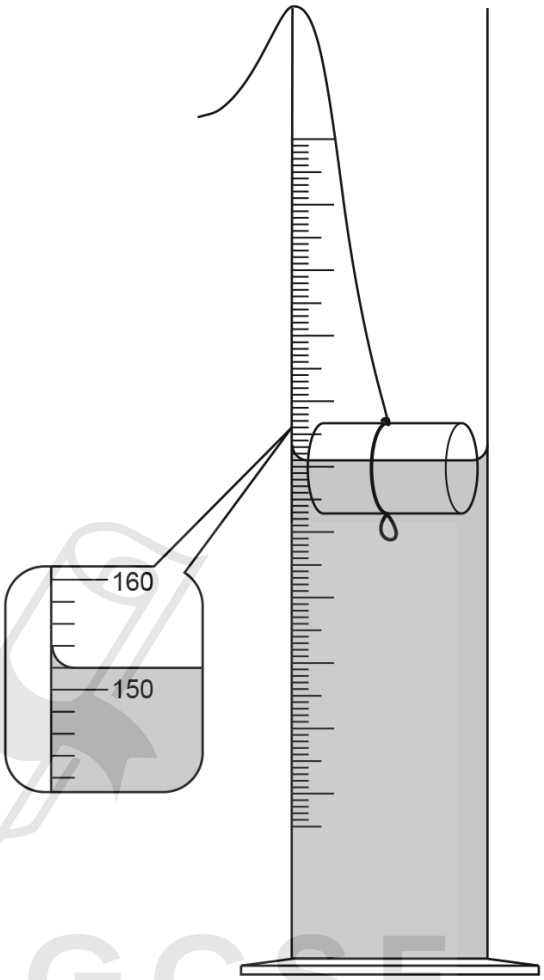

Fig. 1.5

Record the reading V_1 of the water level in the measuring cylinder as shown in Fig. 1.4.

V_1 = ...cm^3

Record the new reading V_2 of the water level in the measuring cylinder with the rod floating in the water as shown in Fig. 1.5.

V_2 = ...cm^3
[1]

(d) The student removes the rod and lowers a piece of modelling clay into the water as shown in Fig. 1.6.
He then hooks the rod to the modelling clay and lowers them into the water as shown in Fig. 1.7.

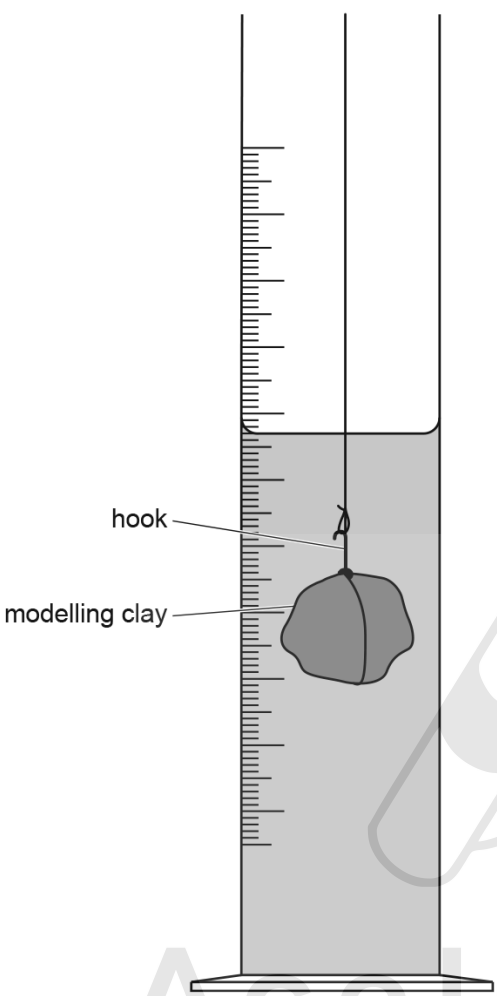

Fig. 1.6

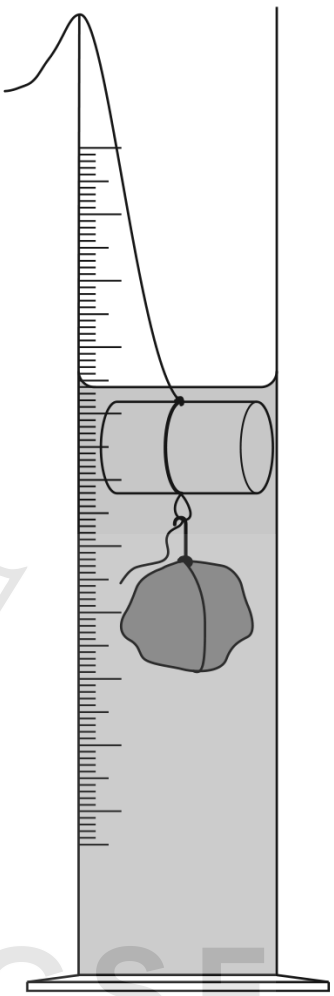

Fig. 1.7

He records the new reading V_3 of the water level in the measuring cylinder with the modelling clay.

He records the reading V_4 of the water level in the measuring cylinder with the modelling clay and rod.

V_3 = ...164.....cm^3

V_4 = ...178.....cm^3

Calculate another value ρ_2 for the density of the wooden rod. Use the values from **(c)** and **(d)** and the equation $\rho_2 = \dfrac{(V_2 - V_1)}{(V_4 - V_3)} \times k$ where $k = 1.0\,\text{g/cm}^3$.

ρ_2 = ... [2]

(e)

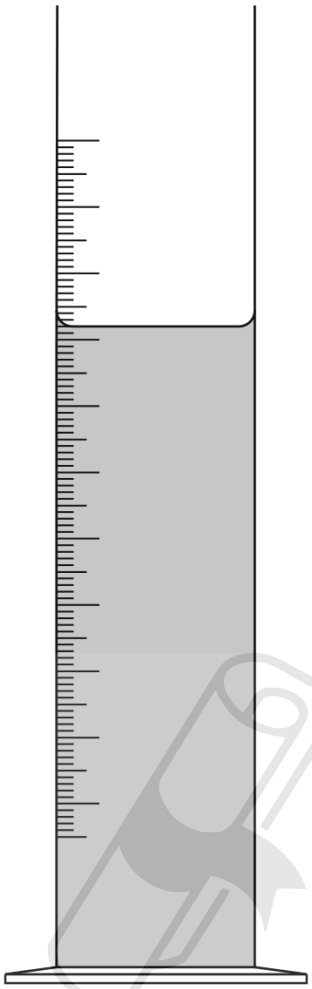

Fig. 1.8

On Fig. 1.8, **draw** an arrow showing the correct line of sight for reading the volume of water in the measuring cylinder. [1]

(f) Suggest a possible source of inaccuracy in **Method 2**, even if it was carried out carefully.

.....

..... [1]

[Total: 11]

02. 0625_s18_qp_62 Q: 1

A student is determining the density of water. She is provided with a plastic cup, shown in Fig. 1.1.

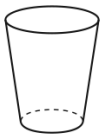

Fig. 1.1

(a) She draws around the base of the cup. Her drawing is shown in Fig. 1.2.

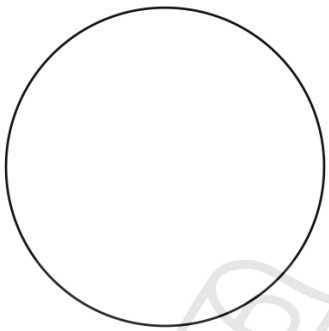

Fig. 1.2

(i) From Fig. 1.2, take and record measurements to determine an accurate value for the diameter D_B of the base of the cup.

D_B = ... cm [2]

(ii) The student places the cup upside down and draws around the rim of the cup.
She determines the diameter D_T of the rim of the cup.

D_T = 7.2 cm

Calculate the average diameter D of the cup using the equation $D = \frac{D_B + D_T}{2}$.

D = ... cm [1]

(b) 1. On Fig. 1.3, measure the vertical height h of the cup.

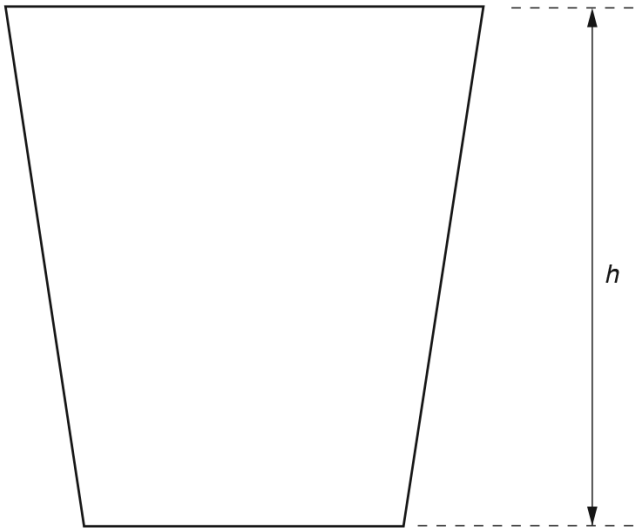

Fig. 1.3

h = ... cm

2. Calculate the volume V of the cup using the equation $V = 0.785\,D^2\,h$.

V = ... cm^3
[1]

(c) The student fills the cup with water. The mass of the cup with the water is shown in Fig. 1.4.

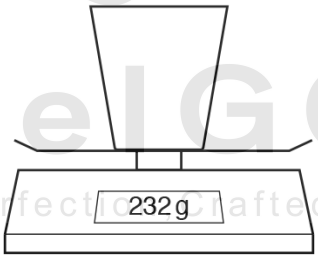

Fig. 1.4

Determine the density ρ of water using the equation $\rho = \frac{m}{V}$ and your value from **(b)2**.

Give your answer to a suitable number of significant figures for this experiment. Include the unit.

ρ = ... [3]

(d) Suggest, with a reason, a part of the procedure **(a)**, **(b)** or **(c)** that could give an unreliable result for the density of water.

part .....

reason .....

.....

[1]

(e) The student pours the water from the cup into a measuring cylinder.

Draw a diagram to show water in a measuring cylinder. Show clearly the meniscus and the line of sight the student should use to obtain an accurate value for the volume of the water.

[2]

[Total: 10]

03. 0625_w18_qp_63 Q: 1

A student is determining the density of modelling clay.

He is using the block shown in Fig. 1.1 and Fig. 1.2.

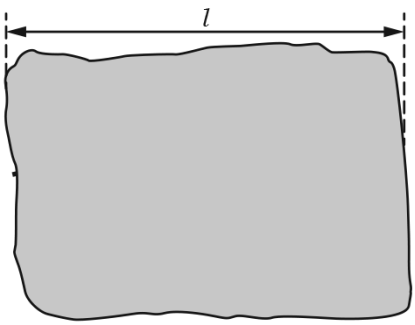

Fig. 1.1

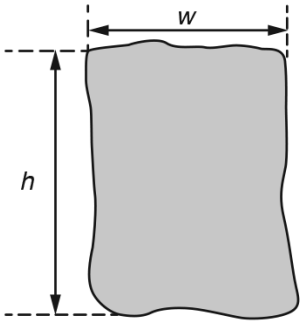

Fig. 1.2 (side view)

(a) (i) Measure the dimensions of the block of modelling clay, as shown in Fig. 1.1 and Fig. 1.2.

length l = ... cm

width w = ... cm

height h = ... cm
[1]

(ii) Calculate the volume V_1 of the block, using your measurements from **(a)(i)** and the equation $V_1 = l \times w \times h$.

V_1 = ... cm^3 [1]

(b) Suggest a possible source of inaccuracy in measuring the dimensions of the block and describe an improvement to the procedure that will produce more reliable measurements of the block.

suggestion .....

.....

improvement .....

.....

.....
[2]

(c) The student suspends the piece of modelling clay from a forcemeter, as shown in Fig. 1.3.

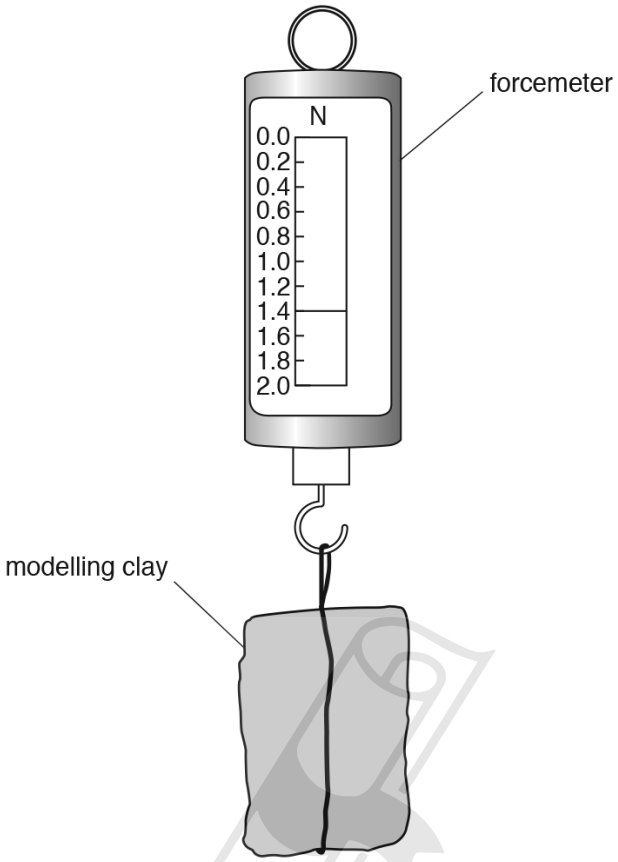

Fig. 1.3

Record the weight W of the block of modelling clay shown in Fig. 1.3.

W = ... N [1]

(d) Calculate a value ρ_1 for the density of the modelling clay, using your results from **(a)(ii)** and **(c)** and the equation

$$\rho_1 = \frac{W \times k}{V_1},$$

where $k = 100\,\text{g/N}$.

ρ_1 = ... [2]

(e) The student pours some water into a measuring cylinder, as shown in Fig. 1.4.

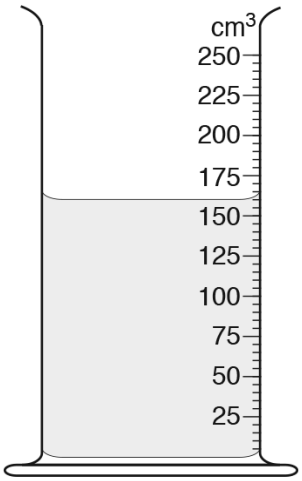

Fig. 1.4

(i) Record the volume V_2 of the water in the measuring cylinder shown in Fig. 1.4.

V_2 = ... cm^3 [1]

(ii) Describe how a measuring cylinder is read to obtain an accurate value for the volume of water. You may draw a diagram to help you.

.....

.....

..... [1]

(f) The student lowers the modelling clay into the water, as shown in Fig. 1.5.

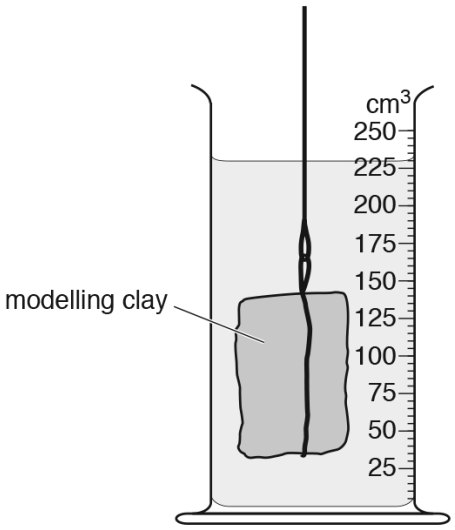

Fig. 1.5

(i) • Record the new reading V_3 of the measuring cylinder in Fig. 1.5, with the block of modelling clay in the water.

V_3 = ... cm^3

• Calculate another value ρ_2 for the density of modelling clay, using your value for V_3, your readings from **(c)** and **(e)(i)** and the equation

$$\rho_2 = \frac{W \times k}{(V_3 - V_2)},$$

where $k = 100\,g/N$.

ρ_2 = ...
[1]

(ii) Suggest which of ρ_1 or ρ_2 is likely to be the more accurate value for the density of the modelling clay.

Justify your answer by referring to the procedure.

.....

.....

..... [1]

[Total: 11]

04. 0625_s17_qp_63 Q: 1

A student is determining the density of water by two methods.

Method 1

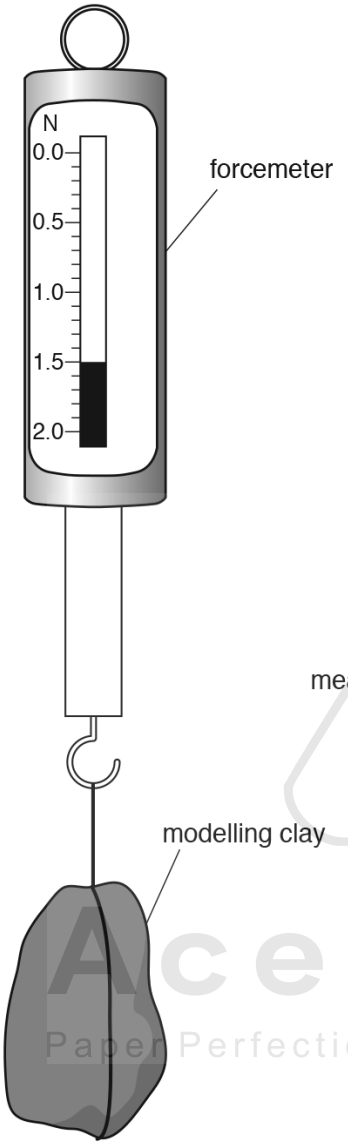

Fig. 1.1

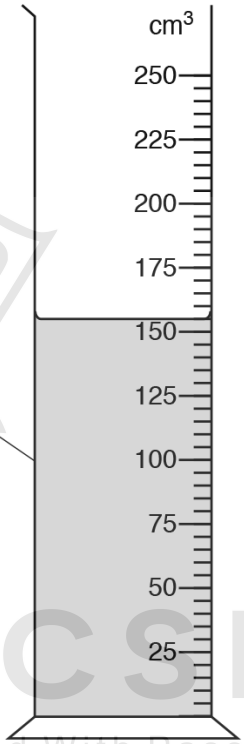

Fig. 1.2

(a) Record the weight W_1 of the piece of modelling clay shown in Fig. 1.1.

W_1 = ... N [1]

(b) **(i)** Record the volume V_1 of the water in the measuring cylinder shown in Fig. 1.2.

V_1 = ... cm^3 [1]

(ii) Describe briefly how a measuring cylinder is read to obtain an accurate value for the volume of water. You may draw a diagram.

.....

.....

.....[2]

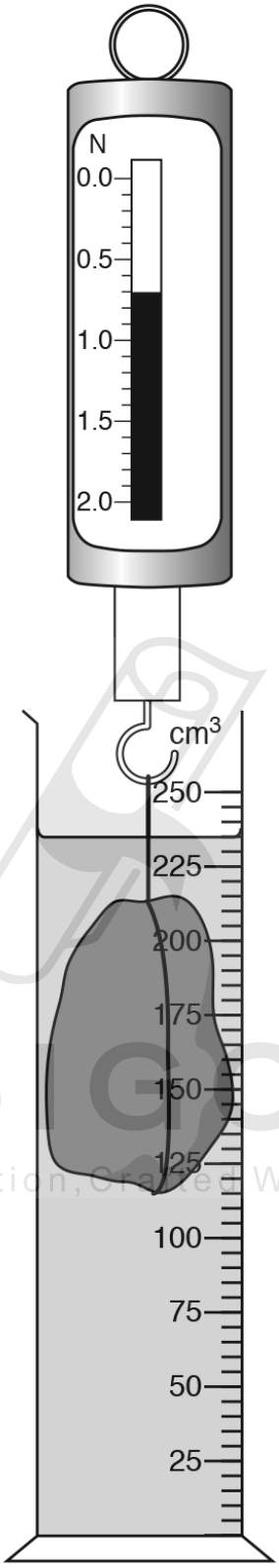

Fig. 1.3

(c) The student lowers the modelling clay into the water, as shown in Fig. 1.3.

- Record the new reading W_2 of the forcemeter.

W_2 = ... N

- Record the new reading V_2 of the measuring cylinder, with the piece of modelling clay in the water.

V_2 = ... cm^3

[1]

(d) Calculate a value ρ_1 for the density of water, using your readings from **(a)**, **(b)** and **(c)** and the equation

$$\rho_1 = \frac{(W_1 - W_2)}{(V_2 - V_1)} \times k$$

where $k = 100\,g/N$.

ρ_1 = ...[2]

Method 2

(e) The student removes the modelling clay from the water and places the measuring cylinder on a balance.

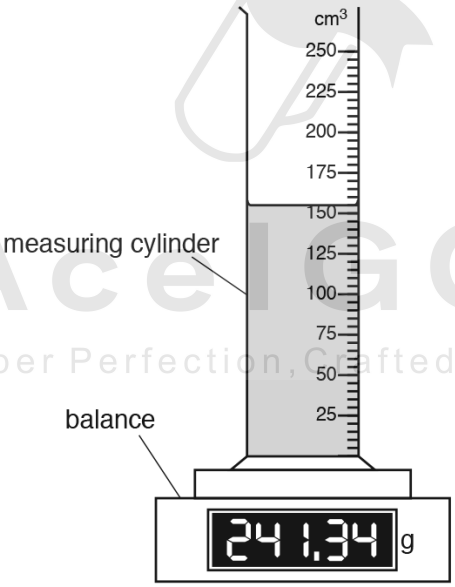

Fig. 1.4

The reading for the mass m_1 of the measuring cylinder and water is shown in Fig. 1.4.

Record m_1 to the nearest gram.

m_1 = ...[1]

(f) The student pours the water out of the measuring cylinder and measures the mass m_2 of the empty measuring cylinder.

m_2 = 93 .....g

- Calculate a second value ρ_2 for the density of water, using your readings from **(b)**, **(e)** and **(f)** and the equation

$$\rho_2 = \frac{(m_1 - m_2)}{V_1}.$$

ρ_2 = ...

- Calculate an average value ρ_{AV} for the density of water, using your results for ρ_1 and ρ_2.

ρ_{AV} = ...
[1]

(g) Suggest a possible source of inaccuracy in either **Method 1** or **Method 2**, even when they are carried out carefully.

Explain how an improvement might be made to reduce this inaccuracy.

suggestion .....

.....

improvement .....

.....
[2]

[Total: 11]

05. 0625_m16_qp_62 Q: 2

The class is carrying out an experiment to determine the density of glass.

Each student has a test-tube, as shown in Fig. 2.1.

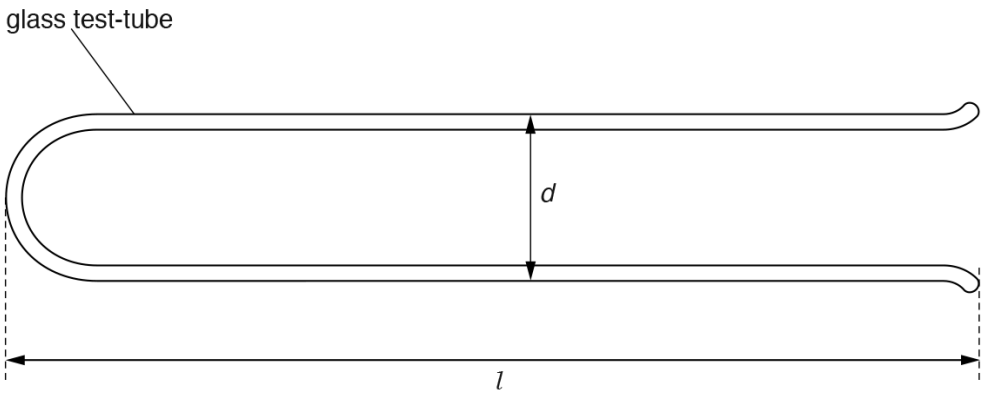

Fig. 2.1

(a) (i) • Measure the length l of the test-tube shown in Fig. 2.1.

l = ... cm

• Measure the external diameter d of the test-tube.

d = ... cm
[1]

(ii) A student uses two wooden blocks to help him to measure the diameter d of the test-tube.

Describe his method. You may draw a diagram. Include one precaution which could be taken to ensure that the value of d is as reliable as possible.

.....

.....

.....[2]

(iii) Assuming that the test-tube is an approximate cylinder, calculate a value for its external volume V_1 using the equation $V_1 = \frac{\pi d^2 l}{4}$.

V_1 = ... cm^3 [1]

(b) The test-tube is completely filled with water and then the water from the test-tube is poured into a measuring cylinder.

(i) Read and record the volume V_2 of the water as shown in Fig. 2.2.

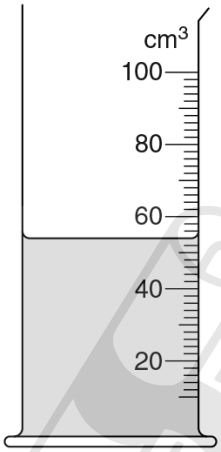

Fig. 2.2

V_2 = ... cm^3 [1]

(ii) Describe briefly how you would read the measuring cylinder to obtain a reliable value for the volume of water. You may add to Fig. 2.2 to illustrate your explanation.

.....

.....

.....[1]

(iii) Calculate the volume V_3 of the glass, using the equation $V_3 = V_1 - V_2$.

V_3 = ... cm^3 [1]

(c) One student uses a balance to measure the mass m of the test-tube, as shown in Fig. 2.3.

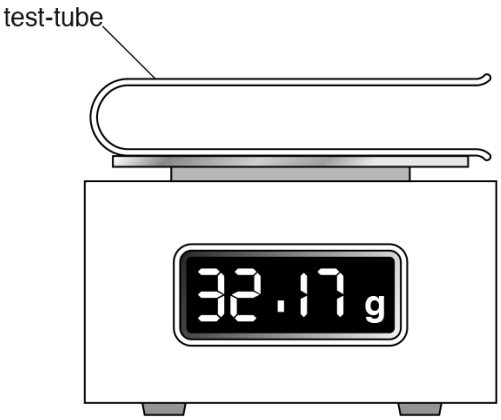

Fig. 2.3

(i) Calculate the density ρ of the glass, using the equation $\rho = \frac{m}{V_3}$.

ρ = ... [2]

(ii) Other students are using a balance which only measures to the nearest gram.

Record the mass m of the test-tube to the nearest gram.

m = ... g [1]

(d) The precision of the balance does not affect the accuracy of this experiment.

State one possible source of inaccuracy in the experiment. Explain what effect this inaccuracy would have on the value obtained for ρ.

.....

.....

.....

.....

.....[2]

[Total: 12]

06. 0625_s14_qp_63 Q: 1

The IGCSE students are carrying out measurements in order to determine the density of water using two methods.

(a) Method 1

Fig. 1.1 shows an empty measuring cylinder on a balance and Fig. 1.2 shows the measuring cylinder containing water.

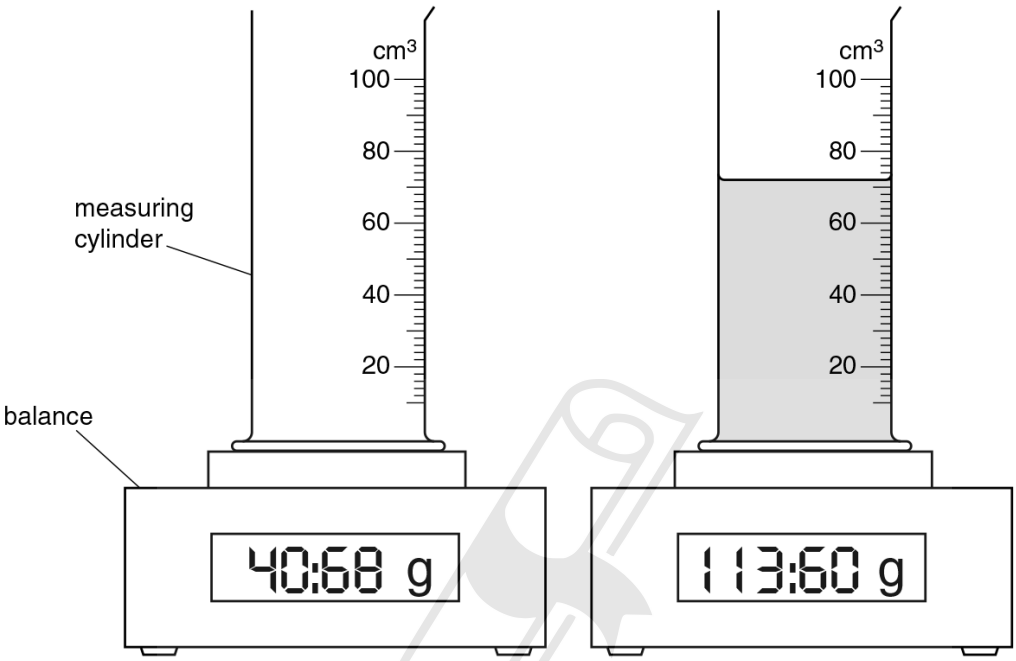

Fig. 1.1 **Fig. 1.2**

(i) Read and record the mass m_1 of the empty measuring cylinder.

m_1 = ... g

(ii) Read and record the mass m_2 of the measuring cylinder and water.

m_2 = ... g

(iii) Read and record the volume V_1 of water, as shown in Fig. 1.2.

V_1 = ... cm^3

(iv) Calculate a value ρ_1 for the density of water using your readings from **(a)(i)**, **(ii)** and **(iii)** and the equation $\rho_1 = \frac{m_2 - m_1}{V_1}$. Give an appropriate unit.

ρ_1 = ...
[3]

(b) Method 2

In this method, a test-tube is floated in the water left in the measuring cylinder from Method 1 and the change in water level is measured.

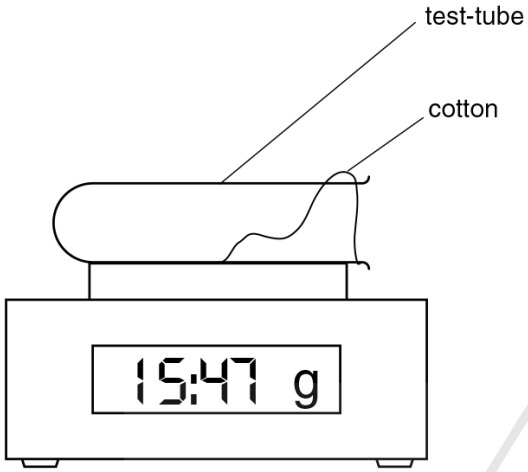

Fig. 1.3

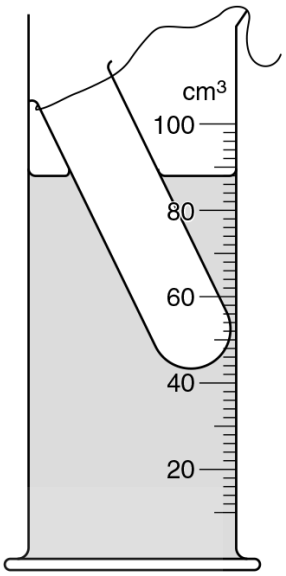

Fig. 1.4

(i) Read and record the mass m_3 of the test-tube, as shown in Fig. 1.3.

m_3 = ...

(ii) The test-tube is carefully lowered, by means of a piece of cotton, into the measuring cylinder until it floats as shown in Fig. 1.4. Read and record the new water level V_2 in the measuring cylinder.

V_2 = ...

(iii) Using your results from **(a)(iii)** and **(b)(ii)**, calculate V_3, the change in the water level, where $V_3 = (V_2 - V_1)$.

V_3 = ...

(iv) Calculate and record a value ρ_2 for the density of water using the equation $\rho_2 = \frac{m_3}{V_3}$.

ρ_2 = ...
[3]

(c) Calculate an average value ρ_{AV} for the density of water using your results from **(a)(iv)** and **(b)(iv)**.

ρ_{AV} = ... [1]

(d) Suggest a precaution that should be taken in **Method 1** to ensure that the volume reading is as accurate as possible.

.....

.....

.....[1]

(e) Suggest a possible source of experimental inaccuracy in **Method 2**, other than with the volume reading.

State and explain the effect that this would have on your value for ρ_2.

suggestion .....

.....

effect and explanation .....

.....

[2]

[Total: 10]

07. 0625_s13_qp_63 Q: 4

The IGCSE class has been asked to determine the density of an object.

One student is finding the volume of the object using a measuring cylinder containing water in which the object is to be placed.

The measuring cylinder containing only water is shown in Fig. 4.1.

The measuring cylinder after the object has been placed in the water is shown in Fig. 4.2.

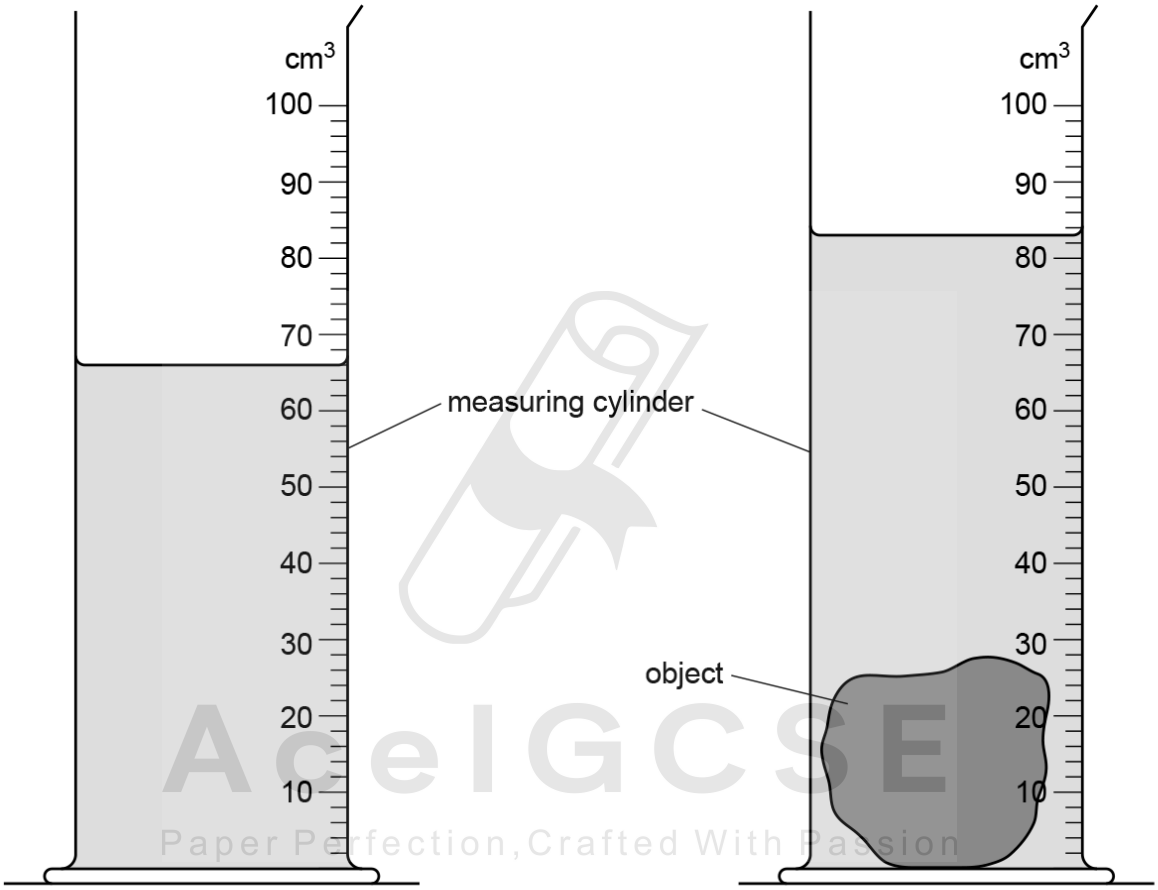

Fig. 4.1 **Fig. 4.2**

(a) **(i)** Read and record the volume V_1 of the water in the measuring cylinder shown in Fig. 4.1.

V_1 = ...

(ii) Read and record the volume V_2 of the water in the measuring cylinder shown in Fig. 4.2.

V_2 = ...
[2]

(b) The student then uses a balance to measure the mass *m* of the object, as shown in Fig. 4.3.

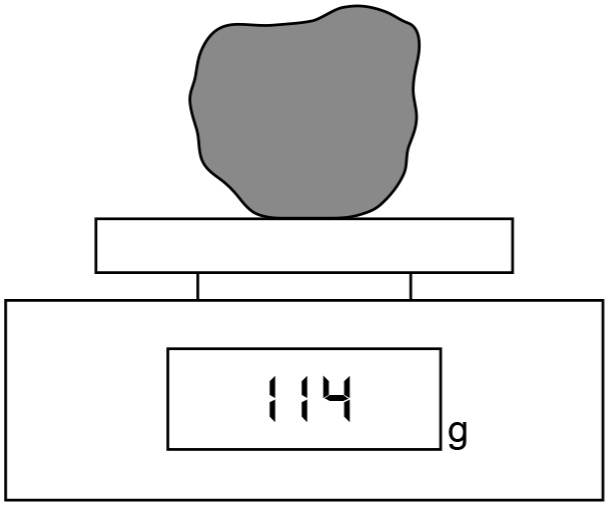

Fig. 4.3

Calculate the density of the object using the equation

$$\text{density} = \frac{m}{(V_2 - V_1)}.$$

density = ...[2]

(c) Suggest a possible practical cause of inaccuracy in this method.

.....

.....

.....[1]

[Total: 5]

01. 0625_m20_MS_62 Q: 1

(a)(i)	l = 4.5 (cm) and d = 2.0 (cm)	1
	both to 1 decimal place	1
(a)(ii)	method outlined /	1
	how diameter determined accurately e.g. use of string wrapped round rod and measured / several turns and calculate diameter from circumference, OR use of rod between two blocks and measure gap / in at least 2 places and take average, OR means of measuring diameter across ends / at several places and take average, OR use of micrometer, (vernier) callipers / at various points (along length or across ends) and take average	1
(b)	m present and ρ_1 = 0.55 / ecf	1
	correct unit (g / cm^3)	1
(c)	V_1 = 144 (cm^3) and V_2 = 152 (cm^3)	1
(d)	ρ_2 = 0.57 / ecf	1
	ρ_1 and ρ_2 to consistent 2 or consistent 3 significant figures	1
(e)	straight arrow perpendicular to measuring cylinder	1

(f)	suitable source of inaccuracy e.g.: measuring cylinder scales less precise / accurate, water lost on transfer / droplets on clay, wood might absorb water	1

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02. 0625_s18_MS_62 Q: 1

(a)(i)	2 or more measurements seen	1
	D_B = 4.8 ± 0.1 (cm)	1
(a)(ii)	D = 6.0 (cm)	1
(b)	1 h = 7.8 (cm) **AND** 2 V = 220(.428) (cm^3)	1
(c)	ρ = 1 / 1.1 / 1.05(…….)	1
	2 or 3 significant figures	1
	g / cm^3	1
(d)	any **one** from: part **(a)** drawn circle not exact / thickness of rim or cup / thickness of the pencil line part **(b)** difficult to measure the height (in practice) / D^2 increases inaccuracy in D part **(c)** mass of cup has been ignored	1
(e)	diagram showing clearly:	
	line of sight perpendicular to measuring cylinder	1
	to the bottom of the meniscus	1

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03. 0625_w18_MS_63 Q: 1

(a)(i)	l = 6.0, w = 3.0, h = 4.0 (cm)	1
(a)(ii)	V_1 = 72 (cm^3)	1
(b)	difficult to measure irregular dimensions / owtte	1
	repeat (in several places for each dimension and take averages)	1
(c)	W = 1.4 (N)	1
(d)	ρ_1 = 1.9(4)	1
	unit g / cm^3	1
(e)(i)	V_2 = 160 (cm^3)	1
(e)(ii)	line of sight perpendicular	1
(f)(i)	V_3 present and ρ_2 = 2.0(g / cm^3)	1
(f)(ii)	*suggestion supported by valid reason e.g.* ρ_2 as volume is measured directly; ρ_1 as measuring cylinder is less precise; string adds to volume displaced.	1

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04. 0625_s17_MS_63 Q: 1

(a)	W_1 = 1.5 (N)	1
(b)(i)	V_1 = 155 (cm^3)	1
(b)(ii)	line of sight perpendicular	1
	to bottom of meniscus	1
(c)	W_2 = 0.7 (N) and V_2 = 235 (cm^3)	1
(d)	ρ_1 = 1.0 or ecf	1
	unit g/cm^3	1
(e)	m_1 = 241 (g)	1
(f)	ρ_{AV} 0.978 / 0.977(g/cm^3)	1
(g)	appropriate cause of inaccuracy: e.g: • some water still in empty measuring cylinder • water spilled, splashed when putty put in water • water drops on putty when removed • air bubbles on putty	1
	suitable improvement: e.g: • measure m_2 at start (when cylinder dry) • measure new volume in Method OR refill to correct value • shake putty to remove air / smooth surface to minimise bubbles	1
	Total:	11

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05. 0625_m16_MS_62 Q: 2

(a) (i) l = 14.7 AND d = 2.5 [1]

(ii) boiling tube between blocks and ruler spanning gap [1]

suitable precaution e.g. [1]
measure in (at least) 2 places and take average,
avoid lip,
ensure blocks smooth,
no dirt between tube and block

(iii) V_1 = 72 [1]

(b) (i) V_2 = 54 [1]

(ii) line of sight perpendicular to reading / [1]
read from bottom of meniscus

(iii) V_3 correctly calculated [1]

(c) (i) ρ = 1.7 to 1.8 [1]

unit g / cm^3 [1]

(ii) m = 32 (g) [1]

(d) suitable source of inaccuracy [1]
e.g.
- any reference to why tube is not a cylinder,
- tube may contain some water when mass taken,
- difficult to fill to brim and then pour out

appropriate effect on value of ρ explained [1]

[Total: 12]

(a)(i)(ii) $m_1 = 40.68\,(g)$ and $m_2 = 113.60\,(g)$
correct answer only (not 40:68, 113:60) [1]

(iii) $V_1 = 72\ (cm^3)$ correct answer only [1]

(iv) ρ_1 with unit of g/cm^3 or kg/m^3 seen in **(a)**, **(b)** or **(c)** and not contradicted
(unit must match value) [1]

(b)(i)(ii) $m_3 = 15.47\,(g)$ and $V_2 = 88\,(cm^3)$ correct answer only [1]

(iii) $V_3 = 16\ (cm^3)$ / ecf [1]

(iv) ρ_2 to 2 / 3 sig. figs. [1]

(c) ρ_{AV} 0.99(1) (g/cm^3) **or** 991 / 990 (kg/m^3) **or** ecf from **(a)** and **(b)** [1]

(d) any one from:
- take reading perpendicularly / at right angles to scale
- read bottom of meniscus
- other suitable precaution [1]

(e) appropriate source of inaccuracy, other than in **(d)**
e.g. balance not at zero / test-tube catches on side of measuring cylinder [1]

matching effect on ρ with explanation
e.g. ρ greater as mass reading larger / ρ greater as volume smaller [1]

[Total: 10]

07. 0625_s13_MS_63 Q: 4

(a) $V_1 = 66\,(cm^3)$ [1]
$V_2 = 83\,(cm^3)$ [1]

(b) density = 6.7 or 6.71 / allow e.c.f. [1]
unit g/cm^3 [1]

(c) suitable cause:
e.g. object not dried before measuring mass
mass measured after immersion
measuring cylinder not read at eye-level / parallax explained
measuring cylinder not read at meniscus (o.w.t.t.e.)
zero reading on balance not allowed for [1]

[Total: 5]