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COMBINED SCIENCE**0653/61**

Paper 6 Alternative to Practical

October/November 2025**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 [].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **16** pages.

- 1 A student investigates an enzyme-controlled reaction.

Catalase is an enzyme found inside potato cells. It catalyses the breakdown of hydrogen peroxide, releasing oxygen gas.

When potato is mixed with aqueous hydrogen peroxide in a boiling tube, oxygen gas produces a foam.

The height of the foam is measured as shown in Fig. 1.1.

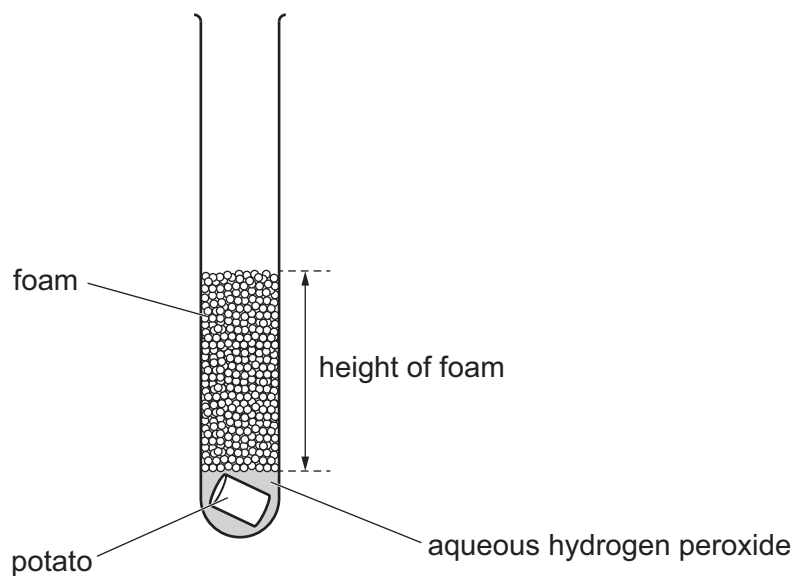


Fig. 1.1



Procedure

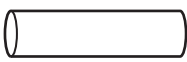
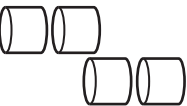
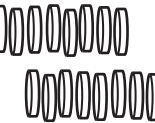
The student:

step 1 labels five boiling tubes **A**, **B**, **C**, **D** and **E**

step 2 cuts five identical cylinders of potato, each to a length of 5 cm

step 3 further cuts four of the potato cylinders into different numbers of equal-sized pieces, as shown in Table 1.1

Table 1.1

	boiling tube				
	A	B	C	D	E
how potato cylinder is cut					
number of pieces	1	2	4	8	16

step 4 puts the pieces of potato into the boiling tubes as shown in Table 1.1

step 5 adds 10 cm³ of aqueous hydrogen peroxide to each boiling tube

step 6 leaves the boiling tubes for 5 minutes

step 7 measures the height of the foam in each boiling tube.



Table 1.2 shows some of the student's data.

Table 1.2

boiling tube	number of pieces of potato	height of foam /mm
A	1	17
B	2	
C	4	44
D	8	
E	16	64

(a) Fig. 1.2 shows the height of the foam after 5 minutes in boiling tubes **B** and **D**.

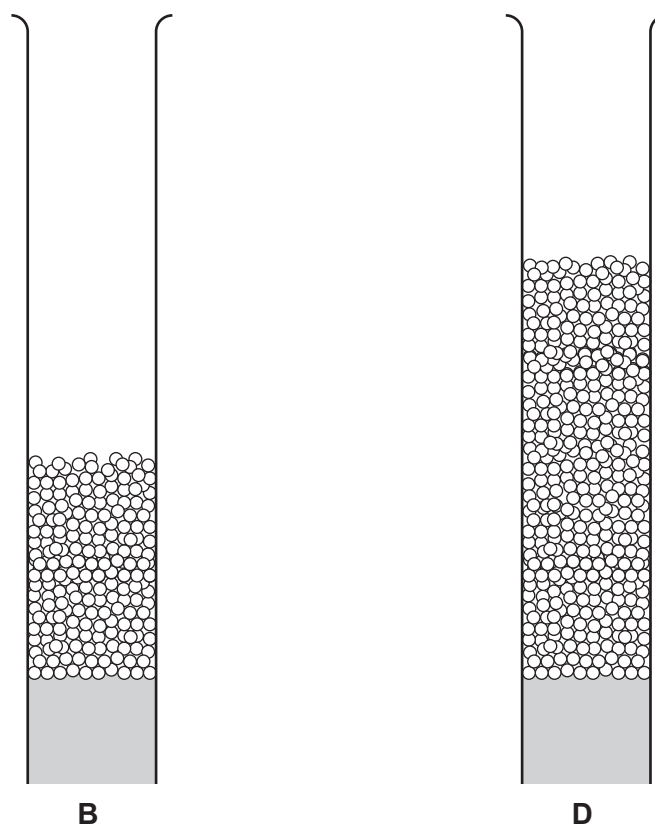
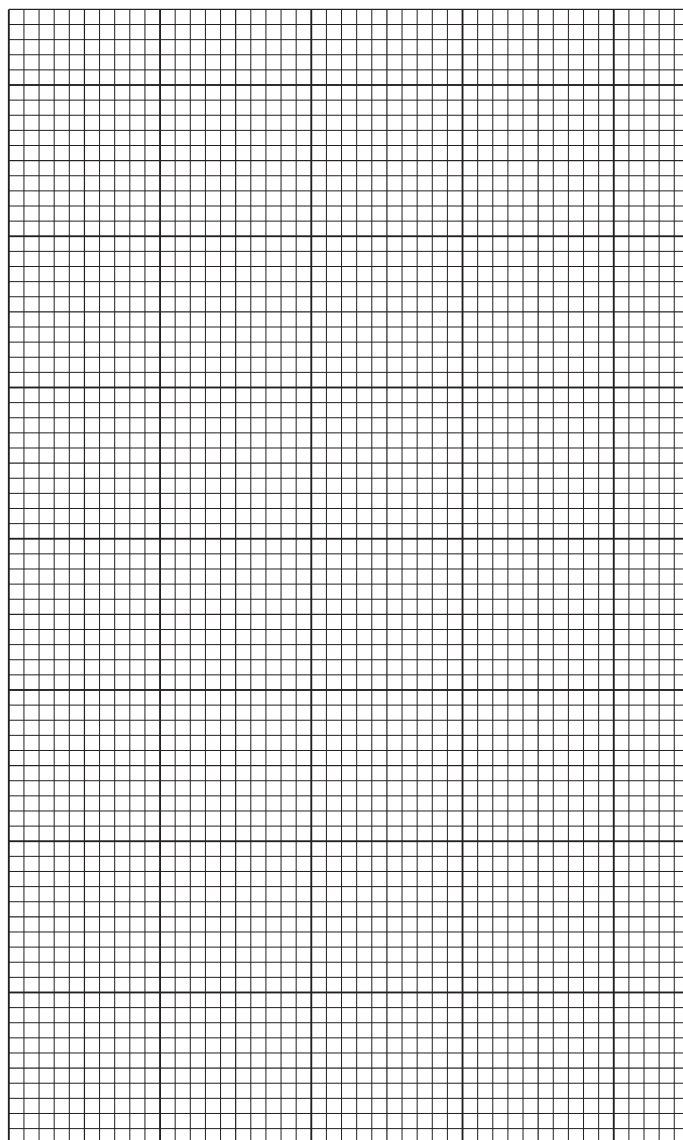


Fig. 1.2

Record in Table 1.2 the height of the foam in each boiling tube in mm to the nearest mm. [2]



- (b) (i) Use the data in Table 1.2 to plot on the grid the height of the foam (vertical axis) against the number of pieces of potato.



[3]

- (ii) Draw the best-fit curve. [1]

- (iii) Cutting the potato cylinder into pieces increases the surface area.

Describe the relationship between the surface area and the height of foam produced.

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

- (iv) Use your graph to estimate the height of foam for 12 pieces of potato.

Show your working on your graph.

height of foam = ... mm [1]



- (c) All of the potato cylinders in **step 2** are cut to have the same length of 5 cm.

Explain why this helps to make the test fair.

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

- (d) Measuring the volume of oxygen produced is a more accurate method than measuring the height of the foam.

- (i) Describe **one** difficulty in measuring the height of the foam in (a).

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

- (ii) Suggest **one other** reason why measuring the volume of oxygen produced is a more accurate method than measuring the height of the foam.

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

- (iii) Complete Fig. 1.3 to show assembled apparatus suitable for collecting and measuring the volume of oxygen produced.

Label the apparatus.

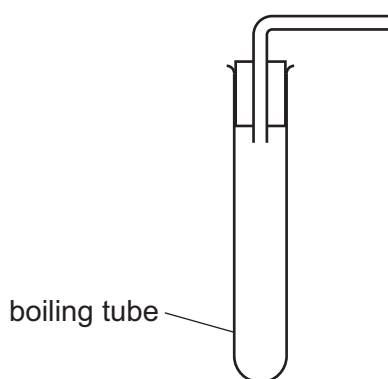


Fig. 1.3

[2]

[Total: 13]



- 2 A student investigates the chemical reaction between aqueous barium nitrate and aqueous H.

Procedure

The student:

- step 1** assembles the apparatus and chemicals shown in Fig. 2.1

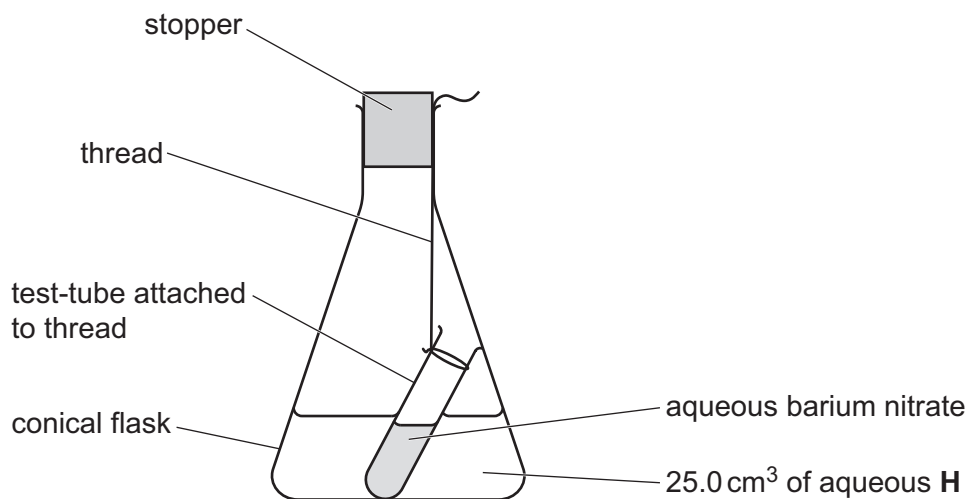


Fig. 2.1

- step 2** records the mass of the flask and its contents
- step 3** turns the flask upside down to mix the chemicals, making certain no chemicals leak from the stopper
- step 4** records the mass of the flask and its contents after mixing
- step 5** records in Table 2.1 any other observations.



(a) Fig. 2.2 shows the balance readings for **step 2** and **step 4**.

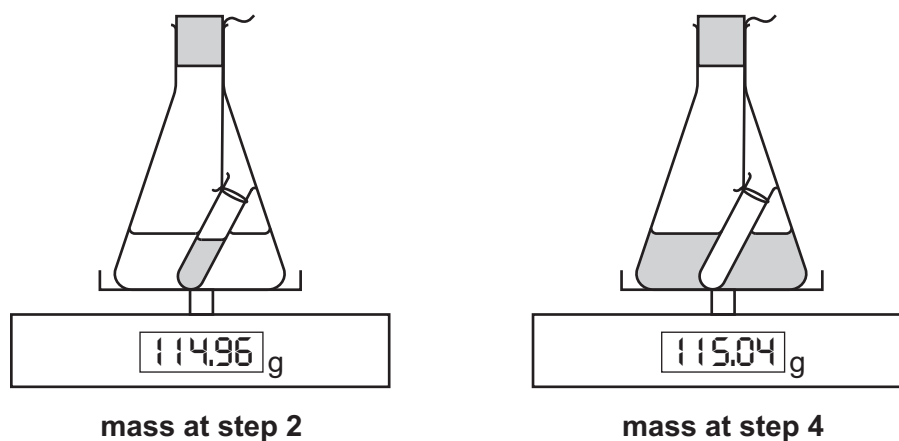


Fig. 2.2

Record in Table 2.1 these masses to the nearest 0.1 g.

Table 2.1

mass of flask and its contents at step 2 /g	
mass of flask and its contents after mixing at step 4 /g	
observations at step 5	white precipitate

[2]

(b) Name a piece of apparatus suitable for measuring 25.0 cm^3 of aqueous **H**.

..... [1]

(c) A teacher states:

“In a chemical reaction, no mass is gained or lost.”

Explain whether your results in Table 2.1 support this statement.

..... [1]



(d) Identify **one** ion present in aqueous **H**.

Explain your answer.

ion

explanation

[1]

(e) Suggest why this procedure is **not** used to investigate the reaction between aqueous sodium carbonate and dilute hydrochloric acid.

Explain your answer.

.....

.....

..... [2]

[Total: 7]



- 3 Solid citric acid is added to aqueous sodium hydrogencarbonate. There is a reaction and the temperature of the aqueous sodium hydrogencarbonate decreases.

Plan an investigation to determine the relationship between the mass of citric acid added to the aqueous sodium hydrogencarbonate and the decrease in temperature.

You are provided with:

- solid citric acid
- aqueous sodium hydrogencarbonate.

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
- what you will measure
- which variables you will control
- how you will process your results to form a conclusion.

You may include a results table (you are **not** required to enter any data into the table).



- 4 A student uses **two** methods to determine the resistance R of resistor **W**.

(a) **Method 1 Procedure**

The student:

- assembles the circuit shown in Fig. 4.1

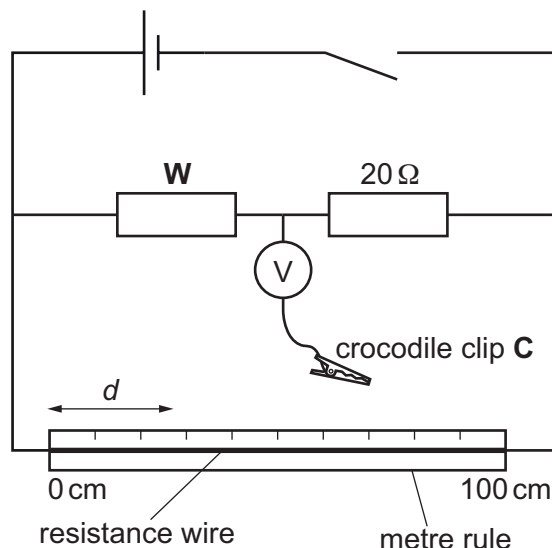


Fig. 4.1

- connects crocodile clip **C** to the resistance wire at $d = 10$ cm, where d is the horizontal distance of the crocodile clip along the metre rule from the 0 cm mark
- closes the switch
- moves crocodile clip **C** along the wire to $d = d_0$, where d_0 is the distance at which the reading on the voltmeter becomes zero
- opens the switch.

Fig. 4.2 shows crocodile clip **C** at d_0 , as viewed from above.

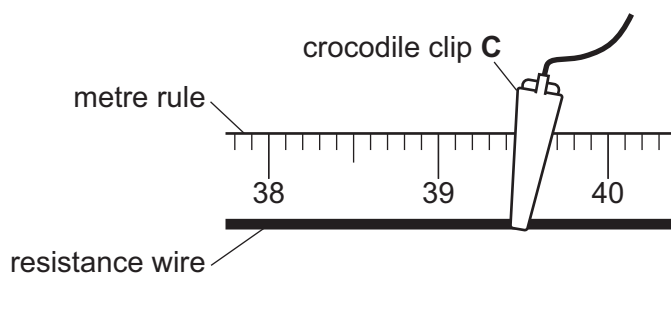


Fig. 4.2

- (i) Record d_0 in cm to the nearest 0.1 cm.

$d_0 = \dots\dots\dots$ cm [1]



- (ii) Another student suggests replacing crocodile clip **C** with the piece of apparatus shown in Fig. 4.3.

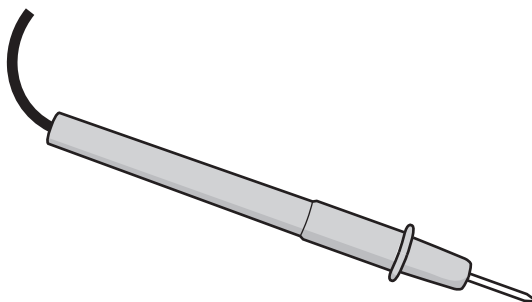


Fig. 4.3

Explain why this is an improvement to the apparatus.

.....

.....

.....

..... [2]

- (iii) Calculate the resistance R of resistor **W**.

Use your answer in (a)(i) and the equation shown.

$$R = 20 \times \left(\frac{d_0}{100 - d_0} \right)$$

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

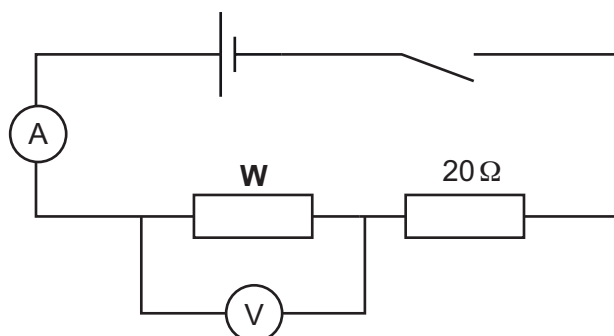
$$R = \dots\dots\dots \Omega \text{ [2]}$$



(b) Method 2 Procedure

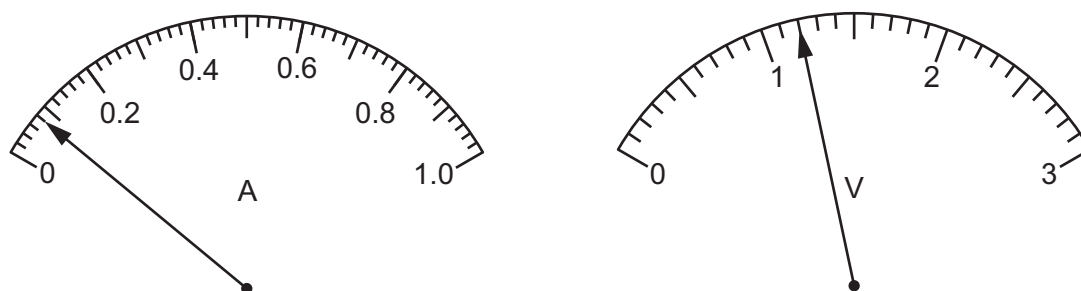
The student:

- assembles the circuit shown in Fig. 4.4

**Fig. 4.4**

- closes the switch
- records the reading on the ammeter, I
- records the reading on the voltmeter, V
- opens the switch.

(i) Fig. 4.5 shows the readings on the ammeter and the voltmeter.

**Fig. 4.5**

Record the values of I and V .

$I = \dots\dots\dots$ A

$V = \dots\dots\dots$ V
[2]

(ii) The ammeter and the voltmeter shown in Fig. 4.5 are **analogue**.

Suggest **one** advantage of taking readings from a **digital** ammeter or voltmeter.

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



(iii) Calculate the resistance R of resistor **W**.

Use your answers in **(b)(i)** and the equation shown.

$$R = \frac{V}{I}$$

$R = \dots\dots\dots \Omega$ [1]

- (c) Two values are considered equal within the limits of experimental error if the difference between them is less than 10%.

Explain whether your values of R in **(a)(iii)** and **(b)(iii)** are equal within the limits of experimental error.

Justify your answer with a calculation.

.....
 [2]

- (d) In both procedures, the student opens the switch after each set of readings.

Suggest **two** reasons why this is a good precaution.

1

2

[2]

[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

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

- 1 A student investigates the effect of light intensity on the rate of photosynthesis.

During photosynthesis, a plant produces oxygen gas.

Procedure

The student:

- step 1** assembles the apparatus shown in Fig. 1.1.

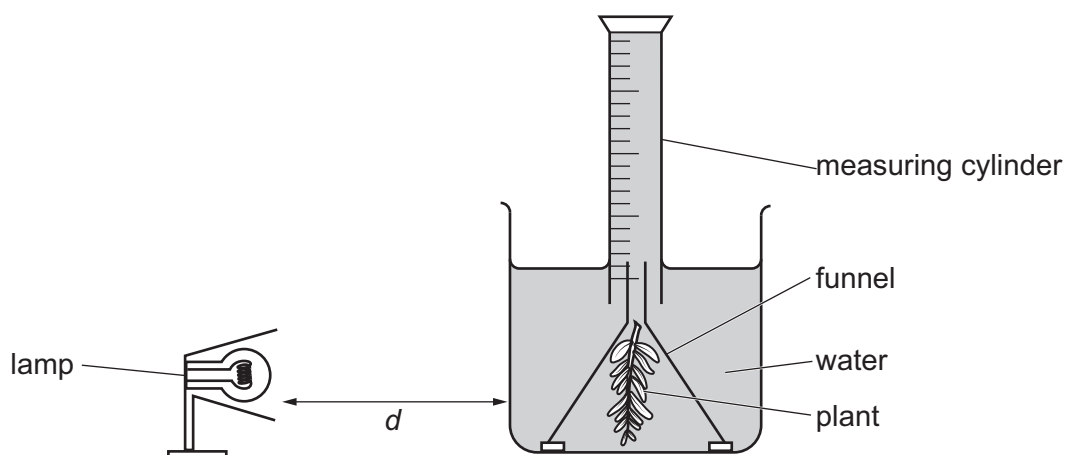


Fig. 1.1

- step 2** turns on the lamp
step 3 sets distance d to 10 cm
step 4 waits for 5 minutes
step 5 records the volume of gas in the measuring cylinder
step 6 waits a further 10 minutes
step 7 records the volume of gas in the measuring cylinder
step 8 repeats **step 3** to **step 7** for $d = 20$ cm, 30 cm, 40 cm and 50 cm by moving the lamp but leaving the rest of the apparatus unchanged.

Table 1.1 shows some of the student's data.

Table 1.1

d /cm	volume of gas at step 5 /cm ³	volume of gas at step 7 /cm ³	change in volume of gas between step 5 and step 7 /cm ³
10	15	47	32
20	57	78	21
30	85	99	14
40	104	113	
50			



- (a) Fig. 1.2 shows the volumes of gas in the measuring cylinder at **step 5** and at **step 7** for $d = 50$ cm.

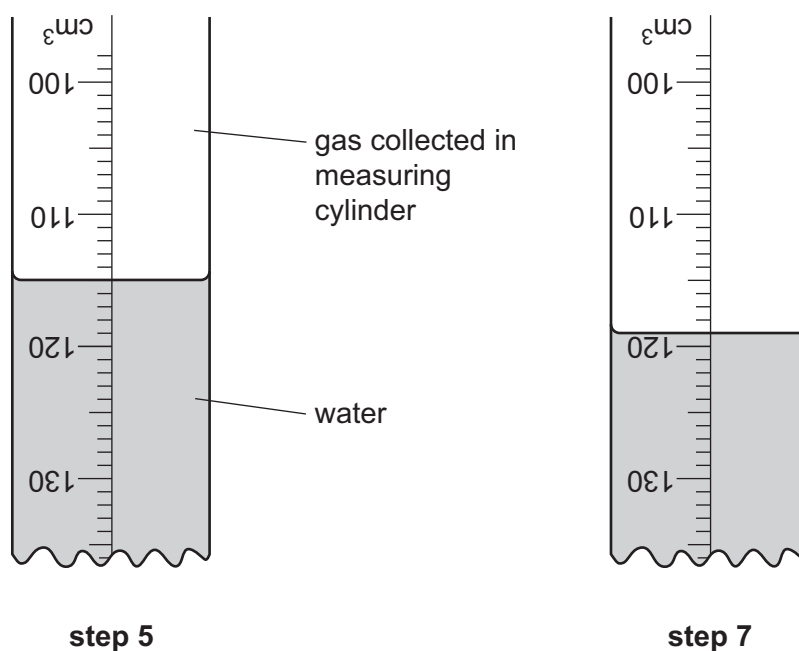


Fig. 1.2

- (i) Record these values in Table 1.1. [2]
- (ii) Calculate the change in volume of gas between **step 5** and **step 7** for $d = 40$ cm and $d = 50$ cm.

Record these values in Table 1.1. [1]

- (b) Increasing the value of d decreases the light intensity.

Use Table 1.1 to describe the relationship between light intensity and the rate of photosynthesis.

..... [1]

- (c) Suggest why the student waits for 5 minutes in **step 4**.

..... [1]



(d) At the start of the procedure, the water has a temperature of 21.5°C .

At the end of the procedure, the temperature of the water has increased.

(i) Fig. 1.3 shows the temperature reading at the end of the procedure.

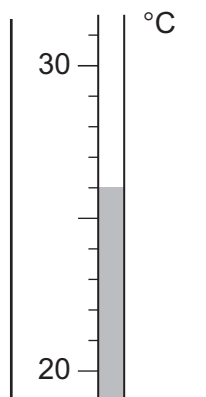


Fig. 1.3

Record this temperature to the nearest 0.5°C .

temperature = ... $^{\circ}\text{C}$ [1]

(ii) The student thinks that the increase in temperature is caused by heat from the lamp.

Suggest a change to the apparatus to overcome this problem.

.....
 [1]

[Total: 7]





- 2 The leaves of plants may be different colours.

When a leaf transpires, it loses water, and the mass of the leaf decreases.

A student states:

The colour of a leaf affects the rate of water loss from the leaf.

Plan an investigation to test this statement.

You are provided with leaves of different colours that have been removed from the same type of plant.

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
- what you will measure
- which variables you will control
- how you will process your results to form a conclusion.

You may include a results table (you are **not** required to enter any data into the table).





[7]



- 3 A student determines the percentage by mass of copper in copper oxide.

When heated, copper oxide reacts with methane gas to make copper, water and carbon dioxide.

(a) Procedure

The student:

- step 1** measures the mass of an empty dish
- step 2** puts some copper oxide into the dish
- step 3** measures the total mass of the copper oxide and the dish
- step 4** passes methane through the assembled apparatus shown in Fig. 3.1

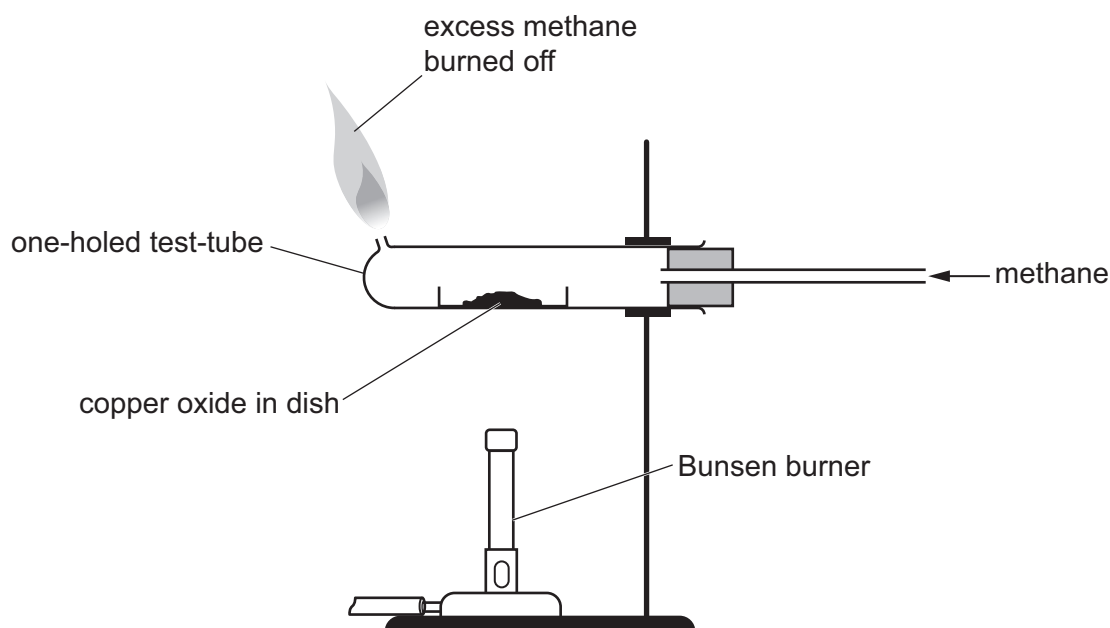


Fig. 3.1

- step 5** ignites the methane gas leaving the test-tube
- step 6** heats the test-tube for five minutes using a blue Bunsen burner flame so that copper oxide is made into copper
- step 7** turns off the Bunsen burner
- step 8** lets the apparatus cool down and then stops the methane passing through
- step 9** measures the total mass of the copper and dish.



- (i) Fig. 3.2 shows the readings on the balance for the three masses measured during the procedure.

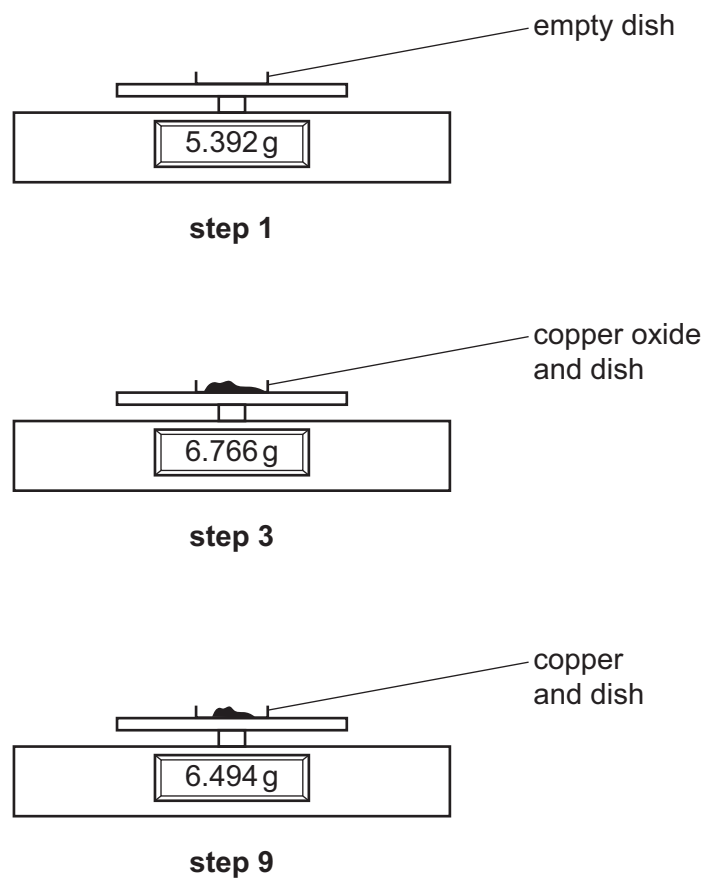


Fig. 3.2

Record in Table 3.1 these masses to **two** decimal places.

Table 3.1

mass of empty dish in step 1 /g	
total mass of copper oxide and dish in step 3 /g	
total mass of copper and dish in step 9 /g	

[3]



- (ii) Calculate the mass of copper oxide put into the dish at **step 2**.

Use data from Table 3.1.

mass of copper oxide = ... g [1]

- (iii) Calculate the mass of copper that is in the dish at the end of the experiment.

Use data from Table 3.1.

mass of copper = ... g [1]

- (iv) Calculate the percentage by mass of copper in copper oxide.

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

$$\text{percentage by mass} = \frac{\text{mass of copper}}{\text{mass of copper oxide}} \times 100$$

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

percentage by mass = ... % [2]

- (v) The unreacted methane is burned instead of being allowed to escape into the air.

Suggest why.

.....
 [1]



- (vi) Suggest why in **step 6** the test-tube is heated with a blue Bunsen burner flame instead of a yellow flame.

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

- (vii) Suggest why in **step 8** the apparatus is left to cool down before the mass is measured in **step 9**.

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

- (b) The student is **not** sure that all the copper oxide has reacted in the experiment.

Describe what the student does after **step 9** to check this.

Explain your answer.

description
.....
explanation
..... [2]

- (c) The student repeats the procedure in (a) using a much larger mass of copper oxide.

Suggest **one** advantage of using a larger mass of copper oxide.

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

[Total: 13]



- 4 A student determines the mass M of a metre rule using a balancing method.

The student uses the apparatus shown in Fig. 4.1.

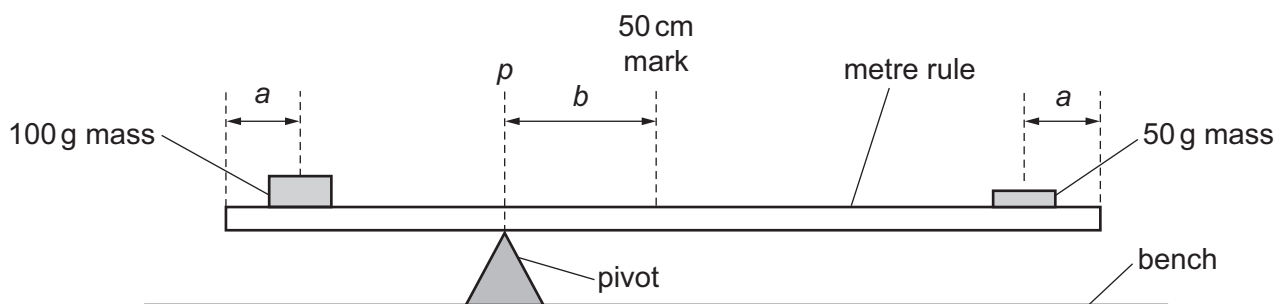


Fig. 4.1

Procedure

The student:

- places the 100 g mass and the 50 g mass at distance a from each end of the metre rule, where $a = 5.0$ cm
- balances the metre rule with the pivot at position p on the metre rule
- calculates b , the distance between the 50 cm mark of the metre rule and the pivot
- records the values of a , p and b in Table 4.1.

The student repeats the procedure for $a = 10.0$ cm, 15.0 cm, 20.0 cm and 25.0 cm.

- (a) Fig. 4.2 shows a view from above of the metre rule balanced on the pivot when $a = 15.0$ cm.

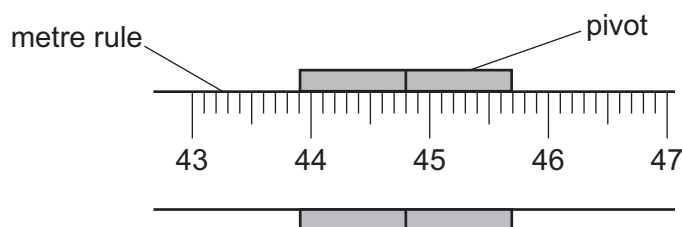


Fig. 4.2

- (i) Record in Table 4.1 position p of the metre rule on the pivot. [1]
- (ii) Calculate b using your answer to (a)(i) and the equation shown.

$$b = 50.0 - p$$

Record this value of b in Table 4.1. [1]

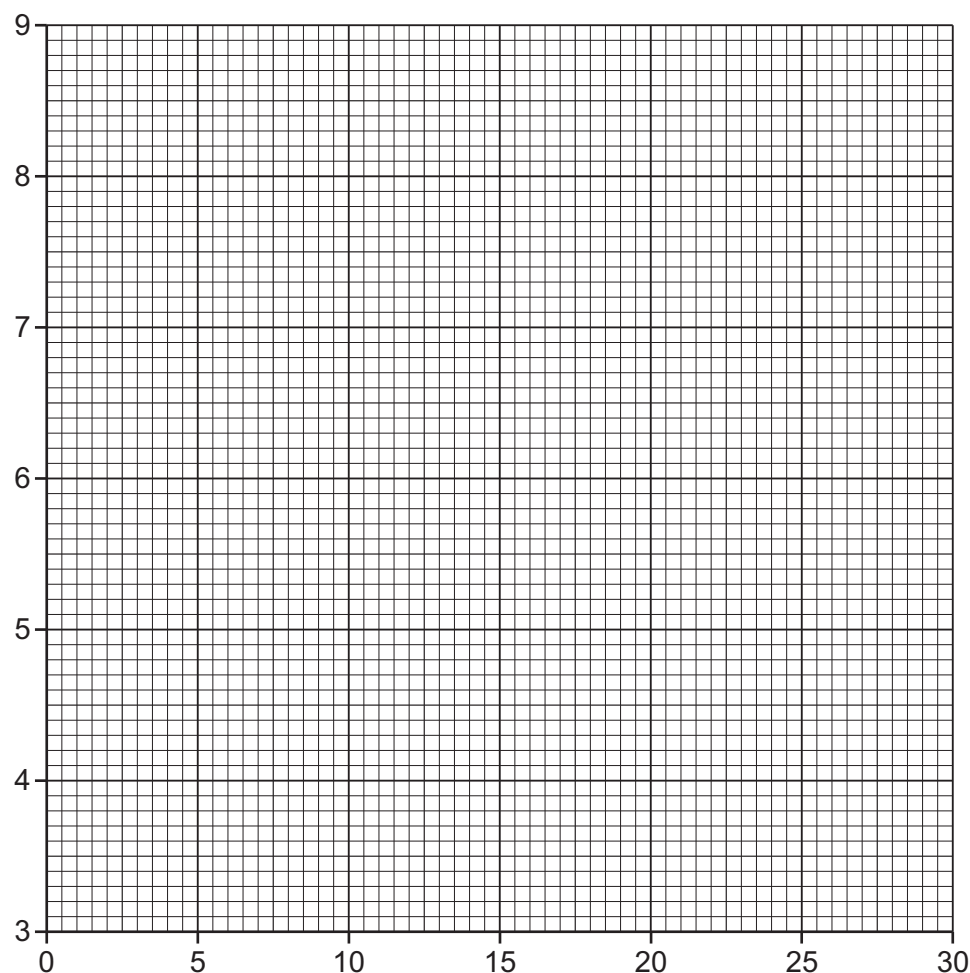


Table 4.1

a/cm	p/cm	b/cm
5.0	43.2	6.8
10.0	44.1	5.9
15.0		
20.0	45.6	4.4
25.0	46.3	3.7

(b) (i) On the grid, plot b (vertical axis) against a .

Label the axes.



[2]

(ii) Draw the straight best-fit line.

[1]

(iii) Determine the intercept I of your graph with the vertical axis.

Show your working on your graph.

$I = \dots\dots\dots$ [2]



- (iv) Calculate the mass M of the metre rule using your answer to (b)(iii) and the equation shown.

$$M = \frac{2500}{I} - 150$$

$$M = \dots\dots\dots \text{ g [1]}$$

- (c) The student moves the 50 g mass to a different position on the metre rule and takes another reading for a .

- (i) Fig. 4.3 shows an enlarged section of the metre rule and the new position of the 50 g mass.

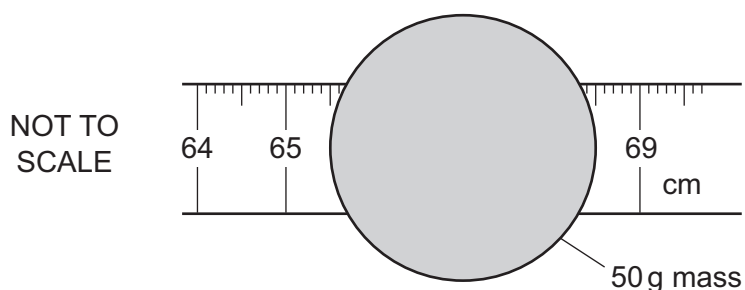


Fig. 4.3

Determine the position c of the centre of the 50 g mass on the metre rule.

Show your working.

$$c = \dots\dots\dots \text{ cm [2]}$$

- (ii) Use your value of c and Fig. 4.1 to determine a .

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



- (d) Another student suggests a different balancing method to determine the mass M of the metre rule using the apparatus shown in Fig. 4.4.

The metre rule and the masses are all suspended from strings.

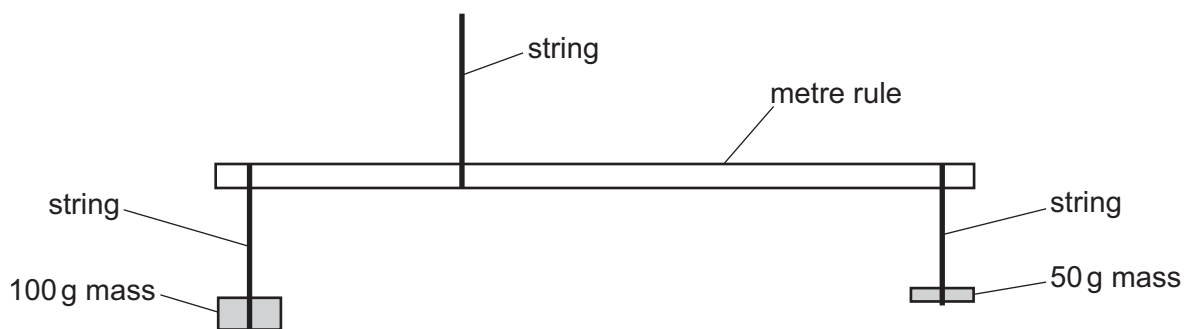


Fig. 4.4

Suggest **one** advantage and **one** disadvantage of using the apparatus in Fig. 4.4 compared with using the apparatus in Fig. 4.1.

advantage

.....

disadvantage

.....

[2]

[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

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COMBINED SCIENCE**0653/63**

Paper 6 Alternative to Practical

October/November 2025**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 [].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **20** pages. Any blank pages are indicated.

- 1 A student investigates the effect of exercise on heart rate.

The student exercises by lifting a metal block up and down 50 times. The student uses five different blocks, **A**, **B**, **C**, **D** and **E**, each with a different mass.

The student measures heart rate by counting the number of heart beats in three minutes.

(a) **Procedure**

The student:

- step 1** measures the mass of block **A**
- step 2** measures heart rate at rest
- step 3** exercises by lifting block **A** up and down 50 times
- step 4** measures heart rate after exercise
- step 5** waits for 15 minutes
- step 6** repeats **step 1** to **step 5** for blocks **B**, **C**, **D** and **E**.

The student calculates the heart rates in beats per minute.

Table 1.1 shows some of the student's data.

Table 1.1

block	mass of block /kg	heart rate at rest /beats per minute	heart rate after exercise /beats per minute
A		66	99
B	0.91	67	105
C	1.36	65	112
D	1.81	66	121
E		68	

- (i) The student counts 403 heart beats in **three** minutes after exercise by lifting block **E**.

Calculate the heart rate after exercise in beats per minute.

Record in Table 1.1 this value to **three** significant figures.

[2]



- (ii) Suggest why it is more accurate to count the number of heart beats for three minutes rather than just one minute.

.....
 [1]

- (iii) Suggest why in **step 5** the student waits for 15 minutes between lifting different blocks.

.....
 [1]

- (b) The student measures the mass of each block at **step 1**.

- (i) Fig. 1.1 shows the balance readings for block **A** and block **E**.

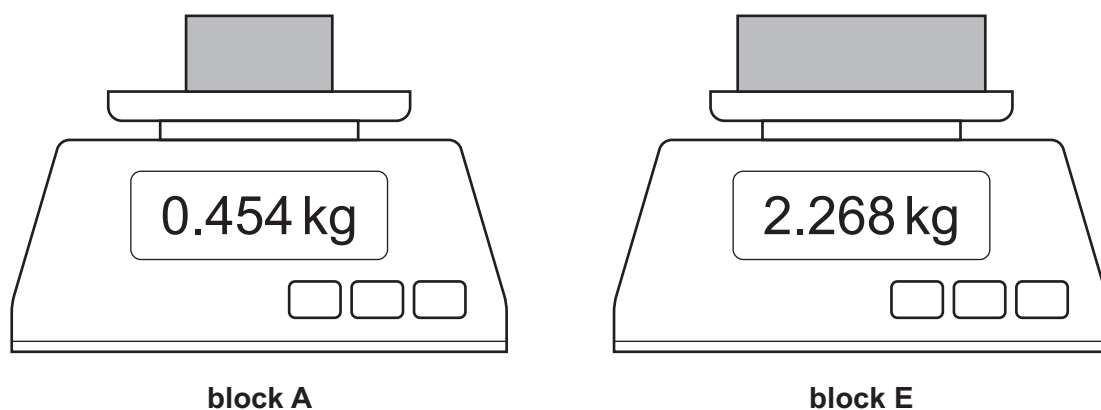


Fig. 1.1

Record in Table 1.1 these values to **two** decimal places. [2]

- (ii) Describe the relationship between mass of the block lifted and heart rate after exercise shown in Table 1.1.

.....
 [1]



- (c) The student calculates the percentage increase in heart rate for lifting each block.

Table 1.2 shows some of the data.

Table 1.2

block	percentage increase in heart rate
A	
B	57
C	72
D	83
E	97

- (i) Complete Table 1.2 by calculating the percentage increase in heart rate for lifting block **A**.

Use information in Table 1.1 and the equation shown.

$$\text{percentage increase in heart rate} = \frac{\text{heart rate after exercise} - \text{heart rate at rest}}{\text{heart rate at rest}} \times 100$$

[1]

- (ii) Explain why the student calculates the **percentage** increase in heart rate rather than the increase in heart rate.

.....

.....

..... [2]



(d) During exercise, cells in the body produce carbon dioxide gas which is breathed out.

After exercising, the student uses the apparatus shown in Fig. 1.2 to test the composition of the air breathed in and the gases breathed out.

The student breathes in and out for 10 seconds.

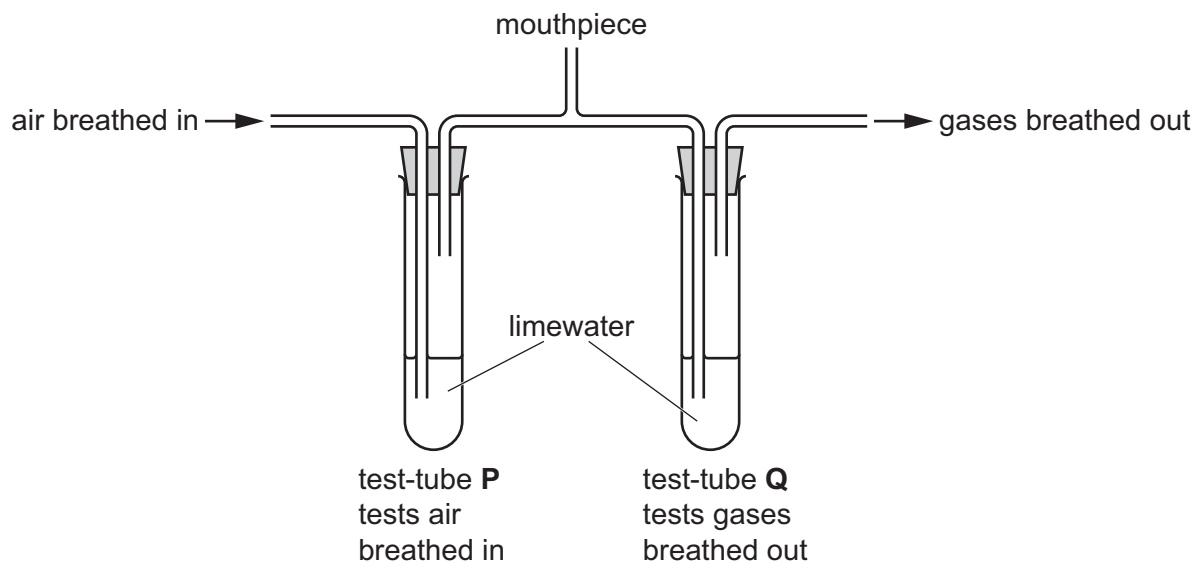


Fig. 1.2

Describe the appearance of the limewater in test-tube **P** and in test-tube **Q**.

Explain your answer.

test-tube **P**

test-tube **Q**

explanation

.....

.....

[3]

[Total: 13]



- 2 A student investigates the effect on the boiling point of water of dissolving solid **H** in the water.

Procedure

The student:

- step 1** half fills a beaker with water
step 2 heats the water until it boils using the assembled apparatus shown in Fig. 2.1

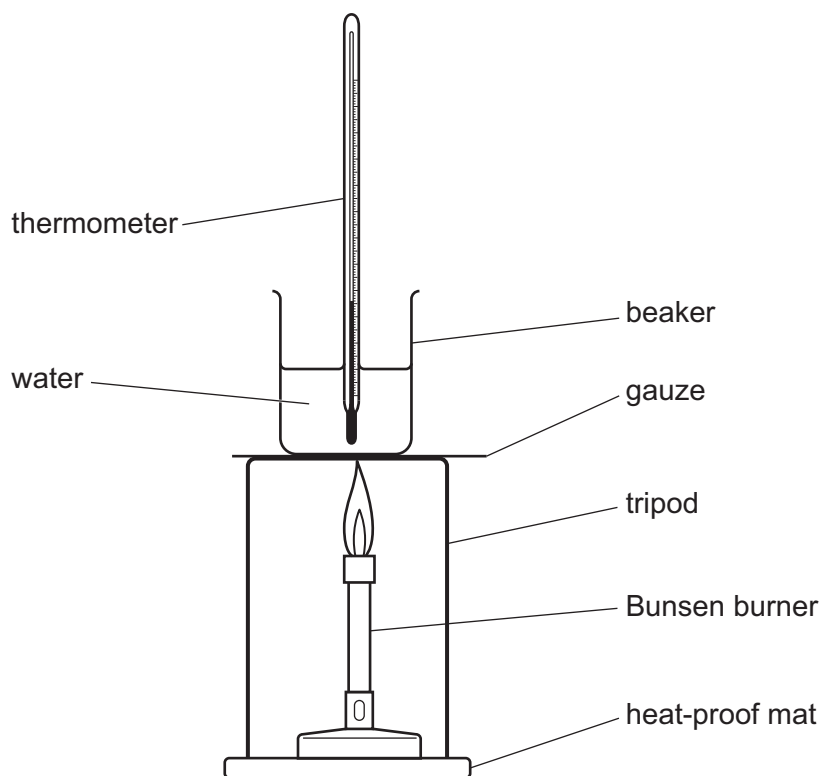


Fig. 2.1

- step 3** records the temperature of the water at boiling point
step 4 turns off the Bunsen burner and allows the water to cool slightly
step 5 adds 1 spatula of solid **H** to the water and stirs until dissolved
step 6 turns on the Bunsen burner
step 7 heats the water until it boils again
step 8 records the temperature of the water at boiling point
step 9 repeats **step 4** to **step 8** until a total of 7 spatulas of solid **H** are dissolved in the water.





Table 2.1 shows some of the student's data.

Table 2.1

number of spatulas of solid H dissolved in the water	boiling point / °C
0	100.0
1	101.0
2	
3	103.5
4	105.5
5	104.0
6	108.0
7	

- (a) Fig. 2.2 shows the temperature reading on the thermometer at **step 8** for 2 spatulas and 7 spatulas of solid **H** dissolved in the water.

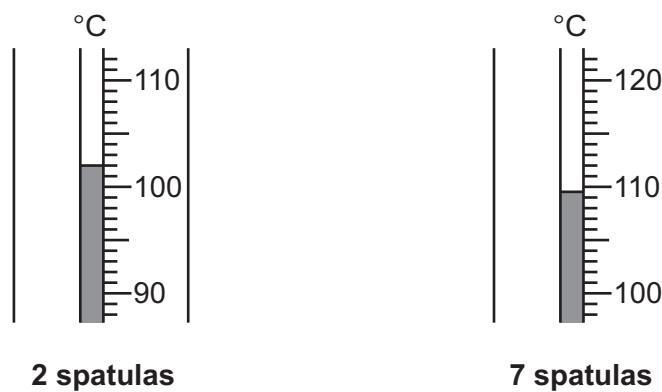


Fig. 2.2

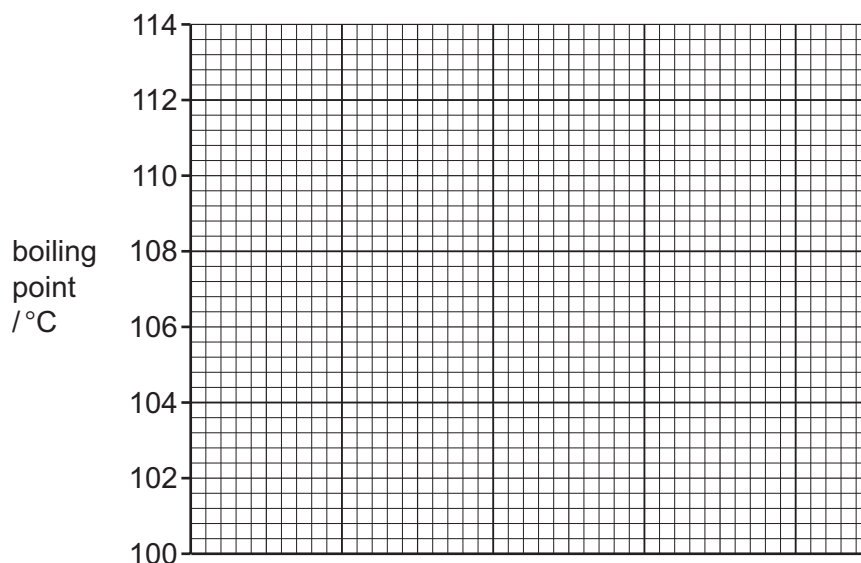
Record in Table 2.1 these temperatures to the nearest 0.5 °C.

[2]



- (b) (i) On the grid, plot boiling point (vertical axis) against number of spatulas of solid **H** dissolved in the water.

The horizontal axis **must** include 8 spatulas of solid **H** dissolved in the water.



[2]

- (ii) One of the results is anomalous.

Circle on the grid this anomalous result.

[1]

- (iii) Draw the best-fit line.

[1]

- (iv) Describe the relationship between the boiling point of the water and the number of spatulas of solid **H** dissolved in the water.

.....

 [1]

- (v) Estimate the boiling point of water containing 8 spatulas of solid **H**.

Show your working on the graph.

boiling point = ... °C [2]





- (c) The student wants to improve the procedure.

Describe an improvement the student makes to:

step 1

step 5. [2]

- (d) The teacher tells the student there is an experimental error in the overall procedure for the investigation.

The teacher says the error affects the results even after improvements are made to **step 1** and **step 5**.

Describe the error in the overall procedure.

Suggest a change to the procedure to minimise the error.

error

change

..... [2]

[Total: 13]





3 A student investigates the resistance X of a fixed resistor using:

- a cell of voltage V
- a switch
- a digital ammeter
- a variable resistor with resistance R , where R varies from $12\ \Omega$ to $39\ \Omega$.

The student assembles the circuit shown in Fig. 3.1.

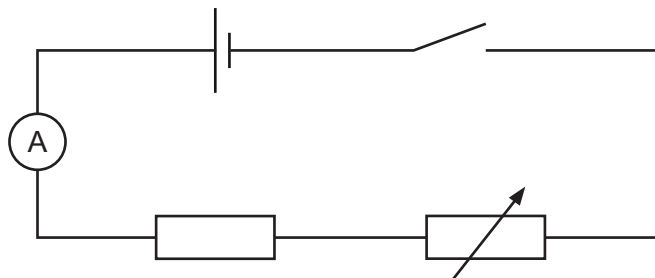
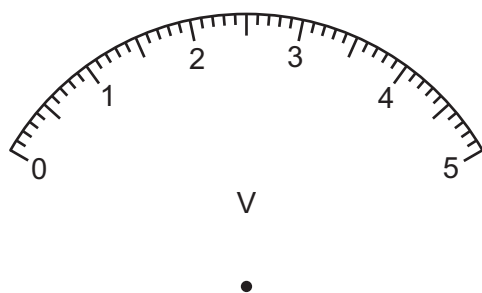
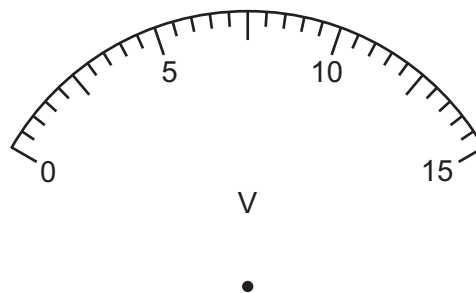


Fig. 3.1

(a) The student has two analogue voltmeters, **P** and **Q**. Fig. 3.2 shows the scale on each voltmeter.



voltmeter P



voltmeter Q

Fig. 3.2

The student uses **one** voltmeter to measure voltage V of the cell as 1.6 V .

State which voltmeter the student uses.

Explain your answer.

voltmeter

explanation

.....

[1]



(b) Procedure

The student:

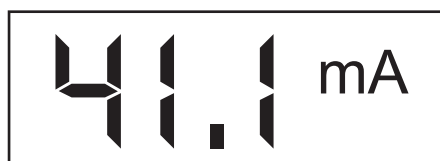
- sets resistance R of the variable resistor to $R = 12\ \Omega$
- closes the switch
- uses the ammeter to measure current I in the circuit
- opens the switch.

The student repeats the procedure for the values of R shown in Table 3.1.

Table 3.1

R/Ω	I/mA
12	44
15	
18	38
22	35
27	31
33	
39	25

Fig. 3.3 shows the readings on the ammeter for $R = 15\ \Omega$ and $R = 33\ \Omega$.



$R = 15\ \Omega$



$R = 33\ \Omega$

Fig. 3.3

Record in Table 3.1 these values of I to the nearest mA.

[2]



- (c) The student plots the graph of $\frac{1}{I}$ against R shown in Fig. 3.4.

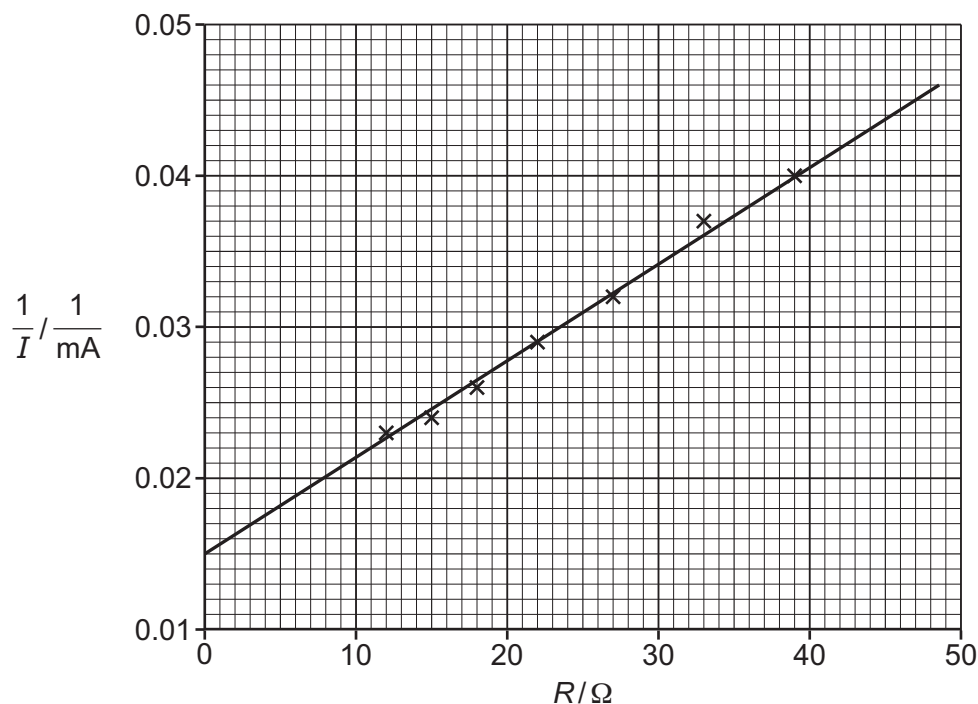


Fig. 3.4

- (i) The intercept is the value of $\frac{1}{I}$ when $R = 0$.

Use Fig. 3.4 to determine the intercept.

intercept = ... [1]

- (ii) The resistance X of the fixed resistor is given by the equation:

$$X = V \times 1000 \times \text{intercept}$$

where $V = 1.6\text{V}$.

Calculate X .

Use your answer to (c)(i) and the equation shown.

$X = \dots\dots\dots \Omega$ [1]



- (d) When the switch is **open**, the student observes a reading on the ammeter, as shown in Fig. 3.5.



Fig. 3.5

The student realises the ammeter has an error.

The values of I in Table 3.1 are incorrect.

- (i) Name the type of error shown in Fig. 3.5.

..... [1]

- (ii) State how the student corrects the values of I in Table 3.1.

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

[Total: 7]



4 Fig. 4.1 shows a wooden beam of length l and width w .

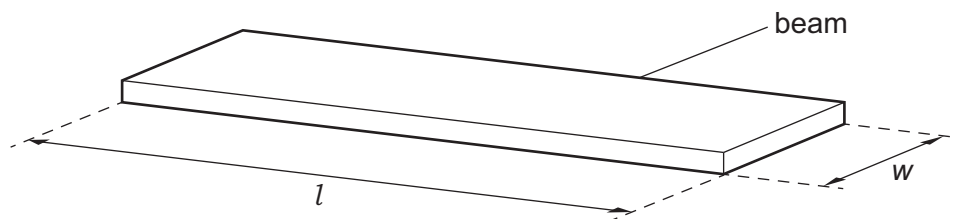


Fig. 4.1

One end of the beam is attached to a bench.

A mass is attached to the other end of the beam.

The beam moves downwards through a distance h , as shown in Fig. 4.2.

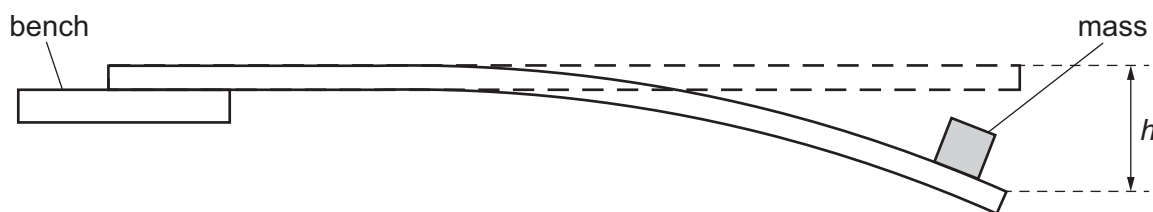


Fig. 4.2

A student states:

Distance h is inversely proportional to width w of the beam.

Plan an investigation to test the student's statement.

You are provided with beams of different widths made from the same wood.

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
- what you will measure
- which variables you will control
- how you will process your results to form a conclusion.

You may include a results table (you are **not** required to enter any data into the table).





[7]





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

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