Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME			
CENTRE NUMBER		CANDIDATE NUMBER	

COMBINED SCIENCE **0653/63**

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.

DC (PQ/CB) 337856/4

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.

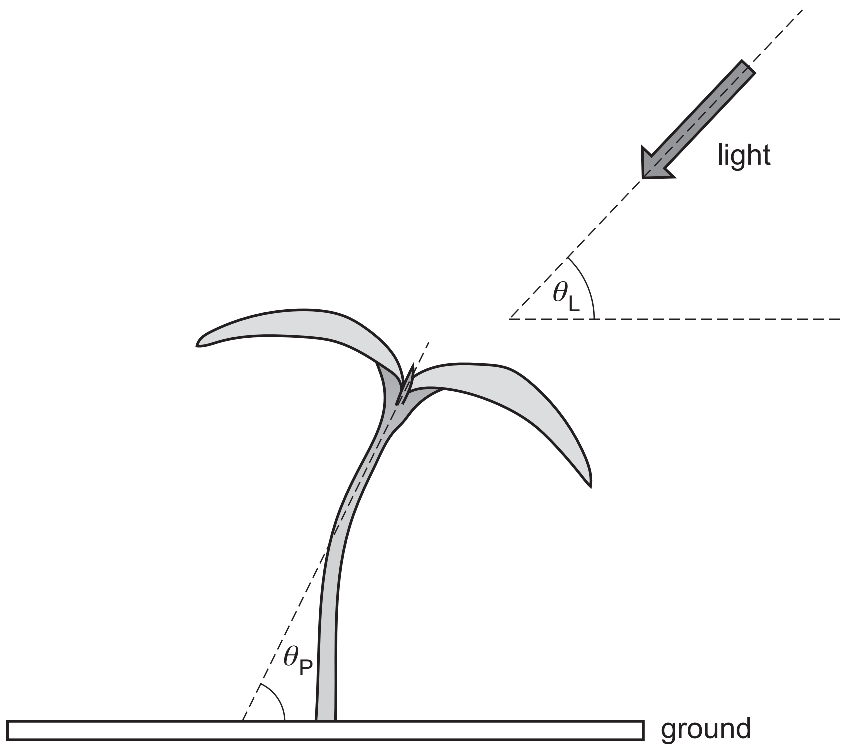


Fig. 1.1

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.

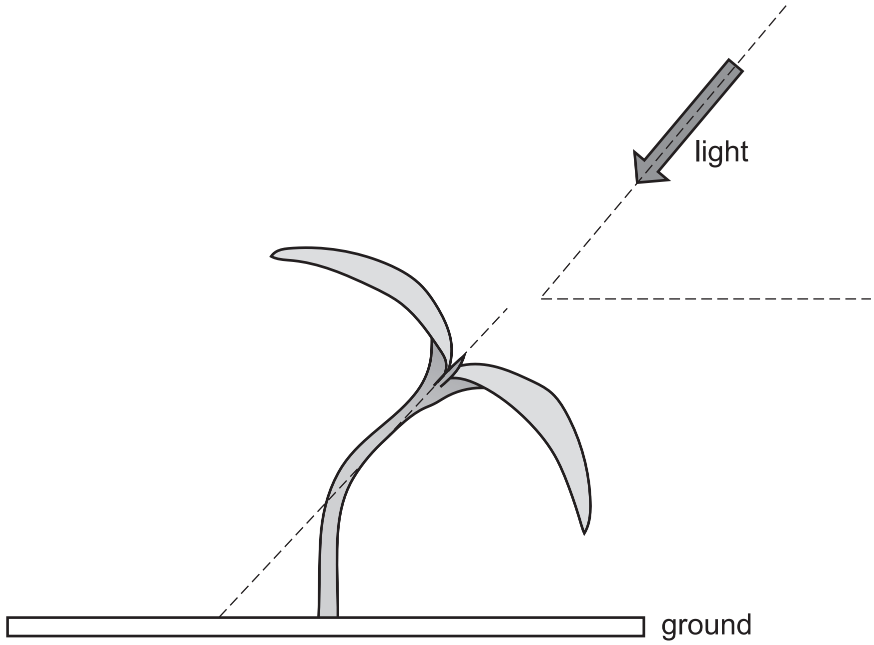


Fig. 1.2

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

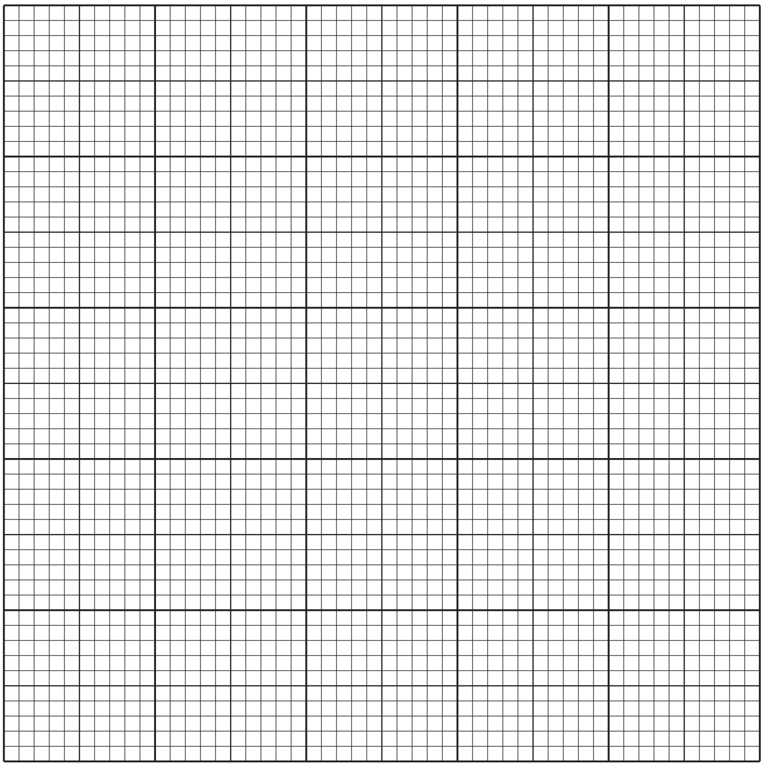
Record in Table 1.1 these values to the nearest degree.

Table 1.1

plant	θ_L / °	θ_P / °
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 θ_L = 60°.

Show on your graph how you obtain your answer.

θ_P = ...° [2]

[Total: 13]

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

Procedure

The student:

step 1 puts 75 cm^3 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.

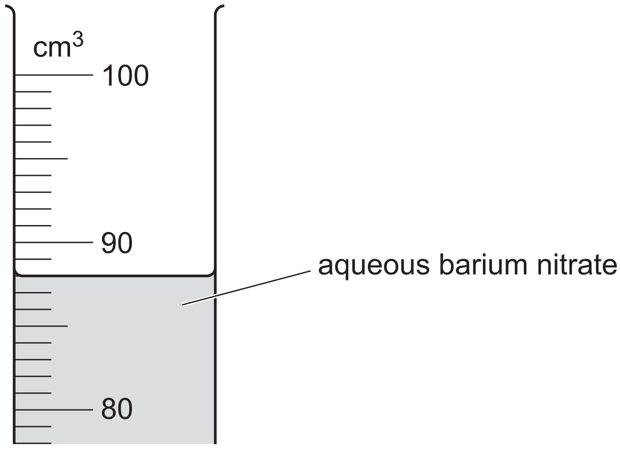


Fig. 2.1

Record the volume of aqueous barium nitrate the student uses.

volume = ... cm^3 [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.

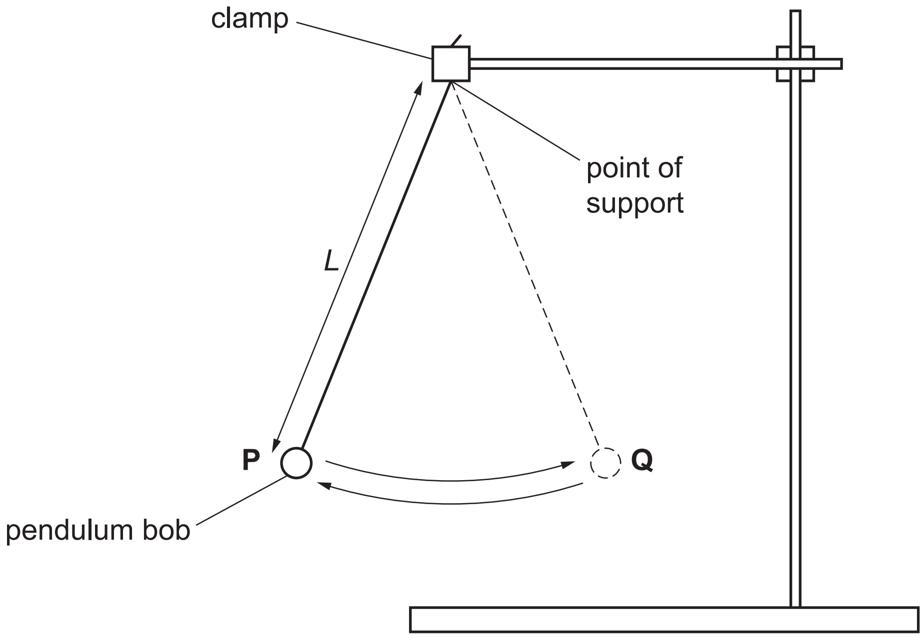


Fig. 4.1

(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.

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 cm.

Fig. 4.2

Record this value of t in the row for L = 60.0 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.

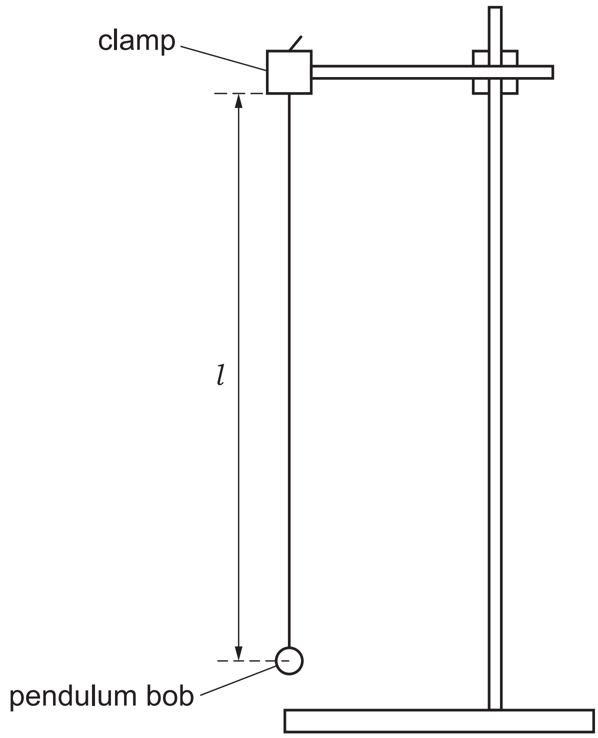


Fig. 4.3 (drawn to scale)

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

l = ... cm [1]

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

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

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

scale = ... [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.

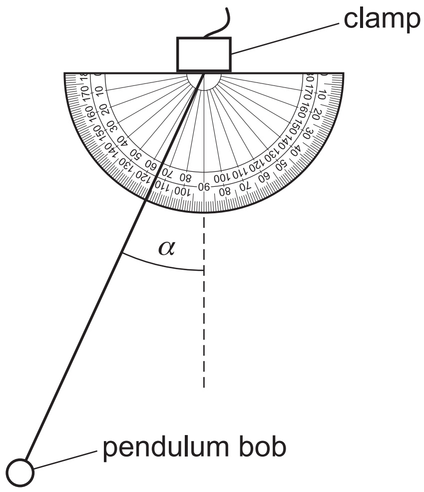


Fig. 4.4

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

α / °	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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CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

* 0 1 2 3 4 5 6 7 8 9 *

COMBINED SCIENCE **0653/06**

Paper 6 Alternative to Practical **For examination from 2025**

SPECIMEN PAPER **1 hour**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
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- 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 [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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1 A student investigates vitamin C in apple juice.

The student is provided with half an apple and some apple juice.

Fig. 1.1 shows the cut surface of the apple provided.

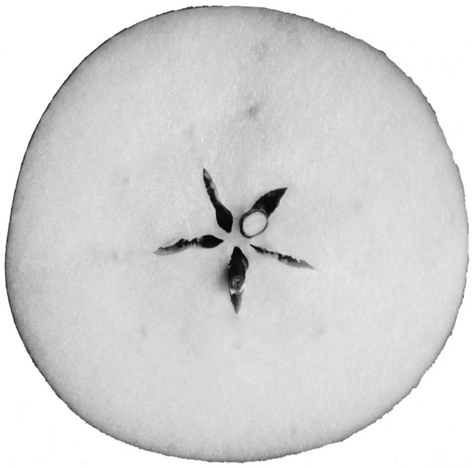

Fig. 1.1

(a) In the box, make a large drawing of the cut surface of the apple shown in Fig. 1.1.

[3]

(b) The student tests the apple juice using DCPIP.

DCPIP is a dark blue solution that turns colourless when vitamin C is added.

The greater the amount of vitamin C in the apple juice, the fewer the drops of apple juice needed to turn the DCPIP colourless.

Procedure

The student:

- puts 2.0 cm^3 DCPIP into a test-tube
- fills a syringe with 10.0 cm^3 of apple juice
- adds apple juice to the DCPIP in the test-tube until the DCPIP turns colourless
- records in Table 1.1 the volume of apple juice **remaining** in the syringe for experiment **1**.

The student repeats the procedure and records the volume of apple juice remaining in the syringe for experiment **2** in Table 1.1.

The student repeats the procedure again for experiment **3**.

Fig. 1.2 shows the volume of apple juice remaining in the syringe in experiment **3**.

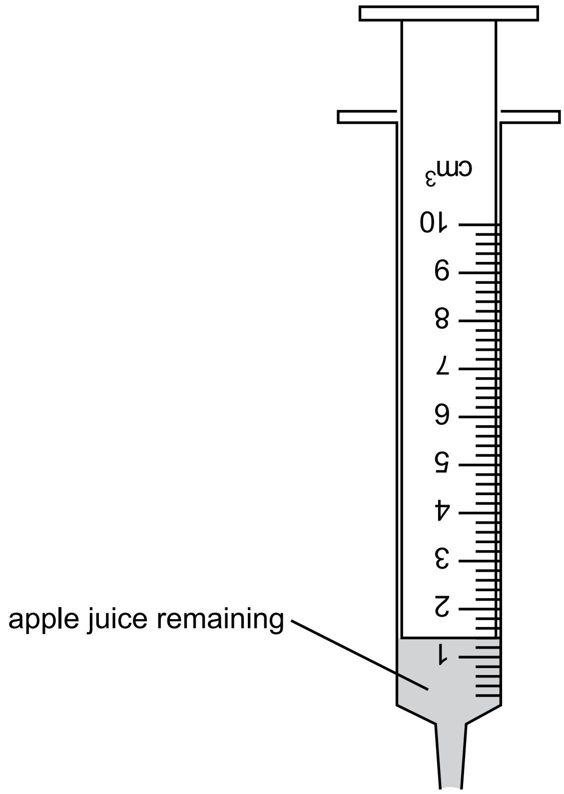

Fig. 1.2

(i) Record in Table 1.1 the volume of apple juice remaining in the syringe in experiment **3**.

Table 1.1

experiment	volume of apple juice remaining in syringe / cm^3	volume of apple juice added to the DCPIP / cm^3
1	1.3	8.7
2	1.5	8.5
3		

[1]

(ii) Calculate the volume of apple juice added to the DCPIP in experiment **3**.

Record your answer in Table 1.1. [1]

(iii) Calculate the average volume of apple juice added.

average volume = ... cm^3 [1]

(iv) Suggest why the student repeats the experiment.

....

.... [1]

[Total: 7]

2 When an aquatic plant is exposed to light, it produces bubbles of oxygen gas.

Plan an investigation to determine the relationship between light intensity and the volume of oxygen gas produced by the aquatic plant.

You are provided with the apparatus shown in Fig. 2.1.

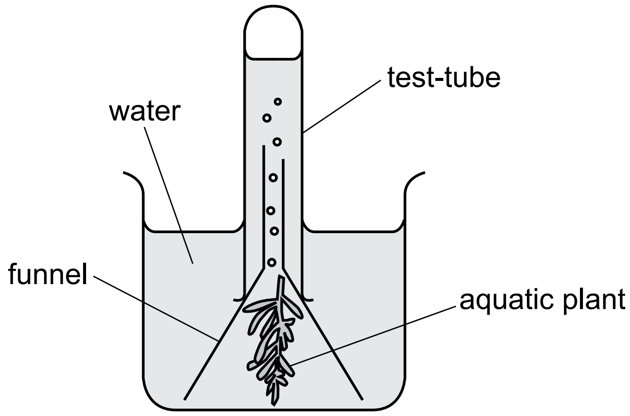

Fig. 2.1

You may use any other common laboratory apparatus in your plan.

In your plan, include:

- any **additional** apparatus and chemicals that you will use
- a brief description of the method, explaining any safety precautions you will take
- what you will measure
- which variables you will control
- how you will process your results to form a conclusion.

You may include a labelled diagram.

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

....

....

....

....

....

....

....

....

....

....

....

....

....

.... [7]

3 A student investigates the reaction between metal **F** and dilute sulfuric acid.

(a) (i) Procedure

The student:

- adds 3 cm depth of dilute sulfuric acid to a test-tube
- adds a spatula of metal **F** to the test-tube
- observes the mixture fizzing slowly
- tests the gas produced with a lighted splint
- hears a squeaky pop.

Identify the gas produced.

.... [1]

(ii) The student repeats the procedure in **(a)(i)** but also adds aqueous copper(II) sulfate to the dilute sulfuric acid and metal **F**.

The student observes that this reaction is faster than the reaction in **(a)(i)**.

Suggest **one** observation the student makes which shows that this reaction is faster.

....

.... [1]

(iii) Procedure

The student:

- pours a small volume of the aqueous product from the procedure in **(a)(i)** into a test-tube
- adds aqueous sodium hydroxide
- observes a white precipitate.

Use this observation to suggest **two** possible identities for the cation produced from metal **F**.

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

(b) Procedure

The student:

- uses a measuring cylinder to measure 10 cm^3 of dilute sulfuric acid
- adds the dilute sulfuric acid to a boiling tube
- sets up apparatus as shown in Fig. 3.1

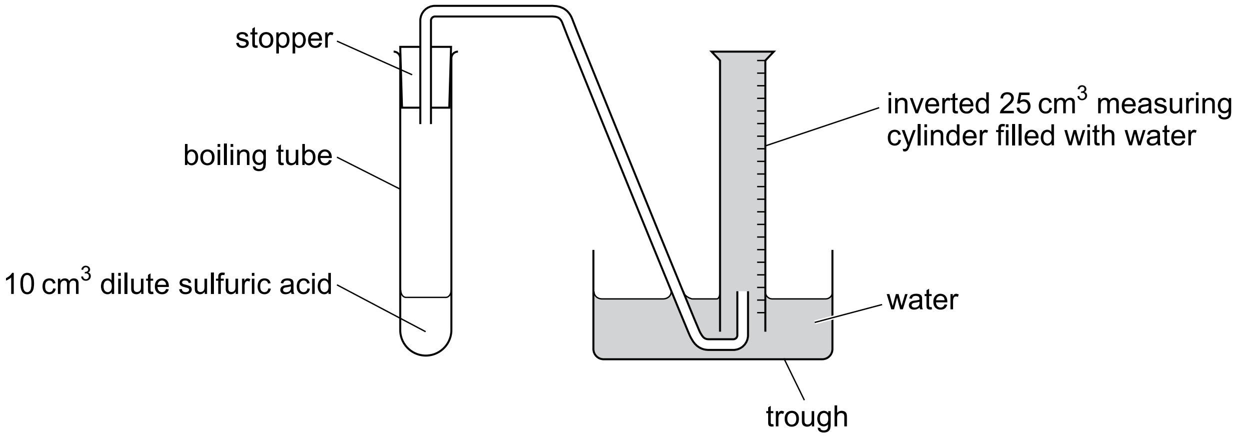

Fig. 3.1

- removes the stopper from the boiling tube
- adds one spatula of metal **F** to the boiling tube
- puts the stopper back into the boiling tube and starts the stop-watch
- records in Table 3.1 the time taken to collect 5 cm^3, 10 cm^3, 15 cm^3, 20 cm^3 and 25 cm^3 of gas.

(i) Fig. 3.2 shows the stop-watch readings for 5 cm^3 and 25 cm^3 of gas collected.

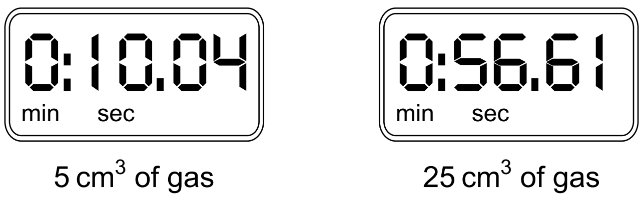

Fig. 3.2

Record in Table 3.1 the time taken to the nearest second to collect 5 cm^3 and 25 cm^3 of gas.

Table 3.1

volume of gas collected / cm^3	time taken / s
5	
10	22
15	34
20	46
25	

[2]

(ii) State the independent variable and the dependent variable in this investigation.

independent variable ....

dependent variable ....

[1]

(iii) On the grid, plot a graph of volume of gas collected (vertical axis) against time taken.

[3]

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

(v) Describe the relationship between the volume of gas collected and the time taken.

....

....

.... [1]

(vi) Suggest **one** possible source of error in the measurement of the time taken.

....

.... [1]

(vii) Suggest **one** way to obtain a more accurate measurement of the volume of gas collected.

....

.... [1]

[Total: 13]

4 A student determines the density of the material used to make a metre rule.

(a) Fig. 4.1 shows the metre rule (**not** drawn to scale).

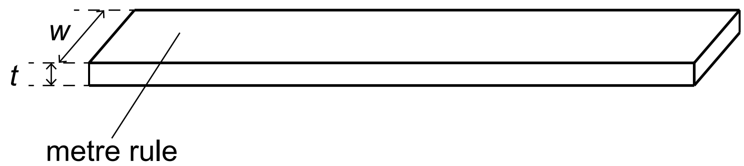

Fig. 4.1 (not to scale)

(i) On Fig. 4.1, draw a double-headed arrow (↔) to show the length *L* of the metre rule. [1]

(ii) Fig. 4.2 shows the **actual** size of the end of the metre rule.

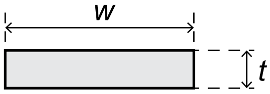

Fig. 4.2 (actual size)

Use a ruler to measure width *w* and thickness *t* of the metre rule in Fig. 4.2.

Record each measurement to the nearest 0.1 cm.

w = ... cm

t = ... cm
[2]

(iii) The measurements in **(a)(ii)** are recorded to the nearest 0.1 cm.

State why it is **not** appropriate to record the measurements to the nearest 0.01 cm.

....

.... [1]

(iv) The length *L* of the metre rule is 100.0 cm.

Calculate the volume *V* of the metre rule.

Use your answers to **(a)(ii)** and the equation shown.

$$V = L \times w \times t$$

V = ... cm^3 [1]

(b) The student determines the mass M of the metre rule using a balancing method.

Procedure

The student:

step 1 places a pivot directly under the 60.0 cm mark on the metre rule.

Fig. 4.3 shows the distance d = 60.0 cm.

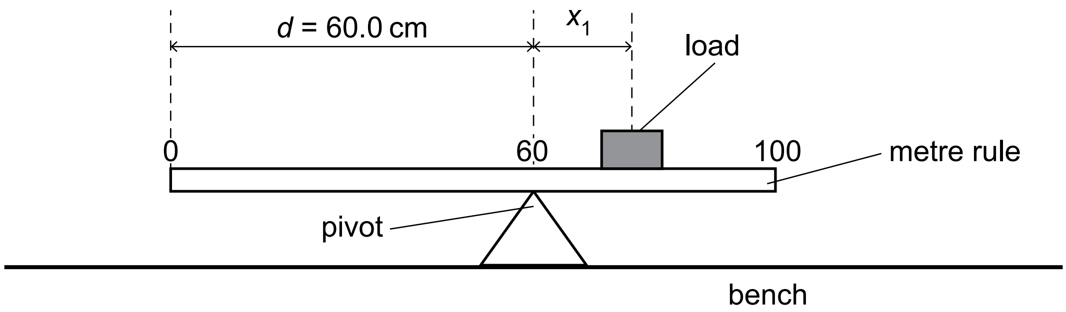

Fig. 4.3 (not to scale)

step 2 places a load on the metre rule and adjusts the position of the load so that the rule balances

step 3 records that the **centre** of the load is directly above the 67.1 cm mark on the metre rule.

(i) Calculate the distance x_1 from the **centre** of the load to the pivot.

x_1 = ... cm [1]

step 4 moves the pivot so that distance d = 70.0 cm

step 5 adjusts the position of the load so that the metre rule balances

step 6 records that the centre of the load is directly above the 84.2 cm mark on the metre rule.

(ii) Calculate the distance x_2 from the **centre** of the load to the pivot.

x_2 = ... cm [1]

(iii) Use the results for **(b)(i)** and **(b)(ii)** to calculate the mass M of the metre rule.

Use the equation shown.

$$M = 5\,(x_1 + x_2)$$

M = ... g [1]

(c) Fig. 4.4 shows apparatus used for measuring mass.

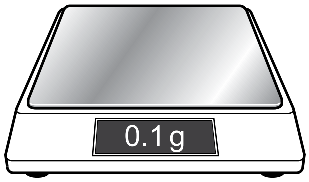

Fig. 4.4

(i) State the name of the apparatus shown in Fig. 4.4.

.... [1]

(ii) The apparatus in Fig. 4.4 is showing an error.

State the type of error shown in Fig. 4.4.

.... [1]

(d) Use your answers to **(a)(iv)** and **(b)(iii)** to calculate the density ρ of the material used to make the metre rule.

Use the equation shown.

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

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

Give the unit for your answer.

ρ = ...

unit = ...
[3]

[Total: 13]

NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

anion	*test*	*test result*
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	*effect of aqueous sodium hydroxide*	*effect of aqueous ammonia*
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess , ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	*test and test result*
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint

Flame tests for metal ions

metal ion	*flame colour*
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
copper(II), Cu^{2+}	blue-green

