1 A science student is trying to find out how much a liquid expands when it is turned into a gas. He is using water as the liquid. The apparatus is shown in Fig 3.1.

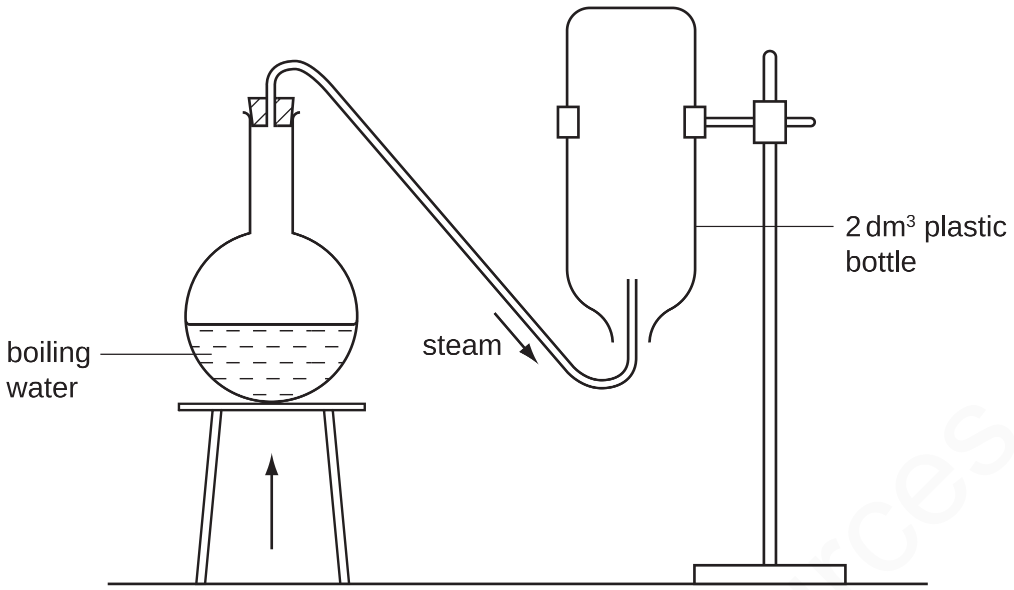


Fig. 3.1

- He weighs a clean, dry plastic 2 dm^3 bottle with its lid on and records the mass, $\mathbf{m_1}$.
- He removes the lid and places the bottle in position as in Fig. 3.1.
- He boils the water and passes steam into the bottle for three or four minutes until the bottle is at 100 °C and no drops of water remain in it. The bottle is now full of steam.
- He quickly removes the bottle from its stand, places it upright and loosely replaces the lid.
- When the bottle has cooled to room temperature he weighs it again and records the mass, $\mathbf{m_2}$.

The balance windows for the masses, $\mathbf{m_1}$ and $\mathbf{m_2}$ are shown in Fig. 3.2.

Fig. 3.2

(a) **(i)** Read and record the masses of the bottle, $\mathbf{m_1}$ and $\mathbf{m_2}$, before and after passing steam into it.

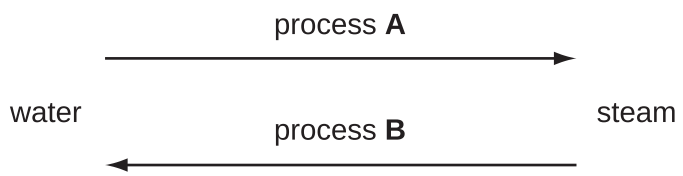
mass $\mathbf{m_1}$= .... g

mass $\mathbf{m_2}$= .... g [2]

(ii) Find the increase in mass of the bottle.

increase in mass of the bottle= .... g [1]

(b) Changing water into steam is a reversible process.



(i) Name process **A** .... [1]

(ii) Name process **B** .... [1]

The mass of water produced when the 2 dm^3 of steam cooled down is given in your answer to **(a)(ii)**.

1 g of water has a volume of 1 cm^3.

(c) **(i)** What volume of water was produced when the 2 dm^3 of steam cooled down?

volume of water = ... cm^3 [1]

(ii) Calculate the volume produced, in cubic centimetres, when 1 cubic centimetre of water is heated and becomes steam.

volume of steam from 1 cm^3 of water = ... cm^3 [2]

(d) In a steam engine, water is heated to give steam. Use the result of this experiment to explain why a powerful force is produced by a steam engine.

....

....

.... [2]

MARKING SCHEME

(a) **(i)** 21.9 g and 23.1 g (exact) ;; [2]

(ii) 23.1 – 21.9 = 1.2 g (ecf) ; [1]

(b) **(i)** process **A** = evaporation / evaporating ; [1]

(ii) process **B** = condensation / condensing ; [1]

(c) **(i)** 1.2 cm^3 (ecf) ; [1]

(ii) volume of steam from 1 cm^3 water = $\frac{2000 \times 1}{1.2}$ (ecf) ;

= 1667 cm^3 (1670) ; [2]

(d) steam has a much greater volume than the water/water expands when it becomes steam ;
expansion causes a force / the particles of steam have a large kinetic energy / OWTTE ; [2]

[Total: 10]

2 A student has three gold-coloured bracelets, **A**, **B** and **C**. She believes that one, two or all three may be different metals, painted gold.

To identify the metal in each bracelet she is going to find out the densities of each one.

To do this she has to find the mass and volume of each bracelet.

(a) To find the volume, she pours exactly 50 cm^3 of water into a 100 cm^3 measuring cylinder.

She carefully drops bracelet **A** into the measuring cylinder and records the new volume in Table 5.1. She calculates the increase in volume. This increase is the volume of the bracelet.

Table 5.1

bracelet	A	B	C
volume of water / cm^3	50.0	50.0	50.0
new volume after / cm^3	54.4		
increase in volume / cm^3	4.4		

(i) Use Fig. 5.1 to read the new volumes for the two bracelets, **B** and **C**. Record these values in Table 5.1. [2]

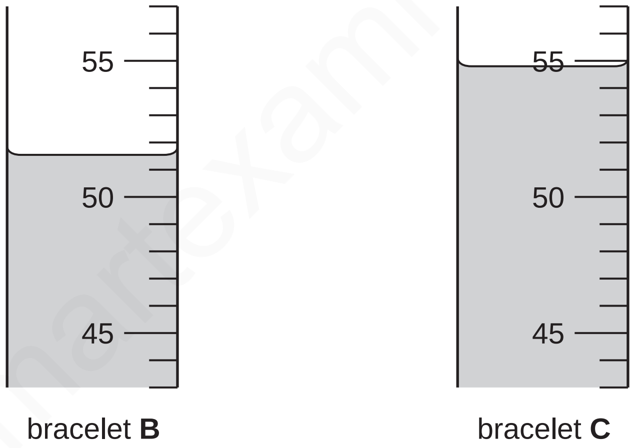


Fig. 5.1

(ii) Calculate the increase in volume for bracelets **B** and **C** and complete Table 5.1. [2]

(b) She now uses a balance to find the mass of bracelet **A**, and records this in Table 5.2.

Table 5.2

bracelet	**A**	**B**	**C**
mass / g	49.8		

Use Fig. 5.2 to find the mass of bracelets **B** and **C** and record the results in Table 5.2. [2]

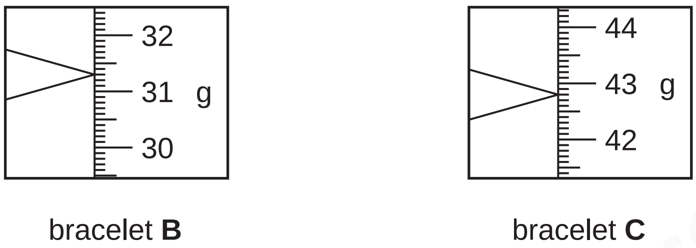


Fig. 5.2

(c) Calculate the density of each bracelet using the following equation.

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

density of bracelet **A** = ... g/cm^3

density of bracelet **B** = ... g/cm^3

density of bracelet **C** = ... g/cm^3 [3]

(d) Use Table 5.3 to suggest what metal each bracelet was made of.

Table 5.3

density in g / cm^3	metal
2.7	aluminium
7.1	zinc
7.7	bronze
7.9	iron
8.9	copper
10.5	silver
11.3	lead
19.9	gold

bracelet **A** ....

bracelet **B** ....

bracelet **C** .... [1]

MARKING SCHEME

(a) **(i)** 51.5 (+/- 0.1) ;
54.8 (+/- 0.1) ; [2]

(ii) 1.5 ;
4.8 ; (ecf) [2]

(b) 31.3 ;
42.8 ; [2]

(c) **A**: 49.8 ÷ 4.4 = **11.3** ;
B: 31.3 ÷ 1.5 = **20.9** ;
C: 42.8 ÷ 4.8 = **8.9** ; (answers = 1 mark each) (ecf) [3]

(d) **A** = lead **B** = gold **C** = copper ; (ecf) [1]

[Total: 10]

3 **(a)** A student is investigating three liquid fuels, **A**, **B** and **C** to find which one gives the largest temperature rise.

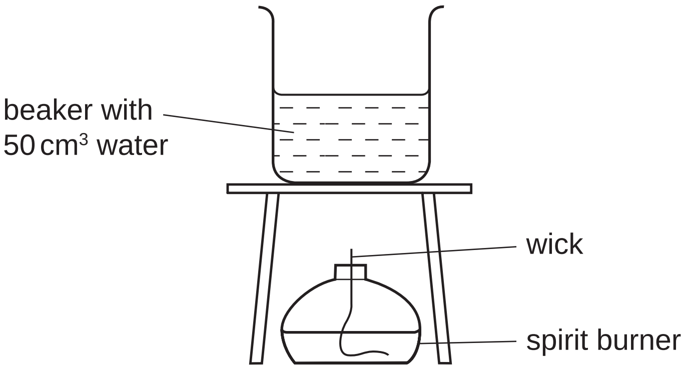
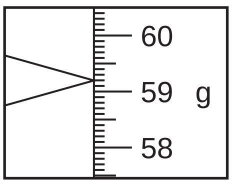


Fig. 2.1

- She fills a spirit burner with fuel **A**. Its mass is measured and recorded in Table 2.1.
- She places 50 cm^3 of water in the beaker on the tripod above the spirit burner, as in Fig. 2.1. She measures the temperature of the water and records it in Table 2.2.
- She lights the wick and allows it to burn for 5 minutes, then extinguishes the flame.
- She measures the temperature of the water after heating and records it in Table 2.2.
- She measures the mass of the spirit burner again and records this in Table 2.1.
- Then she repeats all the steps using fuel **B** and then fuel **C**.

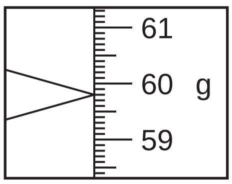
Table 2.1

	fuel A	**fuel B**	**fuel C**
mass of burner and fuel before burning / g	57.0		
mass of burner and fuel after burning / g	55.5	57.9	58.2
mass of fuel used / g	1.5		



fuel **B**

Fig. 2.2



fuel **C**

Fig. 2.3

(i) Use Fig. 2.2 to find, and record in Table 2.1, the mass of the spirit burner and fuel **B**. [1]

(ii) Use Fig. 2.3 to find, and record in Table 2.1, the mass of the spirit burner and fuel **C**. [1]

(iii) Calculate the mass of fuel used in each experiment and record it in Table 2.1. [1]

Table 2.2

	fuel A	fuel B	fuel C
temperature of water before heating / °C	15.5	15.5	15.5
temperature of water after heating / °C	56.8		
temperature rise / °C	41.3		

(iv) The thermometers in Fig. 2.4 show the temperatures of the 50 cm^3 of water after being heated for 5 minutes. Read the thermometers for each fuel and record the temperatures in Table 2.2. [2]

fuel **B** fuel **C**

Fig. 2.4

(v) Use the data in Table 2.2 to calculate the temperature rise caused by fuels **B** and **C**.

Record these values in Table 2.2. [1]

(b) Not all the heat produced by the fuel is used to heat the water.

Suggest **one** improvement to the experiment so that more heat is used in heating the water.

....

.... [1]

(c) The temperature rise per gram, **T**, for fuel **A** is 27.5 °C / g.

Calculate the temperature rise per gram for fuels **B** and **C**.

Use the formula

$$\mathbf{T} = \frac{\text{temperature rise}}{\text{mass of fuel}}$$

T for fuel **B** = ... °C / g

T for fuel **C** = ... °C / g [2]

(d) The liquid with the highest value of **T** may not be suitable for use as a fuel in the home.

Suggest a property that could make this liquid unsuitable to use as a fuel.

....

.... [1]

MARKING SCHEME

(a) **(i)** 59.2 ; (no tolerance) [1]

(ii) 59.8 ; (no tolerance) (allow ecf all through) [1]

(iii) 1.3, 1.6 (both) ; [1]

(iv) 50.4 ; (no tolerance)
62.3 ; (no tolerance) [2]

(v) 34.9, 46.8 (both) ; [1]

(b) shielding insulation / burner closer to beaker ; [1]

(c) 26.8 ; 29.25 ; [2]

(d) too expensive / too smoky ;
too difficult to light / store / transport ;
carcinogenic / gives off toxic fumes ; [max 1]

[Total: 10]

4 You are going to find the density of the material used to make a plastic pipe as shown in Fig. 2.1.

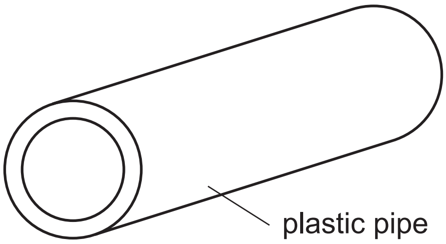


Fig. 2.1

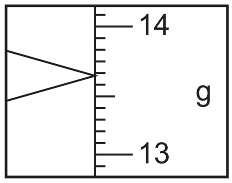


Fig. 2.2

(a) Use Fig. 2.2, which shows a balance reading, to record the mass, **M**, of the piece of pipe to the nearest 0.1 g.

M = ... g [1]

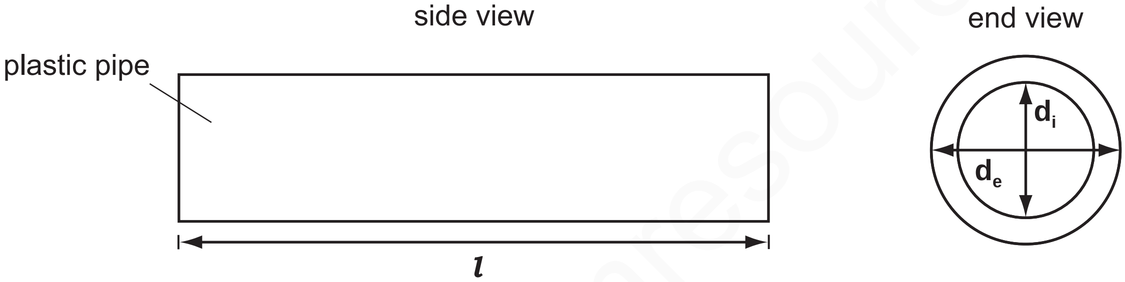


Fig. 2.3

(b) (i) Use a ruler and Fig. 2.3 to measure the length, l, the external diameter, $\mathbf{d_e}$, and the internal diameter, $\mathbf{d_i}$, of the piece of pipe to the nearest 0.1 cm.

length, l = ... cm

external diameter, $\mathbf{d_e}$ = ... cm

internal diameter, $\mathbf{d_i}$ = ... cm [3]

(ii) Use your values of the external diameter, $\mathbf{d_e}$, and the internal diameter, $\mathbf{d_i}$, to calculate **k**, using the formula given below.

$$\mathbf{k} = \mathbf{d_e}^2 - \mathbf{d_i}^2$$

k = ... cm^2 [2]

(iii) Use your values in **(b)(i)** and **(b)(ii)** to calculate **V**, in cm^3, the volume of the piece of pipe.

Use the formula given below.

$$\mathbf{V} = \frac{\pi \mathbf{k} \boldsymbol{l}}{4}$$

V = ... cm^3 [2]

(c) Use your values of the mass, **M**, and the volume, **V**, of the piece of pipe, to calculate **D**, the density of the material used.

Show clearly any formula you use.

D = ... g/cm^3 [2]

MARKING SCHEME

(a) 13.7 ; [1]

(b) **(i)** length ($\boldsymbol{l}$) = 7.8 ;
external diameter, ($\mathbf{d_e}$) = 2.5 ;
internal diameter, ($\mathbf{d_i}$) = 1.8 ; [3]

(ii) $2.5^2 - 1.8^2$; (allow ecf)
= 3.01 ; [2]

(iii) **–** (**V**) = 3.14 × 3.01 × 7.8 ÷ 4 = ; (allow ecf)

(between) 18.1 and 18.5 ; [2]

(c) (formula used) density = mass / volume ;
0.74 ; (allow ecf from incorrect values, but **not** from incorrect formula) [2]

[Total: 10]

5

In this experiment a student is investigating the period of a simple pendulum.

The *period* is the time for one complete oscillation of the pendulum.

The experiment is set up with the point of support 55.0 cm from the bench as in Fig. 2.1.

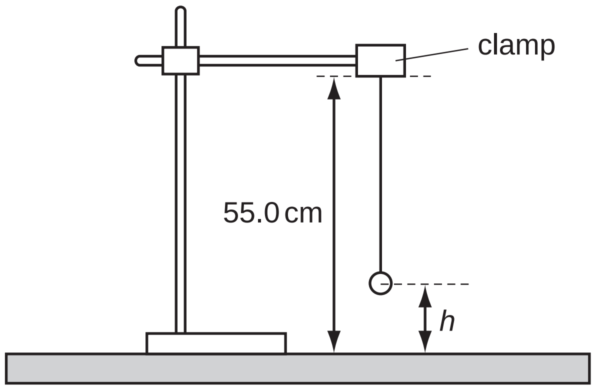


Fig. 2.1

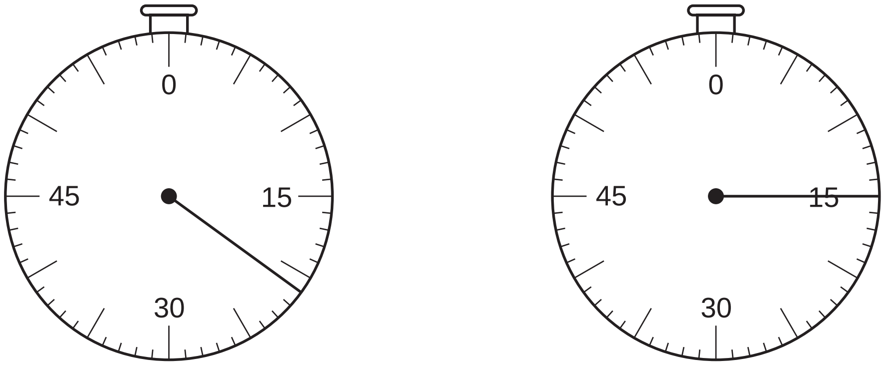
(a) The student adjusts the height, *h*, of the bob so that it is 10.0 cm above the bench. He gently starts the bob oscillating and starts the stopwatch. He counts 20 complete oscillations, stops the stopwatch and records the time in Table 2.1.

Table 2.1

height, *h* / cm	time for 20 oscillations / s	time, *T* for one oscillation / s	T^2 / s^2
10.0	26	1.30	1.69
20.0	23	1.15	1.32
25.0			
30.0	19	0.95	0.90
40.0			

(i) He alters the height, *h*, of the bob so that it is 20.0 cm above the bench. He times 20 complete oscillations and records it in Table 2.1. He repeats the experiment at several different heights, *h*.

Read the stopwatches in Fig. 2.2 and record the times for the 20 complete oscillations, in the appropriate spaces in Table 2.1. [2]



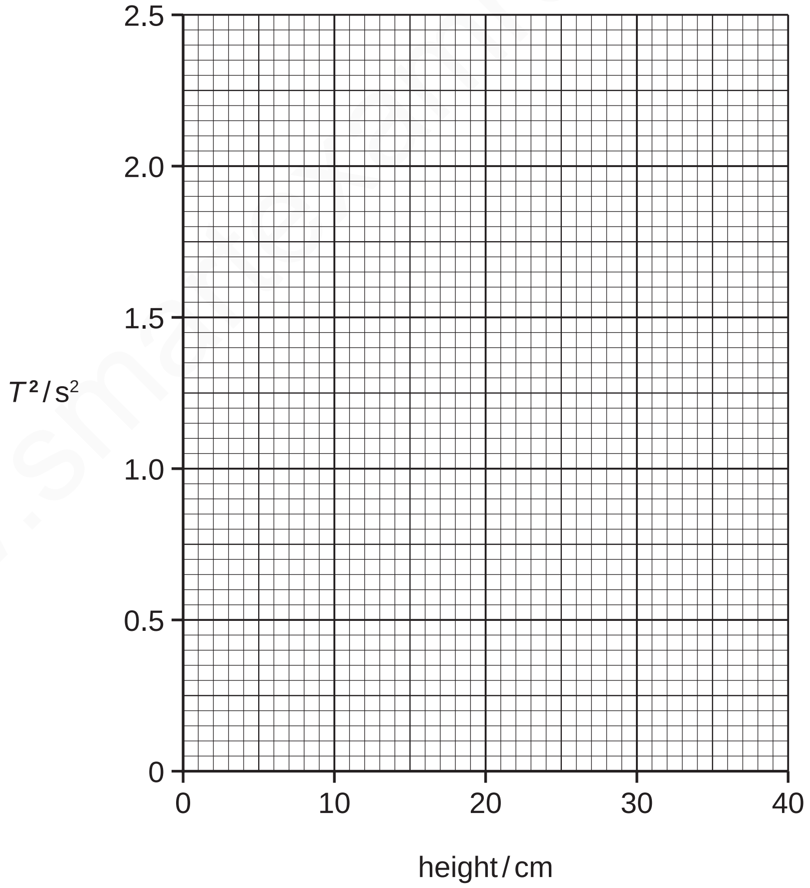
h = 25.0 cm h = 40.0 cm

Fig. 2.2

(ii) Using the results for 20 oscillations, in Table 2.1, calculate the time taken for one oscillation, T, for each height, h, in **(a)(i)** and complete the third column in Table 2.1. [1]

(iii) Calculate the values of T^2 for each value of h, in **(a)(i)** and record them in the final column of Table 2.1. [1]

(b) (i) On the grid provided plot a graph of T^2 against height. Draw the best fit straight line. [2]



(ii) Calculate the gradient of the line, showing on your graph how you do this.

gradient = ... [2]

(iii) Extend the line you have drawn until it cuts the vertical axis.

Read off the value of T^2 when the height, $h = 0$.

T^2 = ... s^2 [1]

(iv) Calculate the height of the support of the bob above the bench by dividing the value of T^2 found in **(b)(iii)** by the gradient found in **(b)(ii)**.

height = ... cm [1]

MARKING SCHEME

(a) **(i)** 21 ;
15 ; [2]

(ii)

height, *h* / cm	**time for 20 swings / s**	**time, *T* for one swing / s**	**T^2 / s^2**
10.0			
20.0			
25.0	**(21)**	**1**	**1.10**
30.0			
40.0	**(15)**	**0**	**0.56**

column 3 both correct (ecf) (2 decimal places) ; [1]

(iii) column 4 both correct (ecf) (2 decimal places) BUT only penalise once in **(ii)** or **(iii)** ; [1]

(b) **(i)** 5 points correct (by eye) ;
straight line of best fit ; [2]

(ii) evidence <u>on graph</u> ;
gradient = 0.035 to 0.04 ; (ignore any sign) [2]

(iii) allow 2 to 2.15 (ecf) ; [1]

(iv) 2.05 / 0.04 = 51.25 cm (allow 50.00 to 53.75) (ecf) ; [1]

[Total: 10]

6 A student is finding the density of plasticine (modelling clay).

(a) She moulds the piece of plasticine into a block as shown in Fig. 3.1.

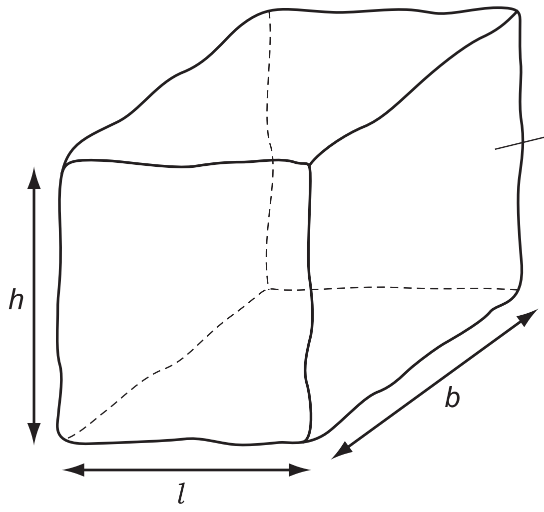


Fig. 3.1

(i) Measure the length, (l), breadth, (b), and height, (h), of the arrows in Fig. 3.1 to the nearest 0.1 cm and record your results below.

l = ... cm

b = ... cm

h = ... cm [3]

(ii) Calculate the volume of the block using the equation:

$$V = l \times b \times h$$

V = ... cm^3 [1]

(b) The student sets up some apparatus as shown in Fig. 3.2.

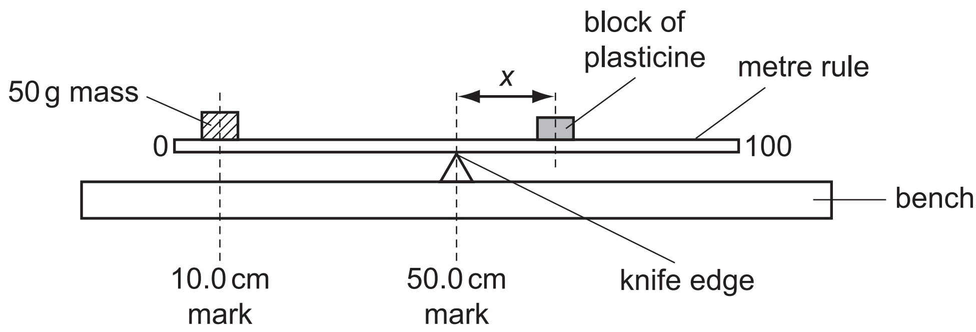


Fig. 3.2

A 50 g mass has been secured to the metre rule. Its position is fixed with its centre over the 10.0 cm mark.

She takes the block of plasticine and places it on the metre rule.

She moves it until the rule is just balanced with the knife edge directly under the 50.0 cm mark.

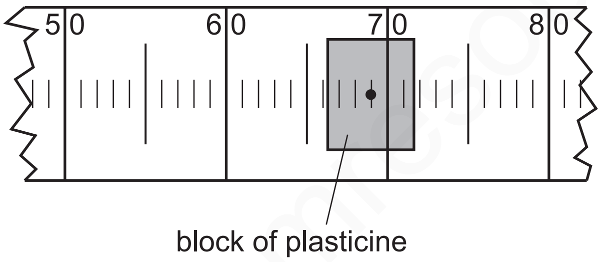


Fig. 3.3

(i) Use Fig. 3.3 to find the distance, x, between the centre of the plasticine and the 50 cm mark.

x = ... cm [1]

(ii) Calculate the mass, m, of the block of plasticine using the equation:

$$m = \frac{2000}{x}$$

m= .... g [1]

(iii) Calculate the density, d, of the plasticine using the equation:

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

d = ... g / cm^3 [2]

(c) Suggest **two** reasons why the data you have used to calculate the density of plasticine may be inaccurate.

reason 1 ....

....

reason 2 ....

.... [2]

(a) **(i)** 3.3 only ; 3.4 only ;
3.7 only ; [3]

(ii) 41.5(..) (ecf) must be rounded correctly ; [1]

(b) **(i)** 19.(0) ; [1]

(ii) 105.(..) (ecf) ; [1]

(iii) $\frac{105.(..)}{41.5}$ (ecf) ; [2]
2.5(….) ;

(c) difficulty in making a block ;
difficulty in finding balance point ;
difficulty in finding centre of block ; [max 2]

[Total: 10]

7 A student is investigating a pendulum.

He sets up the apparatus as shown in Fig. 6.1.

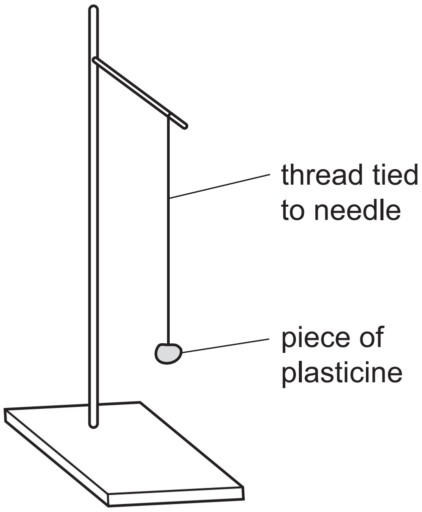


Fig. 6.1

(a) He wants to find out as **accurately** as possible the time taken for one complete swing of the pendulum. This is known as the period of the pendulum.

Describe the best way to find the value of the period of the pendulum.

....

.... [1]

He finds the mass *m* of the plasticine using a balance. Fig. 6.2 shows the balance window.

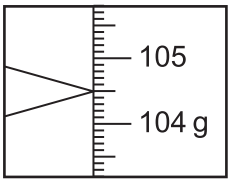


Fig. 6.2

(b) Read and record the mass *m* of the plasticine.

m = ... g [1]

- The student finds the period of the pendulum and records it in Table 6.1.
- He removes some of the plasticine so that the mass of the pendulum is reduced by 10 g and finds the new period.
- He reduces the mass by a further 10 g and finds the new period.
- He repeats this twice more and his results are shown in Table 6.1.

Table 6.1

mass of plasticine / g	period / s
m	2.03
$m-10$	2.05
$m-20$	1.98
$m-30$	2.02
$m-40$	2.06

(c) Comment on the results and decide if the mass of the plasticine has any effect on the period of the pendulum.

Explain your answer.

....

....

.... [2]

The student does another experiment. This time he keeps the mass of the pendulum constant and varies the length of the thread.

He uses a different piece of plasticine with a new mass.

He finds the new mass of the plasticine using a balance. Fig. 6.3 shows the balance window.

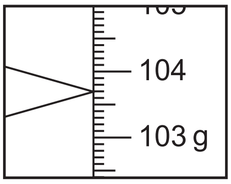


Fig. 6.3

(d) Read and record the mass *m* of the plasticine.

m = ... g [1]

- The student makes the length of the thread between the needle and the plasticine 100 cm and measures the period.
- He records the time in Table 6.2.
- He reduces the length of thread and finds the new period.
- He does this several times.
- His results are in Table 6.2.

Table 6.2

length of string / cm	period / s
100	2.00
78	1.80
61	5.50
38	1.20
19	0.85
h = ...	0.45

(e) Measure the length of the thread *h* in Fig. 6.4 and complete the last row in Table 6.2. [1]

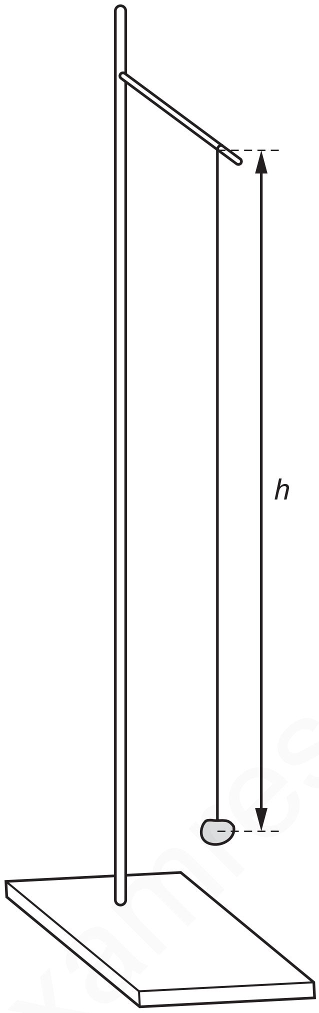


Fig. 6.4

(f) Comment on the results and decide if the length of the thread has any effect on the period of the pendulum.

Explain your answer.

....

....

....

.... [3]

(g) Suggest **one** improvement to this second experiment that would increase the reliability of the results.

....

.... [1]

MARKING SCHEME

(a) time x swings and divide by x ; [1]

(b) 104.5 ; [1]

(c) (no effect) (very) close together ; [2]
no trend or pattern ;

(d) 103.7 ; [1]

(e) 9 ; [1]

(f) one result / 61 cm obviously wrong ; [3]
others show a trend ;
shorter the thread shorter the period ;

(g) repeat experiment (at each length) **and** take average ; [max 1]
or repeat the 61 cm length (as anomalous reading) ;
use different (specified in numbers) lengths ;

[Total: 10]