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0653/61

October/November 2018

1 hour

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

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

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

This document consists of **19** printed pages and **1** blank page.

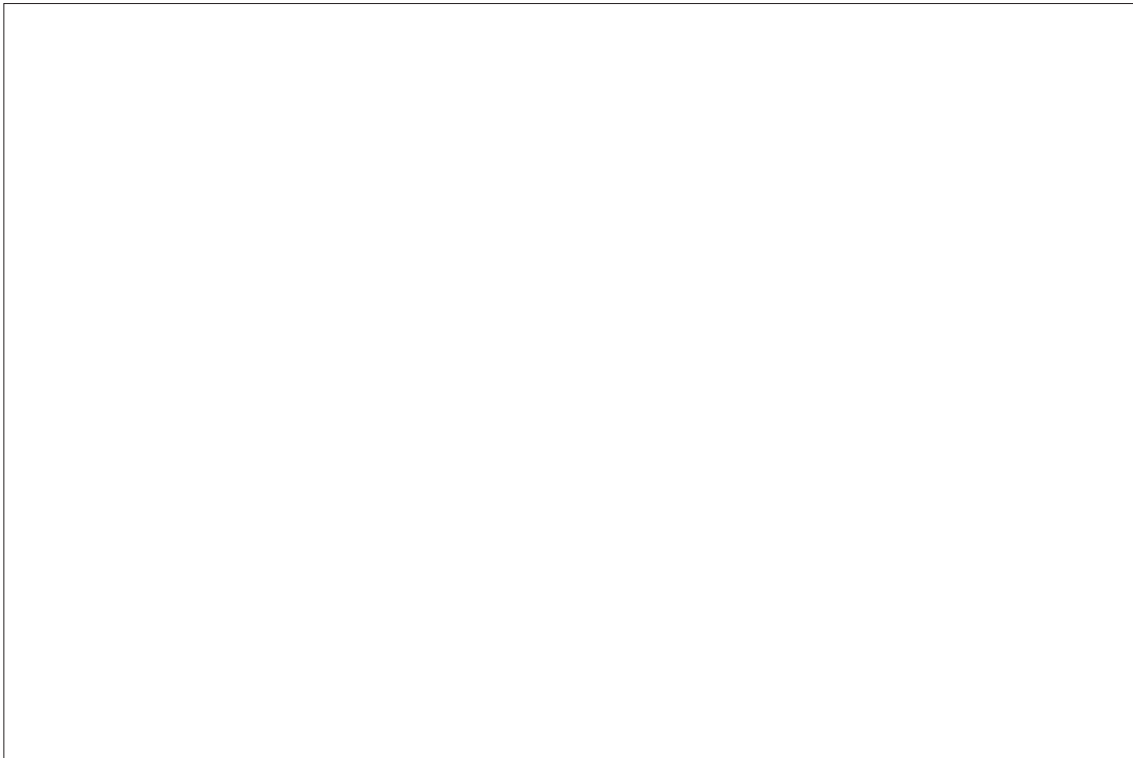
- 1 A student investigates a leaf.

Fig. 1.1 shows the leaf.



Fig. 1.1

- (a) (i) In the box provided, make an enlarged detailed pencil drawing of the leaf shown in Fig. 1.1.



[3]

- (ii) Draw a line on the leaf in Fig. 1.1 to join the points labelled **A** and **B**.

Measure **and** record the length of this line **A–B**, in millimetres, to the nearest millimetre.

length of line **A–B** in Fig. 1.1 mm [1]

- (iii) Draw the equivalent line **A–B** on your drawing.

Measure **and** record the length of this line, in millimetres, to the nearest millimetre.

length of line **A–B** in drawing mm [1]

- (iv) Use your measurements in (a)(ii) and (a)(iii) to calculate the magnification of your drawing.

magnification = ...[1]

- (b) (i) Describe in detail the steps involved to test the leaf for the presence of starch.

.....
.....
.....[3]

- (ii) State the observation for a positive result.

.....[1]

2 A student investigates the temperature changes when solid **H** reacts with solution **J**.

- (a) He uses a thermometer to measure the temperature T of solution **J** to the nearest 0.5°C . He records this in Table 2.1 for time = 0 min.

He records in Table 2.2 the appearance of solid **H** and solution **J** before the reaction.

- He places a sample of solid **H** into a plastic cup.
- He adds 25 cm^3 of solution **J** to solid **H** in the plastic cup.
- He starts the stopclock and stirs the mixture thoroughly.
- He continues stirring and measures the temperature of the mixture every half minute for four minutes.
- He records in Table 2.1 the values to the nearest 0.5°C .
- After the final reading, he records in Table 2.2 the appearance of the solid and the solution.

Table 2.1

time/min	temperature $T/^{\circ}\text{C}$
0	20.5
0.5	56.0
1.0	55.0
1.5	49.5
2.0	45.0
2.5	41.5
3.0	38.0
3.5	36.0
4.0	35.0

Table 2.2

observations	solid	solution
before the reaction	grey	blue
after the reaction	brown	colourless

- (i) The thermometer readings are taken to the nearest 0.5°C .
State the value of one division on the thermometer that makes this possible.

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

- (ii) Use the data in Table 2.1 to calculate the maximum rise in temperature ΔT of the mixture during the reaction.

ΔT °C [1]

- (iii) Explain why the value in (a)(ii) can only be regarded as an estimate.

.....
 [1]

- (iv) Suggest what could have been done to achieve a more accurate value for the rise in temperature for this experiment.

.....
 [1]

- (b) (i) Calculate the energy E released in this reaction. Use the equation shown.

$$E = \text{volume of solution J} \times 4.2 \times \Delta T$$

Give your answer to 2 significant figures.

$E =$ joules [2]

- (ii) Your value of E in (b)(i) is less than the actual amount of thermal energy released by the reaction.

Suggest an improvement to the **apparatus** (not the chemicals) that would result in a higher value of E .

Explain why your improvement would result in a higher value of E .

improvement

 explanation
 [2]

- (c) Using the observations in Table 2.2, the student concludes that solution **J** contains the copper(II) ion, Cu^{2+} .

Describe a test that the student could use to confirm that solution **J** contains the copper(II) ion, Cu^{2+} .

Include the observations for a positive test.

test

.....

observations

.....

[2]

- 3 A student measures the acceleration of free fall g using a spring.

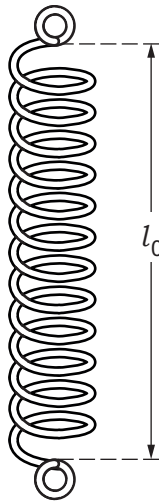


Fig. 3.1

- (a) Measure and record the unstretched length l_0 of the spring shown in Fig. 3.1 to the nearest millimetre.

$l_0 = \dots\dots\dots\text{mm}$ [1]

- (b) The student attaches the spring to a clamp as shown in Fig. 3.2 and suspends a 200 g mass on the spring.

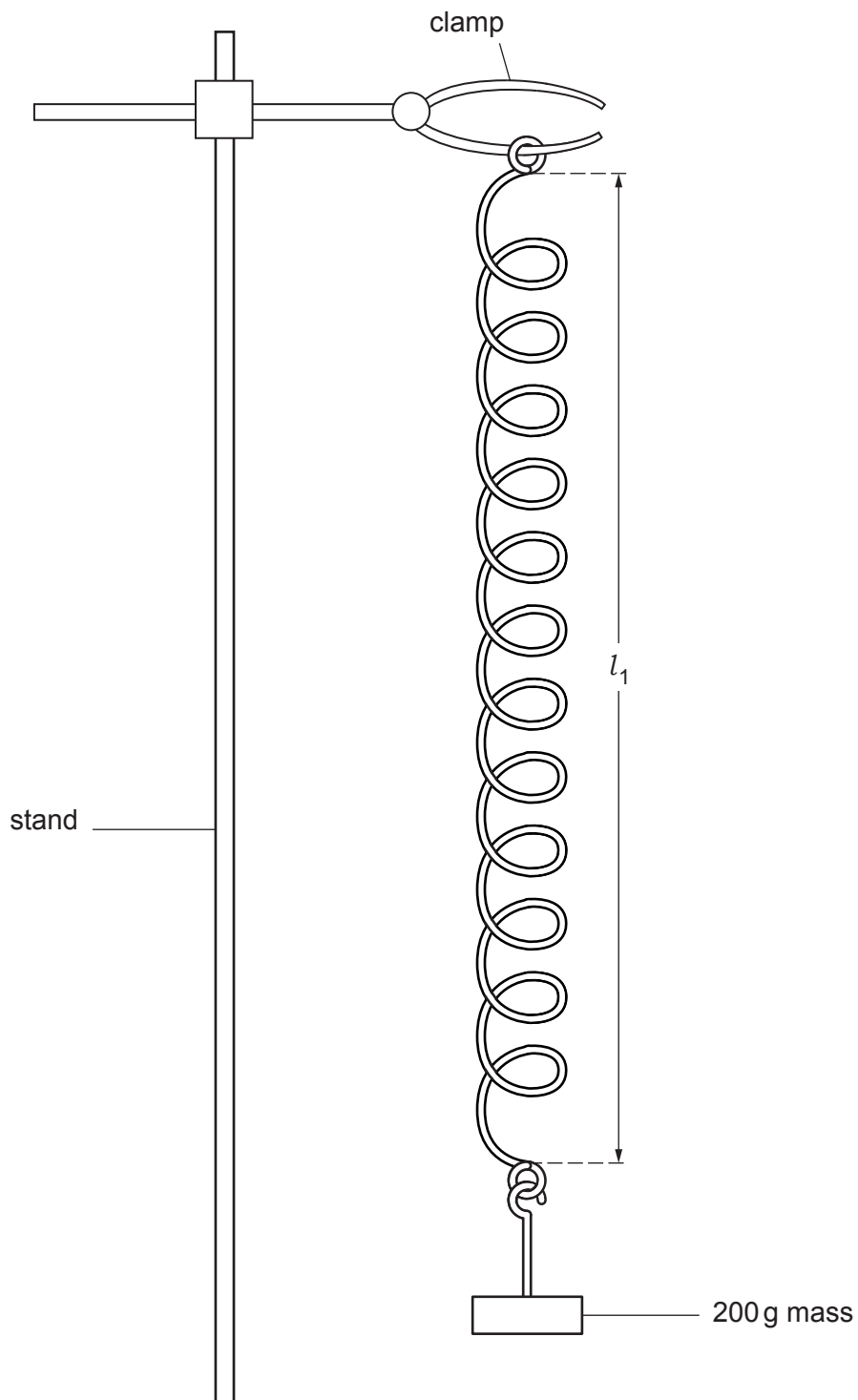


Fig. 3.2

Measure the stretched length l_1 of the spring.

$l_1 = \dots\dots\dots$ mm

Calculate the extension e of the spring produced by the mass. Use the equation shown.

$$e = l_1 - l_0$$

Record your value in Table 3.1.

[1]

Table 3.1

mass m /g	extension e /mm	time t taken for 20 oscillations/s	period T /s	T^2/s^2
200		11.22	0.561	0.31
300	118	13.34	0.667	
400	160	15.81	0.791	0.63
500	202	17.87	0.894	0.80

(c) The student pulls the mass down a small distance and releases it. The mass oscillates up and down. The period T of the oscillations is the time taken for **one** oscillation.

- She measures the time t taken for 20 oscillations and records this time in Table 3.1.
- She repeats the procedure for masses of 300 g, 400 g and 500 g.

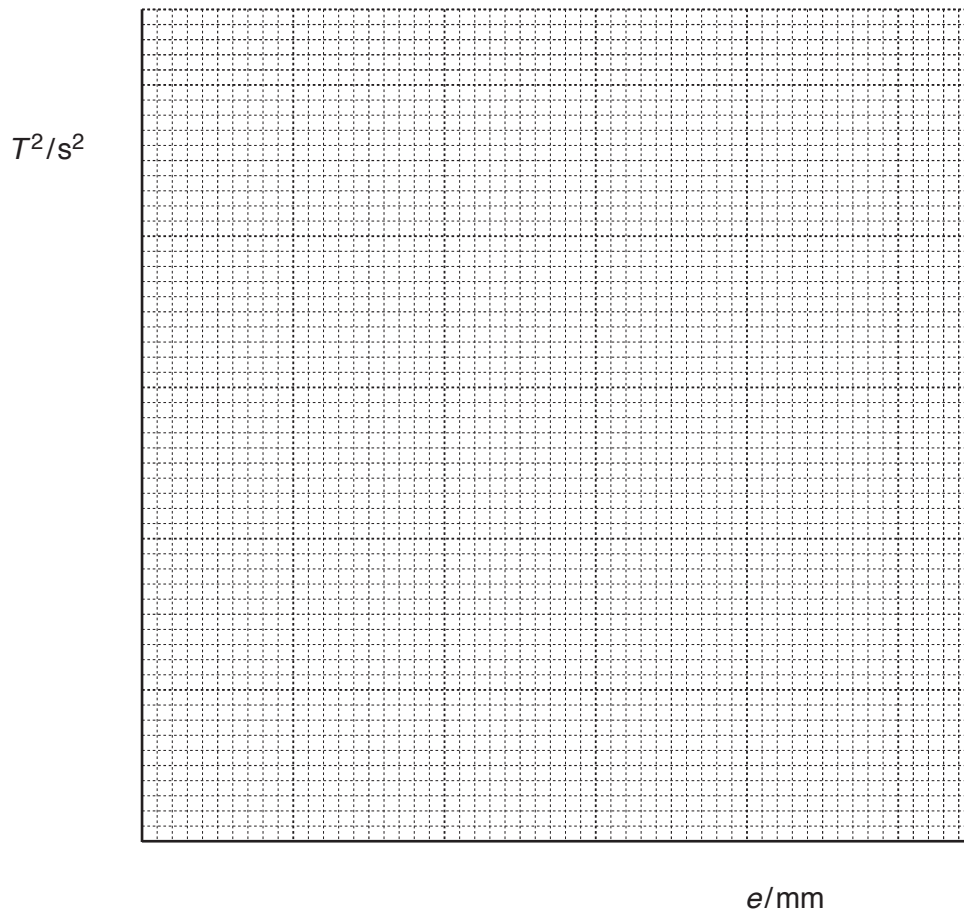
Her results are shown in Table 3.1.

Calculate the missing value of T^2 .

Record your answer in Table 3.1.

[1]

- (d) (i) On the grid provided, plot a graph of T^2 (vertical axis) against e . Start your axes at (0,0).



[2]

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

[1]

- (iii) Calculate the gradient of your line.

Show all working and indicate on your graph the values you chose to enable an accurate value of the gradient to be calculated.

gradient = ...[2]

- (iv) Use your answer to (d)(iii) and the equation shown, to determine a value for the acceleration of free fall g .

$$g = \frac{0.0395}{\text{gradient}}$$

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

- (e) It is important to avoid line-of-sight (parallax) errors when measuring the length of a spring.

Describe how you would avoid this error.

.....

.....

.....[1]

4 A student investigates oxygen consumption in respiring maggots.

(a) She sets up the apparatus shown in Fig. 4.1. The soda lime removes any carbon dioxide in the test-tube.

- The student closes the clip. She reads and records the start position of the left hand edge of the coloured liquid.
- She leaves the apparatus for 30 minutes. The coloured liquid moves towards the maggots.
- She reads and records the end position of the left-hand edge of the coloured liquid.
- She opens the clip.

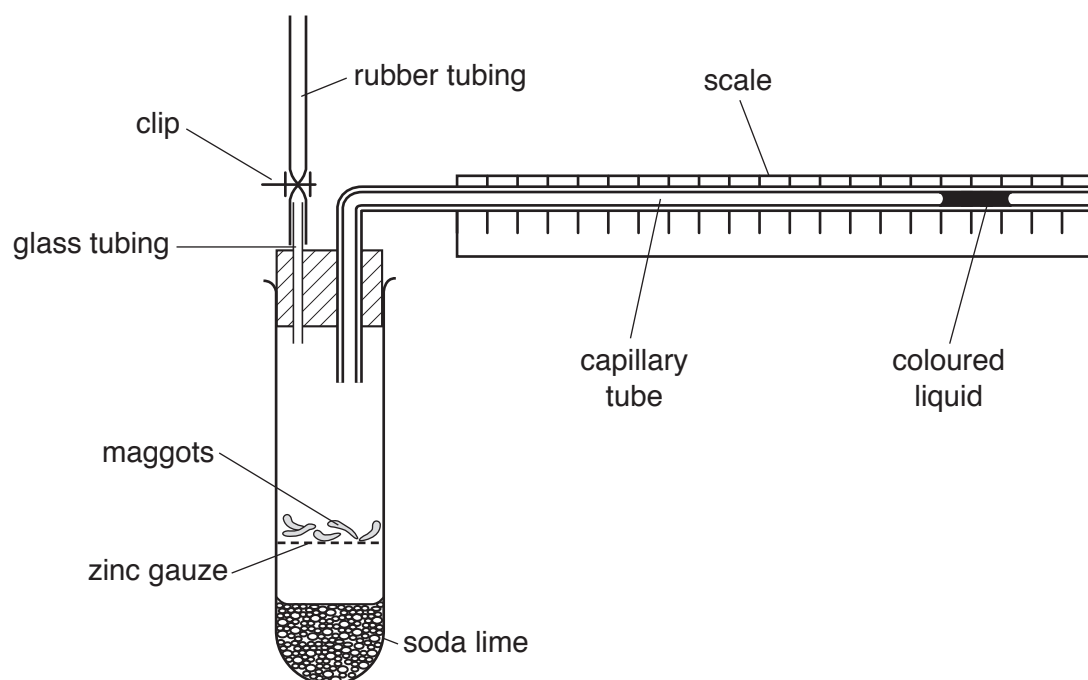


Fig. 4.1

Fig. 4.2 shows the positions of the left-hand edge of the coloured liquid at the start and at the end of the investigation.

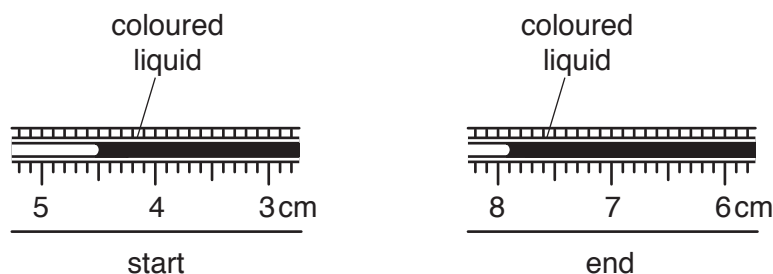


Fig. 4.2

- (i) Use Fig. 4.2 to read the positions of the left-hand edge of the coloured liquid and record them in Table 4.1, in centimetres, to the nearest 0.1 cm. [2]

Table 4.1

start position /cm	end position /cm	total distance moved in 30 minutes/cm	rate of movement of the coloured liquid /cm per minute

- (ii) Calculate the total distance moved by the coloured liquid in 30 minutes. Record your answer in Table 4.1.

[1]

- (iii) Calculate the rate of movement of the coloured liquid in cm per minute. Record your answer in Table 4.1.

[1]

- (b) During the investigation, the apparatus shown in Fig. 4.1 is airtight, and the maggots are respiring.

The word equation for respiration is shown.



Explain why the coloured liquid moves towards the maggots during the investigation.

.....

[2]

- (c) Suggest why the student needs to close the clip at the start of the investigation and open it at the end of the investigation.

close at start

.....

open at end

.....

[2]

- (d) This experiment is repeated using the same apparatus.

State **two** variables that need to be kept constant.

variable 1

variable 2

[2]

- 5 A student prepares a pure sample of blue copper sulfate crystals using black copper oxide powder and sulfuric acid.

He uses the following method.

Step 1: Measure 25 cm^3 of sulfuric acid into a beaker.

Step 2: Place the beaker of sulfuric acid onto a tripod and heat gently with a Bunsen burner.

Step 3: Add copper oxide powder to the sulfuric acid a small amount at a time and stir with a glass rod. Keep adding the copper oxide until no more reacts. Be careful not to let the mixture boil.

Step 4: Filter the mixture into an evaporating basin.

Step 5: Gently heat the copper sulfate solution in the evaporating basin until about half of the water in the solution has evaporated.

Step 6: Leave the basin to cool.

Step 7: Filter off the crystals.

Step 8: Wash the crystals with ice cold water.

Step 9: Dry the crystals with filter paper.

- (a) Name a piece of apparatus suitable for measuring the 25 cm^3 of sulfuric acid used in Step 1.

.....[1]

- (b) Draw a labelled diagram of the apparatus used for Step 2.

[2]

- (c) State how the student knows when no more copper oxide will react with the sulfuric acid in Step 3.

.....[1]

- (d) The apparatus used for Step 4 is shown in Fig. 5.1.

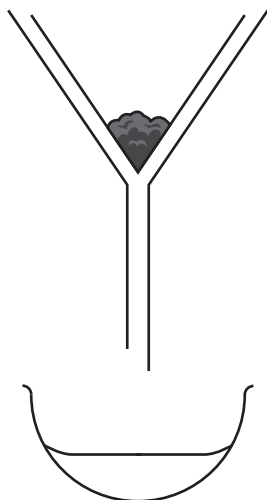


Fig. 5.1

Label **all** of the apparatus and **all** of the substances shown in Fig. 5.1.

[2]

- (e) Explain why only half of the water is evaporated in Step 5.

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

- (f) Explain how the student makes sure that the crystals he produces are pure.

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

- (g) Suggest why the water in Step 8 is ice cold.

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

- (h) The student adds the crystals to a boiling tube and heats them gently until they form a white powder.

State the substance that could be added to the white powder to make the blue colour return.

.....[1]

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6 A student investigates the alcohol content of wine.

- He places a 100 cm^3 measuring cylinder on a mass balance and zeroes the balance (so that the mass reads 0.00 g).
- He places between 95 cm^3 and 100 cm^3 of water into the measuring cylinder. This is 0% alcohol.
- He reads the mass balance, which is the mass of water. He records this mass in Table 6.1.
- He measures the volume of water and records this value, to the nearest 0.5 cm^3 , in Table 6.1.
- He empties the measuring cylinder and repeats the procedure using 4%, 8%, 12%, 16% and 20% alcohol solutions.

Table 6.1

percentage of alcohol / %	volume / cm^3	mass / g	density / g per cm^3
0	99.0	99.0	1.000
4	98.5	97.8	0.993
8	99.5	97.7	0.982
12		94.6	0.980
16	97.0		0.975
20	96.0	93.0	0.969

(a) (i) Fig. 6.1 shows the volume in the measuring cylinder for the 12% alcohol solution.

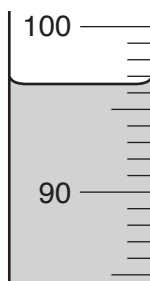


Fig. 6.1

Record this volume in Table 6.1.

[1]

(ii) Fig. 6.2 shows the mass balance reading for the 16% alcohol solution.

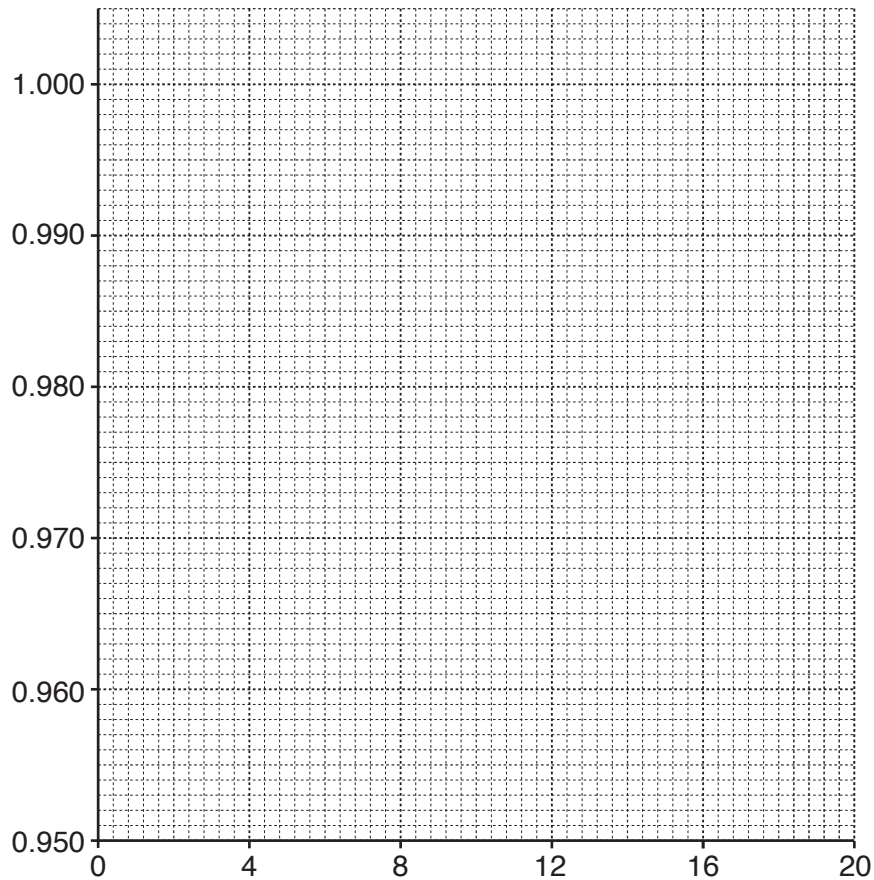


Fig. 6.2

Record this mass in Table 6.1.

[1]

- (b) (i) On the grid provided, plot a graph of density (*vertical axis*) against percentage of alcohol. Label the axes.



[2]

- (ii) On your graph, circle the anomalous point.

[1]

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

[1]

- (c) Use your graph to determine the percentage alcohol content of a sample of wine of density 0.978 g per cm^3 .

Show clearly on your graph how you arrived at your answer.

Percentage alcohol content of wine = ...% [1]

- (d) Suggest how the student could minimise the effect of errors in this experiment.

.....
 [1]

- (e) The density of the alcohol solution is calculated using the formula shown.

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

Suggest **one** reason why the student added between 95 cm³ and 100 cm³ of the alcohol solution into the measuring cylinder rather than adding exactly 100 cm³.

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

- (f) Some wines, for example Champagne, contain dissolved carbon dioxide which makes them fizzy.

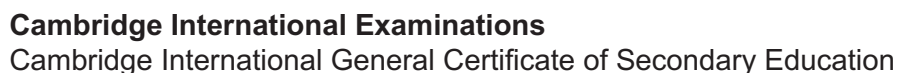
Suggest **one** reason why the method in this experiment is **not** suitable for determining the alcohol content of Champagne.

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

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This document consists of **18** printed pages and **2** blank pages.

- 1 A student investigates the nutrient content of three solutions, **A**, **B** and **C**.

He tests **A**, **B** and **C separately** with Benedict's solution, biuret solution and iodine solution.

- (a) Name the test solution which requires him to use a hot water-bath.

.....[1]

- (b) His results are shown in Table 1.1.

Table 1.1

solution	observation with Benedict's solution	observation with biuret solution	observation with iodine solution
A	blue	purple	blue-black
B	green	blue	brown
C	blue	blue	blue-black

Use Table 1.1 to state the nutrients present in each of solutions **A**, **B** and **C**.

solution **A** contains

solution **B** contains

solution **C** contains

[3]

- (c) State **and** explain **one** safety precaution that the student should use when carrying out these tests.

safety precaution

explanation

[1]

- (d) Describe a method used to test a liquid for the presence of fats. Include the observation for a positive result.

method

.....
.....

observation for a positive result

.....
[2]

- (e) Another student carries out an experiment on two different solutions using Benedict's solution. This allows her to compare the concentration of the nutrient tested for in each solution.

- (i) State **two** variables which need to be controlled in this experiment.

variable 1

variable 2

[2]

- (ii) Explain how the results will allow the concentrations of the nutrient in the two solutions to be compared.

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

2 A student investigates the thermal decomposition of metal carbonates.

(a) **Procedure**

- She places a 1.5 g sample of solid copper carbonate in a test-tube.
- She places about 5 cm depth of limewater in a second test-tube.
- She connects the bung of a delivery tube to the test-tube containing the copper carbonate and places the delivery tube into the limewater.
- She heats the test-tube containing copper carbonate with a hot flame and immediately starts a stopclock.
- When the limewater becomes milky, she stops the stopclock, immediately removes the delivery tube from the limewater and removes the source of heat.
- She records, in Table 2.1, the time to the nearest second.

She repeats the above procedure for magnesium carbonate and zinc carbonate.

Table 2.1

name and formula of metal carbonate	time / s
copper carbonate, CuCO_3	39
magnesium carbonate, MgCO_3	65
zinc carbonate, ZnCO_3	47

- (i) Draw a diagram of the apparatus connected together.

Label the **metal carbonate** and the **limewater**.

- (ii) State why it is important to remove the delivery tube from the limewater before removing the source of heat.

.....
[1]

- (iii) Complete Fig. 2.1 to show the reading on the stopclock for magnesium carbonate.

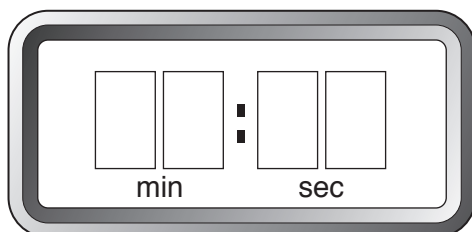


Fig. 2.1

[1]

- (b) (i) Use the information in (a) to identify the gas produced by the thermal decomposition of a metal carbonate.

.....[1]

- (ii) Use the results in Table 2.1 to place the metal carbonates in order of **rate** of turning limewater milky (speed of thermal decomposition).

1		fastest
2		↓
3		slowest

[1]

- (iii) The order of reactivity of the three metals in the metal carbonates is shown.

most reactive	magnesium
↓	zinc
least reactive	copper

Describe the relationship between the reactivity of the metals and the rate of thermal decomposition of their carbonates.

You may wish to use your answers in (b)(ii) or the results in Table 2.1.

.....

[1]

- (c) The rate of gas production when metal carbonates are heated can be measured without the use of limewater.

Suggest an alternative method of measuring the rate of gas production.

Include a diagram to show what replaces the test-tube of limewater and state what should be measured.

.....

.....

.....

.....[3]

3 A student investigates how the power produced in a resistance wire **XY** depends upon its length.

(a) She sets up the circuit shown in Fig. 3.1.

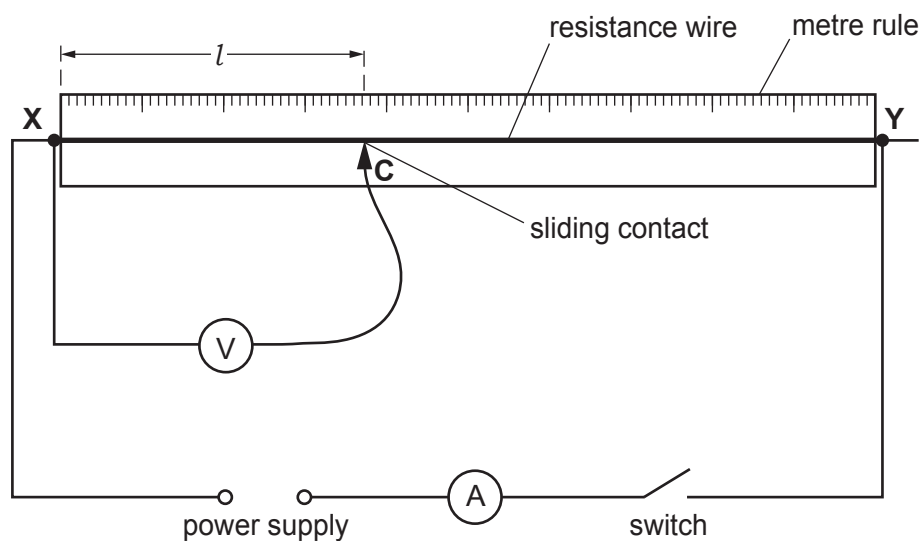


Fig. 3.1

- She closes the switch.
- She places the sliding contact **C** on the resistance wire at a length $l = 10.0$ cm from end **X**.
- She records, in Table 3.1, the current I flowing through the wire and the potential difference V between **X** and **C**.
- She opens the switch.
- She records her results in Table 3.1.

Table 3.1 shows some of her results.

Table 3.1

length l /cm	current I /.....	potential difference V/V	power P /.....
10.0	0.19		
20.0	0.19	0.31	0.06
40.0	0.19	0.61	0.12
60.0	0.19	0.88	0.17
80.0	0.19	1.20	0.23

- (i) Complete the units in the column headings in Table 3.1. [1]
- (ii) Fig. 3.2 shows the voltmeter reading for $l = 10.0$ cm.

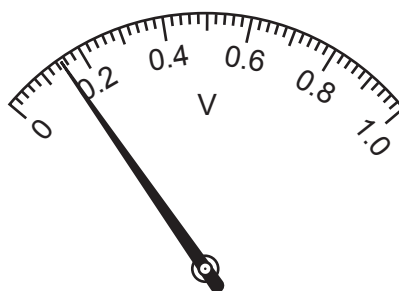


Fig. 3.2

- Read the meter and record, in Table 3.1, the potential difference V across the wire. [1]
- (iii) Calculate the power P produced in the 10.0 cm length of the wire. Use the equation shown.

$$P = I \times V$$

Record the value of P in Table 3.1. [1]

- (b) The student repeats (a) for values of $l = 20.0$ cm, 40.0 cm, 60.0 cm and 80.0 cm.

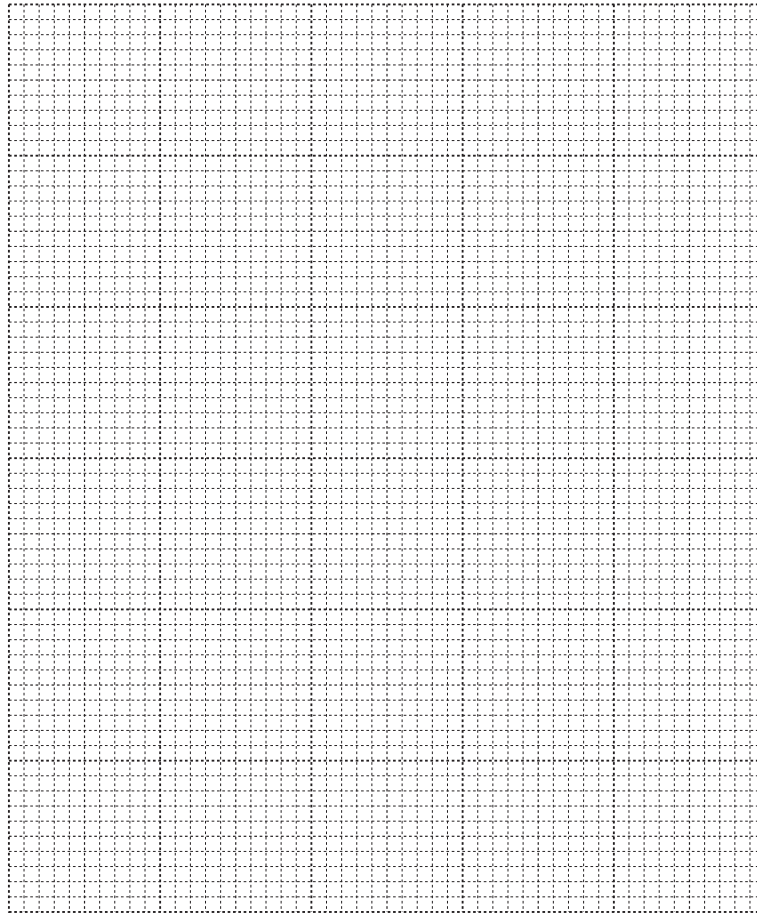
She records, in Table 3.1, her values of I , V and P .

State why it is important to open the switch between taking readings.

.....

.....[1]

- (c) (i) On the grid provided, plot a graph of P (vertical axis) against l . Start your axes at the origin (0,0).



[3]

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

[1]

- (d) Use your graph to suggest the relationship between the power P produced in the wire and its length l .

Explain your answer.

relationship

.....

explanation

.....

[2]

- 4 A student investigates a blood sample using a microscope.

Fig. 4.1 shows what he sees.

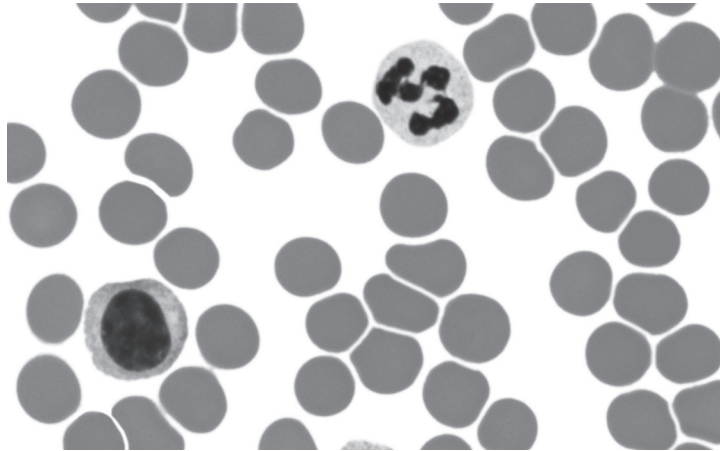


Fig. 4.1

- (a) On Fig. 4.1, use label lines to label a red blood cell **R** and a white blood cell **W**. [1]
- (b) (i) Fig. 4.2 shows a magnified cell.

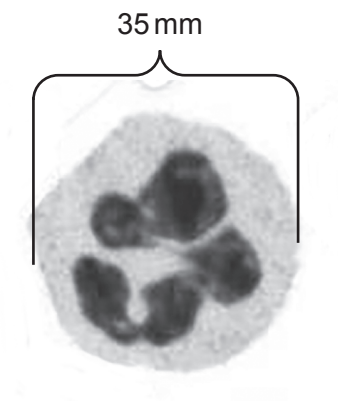


Fig. 4.2

In the box provided, make an enlarged drawing of the magnified cell shown in Fig. 4.2.



[3]

(ii) The width of the cell in Fig. 4.2 is 35 mm.

Measure and record the equivalent width of the cell in your drawing.

width of cell in drawing = ...

Calculate the magnification of your drawing.

magnification = ...
[1]

- (c) (i) A 17-year-old student is training for a cycle race.

Calculate his theoretical maximum heart rate during his training. Use the equation shown.

theoretical maximum heart rate in beats per minute = $(220 - \text{age in years})$

student's theoretical maximum heart rate = ... beats per minute [1]

- (ii) The student wants to find his resting heart rate.

The student does not have a heart rate monitor but does have a stopwatch.

Describe how the student determines his resting heart rate.

.....

.....

.....

.....

.....

.....[4]

- 5 A student investigates the coloured inks in a permanent black marker pen using chromatography.

She takes a piece of chromatography paper and draws a pencil line 1 cm from the bottom of the paper.

She puts spots of red, green, yellow and blue inks onto the pencil line on the paper. She then puts a spot of the black marker pen ink onto the pencil line on the paper.

She rolls the paper into a cylinder, secures it with a paper clip and stands it in a beaker as shown in Fig. 5.1.

She adds ethanol to the beaker and leaves it for several minutes.

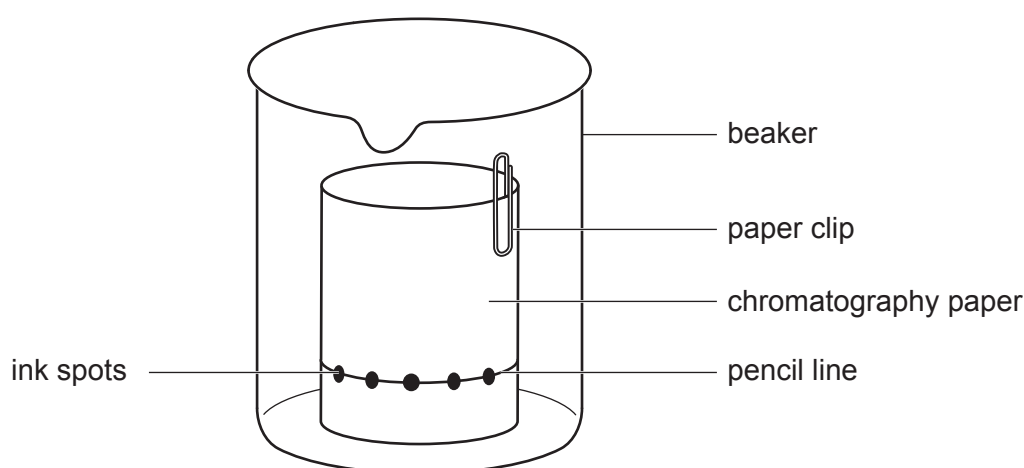


Fig. 5.1

- (a) (i) Draw a line on Fig. 5.1 to show where the level of the ethanol in the beaker should be for this investigation. [1]

- (ii) Explain why the line, 1 cm from the bottom of the paper, is drawn in pencil.

.....
[1]

- (iii) The teacher suggests putting a lid onto the beaker.

Explain why the teacher suggests this.

.....
[1]

- (b) When the ethanol is almost at the top of the paper, the student takes the chromatography paper out of the ethanol and leaves it to dry.

The results are shown in Fig. 5.2.

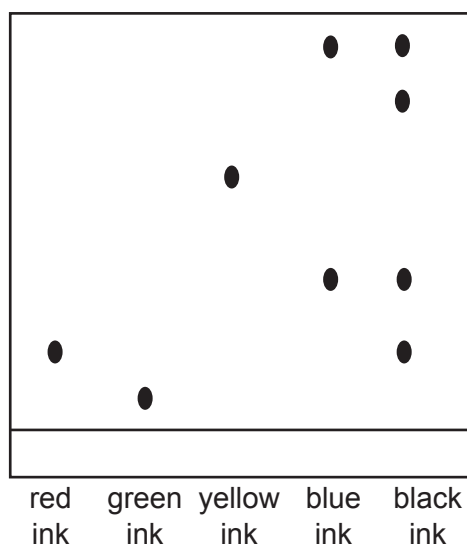


Fig. 5.2

- (i) Use Fig. 5.2 to state how many different coloured inks are in the black ink.

.....[1]

- (ii) State **and** explain which coloured inks are in the black ink.

coloured inks

explanation

.....[2]

- (c) (i) Explain why ethanol is used rather than water.

.....

.....[1]

- (ii) Explain why the ethanol is allowed to reach almost to the top of the paper before the paper is taken out and allowed to dry.

.....

.....[1]

- (d) The student thinks that the red-coloured ink is the same colour as the coloured ink in one of her sweets.

Explain how she can use chromatography to test her prediction.

Include in your answer:

- how the student would extract the red colour from the sweets
- what spots she should put on her chromatography paper.

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

6 A student carries out an experiment to measure her personal power.

- She runs up a flight of stairs as fast as she can.
- She uses a stopwatch to measure the time t that she takes.
- She repeats this procedure three more times in rapid succession.
- She measures her weight W using bathroom scales.

Fig. 6.1 shows the student and the stairs.

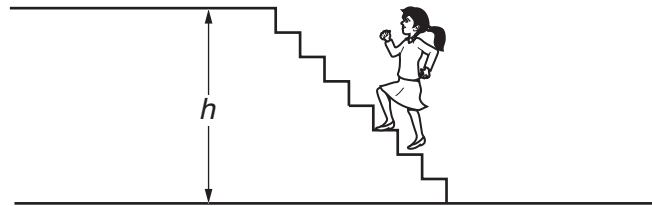


Fig. 6.1

(a) Describe how she measures the vertical height h of the stairs, if the only apparatus available to her is a 50 cm ruler.

.....
[1]

(b) The times recorded for each run are shown in Table 6.1.

Table 6.1

run number	time / s
1	2.07
2	2.13
3	2.25
4	2.37

(i) Suggest why the time taken for each consecutive run increases.

.....
[1]

- (ii) Calculate the average time t_{AV} that the student takes to run up the stairs.

Give your answer to 3 significant figures.

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

- (c) Fig. 6.2 shows the reading on the bathroom scales when the student stands still on it.

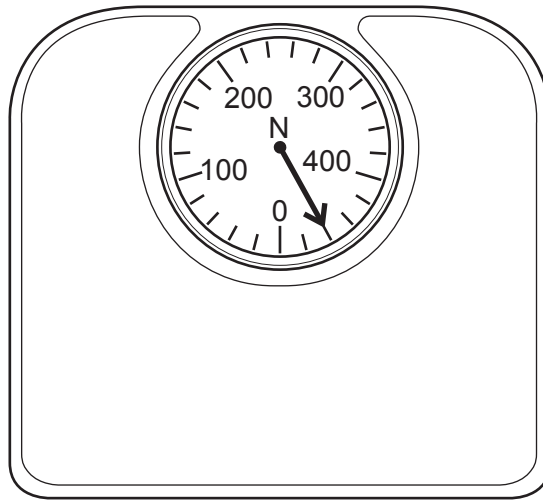


Fig. 6.2

- (i) Read the value on the scale in Fig. 6.2 and write down the weight W of the student.

$$W = \dots\dots\dots \text{ N [1]}$$

- (ii) Explain why she needs to stand still on the scales.

.....
[1]

- (iii) State why the student should look vertically down at the scale reading, when reading her weight from the scales.

.....
[1]

- (d) (i) The vertical height h of the stairs is 2.8 m.

Calculate the amount of gravitational potential energy E that the student gains when she runs from the bottom to the top of the stairs.

Use the equation shown.

$$E = W \times h$$

$$E = \dots\dots\dots \text{ J [1]}$$

- (ii) Calculate the average maximum power P produced by the student.

Use the equation shown.

$$P = \frac{E}{t_{\text{AV}}}$$

$$P = \dots\dots\dots \text{ W [1]}$$

- (e) A second student, who has the same weight as the first student, runs up the same flight of stairs and takes longer to reach the top.

State how the power produced by the second student compares with that of the first student.

Explain your answer.

statement

explanation

..... [1]

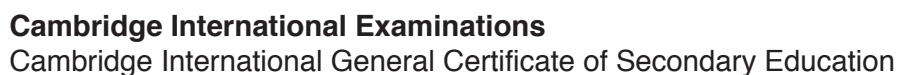
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0653/63

October/November 2018

1 hour

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

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

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

This document consists of **20** printed pages.

- 1 A student investigates a flower.

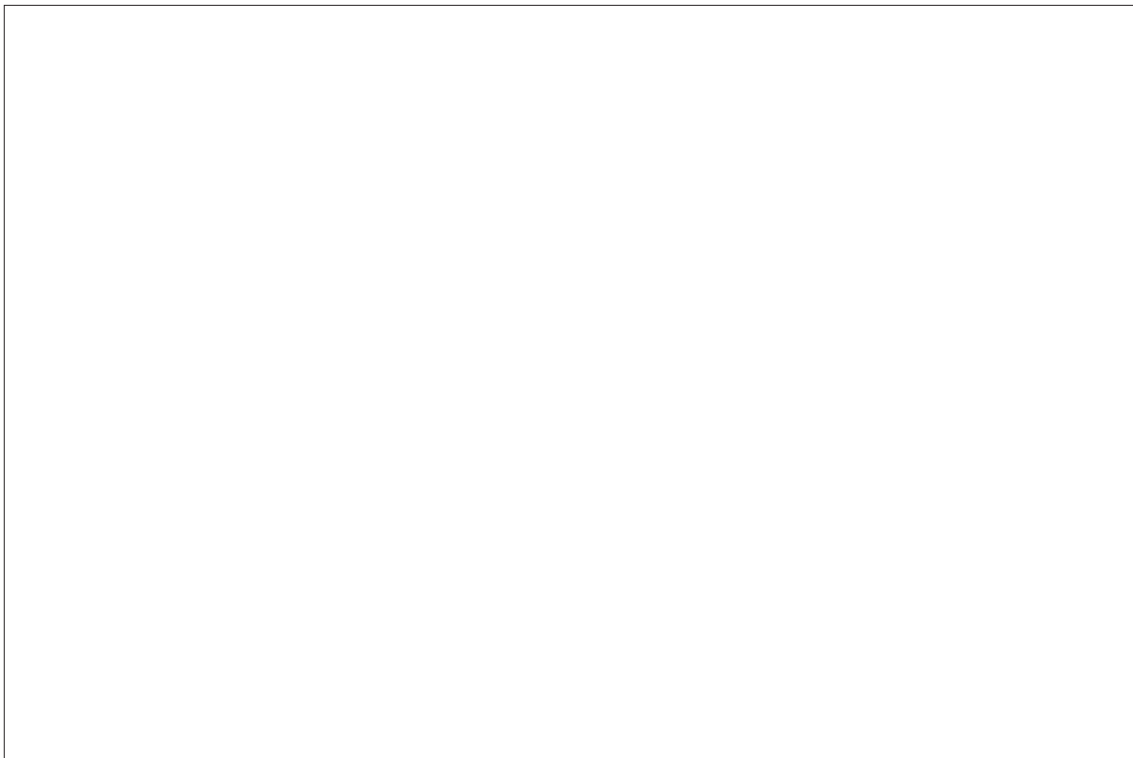
Fig. 1.1 shows part of the student's flower.



Fig. 1.1

- (a) (i) In the box provided, make a large detailed pencil drawing of the flower in Fig. 1.1.

This should show all the flower parts.



[4]

- (ii) On your drawing, label a petal, the stigma and an anther.

[3]

- (b) (i)** A student crushes some olives, producing olive juice.

Describe a test that can be used to confirm that a sample of the olive juice contains fat.

Include the observation for a positive result.

test

.....

observation

[2]

- (ii)** Suggest why this method would be unsuitable to test for the presence of fat in milk.

.....

.....[1]

- 2 Solid **J** is a mixture of two compounds. Only one of the compounds is soluble in water.

A student separates the compounds and identifies some of the ions in each compound.

- (a)
- She places solid **J** in a beaker, adds distilled water and stirs well.
 - She filters the mixture into a test-tube.
 - She keeps the filtrate and the residue for further testing.
 - She records her observations.

the filtrate is colourless

the residue is black

- (i) Draw **and** label the apparatus she uses to filter the mixture.

Label the positions of the filtrate and the residue.

[3]

- (ii) Suggest why the water she uses is distilled water.

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

- (b) • The student scrapes the solid from the filtration in (a) into a beaker.
- She adds dilute sulfuric acid and heats the mixture until the solid disappears.
 - She tests for the cation in the resulting liquid by adding sodium hydroxide solution.
 - She records her observations.

blue precipitate (ppt.)

Identify the cation.

.....[1]

- (c) The student places some of the liquid from the filtration in (a) in a test-tube and tests for the cation by adding sodium hydroxide solution.

She heats the mixture and tests for any gases near the mouth of the test-tube using damp blue and damp red litmus papers.

From her observations, she concludes that the cation is the ammonium ion.

- (i) State her observations for each stage of the method in (c).

observations for:

addition of sodium hydroxide solution

.....

damp blue litmus paper

damp red litmus paper

[2]

- (ii) Explain why she uses sodium hydroxide solution rather than ammonia solution to test for the ammonium ion.

.....

.....[1]

- (iii) • The student places another sample of the liquid from the filtration in **(a)** into a test-tube.
- She adds dilute nitric acid.
 - She then adds a few drops of barium nitrate solution.
 - She records her observations.

observations for:

addition of nitric acid ... *no reaction and no bubbles*

addition of barium nitrate solution ... *white ppt.*

State what the student can conclude about the anions present.

nitric acid test

barium nitrate test

[2]

- 3 A student investigates how the temperature of the surroundings affects the rate of cooling of water in a test-tube.

- (a) • She sets up the test-tube in a stand, as shown in Fig. 3.1.

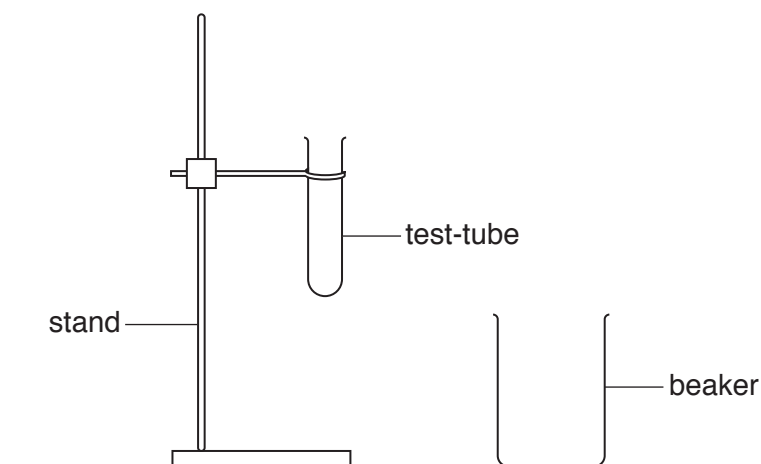


Fig. 3.1

- She pours 200 cm^3 of cold water into the beaker.
- She pours hot water into the test-tube until it is about half full.
- She places the test-tube into a beaker of cold water, as shown in Fig. 3.2.

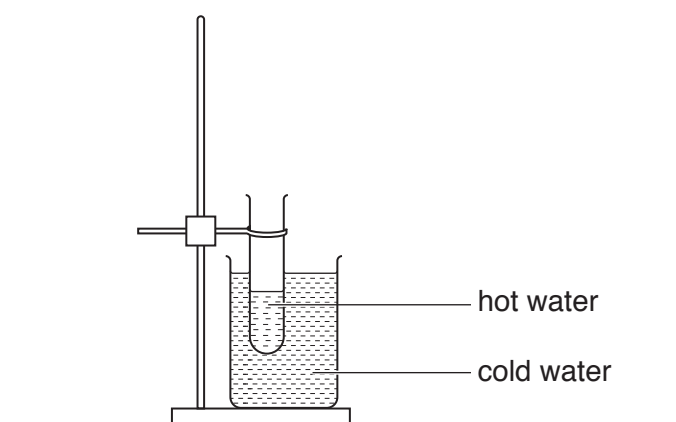


Fig. 3.2

- She places a thermometer into the test-tube.
- She waits for one minute.
- She measures the temperature θ of the hot water in the test-tube and records this in Table 3.1 at time $t = 0$. She starts the stopclock.
- She measures the temperature θ of the water every 30 seconds for a total time of 3 minutes.
- She records the temperatures and times in Table 3.1.

Table 3.1

	test-tube cooling in beaker of cold water	test-tube cooling in beaker of warm water
time t /	temperature of water in test-tube θ /	temperature of water in test-tube θ /
0	83.5	84.0
30	68.5	73.5
60		69.5
90	56.5	66.0
120	53.5	64.0
150	51.5	62.5
180	50.0	61.5

- (i) Fig. 3.3 shows the reading on the thermometer at time $t = 60$ seconds.

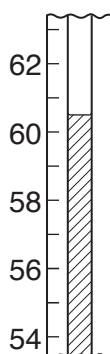


Fig. 3.3

Read the thermometer and record the value in Table 3.1.

[1]

- (ii) State why it is important to wait for one minute before recording the initial temperature of the hot water.

.....
[1]

- (iii) State **two** precautions that the student should take to ensure that the temperatures that she measures are as accurate as possible.

1

2

[2]

- (b) The student repeats the investigation, but this time she replaces the beaker of cold water shown in Fig. 3.2 with a beaker of warm water.

She records her results in Table 3.1.

- (i) Write the units in the column headings in Table 3.1. [1]

- (ii) Calculate the decrease in the temperature of the water in the test-tube after 3 minutes when cooling in the beaker of cold water and when cooling in the beaker of warm water.

temperature decrease in beaker of cold water = ...

temperature decrease in beaker of warm water = ... [1]

- (c) Use the information in (b)(ii) or the results in Table 3.1 to describe how the temperature of the surroundings affects the cooling of the water in the test-tube.

.....

 [2]

- (d) Suggest **one** improvement that could be made to the experimental procedure which would allow a fairer comparison between cooling in cold water and cooling in warm water.

Explain how your improvement makes the comparison fair.

improvement

.....

explanation

.....

..... [2]

- 4 A student uses a choice chamber to investigate the responses of woodlice (small invertebrates) to the intensity of light and the amount of water vapour in their surroundings.

The choice chamber is divided into four sections, each of which has different conditions, as shown in Fig. 4.1.

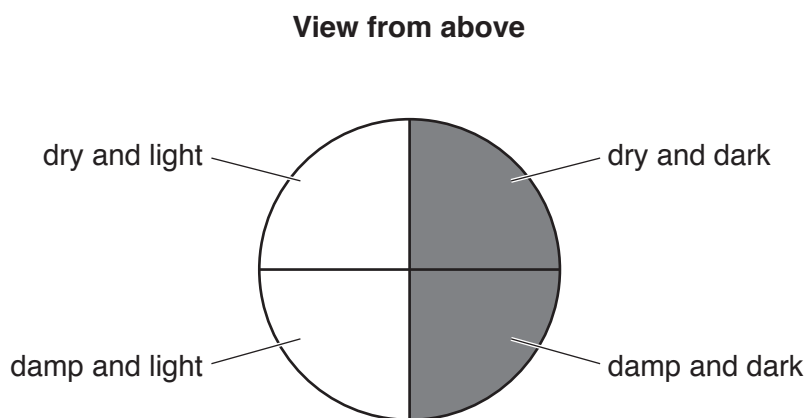


Fig. 4.1

- The student adds 8 woodlice to the choice chamber.
- The woodlice are free to move between any of the four sections.
- The student records the positions of the woodlice after 15 minutes.
- The test is carried out a total of three times.
- The results are shown in Fig. 4.2.

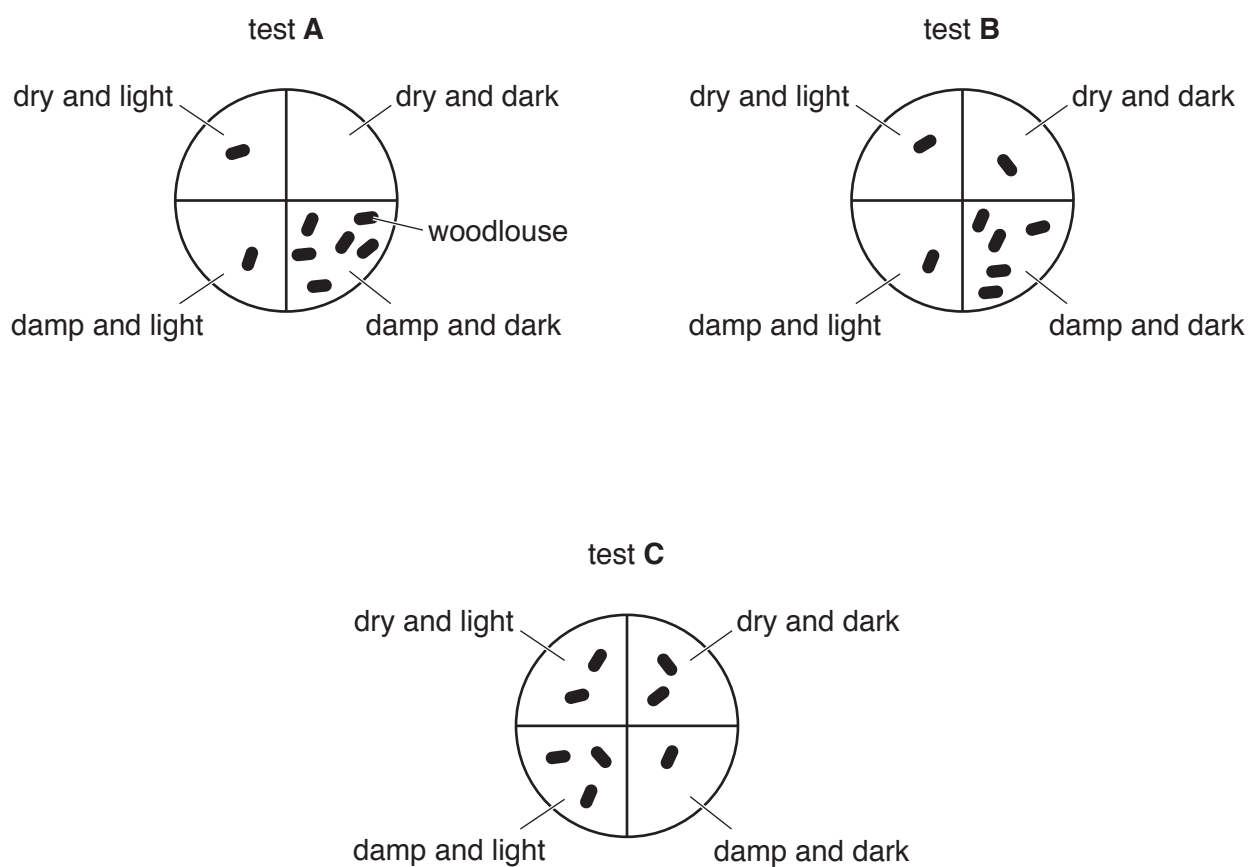


Fig. 4.2

Table 4.1 shows some of these results.

Table 4.1

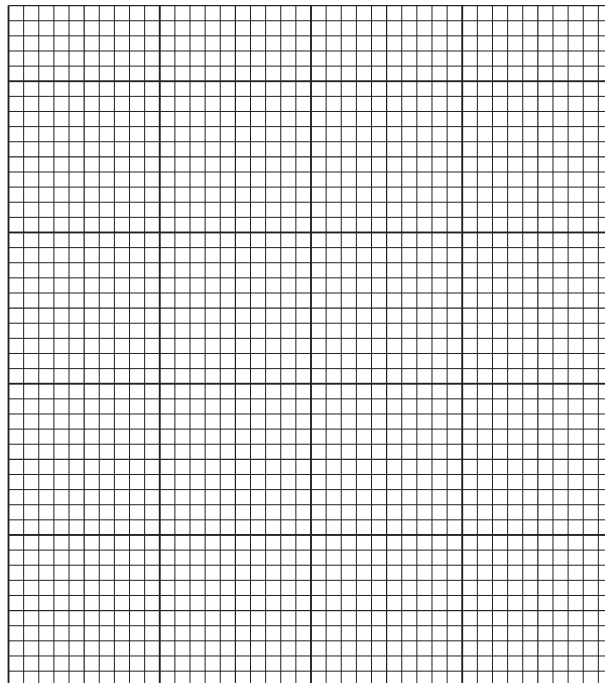
conditions in each section	number of woodlice counted			average number of woodlice
	test A	test B	test C	
dry and dark	0	1		1
damp and dark	6	5		4
damp and light	1	1		2
dry and light	1	1		

- (a) (i) Count the number of woodlice in each section of the choice chamber in test **C** and record the numbers in Table 4.1. [1]
- (ii) Calculate the average number of woodlice in the dry and light section of the choice chamber.

Record this number in Table 4.1.

[1]

- (b) Draw a bar chart to show the average number of woodlice (vertical axis) found in each section.



[4]

- (c) (i) State which section of the choice chamber the woodlice prefer.

.....[1]

- (ii) Suggest how the woodlice should be placed in the choice chamber at the start of the experiment.

.....

.....[1]

- (iii) Using the same apparatus, suggest **two** improvements to this investigation.

1

2

[2]

Please turn over for Question 5.

- 5 A student investigates the products of combustion of a hydrocarbon.

A hydrocarbon is burned in the apparatus shown in Fig. 5.1.

The products of this combustion are drawn through the apparatus by a pump for 10 minutes.

At the start, the U-tube is clean and dry and the limewater is colourless.

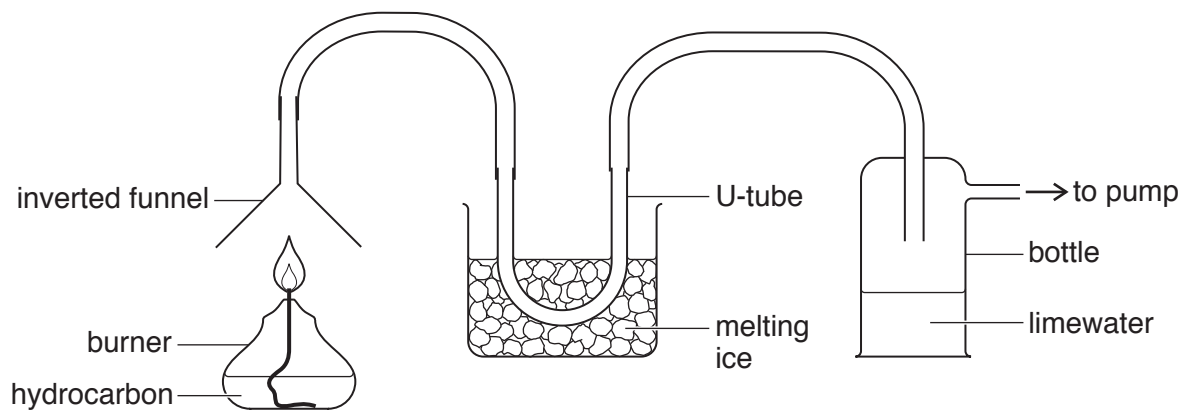


Fig. 5.1

- (a) During the 10 minutes, a colourless liquid forms inside the U-tube.

The student thinks that this is water.

- (i) Describe a chemical test that can be used to confirm that the colourless liquid in the U-tube contains water.

Include the observation for a positive result.

test

.....

observation

.....

[2]

- (ii) Explain why the U-tube is immersed in melting ice.

.....

.....[1]

- (b) The teacher tells the student that the apparatus in Fig. 5.1 contains an error in the bottle containing the limewater.

The student makes the necessary change to the apparatus.

The limewater then changes its appearance showing that carbon dioxide is present.

- (i) Draw on Fig. 5.1 the change that the student makes to the apparatus. [1]

- (ii) State the change in the limewater that shows the presence of carbon dioxide.

.....
[1]

- (c) The student tells his class that the experiment proves that the complete combustion of a hydrocarbon in oxygen produces carbon dioxide and water only.

State whether you agree with the student **and** explain your answer in detail.

Use the observations and conclusions in (a) and (b) and the apparatus shown in Fig. 5.1 to help explain your answer.

statement

explanation

.....

[2]

- (d) Another student says that the bottle containing the limewater should be placed before (to the left of) the U-tube.

Explain why this student is incorrect.

.....
[1]

- (e) The teacher tells the student to carry out a second experiment.

He sets up the apparatus in Fig. 5.1 with a dry U-tube and a correctly connected bottle of fresh limewater but without the burner.

He draws air through the apparatus for 10 minutes without burning the hydrocarbon.

Explain why this second experiment is carried out.

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

- (f) When the student dismantles the apparatus after burning the hydrocarbon, he observes a black solid on the inverted funnel.

Suggest the identity of the black solid.

.....[1]

- 6 A student is using refraction of light to determine the concentration of a solution of sugar. She sets up the apparatus shown in Fig. 6.1.

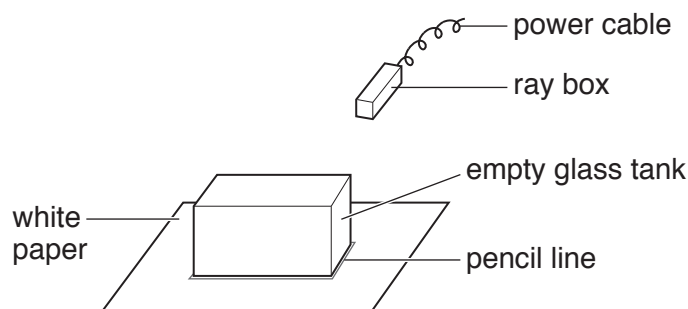


Fig. 6.1

The ray box is used to direct a ray of light towards the glass tank. The student draws around the tank with pencil so that it can be moved and replaced in exactly the same position.

She fills the tank with distilled water and switches on the ray box.

She looks at the apparatus from above so that she can see the ray of light as it enters and leaves the tank, as shown in Fig. 6.2.

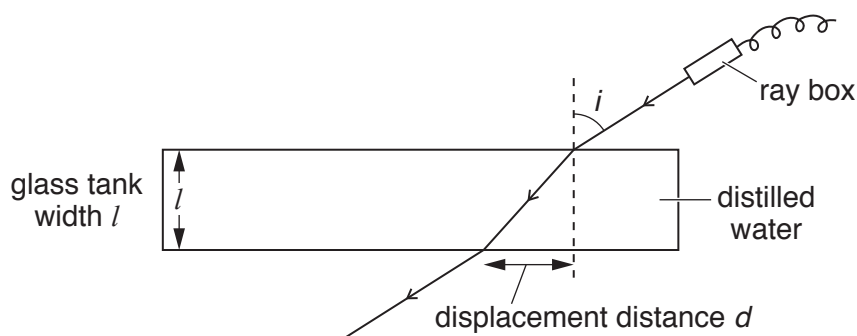


Fig. 6.2

She adjusts the angle of incidence i of the light until there is a large displacement distance d .

She measures the displacement distance d as 8.6 cm and records this value in Table 6.1.

Table 6.1

sugar solution concentration /g per 100cm ³ water	displacement distance d /cm
0	8.6
20	
40	7.9
60	7.5
80	7.0

The angle of incidence i needs to be kept constant throughout the experiment.

She draws a line along the path of the ray onto the paper and measures the angle i .

(a) Fig. 6.3 shows the angle of incidence i of the ray of light.

Measure the angle i and record it to the nearest degree.

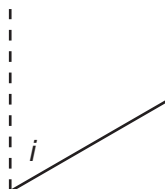


Fig. 6.3

angle = ... ° [1]

(b) The student empties the tank and fills it with a sugar solution of concentration 20 g per 100 cm³ of water.

She places the tank into exactly the same position on the paper and makes sure that the angle of incidence i is the same as in (a).

She measures the displacement distance d and records the value in Table 6.1.

She repeats the procedure for solutions of concentration 40, 60 and 80 g per 100 cm³ of water.

Fig. 6.4 shows the displacement distance d when the concentration is 20 g per 100 cm³ of water.

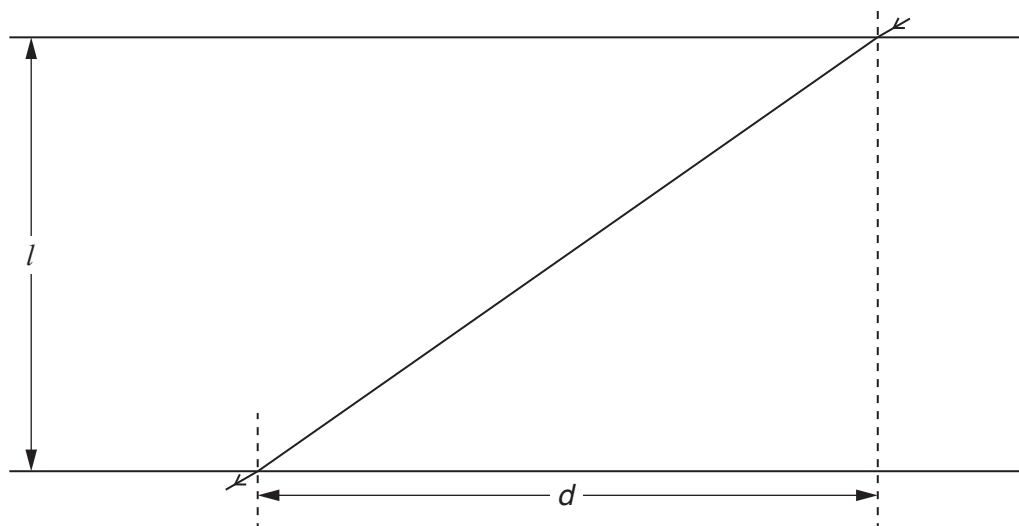


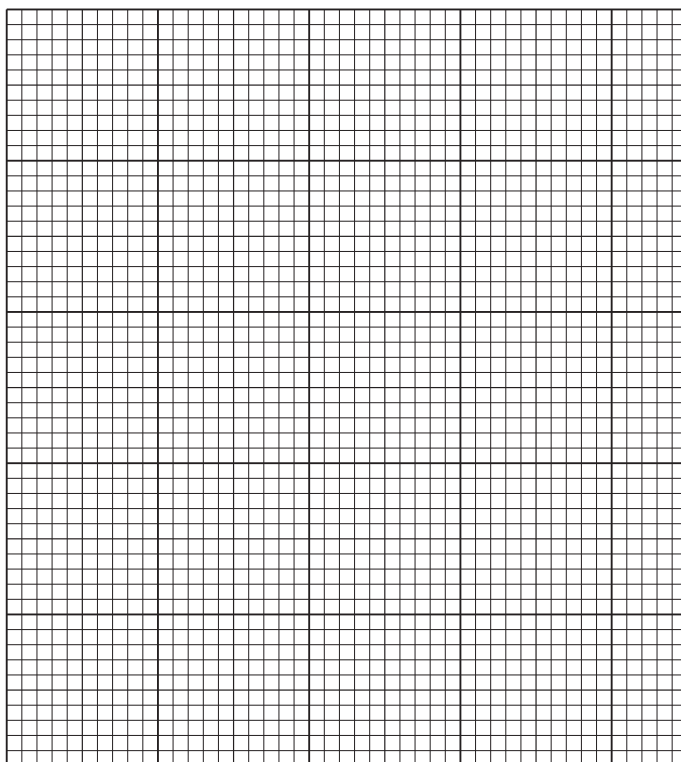
Fig. 6.4

Measure and record the displacement distance d in Table 6.1.

[1]

- (c) (i) On the grid provided, plot a graph of displacement distance d (vertical axis) against sugar solution concentration.

You do **not** need to start the y -axis at 0.



[3]

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

[1]

- (d) The student fills the tank with a sugar solution of unknown concentration.

She measures the displacement distance d as 7.7 cm.

Use your graph to determine the concentration of this solution.

Show clearly on your graph how you arrived at your answer.

concentration g per 100 cm³ water [1]

- (e) The teacher says that if the angle of incidence i is increased then the displacement distance d will also increase.

- (i) Explain why larger values of d would increase the accuracy of the experiment.

.....

.....[1]

- (ii) Suggest another change to this experiment which would result in larger values of d .

.....

.....[1]

- (f) Suggest **one** disadvantage of replacing the sugar solution concentrations used in this experiment with sugar solution concentrations of 40, 45 and 50 g per 100 cm³ of water.

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

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