SMART EXAM RESOURCES
0654 COORDINATED SCIENCES
PHYSICS
DENSITY-MASS-VOLUME-MEASUREMENT-SET-5-QP-MS

1 A student measures the density of water by two different methods.

(a) Method 1

She uses a balance to measure the mass m_1 of an empty measuring cylinder.

The scale of the balance is shown in Fig. 3.1.

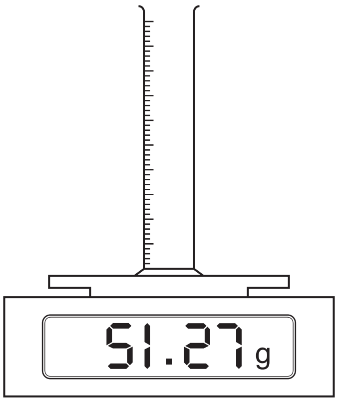

Fig. 3.1

(i) Read the scale and record the mass of the empty measuring cylinder to the nearest 0.1 g.

m_1 = ... g [1]

(ii) She removes the measuring cylinder from the balance and pours water into it. Part of the scale of the measuring cylinder is shown in Fig. 3.2.

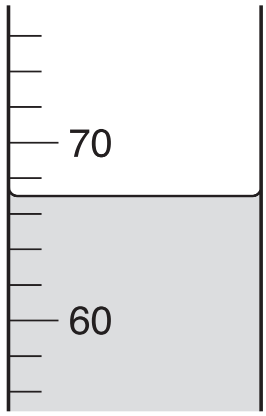

Fig. 3.2

Read the scale and record the volume V_1 of water in the measuring cylinder.

V_1 = ... cm^3 [1]

(iii) State how the student should ensure that the reading of the volume of water in the measuring cylinder that she records in **(a)(ii)** is as accurate as possible.

....

....[1]

(iv) She uses the balance to measure and record the mass m_2 of the measuring cylinder and water.

$$m_2 = 120.4\,g$$

Calculate the density d_1 of the water using your values from **(a)(i)** and **(a)(ii)** and the value of m_2. Use the equation shown. State the unit of your answer.

$$d_1 = \frac{(m_2 - m_1)}{V_1}$$

d_1 = ... unit = ... [2]

(b) **Method 2**

The student uses the balance provided to measure and record the mass m_3 of a test-tube.

$$m_3 = 18.1\,g$$

She takes the measuring cylinder and water used in **Method 1** and slowly lowers the test-tube into the measuring cylinder until it floats, approximately vertically, as shown in Fig. 3.3.

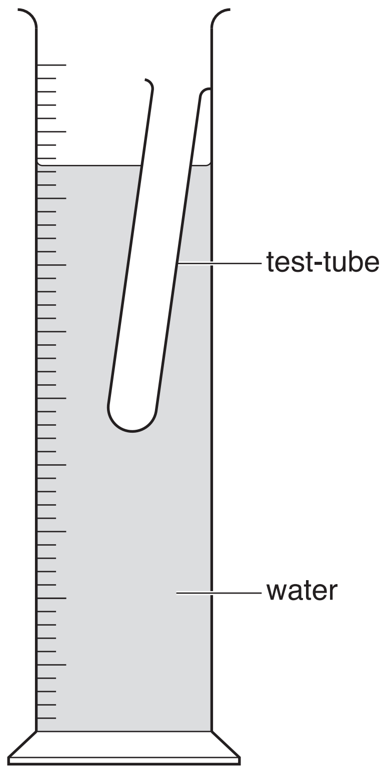

Fig. 3.3

She measures the volume V_2 of water recorded by the measuring cylinder.

$$V_2 = 85\,cm^3$$

(i) Use the volume value from **(a)(ii)** and V_2 to calculate the volume of water V_3 displaced by the test-tube.

V_3 = ... cm^3 [1]

(ii) Calculate the density d_2 of the water using your value from **(b)(i)** and the value of m_3. Use the equation shown.

$$d_2 = \frac{m_3}{V_3}$$

d_2 = ... [2]

(c) **(i)** Apart from the reading of the volumes, suggest **one** other possible source of inaccuracy in **Method 2**.

....

....[1]

(ii) Suggest **one** reason why it is good experimental practice for the student to carry out the two measurements of density in the order that she does.

....

....[1]

Question	Answer	Marks
a)(i)	51.3 (g) ;	**1**
a)(ii)	67 (cm^3) ;	**1**
(a)(iii)	read to bottom of meniscus / take reading at eye level / perpendicular to scale ;	**1**
(a)(iv)	1.03 ; g / cm^3 ;	**2**
(b)(i)	18 (cm^3) ;	**1**
(b)(ii)	($\frac{18.1}{(b)(i)}$) 1.0 / 1.01 (g / cm^3) ; 2 or 3 significant figures ;	**2**
(c)(i)	zero error on balance / test-tube touching side of cylinder ;	**1**
(c)(ii)	measuring cylinder otherwise wet / contains some water when its ‘dry’ mass is measured ;	**1**

DENSITY OF A MATERIAL

2 A student measures the density of the material from which a metre rule is made.

(a) Procedure

The student:

- places a load **M** on a metre rule and adjusts its position carefully until the centre of the load is directly above the 15.0 cm mark on the metre rule
- places a pivot under the rule and adjusts the position of the pivot carefully until the rule is as close to balance as possible.

Fig. 6.1 shows the metre rule at balance viewed from the side.

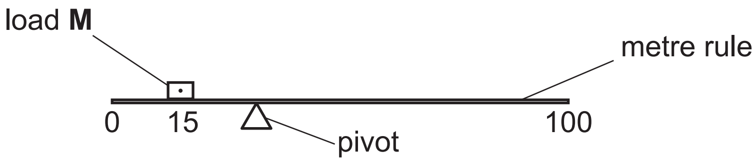

Fig. 6.1

Fig. 6.2 shows the position of the pivot at balance viewed from above.

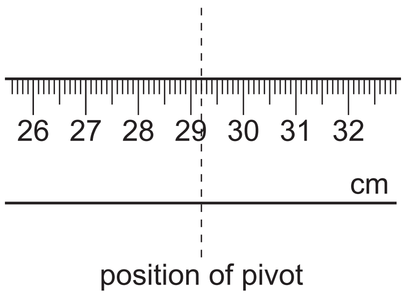

Fig. 6.2

(i) Record the position *r* of the pivot in centimetres to the nearest 0.1 cm.

r = ... cm [1]

(ii) Calculate the distance *d* from the centre of load **M** to the pivot.

d = ... cm [1]

(b) Describe how the student makes sure that the centre of load **M** is directly above the 15.0 cm mark on the metre rule. You may draw a diagram if you wish.

....

(c) **(i)** Calculate the mass *m* of the metre rule.

Use the equation shown.

$$m = \frac{150 \times d}{(35 - d)}$$

m = ... g [1]

(ii) State the name of a piece of apparatus that the student uses to check the result in **(c)(i)**.

.... [1]

(d) The student measures the thickness *t* and the width *w* of the metre rule. The student's results are shown.

$t = 0.5\,\text{cm}$

$w = 2.5\,\text{cm}$

Calculate the volume *V* of the metre rule.

Use the equation shown.

$$V = 100 \times t \times w$$

V = ... cm^3 [1]

(e) Use your answers to **(c)(i)** and **(d)** to calculate the density ρ of the material from which the metre rule is made.

Use the equation shown.

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

ρ = ... unit = ... [2]

[Total: 8]

MARKSCHEME:

(a)(i)	29.2 ;	**1**
(a)(ii)	14.2 ;	**1**
(b)	note reading on either side of load and find the mean value and place on 15 cm mark ;	**1**
(c)(i)	102 (g) ;	**1**
(c)(iii)	(top pan) balance ;	**1**
(d)	125 (cm^3) ;	**1**
(e)	0.816 / 0.82 ; g / cm^3 ;	**2**

3 A student measures the density of plasticine (modelling clay) by two different methods.

Method 1

(a) Procedure

The student:

- places a piece of plasticine onto a top-pan balance
- records the mass m of the plasticine.

Fig. 5.1 shows the reading on the balance.

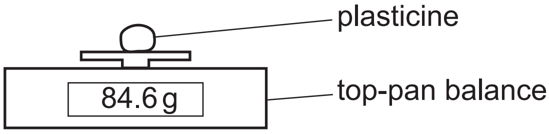

Fig. 5.1

Record the mass of the plasticine to the nearest gram.

m = ... g [1]

(b) (i) Procedure

The student:

- pours water into a measuring cylinder
- records in Table 5.1 the volume V_1 of water in the measuring cylinder
- uses a thread to lower the plasticine into the measuring cylinder until it is completely immersed
- records in Table 5.1 the new volume V_2.

Fig. 5.2 shows the reading V_2 on the measuring cylinder.

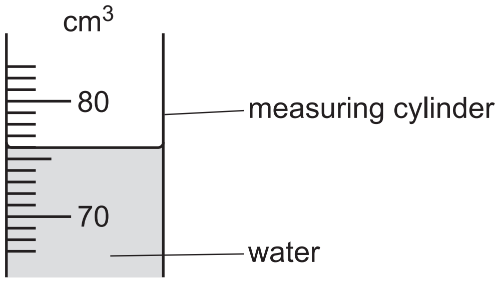

Fig. 5.2

Record in Table 5.1 the reading on the measuring cylinder.

Table 5.1

V_1 / cm^3	V_2 / cm^3
31	

[1]

(ii) Use the values of V_1 and V_2 to calculate the volume V of the piece of plasticine.

V = ... cm^3 [1]

(iii) State **one** precaution that the student takes when reading the volume of water in a measuring cylinder to obtain an accurate reading.

....

.... [1]

(c) Suggest why the mass of the plasticine is measured before its volume is measured.

....

.... [1]

(d) Use your answers to **(a)** and **(b)(ii)** to calculate the density ρ_1 of the plasticine.

Use the equation shown.

$$\rho_1 = \frac{m}{V}$$

Give the unit for your answer.

ρ_1 = ... unit .... [2]

Method 2

(e) Procedure

The student:

- removes the plasticine from the measuring cylinder
- dries the plasticine with a paper towel
- moulds the plasticine into a shape that approximates to a sphere
- places the plasticine between two wooden blocks
- uses a ruler to measure the diameter d_1 of the sphere of plasticine in centimetres to the nearest 0.1 cm.

Fig. 5.3 is a full-size diagram that shows how the student arranges the wooden blocks and the sphere.

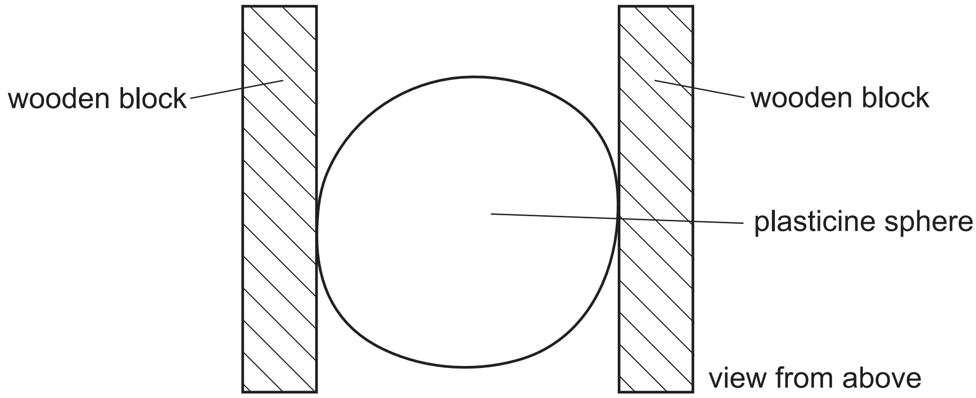

Fig. 5.3

(i) Suggest why the wooden blocks must be parallel to one another.

....

.... [1]

(ii) Use a ruler to measure the horizontal diameter d_1 of the sphere of plasticine in centimetres to the nearest 0.1 cm.

d_1 = ... cm [1]

(iii) The student rotates the sphere and measures the diameter d_2 of the sphere across a different part of the sphere.

d_2 = 4.4 cm

Use the values of d_1 and d_2 to calculate the average diameter D of the sphere.

D = ... cm [1]

(f) Calculate the volume V_S of the plasticine sphere.

Use the equation shown.

$$V_S = 0.52D^3$$

V_S = ... cm^3 [1]

(g) Use your answers to **(a)** and **(f)** to calculate the density ρ_2 of the plasticine.

Use the equation shown.

$$\rho_2 = \frac{m}{V_S}$$

ρ_2 = ... [1]

(h) Compare your answers for the density of plasticine from **(d)** and **(g)**.

Suggest **one practical** reason why the values are different.

....

.... [1]

[Total: 13]

MARKSCHEME:

(a)	85 recorded to nearest gram ;	1
(b)(i)	76 ;	1
(b)(ii)	45 ;	1
(b)(iii)	view scale at right angles / at eye level / perpendicular ;	1
(c)	water on the plasticine adds to its mass ;	1
(d)	1.9 ; g / cm^3 ;	2
(e)(i)	so that the distance between them is constant ;	1
(e)(ii)	4.0 ;	1
(e)(iii)	4.2 ;	1
(f)	38.5 ;	1
(g)	2.2 ;	1
(h)	*any **one** from:* difficult to mould a perfect sphere ; water still remaining on plasticine ; measuring cylinder only reads to 1 cm^3 ; volume of thread adds to total volume ; difficult to get blocks parallel ;	1

4 A student determines the volume of a drinks cup using two methods.

(a) (i) Method 1

- She places the cup with its open end facing down on a sheet of paper.
- She draws around the circumference of the open end of the cup with a pencil.

Fig. 5.1 shows the circle that she draws.

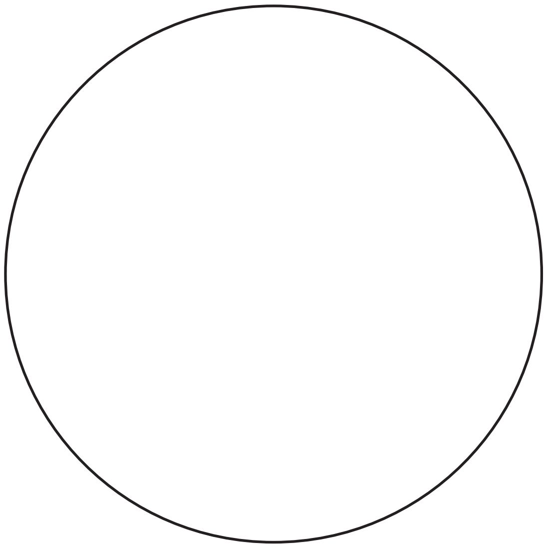

Fig. 5.1

Measure and record to the nearest 0.1 cm the diameter *D* of the circle.

D = ... cm [1]

(ii)
- She turns the cup over and places it with its closed end facing down on the sheet of paper.
- She draws around the circumference of the closed end of the cup with a pencil.

Fig. 5.2 shows the circle that she draws.

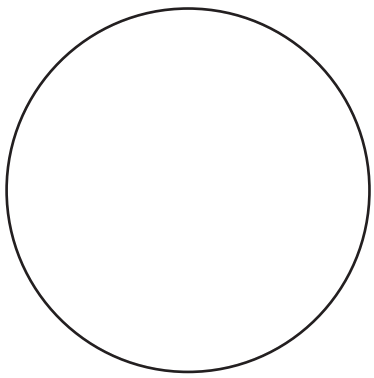

Fig. 5.2

Measure and record to the nearest 0.1 cm the diameter *d* of the circle.

d = ... cm [1]

(b) Measure and record to the nearest 0.1 cm the height h of the cup shown on Fig. 5.3.

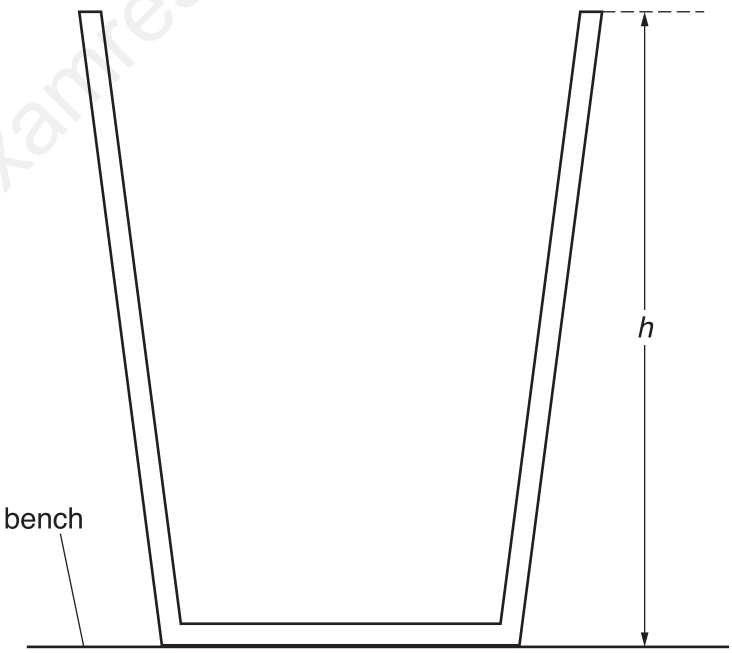

Fig. 5.3

h = ... cm [1]

(c) **(i)** Use your measurements from **(a)(i)** and **(a)(ii)** to calculate the average diameter d_{AV} of the cup. Use the equation shown.

$$d_{AV} = \frac{(D + d)}{2}$$

d_{AV} = ... cm [1]

(ii) Use your values from **(b)** and **(c)(i)** to calculate the volume V of the cup. Use the equation shown.

Give your answer to 3 significant figures.

$$V = 0.785 \times d_{AV}^2 \times h$$

V = ... cm^3 [2]

(d) Method 2

- She fills a measuring cylinder with water up to the 230 cm^3 mark.
- She pours water from the measuring cylinder into the cup until the cup is full.
- She records the new volume V_R of water remaining in the measuring cylinder.

Fig. 5.4 shows the reading V_R.

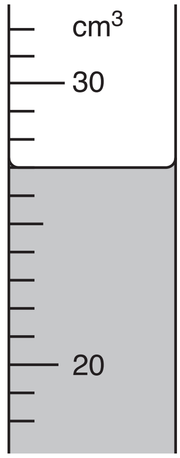

Fig. 5.4

(i) Calculate the volume of water V_W that the cup can hold. Use the equation shown.

$$V_W = 230 - V_R$$

V_W = ... cm^3 [1]

(ii) Describe how the student reads the scale of the measuring cylinder to ensure that her values for volume are as accurate as possible.

....

.... [1]

(e) (i) In the equation in **(c)(ii)**, *h* should be the inside height of the cup. Explain why your measurement of *h* in Fig. 5.3 is likely to be inaccurate.

....

.... [1]

(ii) Suggest one practical difficulty the student has in determining an accurate volume V_W of water that the cup can hold in **method 2**.

....

.... [1]

[Total: 10]

(a)(i)	7.1 (cm) ;	**1**
(a)(ii)	4.8 (cm) ;	**1**
(b)	8.4 (cm) ;	**1**
(c)(i)	5.95 (cm) ;	**1**
(c)(ii)	233.444085 ; 233 ;	**2**
(d)(i)	203 ;	**1**
(d)(ii)	read scale at right angles / eye level / read scale at bottom of meniscus ;	**1**
(e)(i)	*h* not measured to the inside bottom of the cup / difficult to measure *h* / thickness of cup ;	**1**
(e)(ii)	cup not completely full / water spilled (on transfer) ;	**1**

MEASURING MASS AND DENSITY OF STONE

5 A student uses a spring to measure the mass and density of a stone.

(a) Fig. 7.1 shows a full-size diagram of the spring.

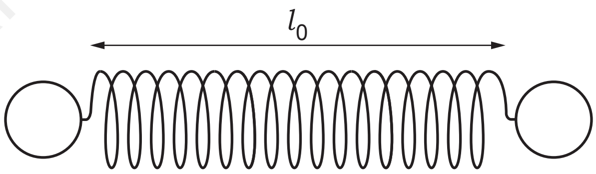

Fig. 7.1

(i) Measure and record the length l_0 of the unstretched spring in centimetres to the nearest millimetre.

l_0 = ... cm [1]

(ii) The student sets up the spring in a clamp, as shown in Fig. 7.2.

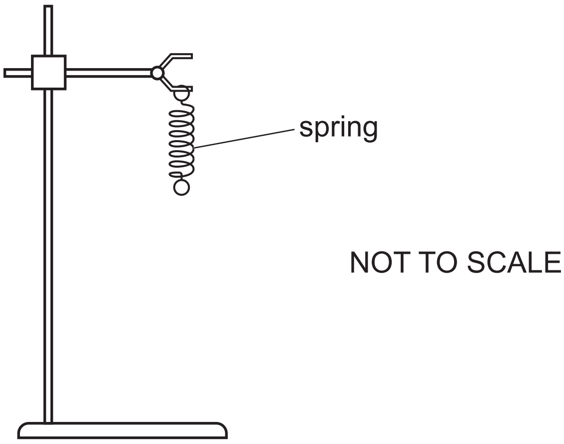

Fig. 7.2

Procedure

The student:

- suspends a mass *m* of 200 g on the spring
- measures the new length l_M of the spring in centimetres to the nearest millimetre.

The student's result is shown.

l_M = ... 13.7 .... cm

Calculate the extension *e* of the spring.

Use the equation shown.

$$e = (l_M - l_0)$$

e = ... cm [1]

(b) Procedure

The student:

- removes the 200 g mass from the spring
- attaches the stone to the spring
- measures the new length l_A of the spring.

The student's result is shown.

l_A = ...14.2.......................... cm

(i) Calculate the extension e_A of the spring caused by the stone.

Use the equation shown.

$$e_A = (l_A - l_0)$$

e_A = ... cm [1]

(ii) Calculate the mass m of the stone.

Use the equation shown.

$$m = \frac{200 \times e_A}{e}$$

Give your answer to **three** significant figures.

m = ... g [2]

(c) Procedure

The student:

- places a beaker of water under the stone
- slowly lowers the clamp until the stone is just completely immersed in the water, as shown in Fig. 7.3

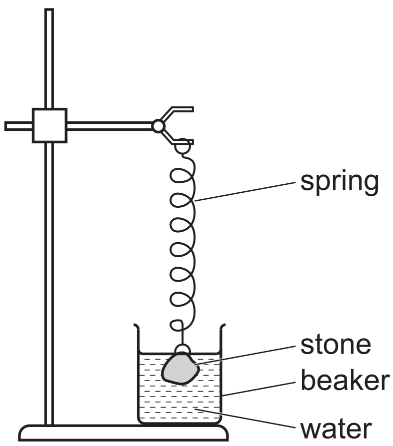

Fig. 7.3

- measures the length l_W of the spring.

The student's result is shown.

l_W = ...10.7.......................... cm

Calculate the extension e_W of the spring.

Use the equation shown.

$$e_W = (l_W - l_0)$$

e_W = ... cm [1]

(d) Use your answers to **(b)(i)** and **(c)** to calculate the density d of the stone.

Use the equation shown.

$$d = \frac{e_A}{(e_A - e_W)}$$

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

(e) **(i)** It is important to avoid a line-of-sight (parallax) error when measuring the length of the spring.

Describe how the student avoids this error.

....

.... [1]

(ii) Suggest how the reliability of the measurements can be improved.

....

.... [1]

(f) The student decides to check their value for the density d of the irregularly shaped stone by using the mass m calculated in **(b)(ii)** and measuring the volume V of the stone.

Suggest a piece of apparatus that the student can use to determine the volume of the stone.

.... [1]

[Total: 10]

MARKSCHEME:

(a)(i)	5.5 (cm) ;	**1**
(a)(ii)	8.2 (cm) ;	**1**
(b)(i)	8.7 (cm) / *e* correct from candidates' values ;	**1**
(b)(ii)	212.195122 (g) ; 212 (g) ;	**2**
(c)	5.2 (cm) ;	**1**
(d)	2.49 / 2.5 (g / cm^3) ;	**1**
(e)(i)	view perpendicularly to scale / rule close to spring / use a fiducial aid ;	**1**
(e)(ii)	repeat measurements and average ;	**1**
(f)	measuring cylinder ;	**1**