



CANDIDATE
NAME

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0653/61

May/June 2023

1 hour

No additional materials are needed.

- 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.

- 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 (a) A student estimates the concentration of vitamin C in a sample of fruit juice.

When iodine solution is added to a mixture of starch and fruit juice the starch turns the iodine blue-black. The vitamin C turns the iodine colourless.

The amount of iodine needed to keep the blue-black colour is an indicator of the concentration of vitamin C.

The student has four different concentrations of vitamin C and a fruit juice with an unknown vitamin C concentration.

Procedure

The student:

- Step 1** Uses a syringe to add 10 cm^3 of 1.00% vitamin C solution to a clean test-tube.
- Step 2** Adds 0.5 cm^3 of starch solution to the test-tube and mixes well.
- Step 3** Fills a 10 cm^3 syringe with 10 cm^3 of iodine solution.
- Step 4** Adds drops of iodine solution to the starch-vitamin C mixture until the blue-black colour remains.
- Step 5** Records in Table 1.1 the volume of iodine solution **remaining** in the syringe.
- Step 6** Refills the syringe to contain 10 cm^3 of iodine solution.
- Step 7** Repeats **Step 1** to **Step 6** using 0.75%, 0.50% and 0.25% concentrations of vitamin C.
- (i) Fig. 1.1 shows the syringe after adding iodine solution to the 0.25% concentration of vitamin C.

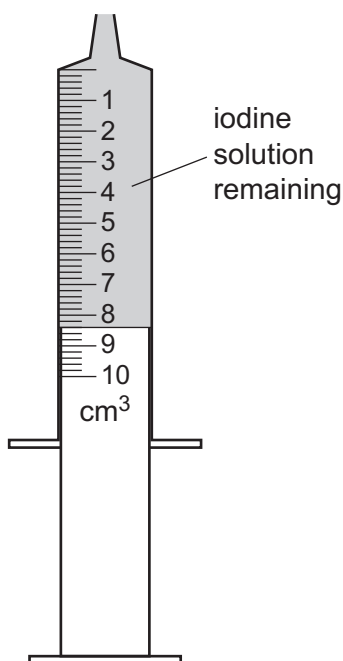


Fig. 1.1

Record in Table 1.1, the volume of iodine solution **remaining** in the syringe.

Table 1.1

percentage concentration of vitamin C	volume of iodine solution remaining /cm ³	volume of iodine solution added /cm ³
1.00	2.2	7.8
0.75	4.0	6.0
0.50	6.2	3.8
0.25		

[1]

- (ii) Calculate the volume of iodine solution **added** to the 0.25% vitamin C solution.

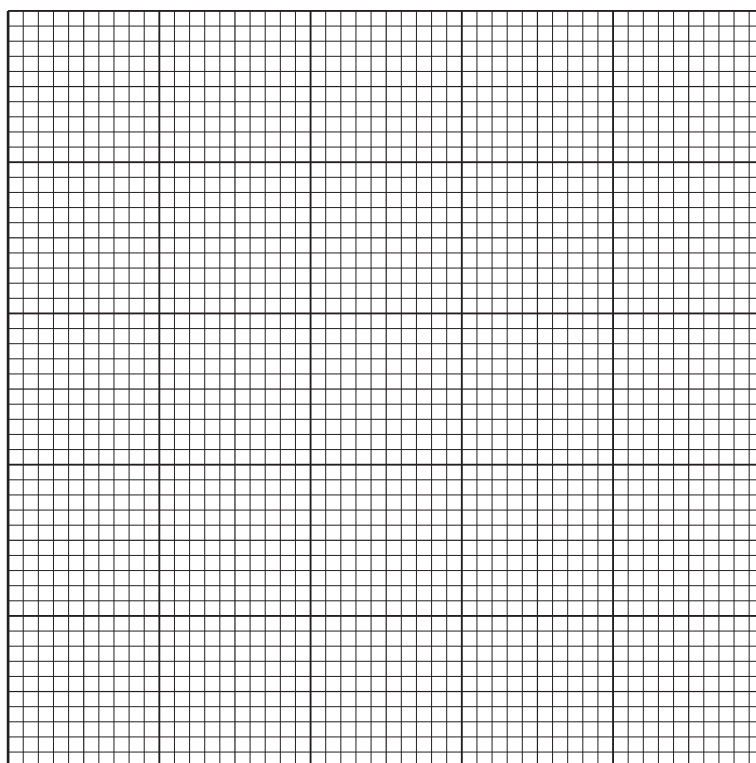
Use the equation shown.

$$\boxed{\begin{array}{c} \text{volume of iodine solution} \\ \text{added} \end{array}} = 10 - \boxed{\begin{array}{c} \text{volume of iodine solution} \\ \text{remaining} \end{array}}$$

Record this value in Table 1.1.

[1]

- (iii) On the grid, plot a graph of the volume of iodine solution **added** (vertical axis) against the percentage concentration of vitamin C.



[3]

- (iv) Draw the line of best-fit.

[1]

- (v) The student repeats **Step 1** to **Step 4** of the procedure in (a) using 10 cm³ of fruit juice instead of the vitamin C solutions.

Fig. 1.2 shows the syringe after adding the iodine solution to the fruit juice.

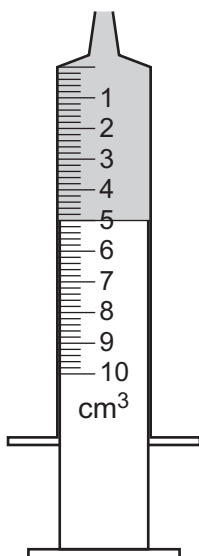


Fig. 1.2

Record the volume of iodine solution **remaining** and the volume **added** when the student tests the fruit juice.

volume of iodine solution **remaining** = ... cm³

volume of iodine solution **added** = ... cm³

[1]

(vi) Use your graph to estimate the percentage concentration of vitamin C in the fruit juice.

percentage concentration of vitamin C in the fruit juice = ... [1]

(vii) The student uses the same syringe for **Step 1** and **Step 7**.

Suggest why this is a possible source of error.

.....
 [1]

(b) Repeating the procedure increases confidence in the results.

(i) Suggest one **other** reason why the procedure for each concentration should be repeated.

.....
 [1]

(ii) Suggest one **other** way to improve confidence in your estimate in (a)(vi).

.....
 [1]

(c) State the reagent that is used to test for protein. Include the observation for a positive result.

reagent

observation [2]

[Total: 13]

- 2 A student investigates the components of a fertiliser.

The fertiliser contains insoluble sand and a soluble salt.

The student has 5.00 g of the fertiliser.

Procedure

The student:

- Step 1** adds distilled water to the fertiliser in a beaker
- Step 2** stirs the mixture for two minutes
- Step 3** filters the mixture into a boiling tube
- Step 4** washes the residue of sand on the filter paper with distilled water
- Step 5** dries the sand on the filter paper in an oven.
- Step 6** records in Table 2.1 the mass of the sand and filter paper.
- Step 7** removes the sand and measures the mass of the filter paper.

- (a) Fig. 2.1 shows the balance reading from **Step 7**.

mass of the filter paper

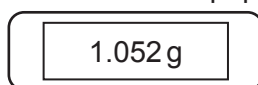


Fig. 2.1

Record in Table 2.1 the mass of the filter paper to **two** decimal places.

Table 2.1

	mass /g
sand and filter paper	3.87
filter paper	

[1]

- (b) (i) Calculate the mass of sand in the sample of fertiliser.

Use the equation shown.

$$\text{mass of sand} = 3.87 - \text{mass of filter paper}$$

mass of sand = ... g [1]

- (ii) Calculate the percentage of sand in the fertiliser.

Use the equation shown.

$$\text{percentage of sand} = \frac{\text{mass of sand}}{5.00} \times 100$$

percentage of sand = ... [1]

- (c) Explain why the mixture is stirred in **Step 2**.

.....
 [1]

- (d) Explain why the residue of sand is washed with distilled water in **Step 4**.

.....
 [1]

- (e) The student does a flame test on the filtrate.

A lilac flame is observed.

Circle the cation (positive ion) in the filtrate.

lithium copper(II) potassium sodium

[1]

- (f) The student adds dilute nitric acid followed by aqueous barium nitrate to the filtrate.

A white precipitate is observed.

Identify the anion (negative ion) in the filtrate.

..... [1]

[Total: 7]

- 3 Cetyl alcohol is a white solid with a melting point of 49°C . If salt is mixed with cetyl alcohol the melting point decreases.

Some of the apparatus needed to determine the melting point of cetyl alcohol is shown in Fig. 3.1.

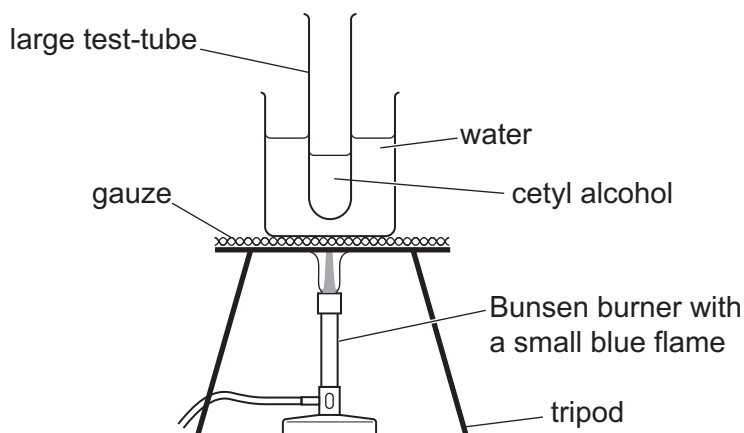


Fig. 3.1

Plan an investigation to find the relationship between the mass of salt added and the decrease in the melting point of cetyl alcohol.

You may use any common laboratory apparatus in your plan.

You are provided with:

- powdered cetyl alcohol
- powdered salt
- the apparatus shown in Fig. 3.1.

In your plan include:

- the additional apparatus needed
- a brief description of the method and an explanation of 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 table that can be used to record the results if you wish.

You do **not** need to include any results in the table.

- 4 A student investigates the resistance of different combinations of two identical lamps **L** and **M**.

(a) Fig. 4.1 shows a circuit using lamp **L**.

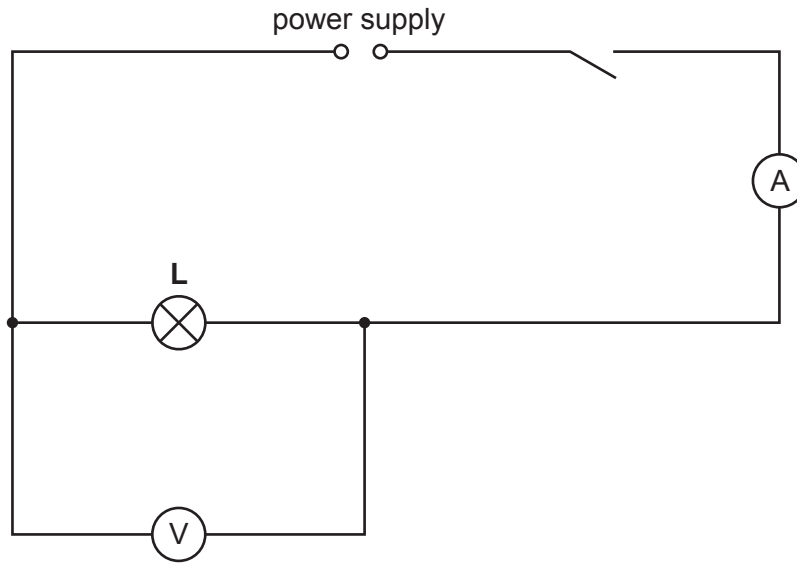


Fig. 4.1

The student closes the switch. Lamp **L** lights up.

Fig. 4.2 shows the readings on the voltmeter and ammeter.

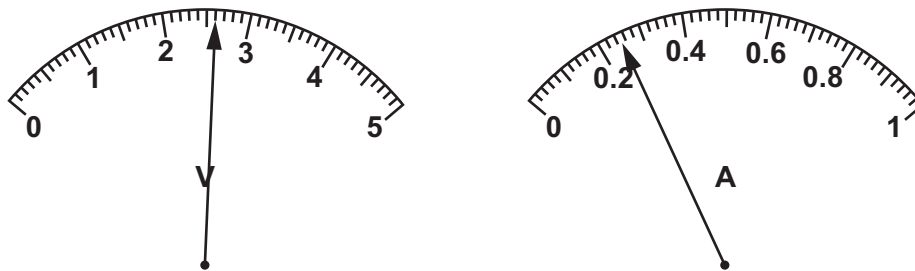


Fig. 4.2

- (i) Record the potential difference V_L across lamp **L**.

V_L V [1]

- (ii) Record the current I_L in the circuit.

I_L A [1]

- (iii) The student opens the switch.
Calculate the resistance R_L of lamp **L**.
Use the equation shown.

$$R_L = \frac{V_L}{I_L}$$

R_L [1]

(b) Procedure

The student:

- disconnects the voltmeter
- adds a second identical lamp **M** to the circuit in series with lamp **L**, as shown in Fig. 4.3
- reconnects the voltmeter to measure the combined potential difference across lamps **L** and **M**.

(i) Complete the circuit diagram in Fig. 4.3 to show how the student connects the voltmeter.

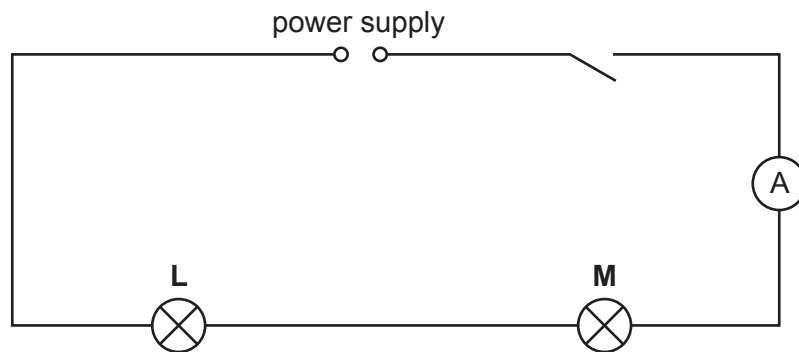


Fig. 4.3

[1]

(ii) The student closes the switch.

The lamps light up.

Fig. 4.4 shows the readings on the voltmeter and ammeter.

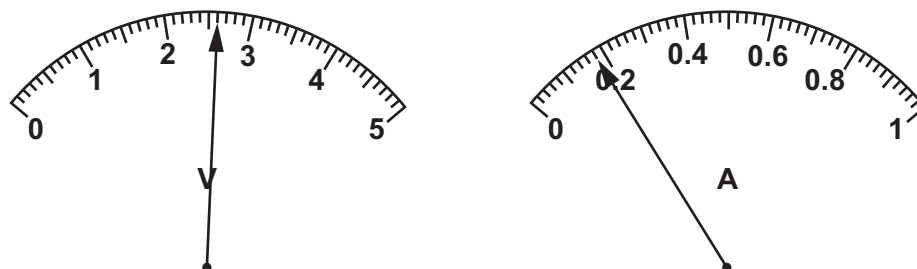


Fig. 4.4

Record the combined potential difference V_S across lamps **L** and **M**.

V_S V

Record the current I_S in the circuit.

I_S A
[1]

- (iii) The student opens the switch.

Calculate the combined resistance R_S of lamps **L** and **M** in series.

Use the equation shown.

$$R_S = \frac{V_S}{I_S}$$

Include the unit in your answer.

R_S unit [1]

(c) Procedure

The student:

- disconnects the **voltmeter**
 - disconnects the two lamps and reconnects lamp **L** in parallel with lamp **M**
 - connects the ammeter to measure the total current through the circuit
 - reconnects the voltmeter to measure the potential difference across the **parallel** lamps.
- (i) Complete the circuit diagram in Fig. 4.5 to show the parallel circuit. The power supply and switch are already shown.

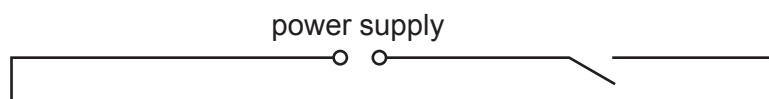


Fig. 4.5

[2]

- (ii) The student closes the switch. The lamps light up.
 The combined potential difference V_p across lamps **L** and **M** is 2.25 volts.
 The total current I_p read by the ammeter in the circuit is 0.50 amps.
 The student opens the switch.

Calculate the power, P_p produced by lamps **L** and **M** in parallel.
 Use the equation shown.

$$P = V \times I$$

P_p W [1]

- (iii) The power, P_s produced by lamps **L** and **M** in series is 0.47 W.

A student predicts the power of the lamps **L** and **M** in parallel is greater than the power of the lamps **L** and **M** in series.

Describe an observation of the lamps that would confirm the student's prediction.

.....
 [1]

- (d) Suggest why the student opens the switch after each measurement.

.....
 [1]

- (e) Another student predicts that the combined resistance of lamps **L** and **M** in series is twice the resistance of lamp **L**.

State if the values from (a)(iii) and (b)(iii) support the student's prediction.

Explain your answer.

statement
 explanation

 [2]

[Total: 13]

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[Turn over

- 1 Fig. 1.1 is a section through okra, a fruit which contains five seeds.

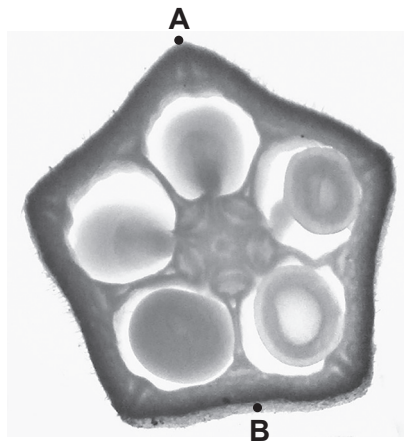


Fig. 1.1

- (a) In the box provided, draw a large, clear pencil drawing of the section of okra.

- (b) (i) The distance between point **A** and point **B** on Fig. 1.1 represents a diameter of the okra.

Measure the distance between point **A** and point **B** on Fig. 1.1.

distance on Fig. 1.1 = ... mm [1]

- (ii) Suggest why the distance between point **A** and point **B** is only an estimate of the diameter of the okra in Fig. 1.1.

.....
 [1]

- (iii) Measure the distance between the same two points on your drawing as in (b)(i).

Mark **A** and **B** on your drawing to show where you have measured.

distance on your drawing = ... mm [1]

- (iv) Calculate the magnification of your drawing.

Use the equation shown.

$$\text{magnification} = \frac{\text{distance on your drawing}}{\text{distance on Fig. 1.1}}$$

magnification = ... [1]

[Total: 7]

- 2 The enzyme amylase breaks down starch to form a reducing sugar.
Iodine is a brown solution that turns blue/black in the presence of starch.

Plan an investigation to determine the relationship between temperature and the time taken to completely break down starch by amylase.

You are provided with:

- 1% amylase solution
- 1% starch solution
- iodine solution.

You may also use any other common laboratory apparatus.

In your plan include:

- the additional apparatus needed
- a brief description of the method and an explanation of 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 table that can be used to record the results if you wish.

You do **not** need to include any results in your table.

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

(a) **Procedure**

The student:

- measures the mass of an empty test-tube and records this mass in Table 3.1
- places some solid **H** into the test-tube
- measures the mass of the test-tube and solid **H** and records this mass in Table 3.1
- heats solid **H** for one minute using the blue flame of a Bunsen burner
- lets the test-tube cool down
- measures the mass of the test-tube and the solid after heating and records this mass in Table 3.1.

Table 3.1

	mass /g
empty test-tube	16.23
test-tube and solid H before heating	
test-tube and the solid after heating	

- (i) Suggest why the student lets the test-tube and the solid cool down before measuring its mass.

.....
 [1]

- (ii) Fig. 3.1 shows two of the balance readings.



Fig. 3.1

Record in Table 3.1 these readings to **two** decimal places. [2]

- (iii) Calculate the mass of solid **H** in the test-tube before heating.

Use the equation shown.

mass of solid H before heating	=	mass of test-tube and solid H before heating	–	mass of empty test-tube
--	---	--	---	-------------------------

mass of solid **H** before heating = ... g [1]

- (iv) Calculate the mass of the solid in the test-tube after heating.

Use the equation shown.

mass of the solid after heating	=	mass of test-tube and the solid after heating	–	mass of empty test-tube
------------------------------------	---	--	---	-------------------------

mass of the solid after heating = ... g [1]

- (v) There is a loss in mass when solid **H** is heated.

Suggest **one** reason for this loss in mass.

..... [1]

- (vi) Calculate the percentage loss in mass.

Use the equation shown.

percentage loss in mass = $\frac{\text{mass of solid **H** before heating} - \text{mass of the solid after heating}}{\text{mass of solid **H** before heating}} \times 100$

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

percentage loss in mass = ... [2]

- (vii) Explain why it is better to heat solid **H** for at least five minutes rather than one minute.

.....
 [1]

- (viii) State **one** reason why the test-tube must be heated with a blue Bunsen burner flame rather than a yellow Bunsen burner flame.

.....
 [1]

- (b) The student puts some solid **H** into dilute hydrochloric acid.

The mixture forms a colourless solution and bubbles of carbon dioxide gas are seen.

- (i) Describe the test to confirm that the gas made is carbon dioxide.

Include the observation for a positive result.

test
 observation [1]

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

..... [1]

- (iii) The student adds aqueous sodium hydroxide to the colourless solution.

A white precipitate forms which is soluble in excess aqueous sodium hydroxide.

Tick (✓) the name of the cation present in the colourless solution.

ammonium	☐	calcium	☐
copper(II)	☐	iron(III)	☐
zinc	☐		

[1]

[Total: 13]

- 4 A student does an experiment to determine the focal length F of a convex lens.

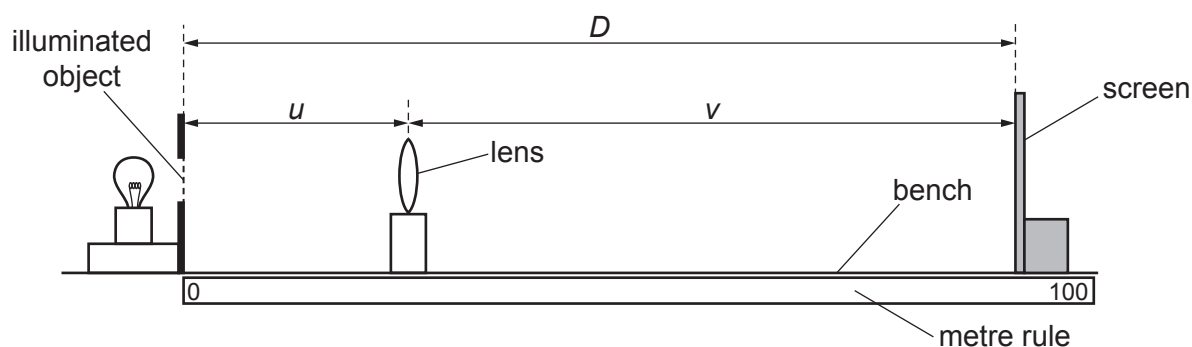


Fig. 4.1

(a) Procedure

The student:

- arranges the equipment as shown in Fig. 4.1
- switches on the lamp
- places the illuminated object (a triangle) at the 0 cm mark on the metre rule
- places the lens at a distance $u = 10.0$ cm from the illuminated object
- places the screen at a distance $D = 95.0$ cm from the illuminated object.

An out of focus fuzzy image appears on the screen.

- moves the lens slowly towards the screen until the image formed is in focus, and as sharp as possible
- measures u and v and records the values in Table 4.1.

- (i) The illuminated object is 1.5 cm high. Fig. 4.2 shows the actual size of the image on the screen.

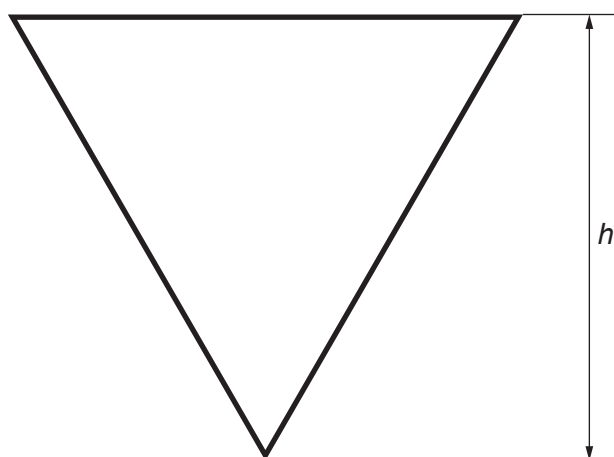


Fig. 4.2

Measure and record the height h of the image.

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

- (ii) The student repeats the procedure for values of $D = 85.0\text{ cm}$, 75.0 cm , 70.0 cm and 65.0 cm .

Fig. 4.3 shows the lens and part of the metre rule when the image is in focus for $D = 75.0\text{ cm}$.

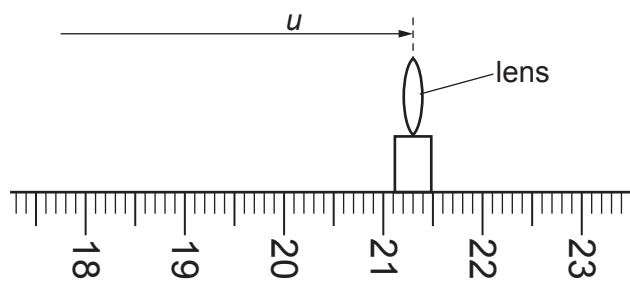


Fig. 4.3

Record the value of u shown on the metre rule in Table 4.1 in the row for $D = 75.0\text{ cm}$.

Table 4.1

D	u	v	uv
/cm	/cm	/cm	/
95.0	19.2	75.8	1460
85.0	20.5	64.5	1320
75.0			
70.0	22.2	47.8	1060
65.0	24.8	40.2	997

[1]

- (iii) Calculate the distance v for $D = 75.0\text{ cm}$ and record the value in Table 4.1. [1]

- (iv) Calculate the product uv and record it for $D = 75.0\text{ cm}$ in the final column of Table 4.1.

Use the equation shown.

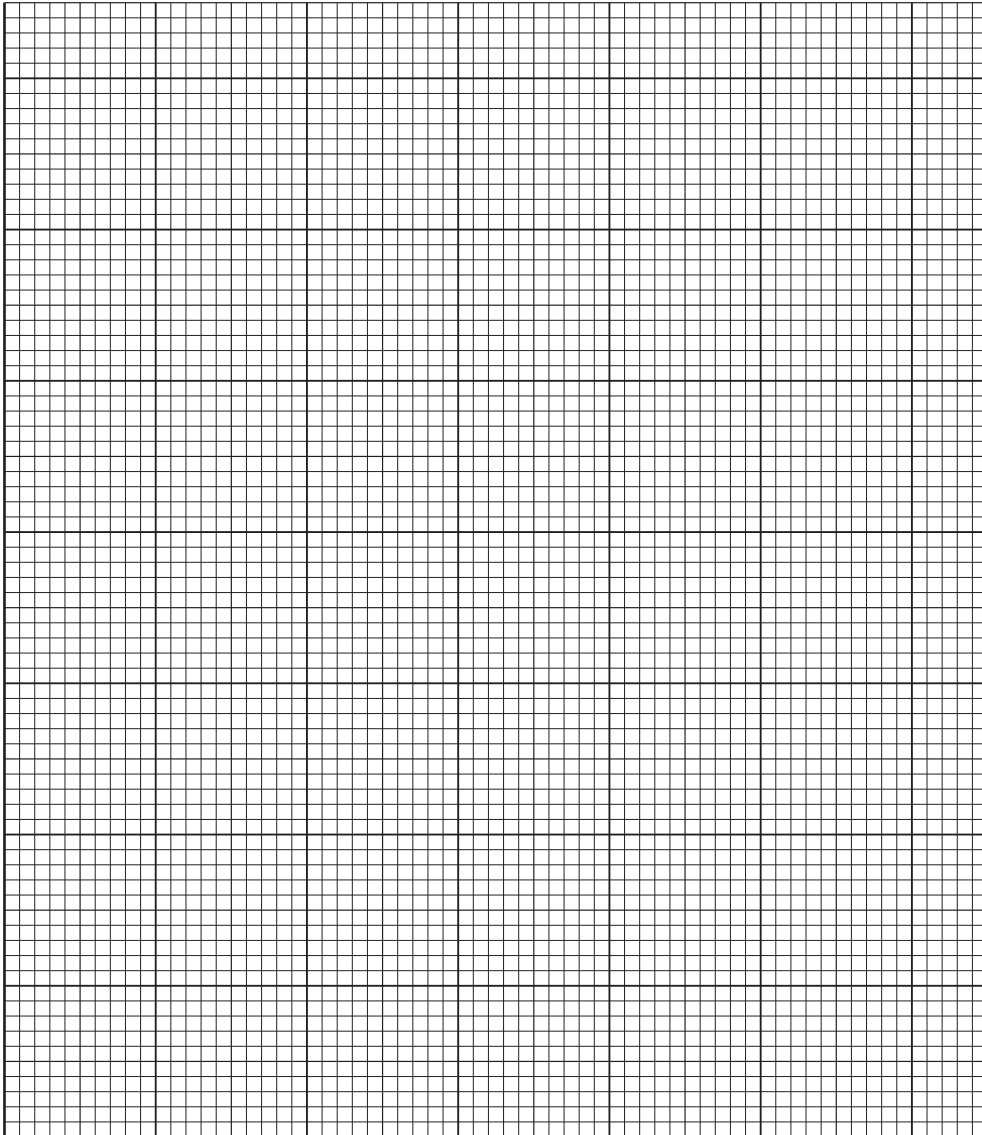
$$uv = u \times v$$

[1]

- (v) Add the unit to the column heading for uv in Table 4.1. [1]

- (b) (i) On the grid, plot a graph of uv (vertical axis) against D .

Do **not** start your graph from the origin (0, 0).



[3]

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

[1]

- (c) The focal length F of the lens is equal to the gradient of your line.

Calculate the gradient of your line.

Indicate on your graph the values you choose to calculate the gradient.

$F = \dots\dots\dots$ [2]

- (d) (i) F can also be calculated without plotting a graph, by using the results for one value of D .

Suggest why plotting a graph and calculating a gradient to find the value of F gives a more accurate answer than calculating F for one value of D .

.....
 [1]

- (ii) State **one** precaution that makes the readings as accurate as possible.

.....
 [1]

[Total: 13]

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- 1 A student investigates the effect of temperature on the growth of mushrooms.

Fig. 1.1 shows a section through a mushroom.



Fig. 1.1

- (a) In the box provided, make a large, clear pencil drawing of this section through a mushroom.

- (b) The student investigates how changing the temperature affects the growth of the cap of mushrooms.

Procedure

The student:

- grows 5 mushrooms at 5 °C for 2 days
- grows 5 mushrooms at 20 °C for 2 days
- measures the diameter of the cap of each mushroom
- records their results in Table 1.1.

Fig. 1.2 shows the cap of the 5th mushroom grown at 5 °C.

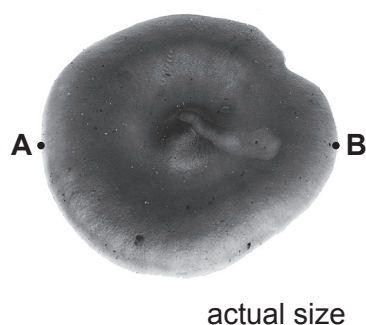


Fig. 1.2

- (i) The distance between point **A** and point **B** on Fig. 1.2 represents a diameter of the mushroom cap.

Measure the distance between point **A** and point **B** on Fig. 1.2 and record your value in Table 1.1.

Table 1.1

mushroom	diameter of mushroom cap grown at 5 °C /mm	diameter of mushroom cap grown at 20 °C /mm
1	42	78
2	37	40
3	40	82
4	38	84
5		79
average diameter /mm		81

[1]

- (ii) Identify the anomalous result in Table 1.1 by circling the value. [1]
- (iii) Complete Table 1.1 by calculating the average diameter of the mushroom caps grown at 5 °C.

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

[2]

- (iv) The student concludes that:

"As the temperature increases to 30°C, the mushroom caps will get larger."

Suggest why this conclusion is **not** correct.

.....
 [1]

- (v) Identify **one** possible source of error when measuring the diameter of an actual mushroom cap.

Suggest a method that reduces this error.

error

 improvement
 [2]

- (vi) Describe one **other** way the investigation can be improved.

.....
 [1]

- (c) Mushrooms grow best in slightly acidic soils.

The student is given a sample of dry soil.

Suggest how the pH of the soil sample is tested.

.....

 [2]

[Total: 13]

2 A student investigates a green solid **H**.

(a) Procedure

The student:

- adds some dilute hydrochloric acid to solid **H** in a test-tube
- observes that the mixture forms a blue solution
- does a flame test on the blue solution.

(i) Describe how to do a flame test on the blue solution.

.....
 [1]

(ii) The blue solution gives a blue-green flame in the flame test.

Tick(✓) the box to identify the cation present in the blue solution.

lithium	☐	sodium	☐
copper(II)	☐	potassium	☐

[1]

(b) Solid **H** decomposes when heated to make a solid and a gas.

The student investigates the loss in mass when solid **H** is heated.

Procedure

The student:

- Step 1** puts some solid **H** into a test-tube
Step 2 heats the test-tube for 1 minute
Step 3 lets the test-tube cool down
Step 4 measures the mass of the test-tube and contents
Step 5 records the mass in Table 2.1.

The student repeats **Steps 2, 3, 4** and **5** on the same test-tube six more times.

Table 2.1

time of heating / minutes	mass after heating / g	mass lost during heating / g
1	4.59	0.41
2		
3	3.79	1.21
4	3.48	1.52
5	3.62	1.38
6	3.60	1.40
7		

- (i) Fig. 2.1 shows the readings on the balance after heating for 2 minutes and 7 minutes.

mass after heating for 2 minutes

mass after heating for 7 minutes

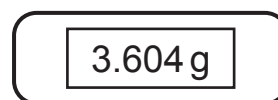
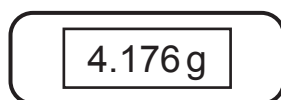


Fig. 2.1

Record in Table 2.1 these values to **two** decimal places.

[2]

- (ii) Calculate the mass lost during heating for 2 minutes and for 7 minutes.

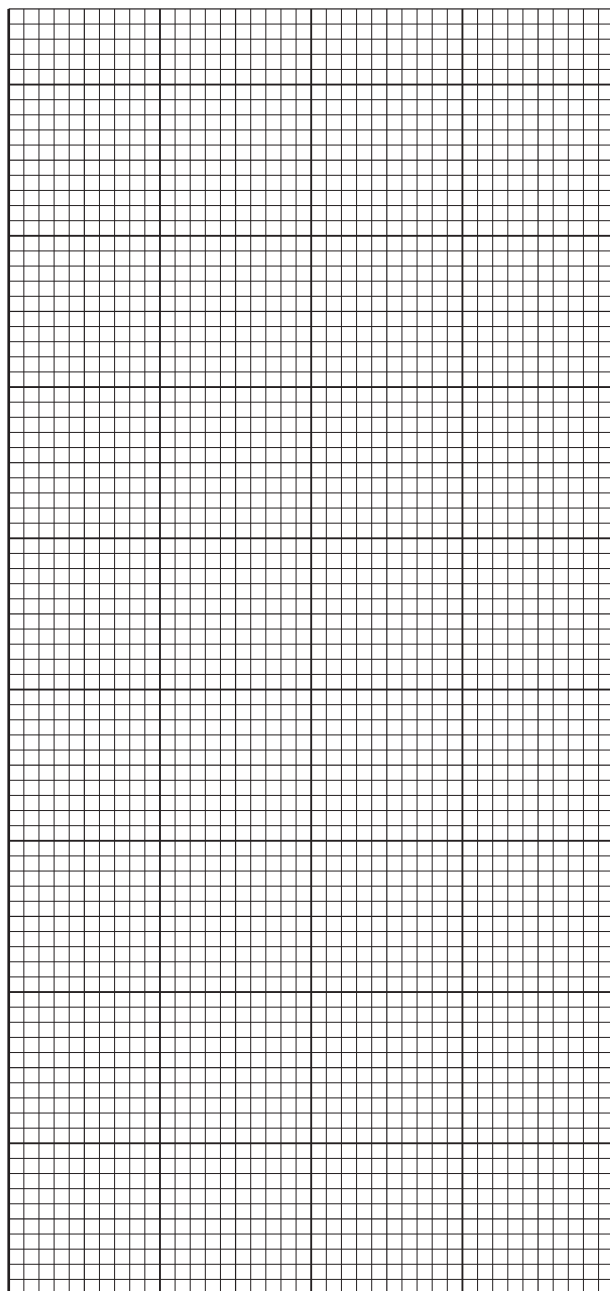
Use the equation shown.

$$\begin{array}{l} \text{mass lost} \\ \text{during heating} \end{array} = 5.00 - \text{mass after heating}$$

Record your values in Table 2.1.

[1]

- (iii) On the grid, plot the mass lost during heating (vertical axis) against the time of heating.



[3]

- (iv) One of the results is anomalous.

Circle the anomalous result on the grid.

[1]

- (v) Draw the curve of best-fit.

[1]

- (vi) Describe the relationship between the mass lost during heating and the time of heating.

.....

.....

..... [2]

(vii) In **Step 2** the student heats solid **H** using a Bunsen burner.

Explain why the student uses a blue flame.

.....

..... [1]

[Total: 13]

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- 3 A student investigates the period of oscillation of a spring when different loads are suspended from the spring.

The period is the time taken for the spring to complete **one** oscillation.

The period is measured by giving the spring a small downwards displacement, releasing it, and timing the oscillations.

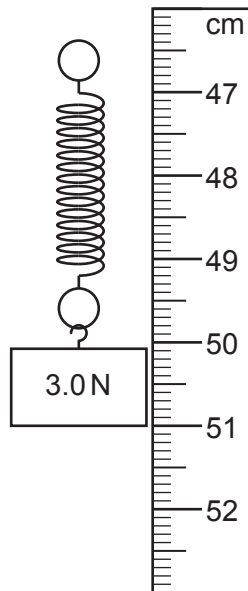


Fig. 3.1

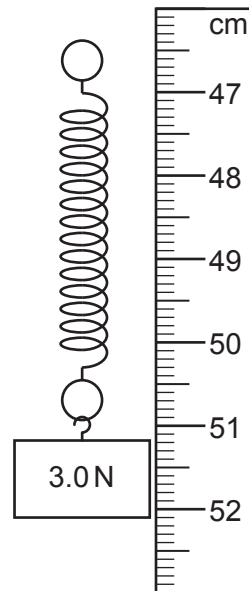


Fig. 3.2

- (a) Fig. 3.1 shows the spring with a load of 3.0 N suspended from it.

Fig. 3.2 shows the same spring with the load displaced a short distance downwards before being released.

- (i) Record the reading on the ruler at the bottom of the load as shown in Fig. 3.1 and Fig. 3.2.

reading in Fig. 3.1 cm

reading in Fig. 3.2 cm
[1]

- (ii) Use the readings from (a)(i) to calculate the displacement of the load.

Use the equation shown. Give your answer in mm.

displacement = reading in Fig. 3.2 – reading in Fig. 3.1

displacement = ... mm [1]

- (b) (i) Fig. 3.3 shows the stop-watch used to measure the period for the load of 3.0 N. Record in Table 3.1 the period to one decimal place.



Fig. 3.3

Table 3.1

load /N	period /s
3.0	
4.0	1.8
5.0	2.0
6.0	2.2
7.0	2.4
8.0	2.6

[1]

- (ii) The student also measures the period for five other loads.

Describe the relationship between load and period shown in Table 3.1.

.....
 [1]

- (c) The student suggests that the period is proportional to the load.

State if the student is correct. Use values from Table 3.1 to justify your answer.

statement

.....

justification

.....

.....

..... [2]

- (d) State **one** improvement to the method for accurate results when measuring the period of the spring.

.....

..... [1]

[Total: 7]

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- 4 A student rolls a toy car down a ramp of height h .

At the bottom of the ramp, the car rolls a distance d along the horizontal floor until it stops.

Plan an investigation to determine the relationship between the height of the ramp h and the stopping distance d .

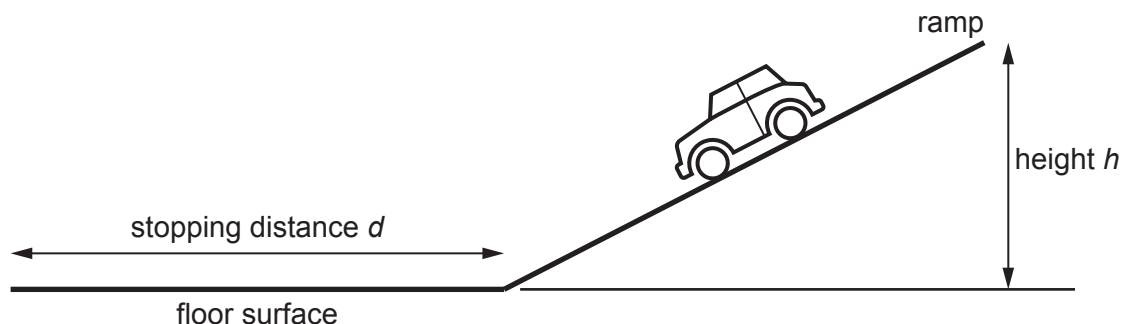


Fig. 4.1

You are provided with:

- a ramp that can be adjusted to different heights
- toy cars.

You may use any common laboratory apparatus in your plan.

In your plan include:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- 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.

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