



**Cambridge Assessment International Education**  
Cambridge International General Certificate of Secondary Education (9–1)

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**CO-ORDINATED SCIENCES**

**0973/61**

Paper 6 Alternative to Practical

**May/June 2019**

**1 hour 30 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **17** printed pages and **3** blank pages.

1 A student investigates the loss of body heat from an adult animal and from a baby animal, by using a large test-tube and a small test-tube to represent the animals.

(a) (i) Read through part (a)(ii) and complete the heading of the first column of Table 1.1, including units. [1]

- (ii) • He fills each test-tube with hot water as shown in Fig. 1.1, and immediately reads and records the temperature of the water to the nearest  $0.5^{\circ}\text{C}$  in each test-tube for time = 0.

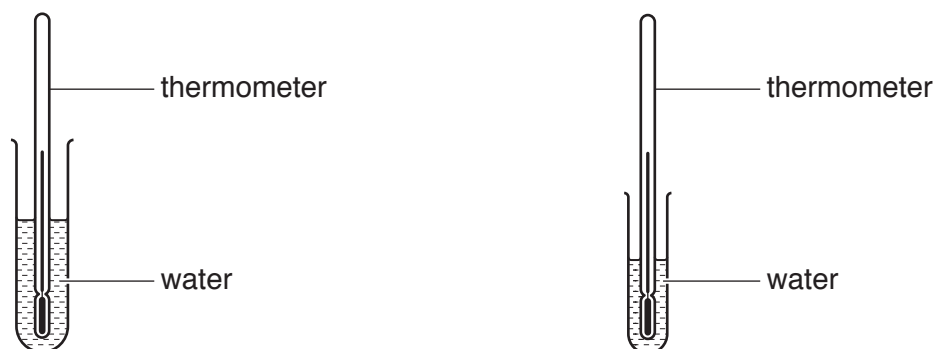


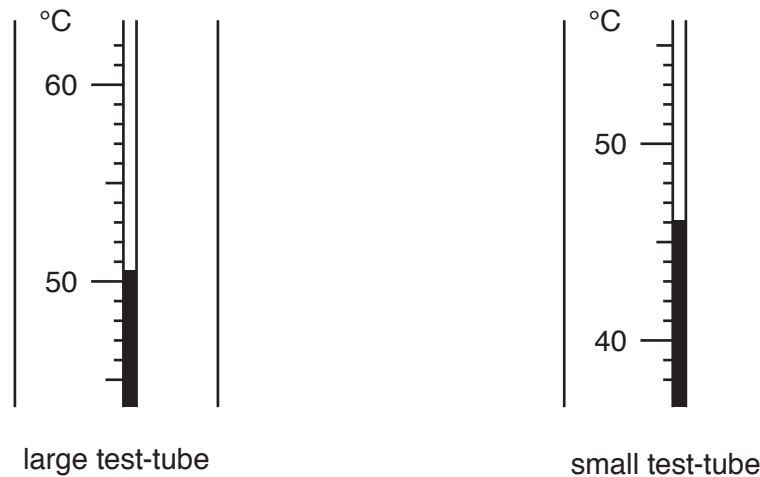
Fig. 1.1

- He starts a stopclock.
- He reads and records the temperatures of the water to the nearest  $0.5^{\circ}\text{C}$  in each test-tube every minute, for 5 minutes.
- Some of his results are shown in Table 1.1.

Table 1.1

..... / .....	Temperature of water in large test-tube/ $^{\circ}\text{C}$	Temperature of water in small test-tube/ $^{\circ}\text{C}$
0	80.0	78.0
1	69.0	64.5
2	61.5	56.0
3	55.0	50.0
4		
5	47.5	44.0

Use the thermometer diagrams in Fig. 1.2 to read the missing temperature values for each test-tube after 4 minutes, and record these in Table 1.1.



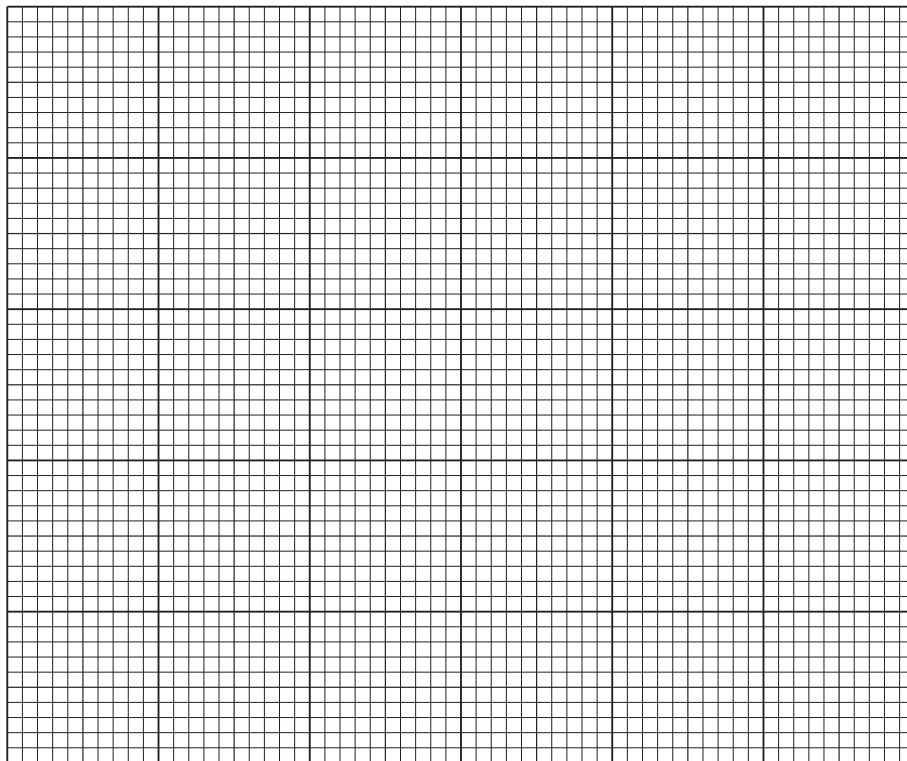
**Fig. 1.2**

[2]

- (b) (i) On the grid provided, draw and label the axes for a graph of temperature (vertical axis) against time.

Choose a scale for the temperature axis suitable to plot all the data in Table 1.1. [2]

- (ii)
- Plot the points for the large test-tube.
  - Draw the smooth curve of best fit and label the line L.
  - Using the same axes, plot the points for the small test-tube.
  - Draw the smooth curve of best fit for the small test-tube and label the line S.



[2]

- (c) (i) Use the results in Table 1.1 to calculate the drop in temperature of the water over 5 minutes for each test-tube.

large test-tube = ..... °C

small test-tube = ..... °C  
[1]

- (ii) State and explain what the graphs show about the rate of heat loss from the test-tubes.

.....  
..... [1]

- (iii) The teacher says that baby animals need more energy from food for each gram of their body mass than adults. Use your answers to (c)(i) and (c)(ii) to explain whether the results support this statement.

.....  
..... [1]

[Total: 10]

2 When acids react with alkalis, heat is given out. These reactions are exothermic.

Plan an investigation using a thermometer to compare the amount of heat given out when each of the acids listed reacts with an alkali.

**hydrochloric acid**  
**nitric acid**  
**sulfuric acid**

Your plan should include:

- a suitable named alkali
- a description of the apparatus needed and how it is used, including how to reduce heat losses
- the readings to be taken
- which variables you will keep the same
- how you will use the readings to make the comparison.

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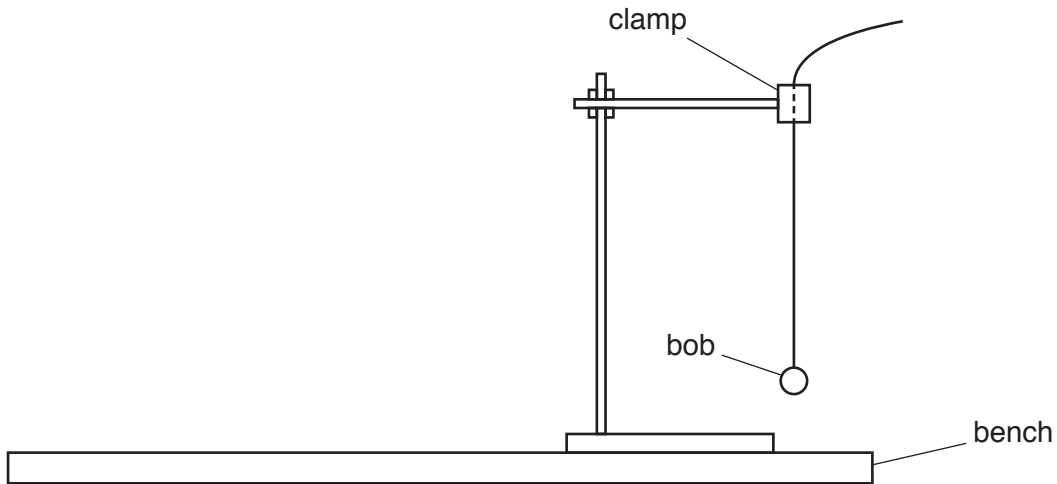
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..... [7]

[Total: 7]

- 3 A student uses a pendulum to measure the acceleration of free fall  $g$ .

She sets up a pendulum in a clamp as shown in Fig. 3.1.



**Fig. 3.1**

The length of a pendulum is the distance from the bottom of the clamp to the centre of the bob.

- (a) Draw on Fig. 3.1 an accurate line to show the length of the pendulum. The exact start and end points of the line should be marked with arrows.

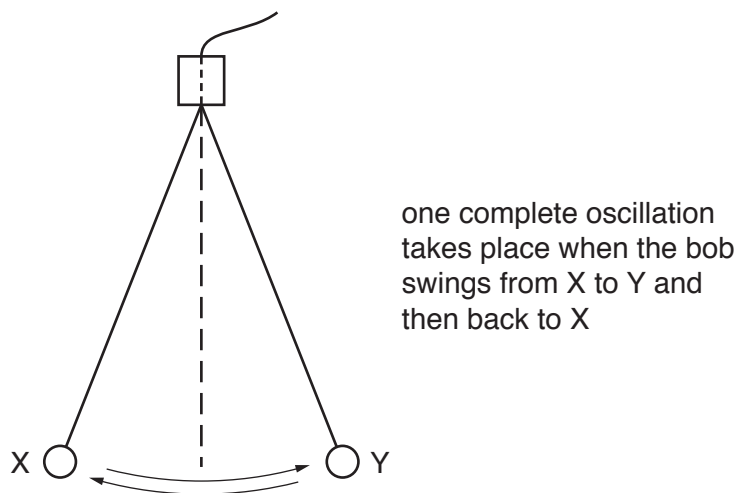
Label the length of the line with the letter  $l$ .

[1]

- (b) The student adjusts the string until the length  $l$  of the pendulum is 40.0 cm.

She gives the bob a small sideways displacement and releases it so that it oscillates freely.

One complete oscillation of the pendulum is shown in Fig. 3.2.



**Fig. 3.2**

- (i) She measures the time  $t$  for 20 complete oscillations three times. Her results are shown below.

25.5s                  25.7s                  25.4s

Calculate the mean time  $t_{AV}$  for 20 oscillations. Give your answer to 3 significant figures.

$$t_{AV} = \dots\dots\dots \text{ s [2]}$$

- (ii) Calculate the time  $T$  for **one** oscillation of the pendulum.

$$T = \dots\dots\dots \text{ s [1]}$$

- (iii) Calculate  $T^2$ .

$$T^2 = \dots\dots\dots \text{ s}^2 [1]$$

- (c) The acceleration of free fall  $g$  is given by the equation shown.

$$g = \frac{0.395 \times l}{T^2}$$

Use this equation with  $l = 40.0 \text{ cm}$  to calculate a value for  $g$ .

$$g = \dots\dots\dots \text{ m/s}^2 [1]$$

- (d) The student repeats the experiment in (b), using a pendulum of length  $l = 80.0 \text{ cm}$ .

Her results are shown below.

$$t = \dots\dots\dots 35.9 \dots\dots\dots \text{ s}$$

$$T = \dots\dots\dots 1.80 \dots\dots\dots \text{ s}$$

$$T^2 = \dots\dots\dots 3.24 \dots\dots\dots \text{ s}^2$$

Use the equation in (c), with  $l = 80.0 \text{ cm}$  to calculate a second value for  $g$ .

$$g = \dots\dots\dots \text{ m/s}^2 [1]$$

- (e) Compare your values of  $g$  from parts (c) and (d) with the actual value of  $9.8 \text{ m/s}^2$ .

State whether or not your values agree with the actual value of  $g$  within the limits of experimental error. Justify your answer with reference to your values.

.....  
 .....  
 .....  
 ..... [1]

(f) Suggest why it is better experimental practice to use longer lengths of pendulum when performing this experiment.

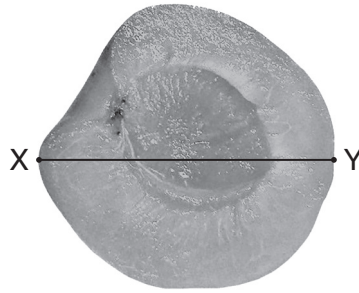
.....  
..... [1]

[Total: 9]



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- 4 Fig. 4.1 shows an apricot fruit that has been cut in half and the stone removed.



**Fig. 4.1**

- (a) In the box, make an enlarged detailed pencil drawing of the surface of the apricot. [3]



- (b) (i) Measure to the nearest millimetre, the line XY, representing the diameter of the apricot in Fig. 4.1.

diameter of apricot in Fig. 4.1 = ..... mm [1]

- (ii) Draw a line to show the same diameter XY on your drawing. Measure this diameter in millimetres to the nearest millimetre and record this diameter.

diameter in drawing = ..... mm [1]

- (iii) Use these measurements to calculate the magnification of your drawing.

magnification = ..... [1]

- (c) (i) A student tests the piece of fruit for the presence of reducing sugar.

State the name of the solution she uses to test for reducing sugar, and state a colour that indicates a positive result for reducing sugar.

solution .....

colour that indicates positive result .....

[2]

- (ii) State and explain a safety precaution the student takes when testing the piece of fruit for the presence of reducing sugar.

..... [1]

- (iii) The student tests a variety of fruits for the amount of reducing sugar present.

State one factor that the student needs to keep the same to make a valid comparison.

..... [1]

[Total: 10]

- 5 A student investigates the use of barium nitrate solution as a reagent in qualitative analysis. He then identifies the cation and anion in an unknown substance **H**.

(a) He reacts sodium carbonate solution with dilute nitric acid in a test-tube.

In a separate test-tube he reacts sodium carbonate solution with barium nitrate solution. His results are shown in Table 5.1.

**Table 5.1**

	observations	
	reaction with dilute nitric acid	reaction with barium nitrate solution
sodium carbonate solution	bubbles	white ppt.
sodium sulfate solution	no reaction	white ppt.

He repeats the procedure using sodium sulfate solution instead of sodium carbonate solution. His results are shown in Table 5.1.

- (i) Use of barium nitrate solution alone does not distinguish between the carbonate ion and the sulfate ion.

Use the results in Table 5.1 to explain why this statement is correct.

.....  
 ..... [1]

- (ii) State and explain how the problem in (a)(i) is overcome when testing for sulfate ions.

.....  
 .....  
 ..... [2]

- (iii) The student thinks that the bubbles formed when sodium carbonate solution reacts with dilute nitric acid are carbon dioxide gas.

Describe a test which the student can carry out to see if he is correct.

State the observation for a positive result.

test .....

.....

observation ..... [2]

- (b) The student uses Qualitative Analysis to identify the **cation and anion** in the unknown substance **H**.

He is told that **H** is **not** a nitrate.

- First he makes a solution of solid **H** in distilled water.
- He carries out tests on the solution of **H** and records his tests and observations in Table 5.2.

**Table 5.2**

test for ion	observations	conclusions
test 1 add ammonia solution to a solution of <b>H</b>		not $\text{Cu}^{2+}$ , not $\text{Zn}^{2+}$ , not $\text{Fe}^{2+}$ , not $\text{Fe}^{3+}$
test 2 heat <b>H</b> with sodium hydroxide solution	gas turns red litmus to blue	
test 3 add silver nitrate solution to a solution of <b>H</b>	solution remains colourless	
test 4 add barium nitrate solution to a solution of <b>H</b>	white ppt	

- (i) Explain why it is important to use distilled water instead of other types of water to dissolve solid **H**.

.....  
..... [1]

- (ii) Complete the observations column in Table 5.2 for test 1 by suggesting an observation which leads to the conclusion shown. [1]

- (iii) Complete the conclusions column of Table 5.2 for tests 2, 3 and 4 to identify the ions in **H**.

Also identify ions that are **not** present. [3]

- (iv) The student has left out a chemical when testing for the anions.

State what he has left out and explain why leaving out the chemical makes his results difficult to interpret accurately.

Your answers in (a) may be helpful.

chemical left out .....

explanation .....

.....  
..... [2]

- (v) Explain why ammonia solution cannot be used in test 2 instead of sodium hydroxide solution.

.....  
..... [1]

[Total: 13]

- 6 A student measures the spring constant  $k$  of a spring. He then uses the spring to measure the mass and density of a stone.

The spring constant  $k$  of a spring is a measure of the elastic stiffness of the spring.

Fig. 6.1 shows a full size diagram of the spring.

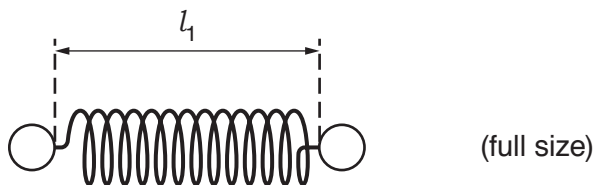


Fig. 6.1

- (a) Measure the unstretched length  $l_1$  of the spring to the nearest millimetre. Do not include the loops at the ends of the spring in your measurement.

$l_1 = \dots\dots\dots$  mm [1]

- (b) The student sets up the spring on a stand as shown in Fig. 6.2.

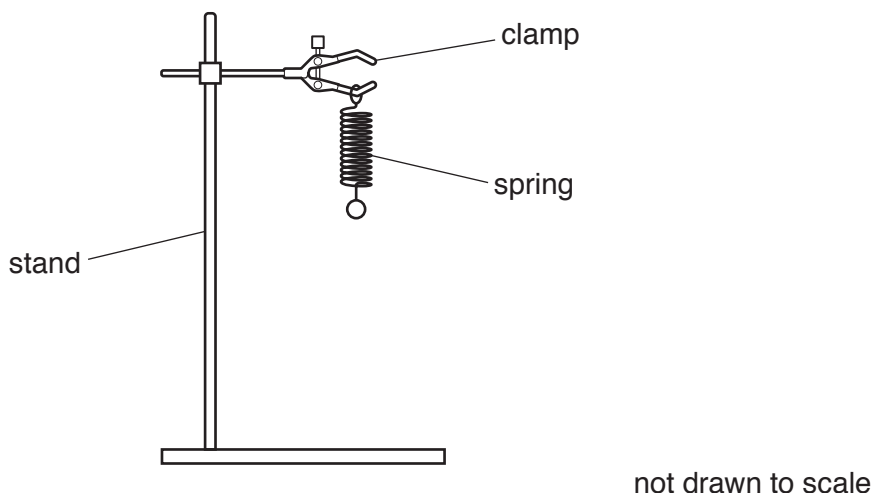


Fig. 6.2

He suspends a 300 g mass on the spring and measures the stretched length  $l_2$  of the spring.

$l_2 = \dots\dots\dots 95 \dots\dots\dots$  mm

- (i) Calculate the extension  $e$  of the spring produced by the mass. Use the equation shown.

$e = l_2 - l_1$   
 $e = \dots\dots\dots$  mm [1]

- (ii) Calculate the spring constant  $k$  of the spring. Use the equation

$k = \frac{F}{e}$

where  $F = 3\text{ N}$  (the weight of the 300 g mass).

$k = \dots\dots\dots$  N/mm [1]

(c) It is important to avoid errors when measuring the length of the spring. Describe **two** ways in which the student can avoid errors.

- 1 .....
- .....
- 2 .....
- .....

[2]

(d) The student removes the 300g mass from the spring.

He attaches a stone to the spring.

He measures the stretched length  $l_A$  of the spring and calculates the extension  $e_A$  of the spring caused by the stone.

$$e_A = \dots\dots\dots 45 \dots\dots\dots \text{mm}$$

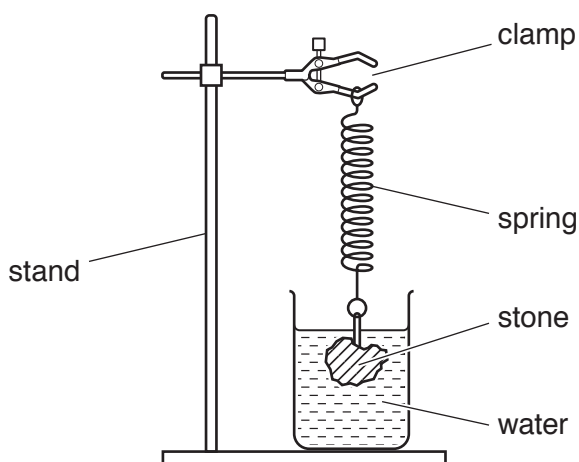
Use your answer to (b)(ii) to calculate the mass  $m$  of the stone. Use the equation shown.

$$m = 100ke_A$$

$$m = \dots\dots\dots \text{g} \quad [1]$$

(e) He places a beaker of water under the spring.

He slowly lowers the clamp until the stone is completely submerged in water, as shown in Fig. 6.3.



not drawn to scale

**Fig. 6.3**

He measures the length  $l_W$  of the spring and calculates the extension  $e_W$  of the spring caused by the stone.

$$e_W = \dots\dots\dots 27 \dots\dots\dots \text{mm}$$



Use the results from (d) and (e) to calculate the density  $\rho$  of the stone. Use the equation shown.

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

$\rho = \dots\dots\dots\text{g/cm}^3$  [1]

- (f) Another student investigates the density of a block of metal. He measures the length, width and height of the block. His measurements are shown in Fig. 6.4.

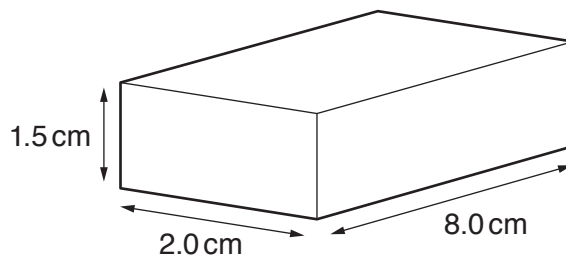


Fig. 6.4

- (i) Calculate the volume of this block of metal.

volume =  $\dots\dots\dots\text{cm}^3$  [1]

- (ii) The student measures the mass of the block of metal using a balance.

Fig. 6.5 shows the reading on the balance.

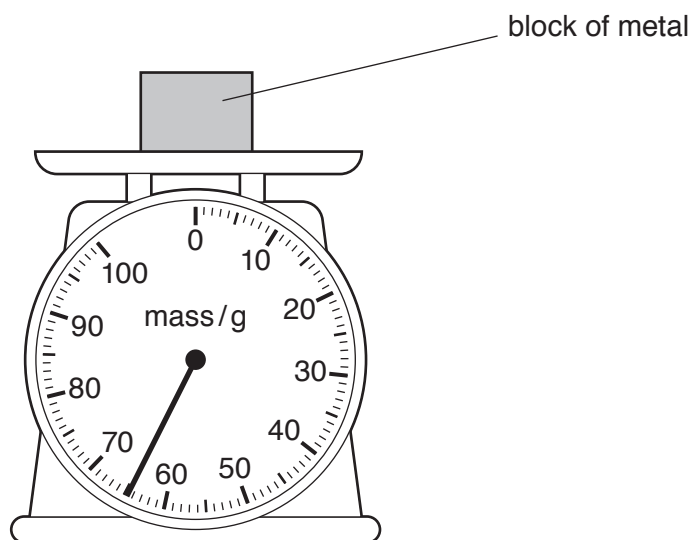


Fig. 6.5

Read the scale to the **nearest** 1 g and record the mass of the block of metal below.

mass of block of metal =  $\dots\dots\dots\text{g}$  [1]

- (iii) Find the density of the block of metal using your answers from (f)(i) and (f)(ii). Use the formula shown.

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

density of block of metal = .....g/cm<sup>3</sup> [1]

- (iv) Suggest **one** improvement to the equipment the student has used in (f) to determine a more accurate measurement of the density of the block of metal.

.....

..... [1]

[Total: 11]



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