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COMBINED SCIENCE**0653/61**

Paper 6 Alternative to Practical

October/November 2024**1 hour**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Any blank pages are indicated.



1 Fig. 1.1 is a photograph showing the cut surface of an onion.

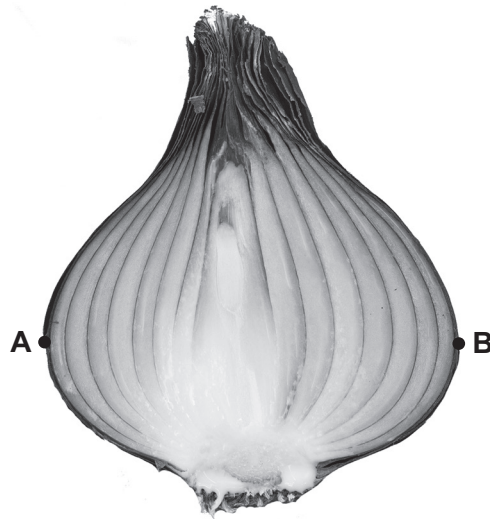
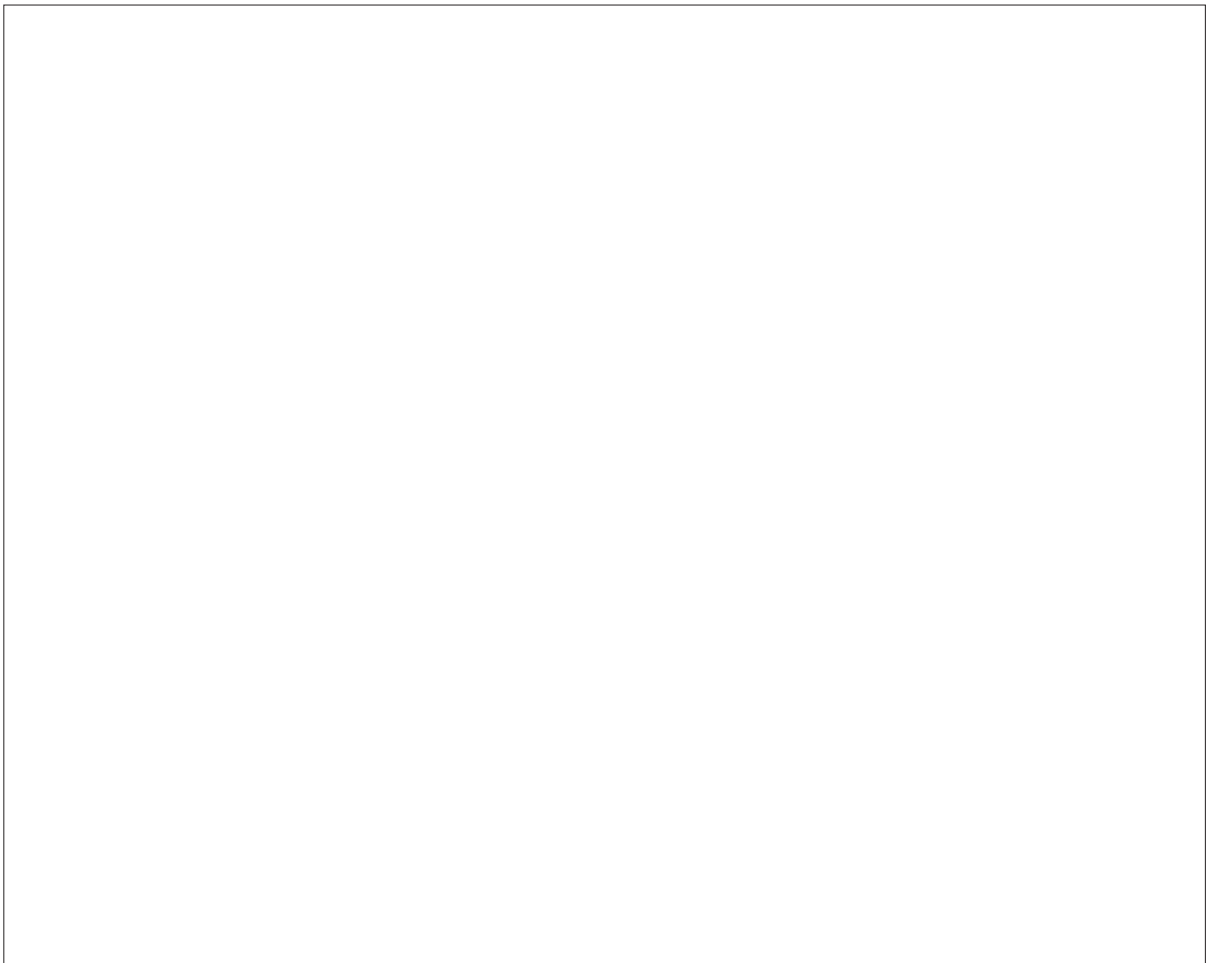


Fig. 1.1

(a) In the box, make a large and detailed pencil drawing of the cut surface of the onion.



[3]





- (b) The photograph in Fig. 1.1 shows the onion in actual size.

The horizontal distance from point **A** to point **B** in Fig. 1.1 represents the diameter d of the onion.

- (i) Measure the diameter d of the onion in Fig. 1.1.

$d =$ mm [1]

- (ii) Add point **A** and point **B** to your drawing in (a).

Measure the horizontal distance D from point **A** to point **B** on your drawing in (a).

$D =$ mm [1]

- (iii) Calculate the magnification of your drawing.

Use the equation shown.

$$\text{magnification} = \frac{D}{d}$$

magnification = ... [1]

- (c) A few drops of iodine solution are added to the cut surface of the onion.

Complete the observation.

observation

conclusion *no starch present*

[1]

[Total: 7]





- 2 Plants such as onions need minerals in the soil to grow.

Fig. 2.1 shows an onion plant.



Fig. 2.1

Plan an investigation to determine the relationship between the concentration of minerals in the soil and the growth of onion plants.

You are provided with:

- onion plants
- soil
- planting containers
- 10% mineral solution
- distilled water.

You may also use any other common laboratory apparatus.

In your plan, include:

- the additional apparatus needed
- a brief description of the method
- what you will measure
- which variables you will keep constant
- how you will process your results to draw a conclusion.

You may include a results table if you wish (you are not required to enter any readings in the table).





[7]



3 A student investigates a white solid, **solid H**.

Procedure

The student:

step 1 measures the mass of an empty test-tube and records the value in Table 3.1

step 2 places some **solid H** into the test-tube

step 3 measures the total mass of the test-tube and **solid H** and records the value in Table 3.1

step 4 heats this test-tube using a blue Bunsen burner flame for three minutes

step 5 leaves the test-tube to cool down

step 6 measures the mass of the test-tube and its contents and records the value in Table 3.1.

(a) Explain **two** safety precautions needed when heating **solid H** to avoid injury to the student or to other students.

1

.....

2

.....

[2]

(b) Fig. 3.1 shows the balance readings from **step 3** and **step 6**.



Fig. 3.1

Record in Table 3.1 these balance readings to **two** decimal places.

Table 3.1

mass of empty test-tube at step 1 / g	16.45
mass of test-tube and solid H at step 3 / g	
mass of test-tube and contents at step 6 / g	

[2]





- (c) Calculate the mass of **solid H** heated.

Use the equation shown.

$$\text{mass of solid H} = \text{mass at step 3} - \text{mass at step 1}$$

$$\text{mass of solid H} = \dots\dots\dots \text{g} \quad [1]$$

- (d) The mass of **solid H** decreases when it is heated.

- (i) Calculate the decrease in mass of **solid H**.

Use the equation shown.

$$\text{decrease in mass} = \text{mass at step 3} - \text{mass at step 6}$$

$$\text{change in mass} = \dots\dots\dots \text{g} \quad [1]$$

- (ii) Suggest a reason for this decrease in mass.

.....
 [1]

- (iii) Calculate the percentage decrease in mass of **solid H**.

Use the equation shown.

$$\text{percentage decrease in mass} = \frac{\text{change in mass in (d)(i)}}{\text{mass of solid H in (c)}} \times 100$$

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

$$\text{percentage decrease in mass} = \dots\dots\dots \% \quad [2]$$





- (e) Explain why it is important to heat **solid H** with a blue Bunsen burner flame instead of a yellow flame.

.....
 [1]

- (f) The teacher tells the student that the decrease in mass of **solid H** is smaller than expected.

Describe how to improve the procedure to make sure that **solid H** has the maximum decrease in mass.

.....
 [1]

- (g) The student adds some **solid H** to dilute nitric acid.

A colourless solution and a colourless gas are formed.

- (i) The student tests the gas with limewater.

A white precipitate is formed.

Identify the anion (negative ion) present in **solid H**.

..... [1]

- (ii) The student adds aqueous ammonia slowly to the colourless solution in (g).

A white precipitate forms.

The precipitate is soluble in excess aqueous ammonia, giving a colourless solution.

Identify the cation (positive ion) present in **solid H**.

..... [1]

[Total: 13]





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- 4 A student investigates the stretching of a pair of identical springs.

The student assembles the apparatus as shown in Fig. 4.1.

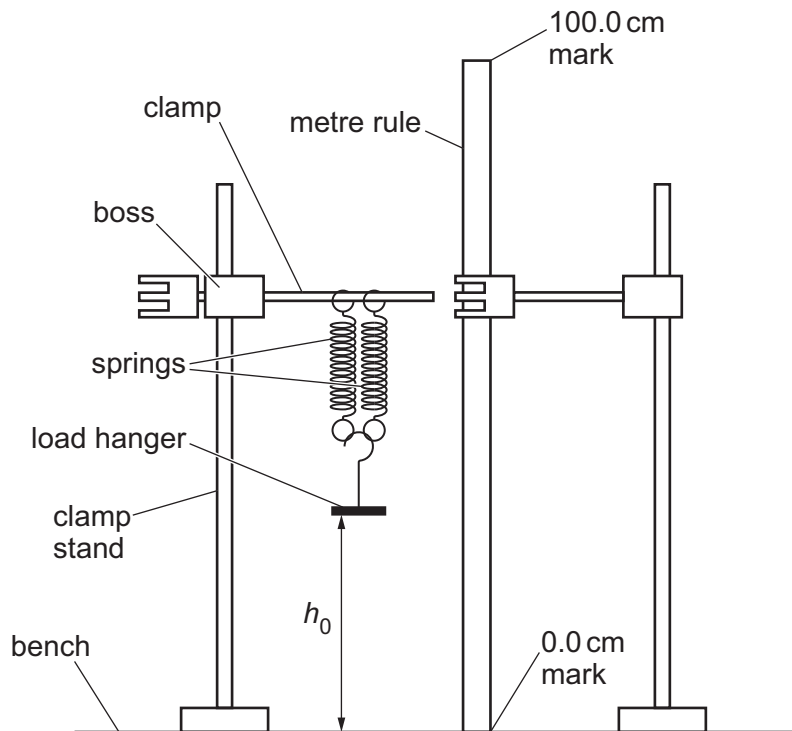


Fig. 4.1

- (a) The height of the bottom of the load hanger above the bench is h_0 .

The student uses a set square to help take the reading of height h_0 on the metre rule. The student does **not** move the metre rule.

- (i) Using the set square improves the accuracy of the reading of h_0 on the metre rule.

Draw on Fig. 4.1 to show the position of the set square when the h_0 reading is taken. [1]

- (ii) Describe how the student avoids a parallax (line-of-sight) error when taking the reading of h_0 on the metre rule.

..... [1]



(iii) Fig. 4.2 shows the bottom of the load hanger with the metre rule next to it.

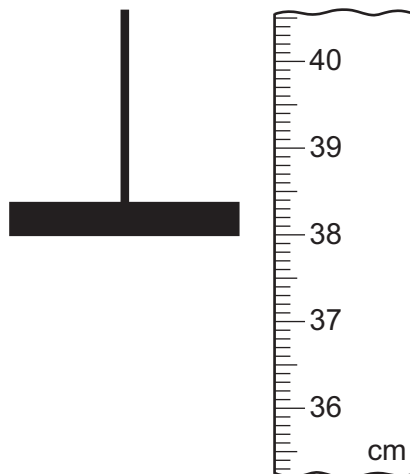


Fig. 4.2

Record h_0 to the nearest 0.1 cm.

$h_0 = \dots\dots\dots$ cm [1]



**(b) Procedure**

The student:

- adds a load L to the load hanger, where $L = 1.0\text{ N}$
- measures to the nearest 0.1 cm the new height h of the bottom of the load hanger above the bench.

The student repeats the procedure for loads of $L = 2.0\text{ N}$, 3.0 N , 4.0 N and 5.0 N .

Table 4.1 shows some of the student's data.

Table 4.1

L / N	h / cm	e / cm
0.0	—	0.0
1.0	35.9	
2.0	34.0	
3.0		
4.0	30.3	
5.0	28.4	

- (i) Fig. 4.3 shows the load hanger next to the metre rule for load $L = 3.0\text{ N}$.

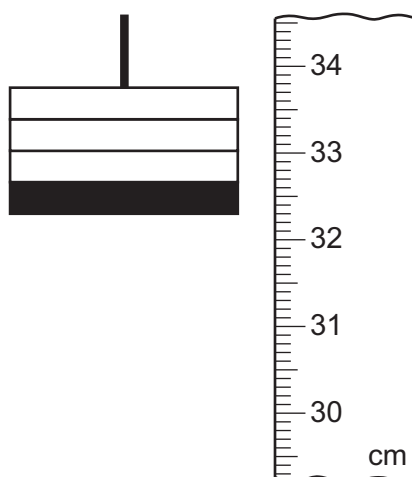


Fig. 4.3

Record in Table 4.1 the new height h for load $L = 3.0\text{ N}$.

[1]



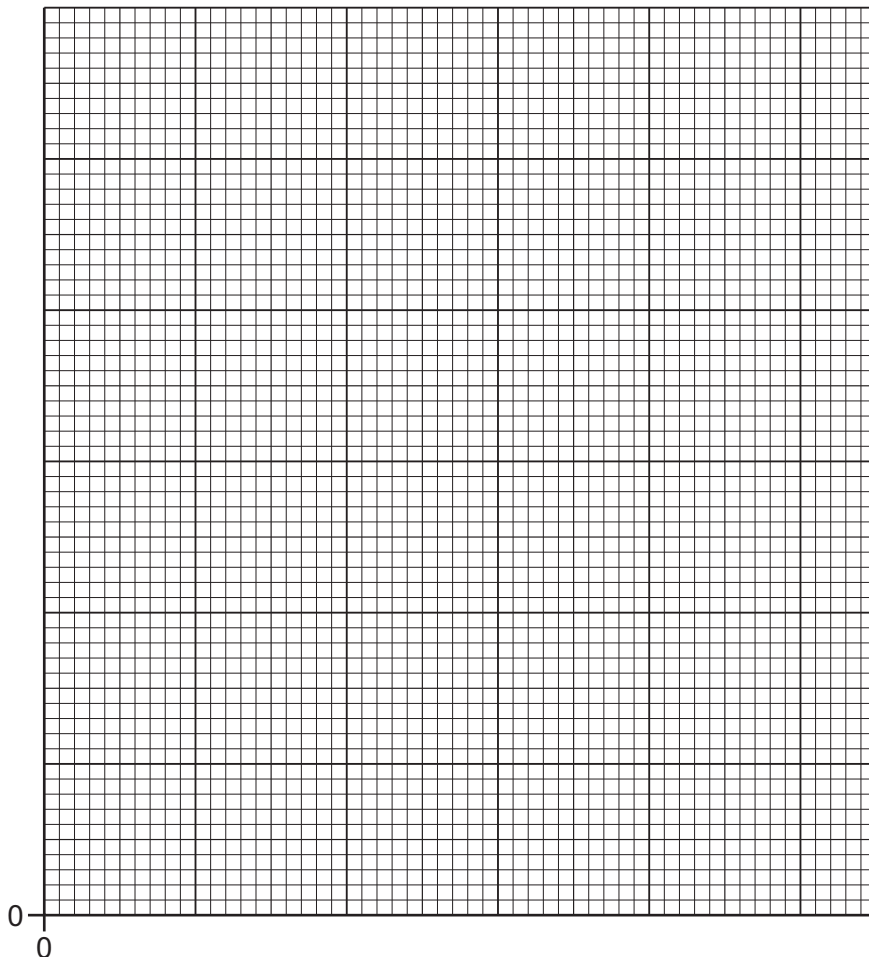
- (ii) The extension e of the springs is calculated using the equation shown.

$$e = h_0 - h$$

Use the equation shown and your value of h_0 from (a)(iii) to complete Table 4.1. [2]

- (iii) On the grid, plot a graph of e (vertical axis) against L .

Start both axes from the origin (0, 0).



[3]

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

- (c) Using a set square helps overcome one practical difficulty encountered when reading h on the metre rule.

Suggest **one** other practical difficulty encountered when reading h .

.....
 [1]





(d) The student now investigates the stretching of a **single** spring.

The student:

- suspends the empty load hanger from a single spring
- records the new value of h_0
- adds a load L to the load hanger, where $L = 2.0 \text{ N}$
- records the new value of h .

(i) The new values of h_0 and h recorded by the student are:

$$h_0 = 35.8 \text{ cm}$$

$$h = 28.1 \text{ cm.}$$

Use the student's new values and the equation shown to calculate the extension e_s of the single spring.

$$e_s = h_0 - h$$

$$e_s = \dots\dots\dots \text{ cm [1]}$$

(ii) On the grid in (b)(iii), plot extension e_s against load $L = 2.0 \text{ N}$.

Use this plot to draw an estimated line of best fit for the single spring. Label your estimated line of best fit, **single spring**.

[1]

[Total: 13]





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- 1 A student uses the apparatus shown in Fig. 1.1 to compare the energy content of two different types of food, **A** and **B**.

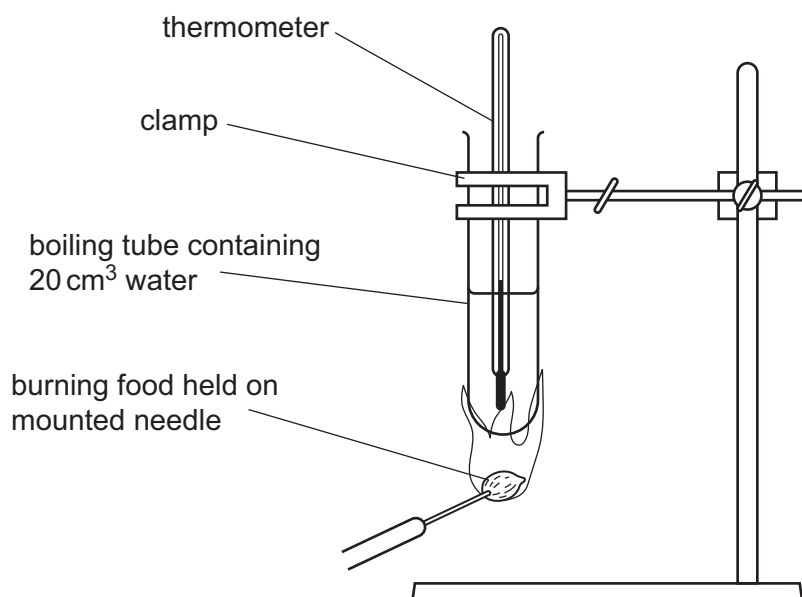


Fig. 1.1

The thermal energy released by the burning food heats the water in the boiling tube. The more energy the food contains, the greater the increase in temperature of the water.

Procedure

The student:

- step 1** records in Table 1.1 the initial temperature of the water in the boiling tube
- step 2** records in Table 1.1 the mass of a small piece of food **A**
- step 3** ignites the food and holds it under the boiling tube as shown in Fig. 1.1 until the food stops burning
- step 4** records in Table 1.1 the final temperature of the water in the boiling tube.

The student allows the apparatus to cool and then repeats the procedure for food **B**.



- (a) (i) Fig. 1.2 shows the balance readings for the mass of food **A** and the mass of food **B**.

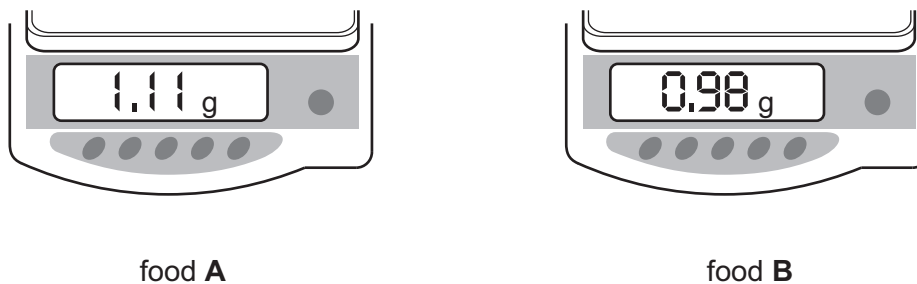


Fig. 1.2

Record in Table 1.1 these values to **one** decimal place.

Table 1.1

food	mass of food /g	initial temperature of water /°C	final temperature of water /°C	change in temperature of water /°C
A		20.0	56.0	36.0
B		19.0	37.0	18.0

[2]

- (ii) The energy contained in 1.0g of food is calculated using the equation shown.

$$\text{energy per gram of food} = \frac{20 \times \text{change in temperature of water} \times 4.2}{\text{mass of food}}$$

Use the equation to calculate the amount of energy in:

- 1.0g of food **A**
- 1.0g of food **B**.

energy per gram in food **A** = ... J/g

energy per gram in food **B** = ... J/g
[2]





- (iii) Food **A** is high in fat and food **B** is high in protein.

State what can be concluded about the amount of energy in fat compared to the amount of energy in protein.

.....
 [1]

- (iv) Explain why the amount of energy is calculated per gram of food.

.....
 [1]

- (b) (i) The student states that the procedure gives an inaccurate estimate of the energy of the food samples.

Identify **two** sources of error in the procedure.

1
 2 [2]

- (ii) Consider **one** source of error identified in (b)(i).

Describe **one** improvement in the procedure to minimise this error.

.....

 [1]

- (c) Describe the tests that confirm the presence of fat and the presence of protein in food. Include the observation for a positive result for each test.

test for fat

 observation for a positive result
 test for protein

 observation for a positive result [4]

[Total: 13]





2 A student investigates a white solid, **H**.

- (a) The student investigates the relationship between the mass of **H** added to water and the temperature increase it produces.

Procedure

The student:

- step 1** pours 20.0 cm³ of distilled water into a beaker
- step 2** records in Table 2.1 the temperature of the distilled water
- step 3** adds 0.5 g of **H** to the distilled water
- step 4** stirs the mixture of **H** and distilled water
- step 5** records in Table 2.1 the highest temperature reached.

The student repeats **step 1** to **step 5** using the different masses of **H** shown in Table 2.1.

- (i) Explain why it is important to stir the mixture of **H** and distilled water in **step 4**.

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





- (ii) Fig. 2.1 shows the reading on the thermometer for the highest temperature reached for 1.0 g and for 2.5 g of H.

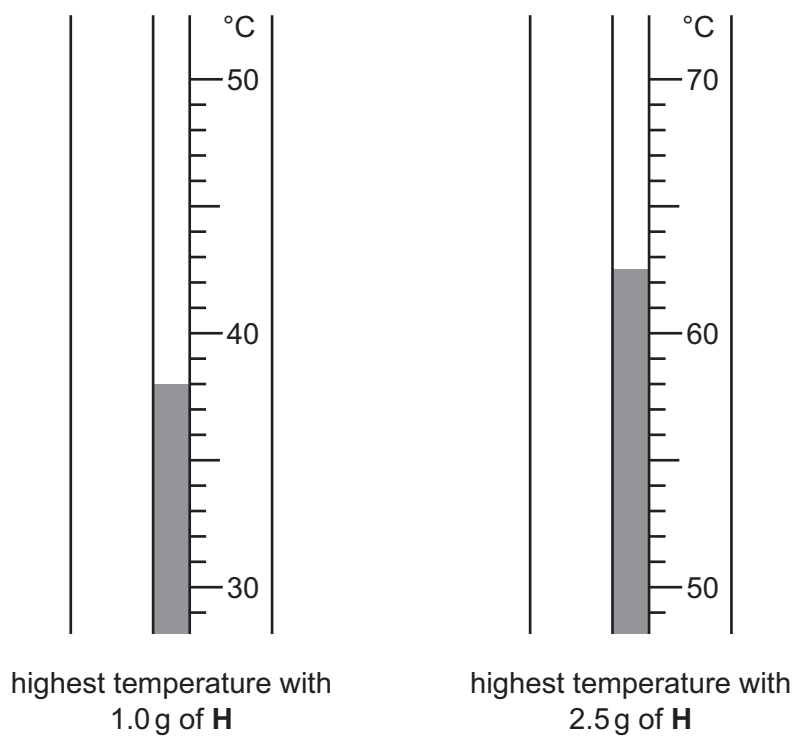


Fig. 2.1

Record in Table 2.1 these temperatures to the nearest 0.5 °C.

Table 2.1

mass of H/g	temperature of distilled water/°C	highest temperature reached/°C	temperature increase/°C
0.5	21.0	29.5	8.5
1.0	21.0		
1.5	21.0	46.0	25.0
2.0	21.0	48.0	27.0
2.5	21.0		
3.0	21.0	70.0	49.0

[2]

- (iii) Calculate the temperature increase for 1.0 g and for 2.5 g of H.

Record your answers in Table 2.1.

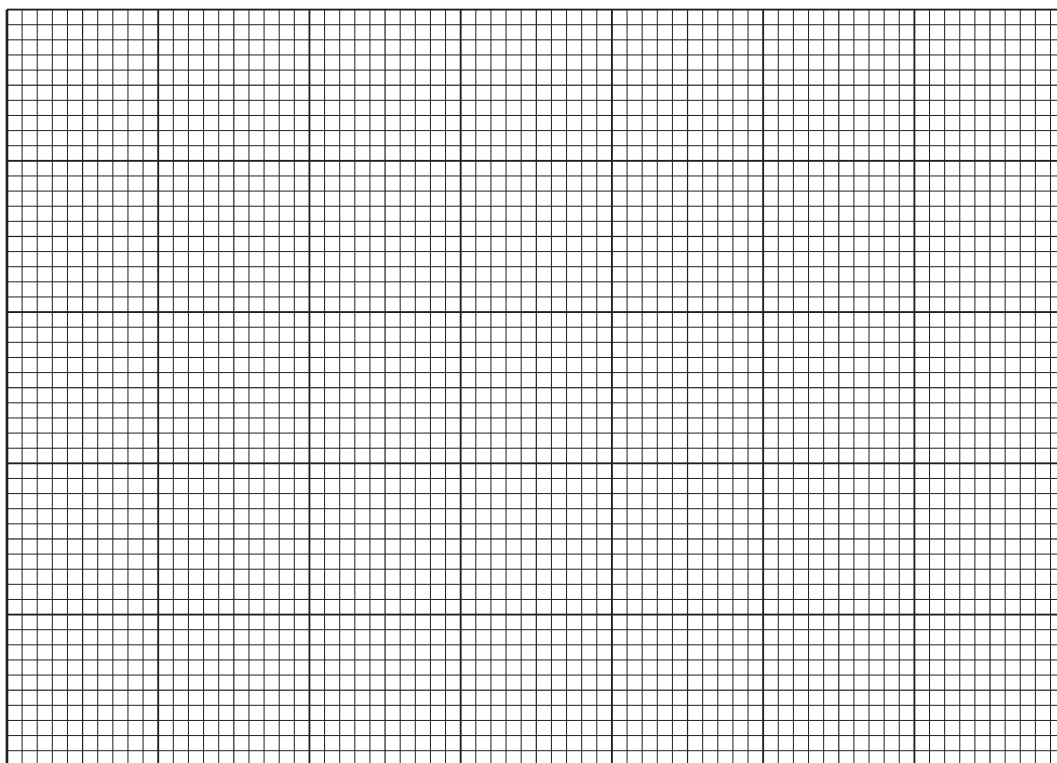
[1]





(iv) On the grid, plot a graph of temperature increase (vertical axis) against mass of **H**.

Start the axes at the origin (0, 0).



[3]

(v) One of the values for the temperature increase is anomalous.

Circle on the grid the anomalous value.

[1]

(vi) Draw the straight line of best fit.

[1]

(vii) Describe the relationship between the mass of **H** and the temperature increase.

.....

..... [1]





(b) During the procedure in (a), the white solid **H** dissolves to form a blue solution.

The student tests the blue solution to identify **H**.

The tests and observations are shown in Table 2.2.

Table 2.2

test	observation
add dilute nitric acid followed by aqueous barium nitrate	white precipitate
flame test	green-blue flame

Identify **H** by placing a tick (✓) in the correct box.

copper(II) chloride

☐

copper(II) sulfate

☐

potassium chloride

☐

potassium sulfate

☐

sodium chloride

☐

sodium sulfate

☐

Explain your answer using information from the tests in Table 2.2 and the information about **H**.

.....

.....

.....

.....

[3]

[Total: 13]





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- 3 A student investigates the refraction of light through a semi-circular glass block.

Procedure

The student:

- draws a straight line **AB** down the centre of a sheet of white paper
- draws a straight line **PQ** across the sheet of paper that intersects line **AB** at right angles at point **O**
- uses a protractor to draw a straight line from point **O** at an angle of 10° to line **AB**
- places the semi-circular glass block onto the paper with the straight face along line **PQ** and the middle of the straight face at point **O**
- uses a ray box to shine an incident ray of light towards point **O** at an angle of incidence $i = 10^\circ$, as shown in Fig. 3.1

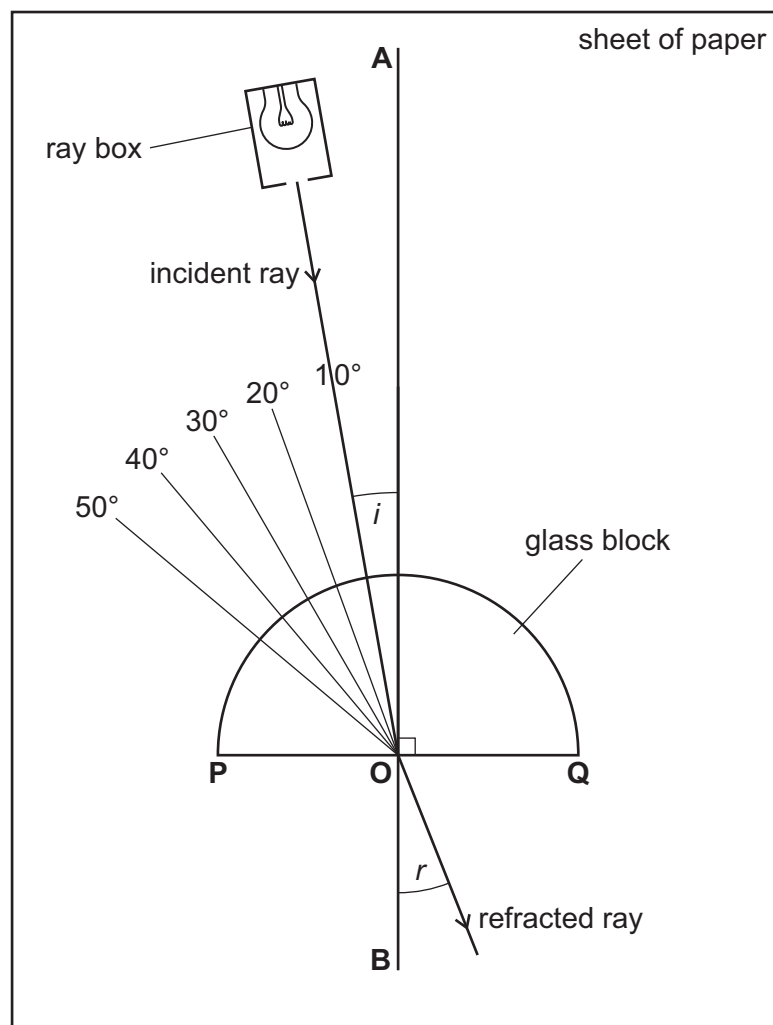


Fig. 3.1 (not to scale)

- uses a protractor to measure the angle of refraction r of the refracted ray
- records angles i and r in Table 3.1.

The student repeats the procedure for $i = 20^\circ$, 30° , 40° and 50° .



- (a) Suggest why the student does this investigation in a dark room.

.....
 [1]

- (b) The ray box in Fig. 3.1 is connected to a power supply.

The student uses a voltmeter to measure the electromotive force (e.m.f.) of the power supply.

Fig. 3.2 shows the reading on the voltmeter.

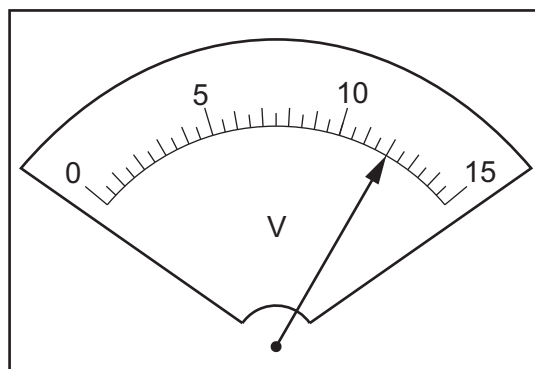


Fig. 3.2

Record the e.m.f. of the power supply.

e.m.f. = ... V [1]





- (c) Fig. 3.3 is drawn to scale and shows the refracted ray for the incident ray at angle of incidence $i = 20^\circ$.

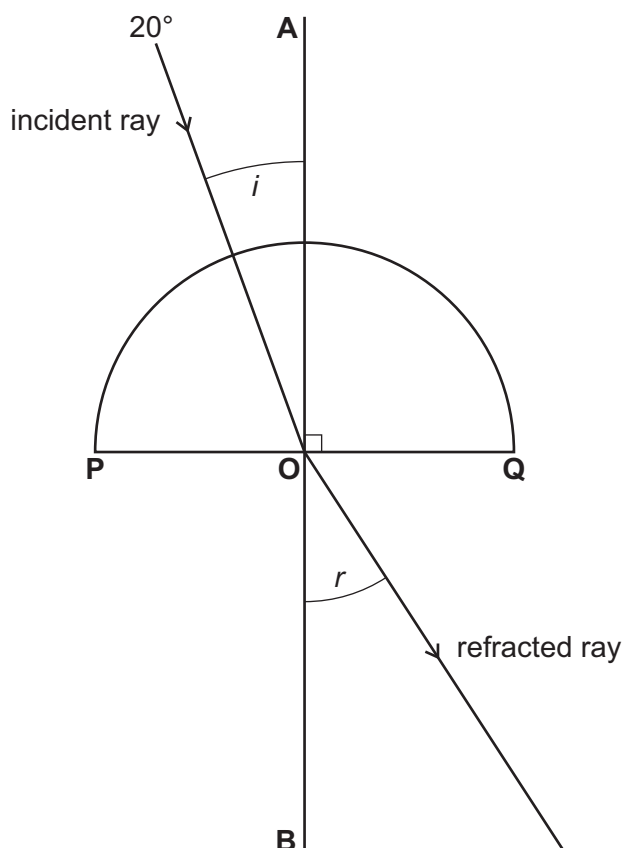


Fig. 3.3 (drawn to scale)

Measure angle r in Fig. 3.3.

Record in Table 3.1 angle r to the nearest degree.

Table 3.1

angle of incidence $i/^\circ$	angle of refraction $r/^\circ$
10	15
20	
30	49
40	75
50	total internal reflection observed

[1]



- (d) For the incident ray at angle of incidence $i = 50^\circ$, the student observes an effect called total internal reflection. The incident ray is not refracted at **O** but instead is reflected, as shown in Fig. 3.4.

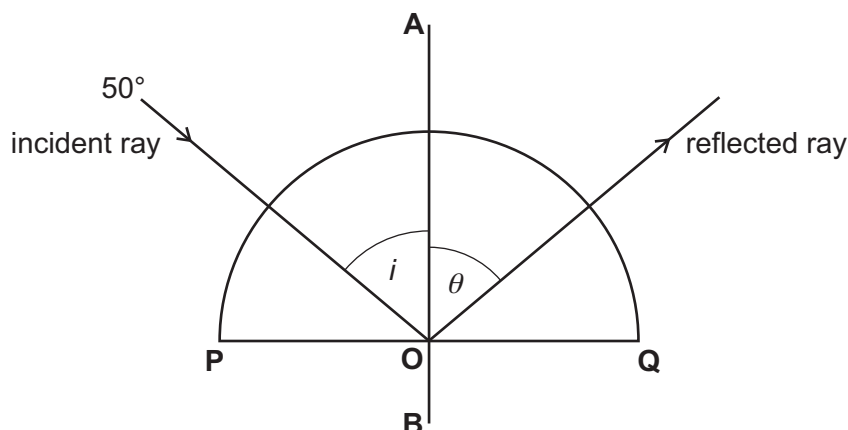


Fig. 3.4 (not to scale)

The student tries to measure the angle of reflection θ of the reflected ray, but the position of the semi-circular block makes it difficult to use the protractor.

Describe a method for marking the path of the reflected ray that overcomes this difficulty.

.....

.....

.....

..... [2]

- (e) The effect of total internal reflection only occurs when the angle of incidence i is greater than a critical angle, i_c .

- (i) Use the results in Table 3.1 to estimate a value for i_c .

$$i_c = \dots\dots\dots^\circ \quad [1]$$

- (ii) Suggest what the student can do to obtain a more accurate estimate of i_c .

.....

..... [1]

[Total: 7]





4 Fig. 4.1 shows a spring of diameter D made using a coil of metal wire.



Fig. 4.1

The spring stretches with an extension x when a load F is applied to the spring.

The spring constant k is a measure of the elastic stiffness of the spring. The spring constant k is calculated using the equation shown.

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

Plan an investigation to determine the relationship between the diameter D of the spring and the spring constant k .

You are provided with:

- springs of different diameter.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any apparatus needed
- a brief description of the method, including what you will measure and any safety precautions you will take
- the variables you will keep constant
- a results table to record your measurements (you do not need to enter any readings in the table)
- how you will process your results to draw a conclusion.





[7]



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1 A student investigates phototropism in a plant.

Phototropism is a response in which parts of a plant grow towards the direction from which light is coming.

Fig. 1.1 shows a plant growing towards the light, where:

- θ_L = the angle of the light to the ground
- θ_P = the angle that the plant grows to the ground.

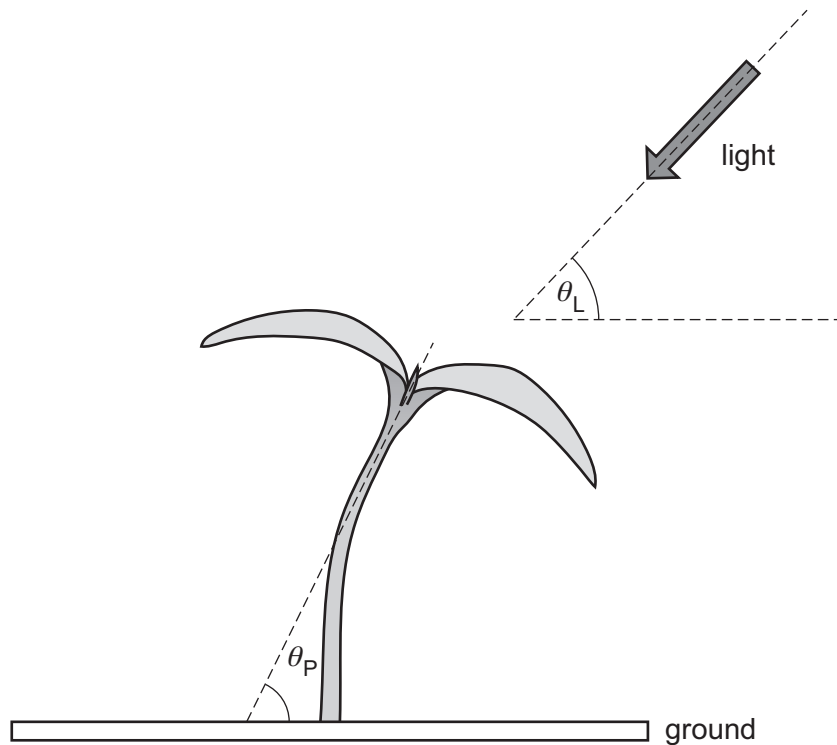


Fig. 1.1

The student investigates the relationship between θ_L and θ_P .

Procedure

The student:

- takes six plants, **A, B, C, D, E** and **F**
- shines light on each plant at a different value of θ_L
- allows the plants to grow for 24 hours
- measures the value of θ_P for each plant
- records the values in Table 1.1.





- (a) The plants are left for 24 hours before θ_p is measured.

Suggest why the plants are left for 24 hours.

.....
 [1]

- (b) The student states:

For a fair test, the light intensity is kept constant during the investigation, and the same light intensity is used for each plant.

- (i) Explain why keeping the light intensity constant in this way makes it a fair test.

.....

 [1]

- (ii) Suggest **one** way that the student makes sure that the light intensity is kept constant.

.....

 [1]

- (iii) Suggest **one** other factor that is kept constant in this investigation.

..... [1]





(c) Fig. 1.2 shows plant **D** after 24 hours.

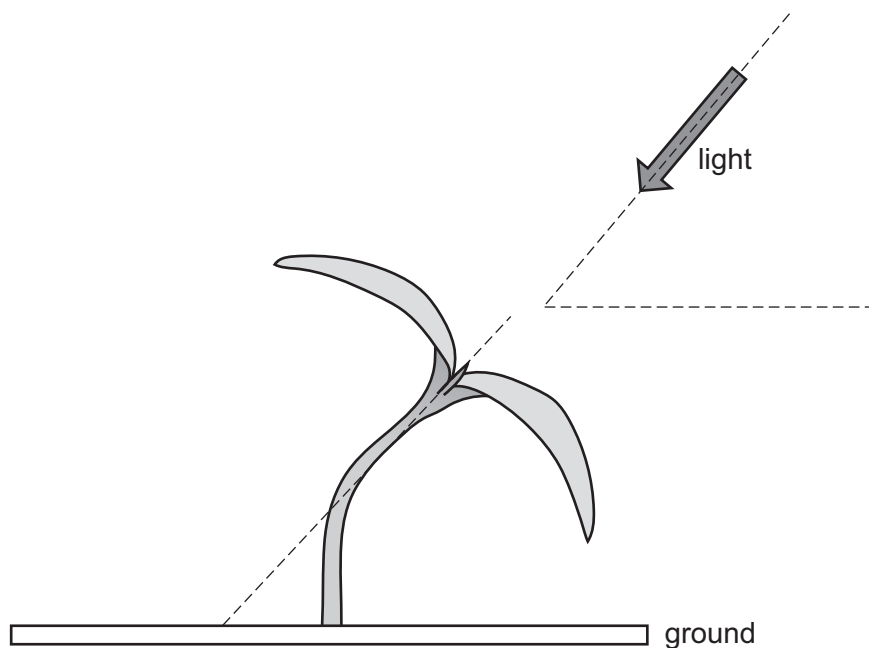


Fig. 1.2

Use a protractor to measure θ_L and θ_P for plant **D** in Fig. 1.2.

Record in Table 1.1 these values to the nearest degree.

Table 1.1

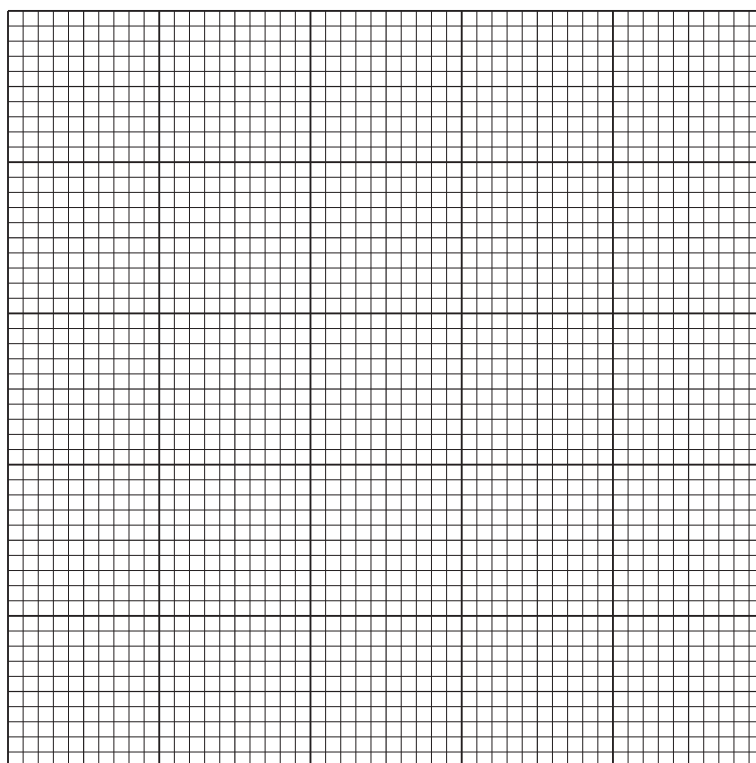
plant	$\theta_L / ^\circ$	$\theta_P / ^\circ$
A	0	8
B	10	19
C	30	32
D		
E	70	68
F	90	86

[2]





- (d) (i) Use the data in Table 1.1 to plot on the grid a graph of θ_P (vertical axis) against θ_L .



[3]

- (ii) Draw the straight line of best fit.

[1]

- (iii) Describe the relationship between θ_L and θ_P .

.....

..... [1]

- (iv) Use your graph to estimate θ_P when $\theta_L = 60^\circ$.

Show on your graph how you obtain your answer.

$\theta_P = \dots\dots\dots^\circ$ [2]

[Total: 13]





- 2 A student prepares a pure dry sample of the insoluble salt, barium sulfate.

Procedure

The student:

- step 1** puts 75 cm³ of aqueous sodium sulfate into a beaker
- step 2** adds an excess of aqueous barium nitrate to the beaker
- step 3** stirs the reaction mixture
- step 4** filters the reaction mixture
- step 5** pours distilled water over the residue in the filter paper
- step 6** dries the filter paper and residue in a warm oven
- step 7** uses a spatula to scrape the barium sulfate off the filter paper and puts the barium sulfate into a sample bottle
- step 8** measures the mass of the pure dry barium sulfate prepared.

- (a) Fig. 2.1 shows the volume of aqueous barium nitrate the student adds to the beaker.

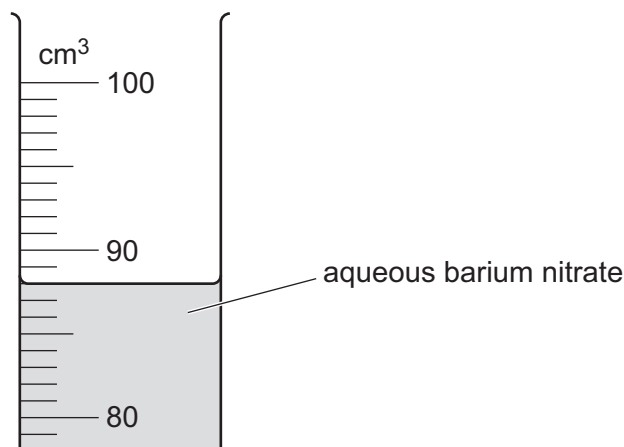


Fig. 2.1

Record the volume of aqueous barium nitrate the student uses.

volume = ... cm³ [1]

- (b) Describe the observation made during **step 2**.

..... [1]

- (c) Explain why the student stirs the reaction mixture in **step 3**.

.....
 [1]





(d) Draw a labelled diagram to show the assembled apparatus used in **step 4**.

Include a label to show where the barium sulfate is found.

[2]

(e) Explain the importance of **step 5**.

.....
 [1]

(f) The mass of pure dry barium sulfate prepared by the student is less than expected.

Describe **one** practical reason why the mass is less than expected.

.....
 [1]

[Total: 7]





3 Antacids are used to neutralise excess acid in the stomach.

Stomach acid has a pH of 2. When antacid is added to stomach acid, the pH increases.

Plan an investigation to determine the relationship between the mass of antacid and the pH increase when antacid is added to excess stomach acid.

You are provided with:

- dilute hydrochloric acid with a pH of 2, to use as stomach acid
- antacid powder
- universal indicator solution and a pH colour chart.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- the apparatus you will use
- a brief description of the method and explain any safety precautions you will take
- what you will measure
- which variables you will keep constant
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

You may include a results table if you wish. You do not need to include any results in the table.





[7]



- 4 A student investigates the effects of two factors on the period T of a simple pendulum.

The period T of a pendulum is the time for one oscillation (swing) of the pendulum. This is shown in Fig. 4.1, where the period is the time taken for the pendulum bob to move from **P** to **Q** and back to **P** again.

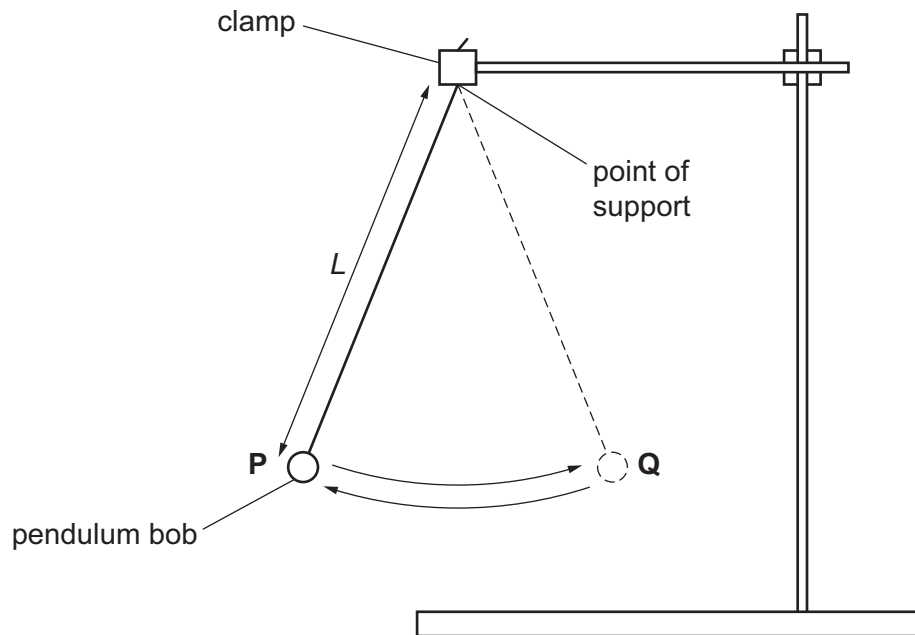


Fig. 4.1

- (a) The student first investigates the effect of varying the length L of the pendulum.

Procedure

The student:

- sets the pendulum length L to 20.0 cm
- measures the time t for 15 oscillations
- calculates the period T
- calculates T^2 .

The student repeats the procedure for $L = 40.0, 60.0, 80.0$ and 100.0 cm.





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Table 4.1 shows some of the student's data.

Table 4.1

L/cm	t/s	T/s	T^2/s^2
20.0	13.4	0.893	0.797
40.0	19.0	1.27	1.61
60.0			
80.0	26.9	1.79	3.20
100.0	30.1	2.01	4.04

- (i) Fig. 4.2 shows the reading on the stop-watch for time t when $L = 60.0\text{ cm}$.



Fig. 4.2

Record this value of t in the row for $L = 60.0\text{ cm}$ in Table 4.1.

[1]

- (ii) Complete Table 4.1 by calculating T and T^2 .

Record T and T^2 to **three** significant figures.

[3]

- (iii) The student thinks that either T or T^2 is proportional to L .

State which variable, T or T^2 , is proportional to L .

Use values from Table 4.1 to justify your answer.

variable

justification

.....

.....

.....

[2]



- (iv) Fig. 4.3 shows a diagram of the pendulum of length $L = 60.0$ cm. The diagram is drawn to scale.

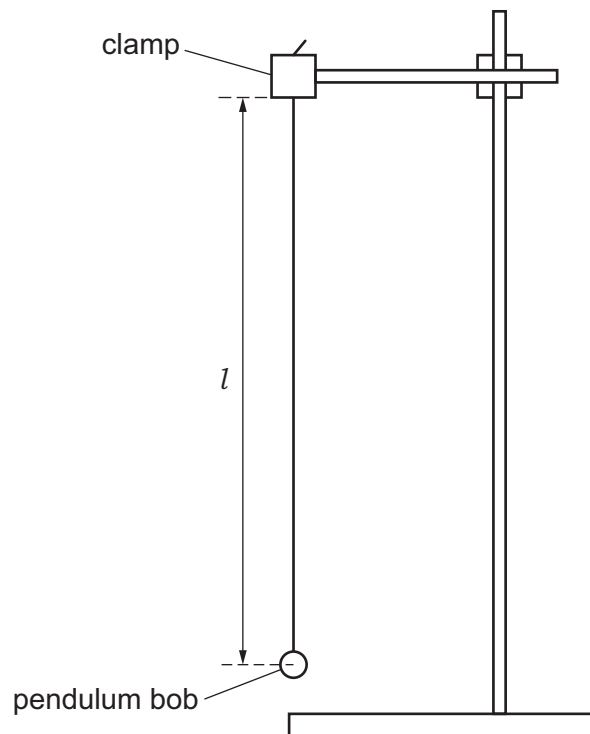


Fig. 4.3 (drawn to scale)

Record to the nearest 0.1 cm the length l of the pendulum shown in Fig. 4.3.

$$l = \dots\dots\dots \text{ cm [1]}$$

- (v) Calculate the scale of the diagram in Fig. 4.3.

Use your answer to (a)(iv) and the equation shown.

$$\text{scale} = \frac{l}{60.0}$$

$$\text{scale} = \dots\dots\dots [1]$$





- (b) The student now uses a protractor to investigate the effect of varying the angle of displacement α of the pendulum.

The angle of displacement α of the pendulum is the initial angle from the vertical at which the pendulum is released, as shown in Fig. 4.4.

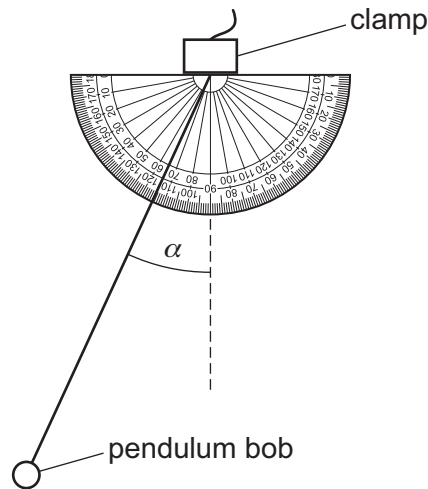


Fig. 4.4

Procedure

The student:

- sets the pendulum length L to 80.0 cm
- measures the time t for 15 oscillations at five different values of α
- calculates the period T for each value of α
- records α , t and T in Table 4.2.

Table 4.2

$\alpha/^\circ$	t/s	T/s
10.0	27.1	1.81
20.0	27.0	1.80
25.0	27.2	1.81
35.0	27.5	1.83
40.0	28.1	1.87

- (i) Suggest **one** precaution the student takes to make an accurate measurement of angle α .

.....
 [1]





- (ii) Values are considered to be equal within the limits of experimental accuracy if they are within 10% of each other.

State whether the five values of T in Table 4.2 are equal within the limits of experimental accuracy.

Justify your statement with a calculation.

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

- (c) (i) Explain why the student measures the time t for 15 oscillations and then calculates the period T , rather than measuring T directly.

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

- (ii) Suggest why the student does **not** choose to measure the time for 150 oscillations.

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

[Total: 13]





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