



CANDIDATE
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0653/61

October/November 2021

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.
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- 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 **20** pages. Any blank pages are indicated.

- 1 (a) Fig. 1.1 shows two animals, one from a cold climate and one from a hot climate.



cold climate



hot climate

Fig. 1.1

The animal from the cold climate is much larger than the animal from the hot climate.

Identify **two** other visible differences which can be seen in Fig. 1.1.

1

.....

2

.....

[2]

(b) A student investigates heat loss in animals of different sizes.

Two beakers of different sizes represent the animals:

- A large beaker represents a large animal.
- A small beaker represents a small animal.

Procedure

The student:

- clamps one thermometer in a large beaker and another thermometer in a small beaker, as shown in Fig. 1.2

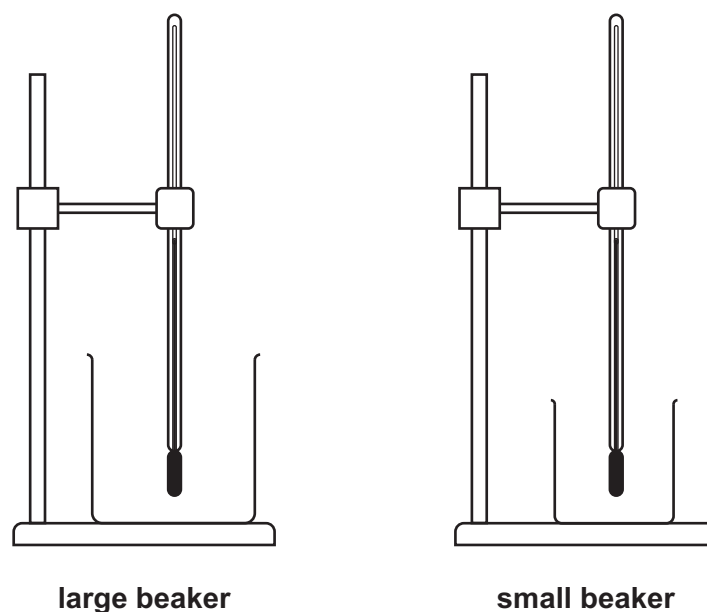


Fig. 1.2

- adds approximately 200 cm^3 of hot water to the large beaker
- adds approximately 50 cm^3 of hot water to the small beaker
- records both temperatures in Table 1.1
- records in Table 1.1 the temperature in each beaker every 60 seconds for 300 seconds.

- (i) Fig. 1.3 shows the readings on the thermometers at 60 seconds.

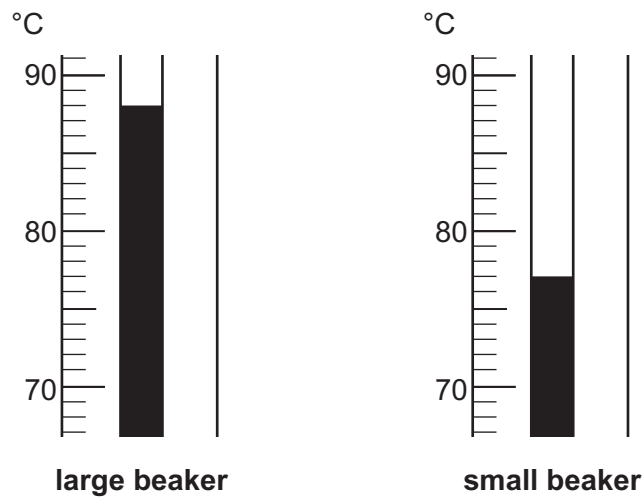


Fig. 1.3

Record in Table 1.1 the temperature of the hot water in each beaker at 60 seconds.

Table 1.1

time /seconds	temperature of water in large beaker /°C	temperature of water in small beaker /°C
0	91	82
60		
120	84	72
180	81	67
240	78	63
300	75	59

[2]

- (ii) Calculate the temperature change of the water in **each** beaker.

Use the equation shown.

$$\text{temperature change} = (\text{temperature at 0 seconds}) - (\text{temperature at 300 seconds})$$

temperature change in **large** beaker = ... °C

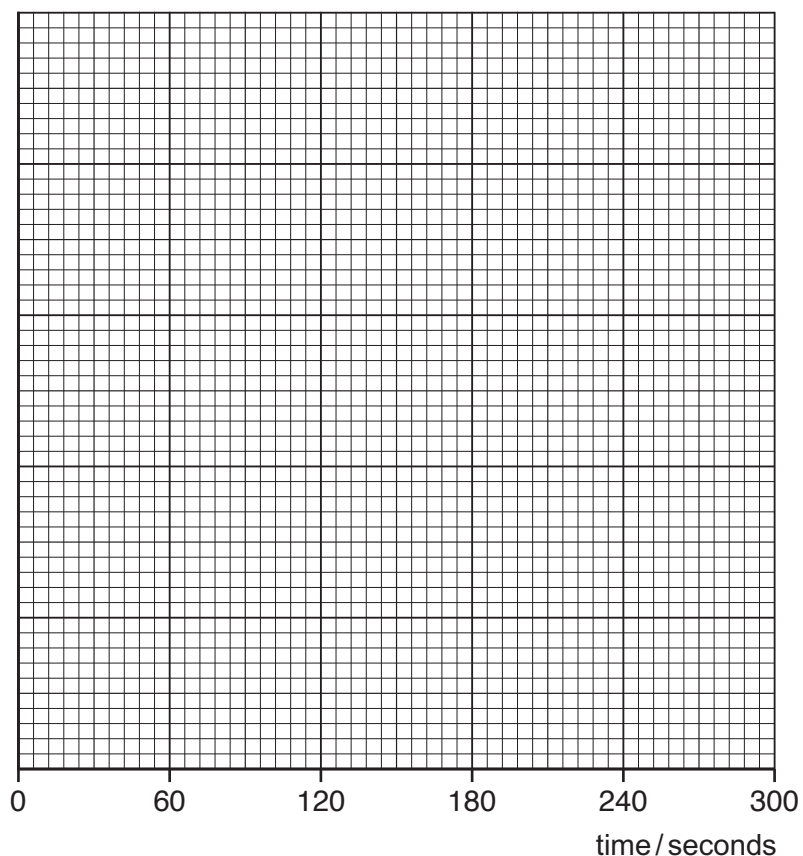
temperature change in **small** beaker = ... °C

[1]

(c) You are going to plot a graph of temperature against time for **both** beakers **on the same axes**.

- Use a scale for the temperature axis that is suitable for **both** beakers. You do **not** need to start the scale at zero.
- Plot the points for the **large** beaker.
- Draw the smooth best-fit curve. Label this curve **L**.
- Plot the points for the **small** beaker.
- Draw the smooth best-fit curve. Label this curve **S**.

temperature/°C



[4]

(d) Compare the temperature changes of the water in each beaker.

.....

.....

.....

..... [2]

- (e) Suggest which animal, large or small, loses heat more quickly.

Explain your choice using your answers to (b)(ii) and (c).

animal

explanation

[1]

- (f) Suggest **one** improvement to the procedure which gives a fairer comparison of the rate of heat loss from the beakers.

.....

..... [1]

[Total: 13]

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- 2 A student prepares a sample of the blue salt, copper(II) sulfate.

The student reacts copper(II) carbonate with dilute sulfuric acid.

Copper(II) carbonate is a green insoluble solid.

(a) Procedure

The student:

- step 1 puts 20 cm^3 of dilute sulfuric acid into a beaker
- step 2 adds excess copper(II) carbonate
- step 3 stirs the mixture until the mixture stops fizzing
- step 4 filters the mixture into a flask
- step 5 keeps the filtrate of copper(II) sulfate in the flask to make crystals.

- (i) Name a piece of apparatus suitable for measuring 20 cm^3 of dilute sulfuric acid in step 1.

..... [1]

- (ii) The student tests the gas given off in step 3.

The gas turns limewater milky.

Name the gas given off.

..... [1]

- (iii) Describe the appearance of the residue in the filter paper and the filtrate in the flask in step 4.

residue

filtrate

[2]

- (iv) Describe, in detail, how to make large crystals of copper(II) sulfate from the filtrate.

.....

.....

.....

.....

.....

..... [3]

- (b) The filtrate contains both copper(II) ions and sulfate ions.

The student does some tests on the filtrate.

- (i) The student adds aqueous ammonia until it is in excess to a sample of the filtrate.

Describe what the student observes.

.....

.....

.....

..... [2]

- (ii) The student uses two reagents to test for the presence of aqueous sulfate ions.

Tick (✓) **two** boxes to identify the reagents.

aqueous barium nitrate

dilute nitric acid

aqueous sodium hydroxide

aqueous silver nitrate

dilute sulfuric acid

[1]

(c) A student does a flame test.

The student:

- cleans a flame test wire
- dips the flame test wire into a sample of solid copper(II) sulfate
- places the wire in the top of a blue Bunsen burner flame
- observes a blue-green and yellow flame.

(i) Suggest why the student cleans the flame test wire.

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

(ii) Explain why the student thinks the sample of copper(II) sulfate is **not** pure.

..... [1]

(iii) Suggest why it is important to use a blue Bunsen burner flame rather than a yellow Bunsen burner flame in the flame test.

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

[Total: 13]

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3 A student determines the density of a cork.

(a) The student determines the volume of the cork using the method of displacement.

Procedure

The student:

- adds 70.0 cm^3 of water to a measuring cylinder
- lowers a metal object into the water using a thin cotton thread
- records the total volume of the water and metal object
- removes the metal object and attaches the cork to it
- lowers the metal object and cork into the water
- records the total volume of the water, metal object and cork.

Fig. 3.1 shows the procedure.

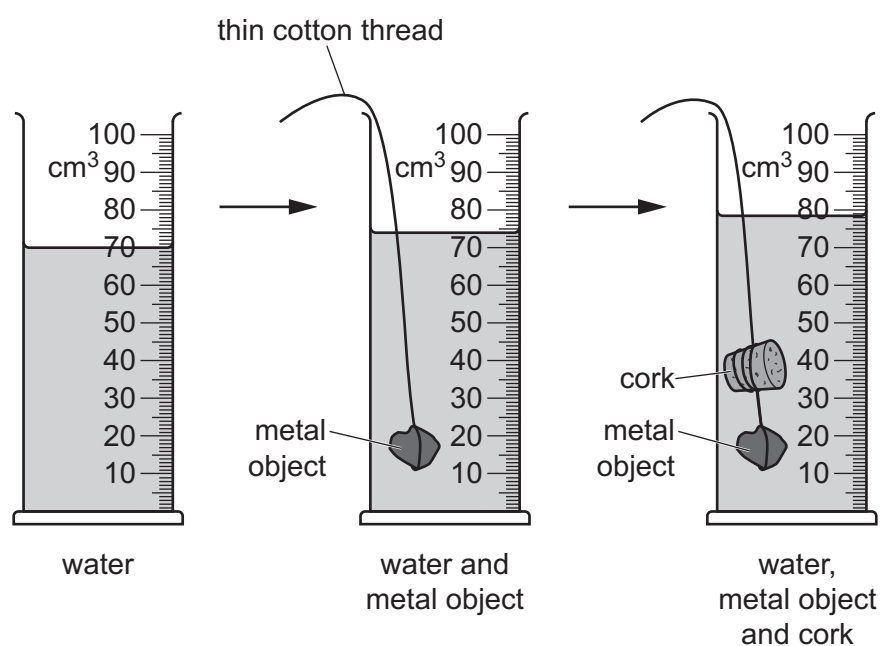


Fig. 3.1

- (i) State one precaution the student takes when reading the level of water in the measuring cylinder.

.....
 [1]

- (ii) Fig. 3.2 shows the levels of water in the measuring cylinder for the water and metal object and the water, metal object and cork.

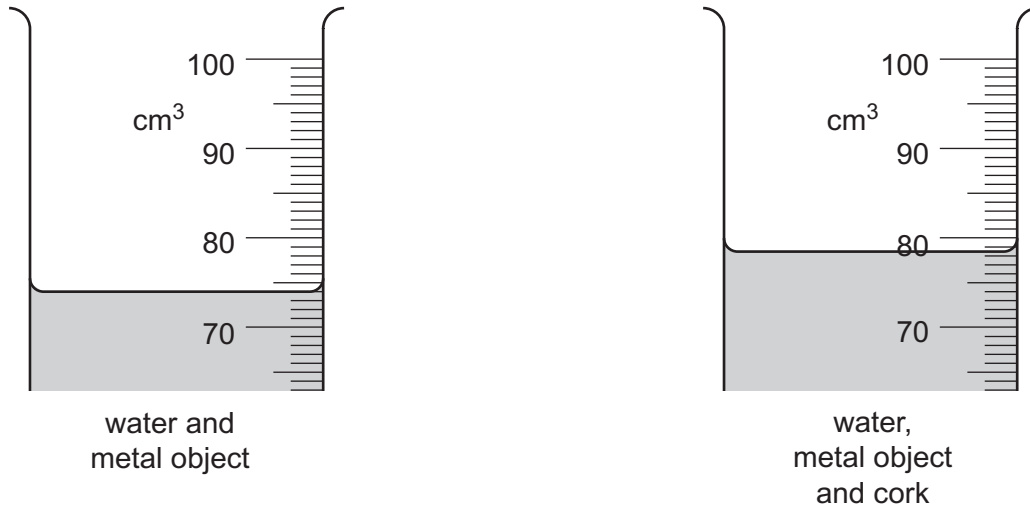


Fig. 3.2

Record in Table 3.1 the volumes shown in Fig. 3.2.

Table 3.1

contents of measuring cylinder	volume / cm ³
water and metal object	
water, metal object and cork	

[2]

- (iii) Use the volumes in Table 3.1 to calculate the volume of the cork.

Use the equation shown.

$$\text{volume of cork} = \text{volume of water, metal object and cork} - \text{volume of water and metal object}$$

$$\text{volume of cork} = \dots\dots\dots \text{ cm}^3 \quad [1]$$

- (b) The student uses a balance to measure the mass of the cork.

The mass of the cork is 1.9g.

Calculate the density of the cork.

Use the equation shown.

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

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

density of cork = ... g/cm³ [2]

- (c) Cork floats on water.

Suggest why the metal object is needed in this experiment.

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

[Total: 7]

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- 4 A student has clothes made of three different materials: cotton, polyester and wool.

After washing the clothes, the student observes the wet clothes becoming dry as the water evaporates.

The student wants to know if the material of the clothes affects the rate at which the water evaporates.

Plan an investigation to determine how the **material** of the clothes affects the **rate of evaporation** of water from the clothes.

You are provided with:

- samples of cotton, polyester and wool
- water

You may use any common laboratory apparatus in your plan.

Include in your plan:

- the apparatus needed
- a brief description of the method, explaining 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.

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

.....

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..... [7]

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

- 1 A student investigates the effect of concentration of salt solution on the movement of water into and out of a potato.

(a) Procedure

The student:

- cuts five identical samples of the potato with the dimensions shown in Fig. 1.1

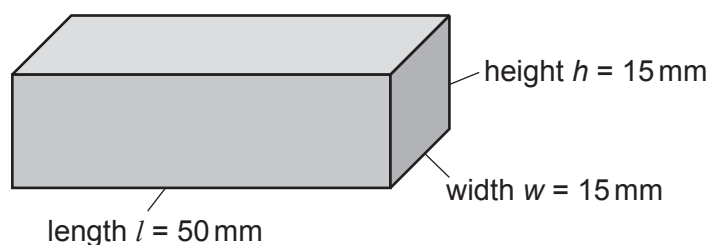


Fig. 1.1

- prepares five different percentage concentrations of salt solution in separate beakers
 - places one sample of potato in each beaker of salt solution for 30 minutes
 - removes the potato samples and dries them
 - measures the new length, height and width of each sample of potato and records the values in Table 1.1.
- (i) The actual size of the sample of potato removed from the 1% salt solution is shown in Fig. 1.2.

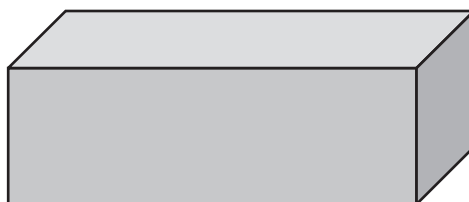


Fig. 1.2

Measure the length l and the height h of the sample of potato in Fig. 1.2 and record these values in Table 1.1.

Table 1.1

percentage salt solution	length l / mm	height h / mm	width w / mm	volume V / mm ³
1			18	
2	51	15	16	12 000
3	48	14	14	9 400
4	47	13	13	7 900
5	46	13	12	7 200

[2]

- (ii) Calculate the volume V for the sample of potato removed from the 1% salt solution.

Use the equation shown.

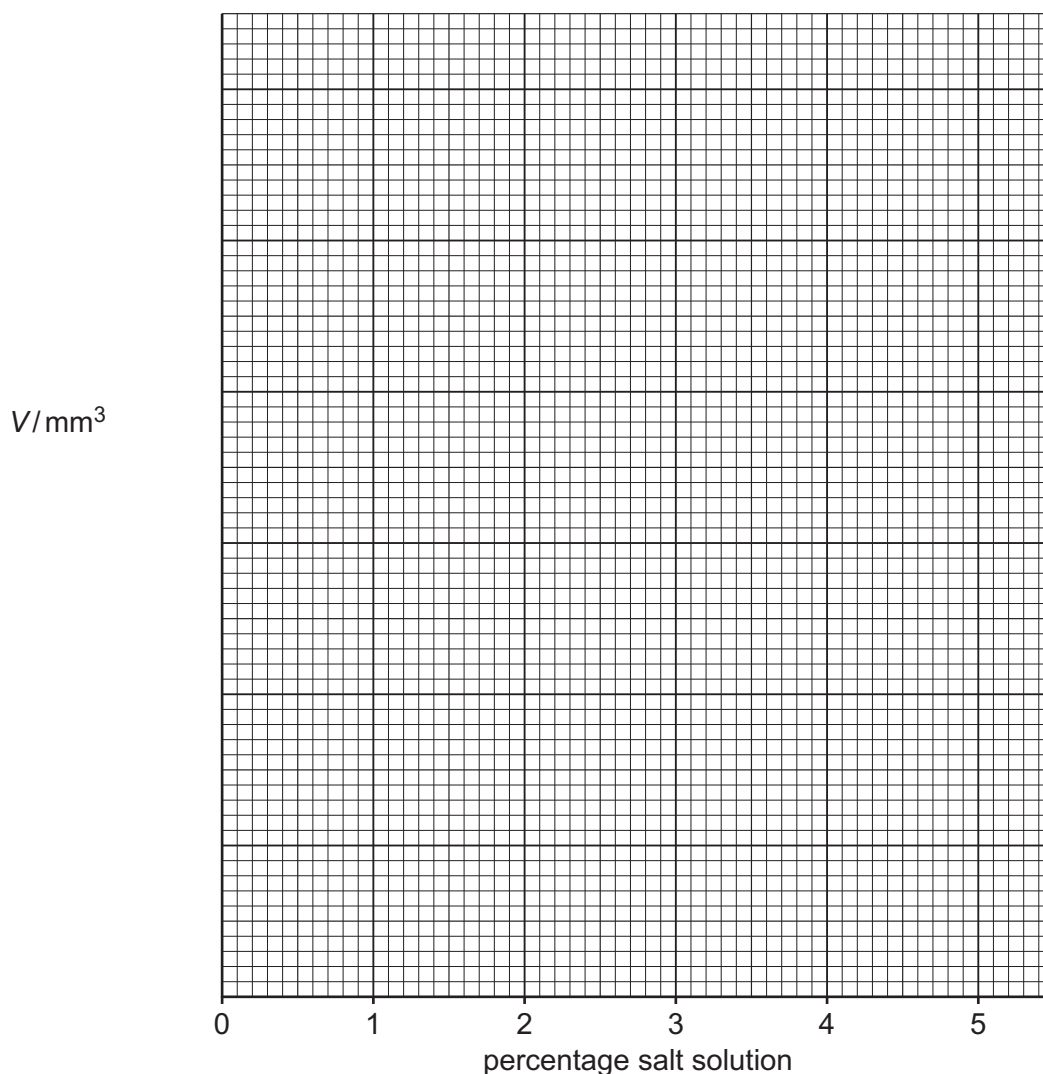
$$V = l \times h \times w$$

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

[2]

- (iii) Use the data in Table 1.1 to plot a graph of volume V against percentage salt solution.

Use a suitable scale for the volume axis. You do **not** need to start the scale at zero.



[2]

- (iv) Draw the best-fit curve.

[1]

- (v) Use your graph to estimate the volume of a sample of potato removed after 30 minutes from a 3.5% salt solution.

Show on your graph how you obtain your answer.

volume = ... mm^3 [2]

- (b) The student repeats the procedure using **three** samples of potato in each concentration of salt solution.

Explain how this improves the investigation.

.....

..... [1]

(c) Fig. 1.3 shows a photograph of part of a potato plant.



Fig. 1.3

In the box, make a large detailed drawing of the part of the potato plant shown in the photograph in Fig. 1.3.

[3]

[Total: 13]

[Turn over

- 2 A student prepares a sample of a salt by neutralising aqueous sodium hydroxide with dilute sulfuric acid.

It is important that the aqueous sodium hydroxide is neutralised by the correct amount of dilute sulfuric acid.

Aqueous sodium hydroxide and dilute sulfuric acid are both corrosive.

(a) Procedure

The student:

- step 1 fills a burette with dilute sulfuric acid
- step 2 records in Table 2.1 the initial reading of dilute sulfuric acid in the burette
- step 3 adds 25.0 cm^3 of aqueous sodium hydroxide to a conical flask
- step 4 puts three drops of litmus indicator into the aqueous sodium hydroxide
- step 5 slowly adds the dilute sulfuric acid to the aqueous sodium hydroxide
- step 6 stops adding the dilute sulfuric acid as soon as the litmus changes from blue to red
- step 7 records in Table 2.1 the reading of dilute sulfuric acid in the burette
- step 8 keeps the red solution in the flask for step 9 in **(b)**.

- (i) Explain why it is important that the student wears safety goggles during the procedure.

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

- (ii) Name a piece of apparatus suitable for measuring the 25.0 cm^3 of aqueous sodium hydroxide in step 3.

..... [1]

- (iii) Fig. 2.1 shows the initial reading of dilute sulfuric acid in the burette and the reading when the litmus changes to red.

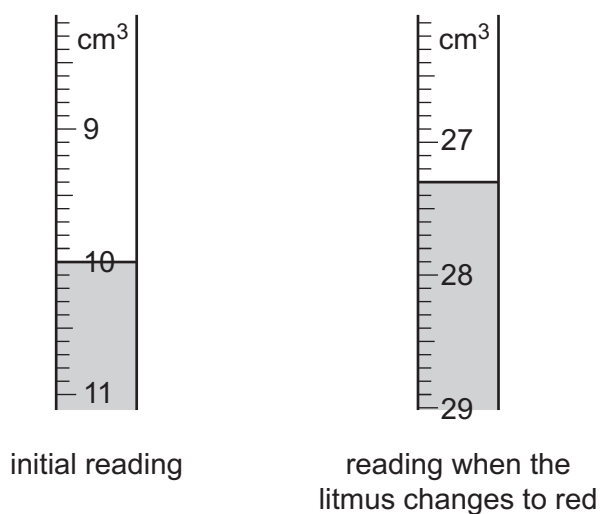


Fig. 2.1

Record in Table 2.1 the burette readings to the nearest 0.1 cm³.

Table 2.1

initial reading / cm ³	
reading when the litmus changes to red / cm ³	

[2]

- (iv) Calculate the volume of dilute sulfuric acid added to change the colour of the litmus.

Use the equation shown.

$$\text{volume of dilute sulfuric acid added} = \text{reading when the litmus changes to red} - \text{initial reading}$$

$$\text{volume of dilute sulfuric acid added} = \dots\dots\dots \text{ cm}^3 \text{ [1]}$$

- (v) Explain why in step 5 the student adds the dilute sulfuric acid slowly instead of adding it all in one go.

.....

..... [1]

(b) Procedure

The student:

step 9 adds a black insoluble powder called carbon to the red solution in the flask

step 10 warms this mixture and then allows it to cool

step 11 filters the mixture into a clean flask to obtain a colourless solution of the salt.

(i) Describe the appearance of the **residue** in the filter paper after step 11.

..... [1]

(ii) The filtrate is a colourless solution of the salt.

Suggest the function of the carbon in steps 9 and 10.

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

(c) The student wants to obtain crystals of the salt from the colourless solution.

Describe what the student does to obtain crystals.

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

(d) The student tests samples of the salt.

(i) The student does a flame test on a solution of the salt.

The student observes a yellow-coloured flame.

Identify the metal ion present in the salt.

..... [1]

(ii) The student adds dilute nitric acid followed by aqueous barium nitrate to a solution of the salt.

The student observes a white precipitate and no gas is formed.

Tick (✓) the correct box to identify the anion (negative ion) present in the salt.

carbonate

☐

chloride

☐

nitrate

☐

sulfate

☐

[1]

[Total: 13]

- 3 A student uses a balancing method to determine the mass of a metre rule.

The apparatus is shown in Fig. 3.1.

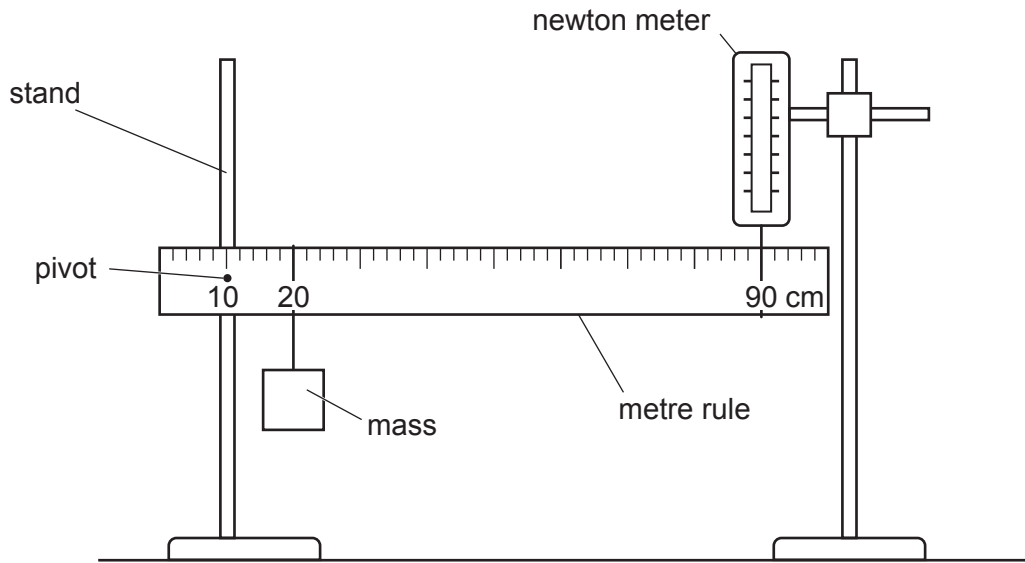


Fig. 3.1

The metre rule is attached to the stand at the 10 cm mark to form a pivot.

The metre rule can rotate freely about this pivot.

(a) Procedure

The student:

- suspends a mass from the metre rule at the 20 cm mark
- suspends the metre rule from a newton meter at the 90 cm mark
- adjusts the height of the newton meter so the metre rule is horizontal.

- (i) Calculate the distance of the newton meter from the pivot.

distance of newton meter to pivot = ... cm [1]

- (ii) When the metre rule is horizontal, the newton meter provides a balancing force F .

Fig. 3.2 shows the reading on the newton meter.

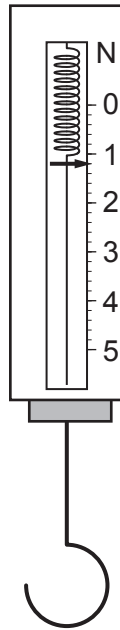


Fig. 3.2

Record the size of the balancing force F shown on the newton meter.

$F =$ N [1]

- (iii) State how the student avoids a line of sight (parallax) error when reading the newton meter scale.

.....
 [1]

- (iv) Suggest how the student makes sure the meter rule is horizontal.

.....
 [1]

- (b) Calculate the mass of the metre rule.

Use your value of F from (a)(ii) and the equation shown.

$$\text{mass of metre rule} = (200 \times F) - 123$$

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

mass of metre rule = ... g [2]

- (c) The student measures the mass of the metre rule using an electronic balance.

$$\text{mass of metre rule} = 119\text{g}$$

Explain whether the values of mass in (b) and (c) agree within the limits of experimental error.

.....
 [1]

[Total: 7]

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- 4 Fig. 4.1 shows a 'drinks cooler sleeve'. The sleeve is a hollow cylinder which fits tightly around a glass containing water.

The sleeve is first chilled in a freezer at -20°C .

The sleeve is then taken out of the freezer, and the glass containing water is placed inside it.



Fig. 4.1

The company that makes the sleeve claims that:

- 1 It can cool a glass containing 200 cm^3 of water at room temperature to below 10°C in 5 minutes.
- 2 It can keep 200 cm^3 of water at a temperature below 10°C for at least 30 minutes.

Plan an investigation to check whether the claims of the company are true.

You are provided with:

- the drinks cooler sleeve
- a glass that fits inside the sleeve
- access to a freezer
- access to water at room temperature.

You may use any common laboratory apparatus in your plan.

Include in your plan:

- the apparatus needed
- a brief description of the method
- what you will measure
- how you will use your results to draw a conclusion.

You may include a labelled diagram.

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

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- 1 A student investigates the effect of temperature on the amount of water lost (by transpiration) from a cut plant shoot.

The student sets up the apparatus shown in Fig. 1.1.

As water is lost from the plant shoot, the bubble moves along the scale.

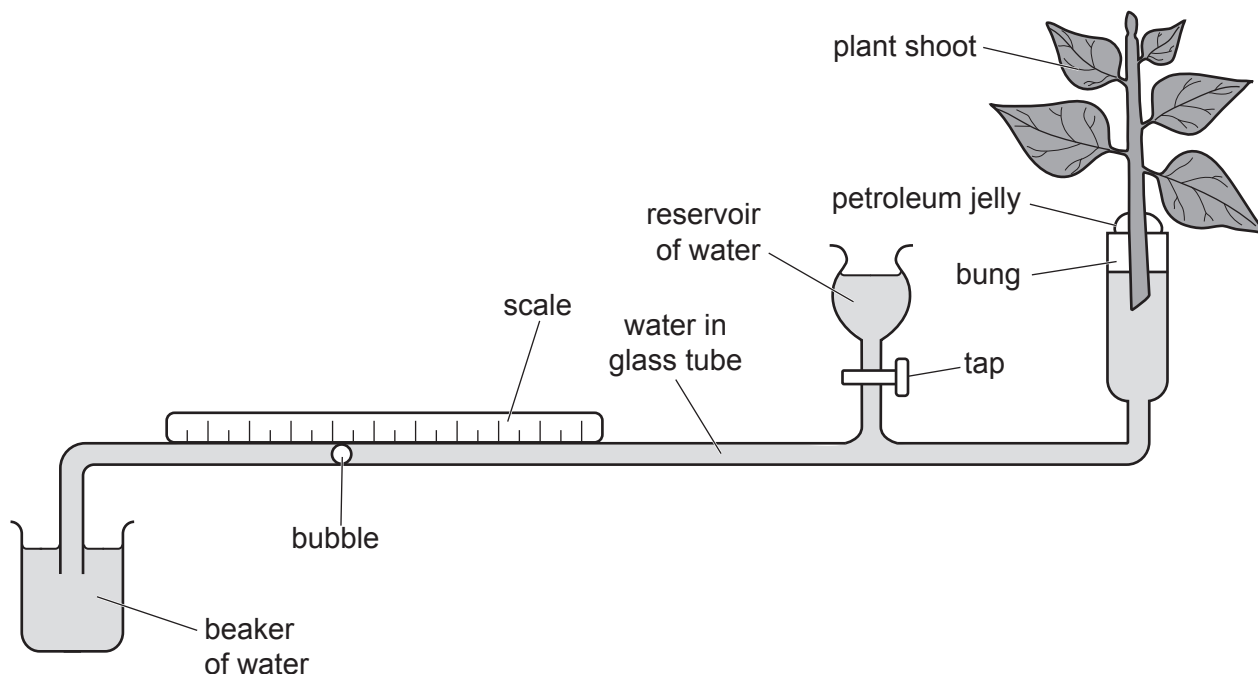


Fig. 1.1

Procedure

The student:

- places the apparatus in a room with a constant temperature of 10°C
- records in Table 1.1 the start position of the bubble
- leaves the apparatus in the room at 10°C for one hour
- records in Table 1.1 the final position of the bubble
- repeats the experiment with the room at a constant temperature of 15°C , 20°C , 25°C and 30°C .

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- (a) Fig. 1.2 shows the start position and the final position of the bubble at 25 °C.

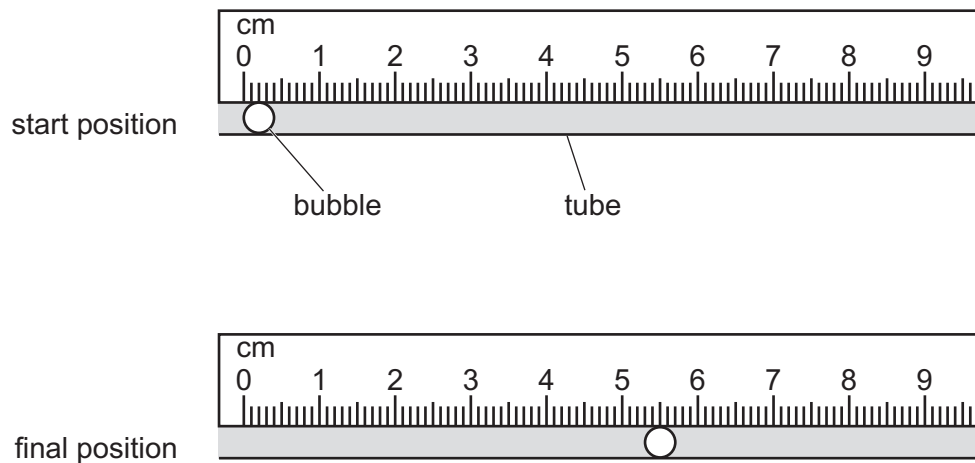


Fig. 1.2

- (i) Record in Table 1.1 the start position and final position of the **centre** of the bubble shown in Fig. 1.2.

Record your values in millimetres.

Table 1.1

temperature /°C	start position /mm	final position /mm	distance moved /mm
10	5	15	10
15	5	24	19
20	1	36	35
25			
30	1	67	66

[2]

- (ii) Describe your method for determining the centre of the bubble.

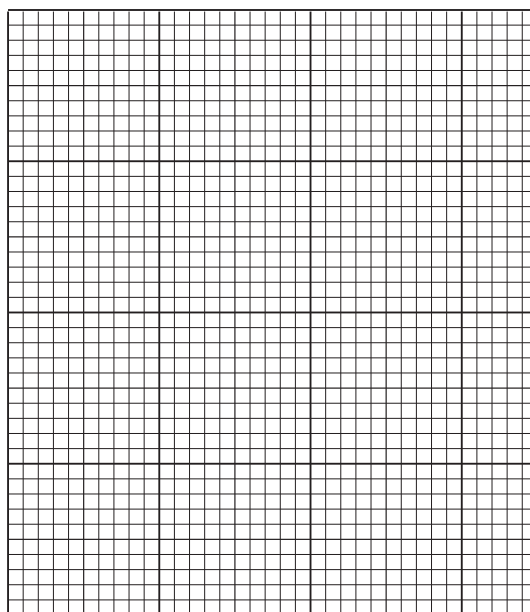
.....
 [1]

- (iii) Calculate the distance moved by the bubble at 25 °C.

Record this value in Table 1.1.

[1]

- (b) (i) On the grid, plot a graph of distance moved (vertical axis) against temperature.



[3]

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

[1]

- (c) (i) Describe the relationship between temperature and the distance moved by the bubble.

.....
 [1]

- (ii) Describe the relationship between temperature and the amount of water lost by the plant shoot.

.....
 [1]

- (d) Identify **two** variables to keep constant during this investigation.

1

2

[2]

- (e) Petroleum jelly is used to seal the apparatus and prevent water from leaking from the apparatus.

A student repeats the experiment at 10°C but forgets to seal the apparatus with the petroleum jelly.

Suggest how this affects the distance moved by the bubble.

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

[Total: 13]

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- 2 A student prepares a sample of the salt, magnesium sulfate.

The student reacts magnesium ribbon with dilute sulfuric acid.

- (a) Fig. 2.1 shows the length of magnesium ribbon and the volume of dilute sulfuric acid the student uses.

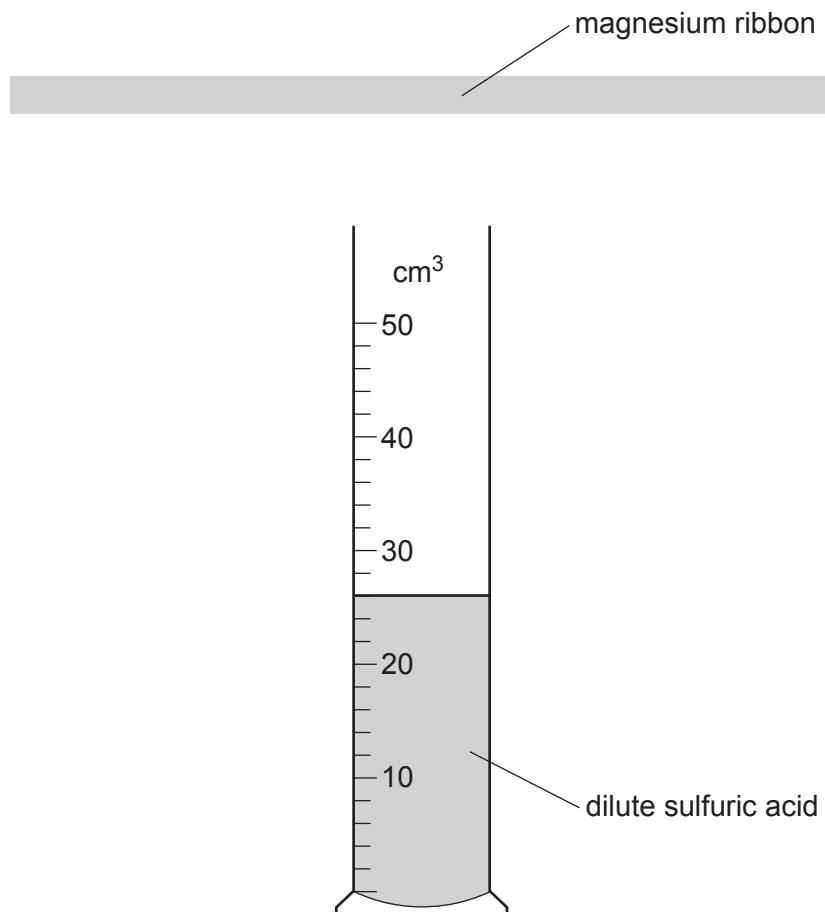


Fig. 2.1

- (i) Measure the length of the magnesium ribbon shown in Fig. 2.1.

Record your answer in millimetres to the nearest millimetre.

length = ... mm [1]

- (ii) Record the volume, to the nearest cm^3 , of dilute sulfuric acid in the measuring cylinder shown in Fig. 2.1.

volume = ... cm^3 [1]

- (b) The student pours the dilute sulfuric acid into a beaker and then adds the piece of magnesium ribbon.

The mixture fizzes and makes a gas that gives a squeaky pop with a lighted splint.

A colourless solution and a small piece of magnesium remain when the reaction has finished.

- (i) Name the gas produced in the reaction.

..... [1]

- (ii) State how the observations show that **all** the dilute sulfuric acid has reacted.

.....

..... [1]

- (iii) The mixture in the beaker is filtered into a flask.

Describe the appearance of the residue in the filter paper and the filtrate in the flask.

residue

filtrate

[2]

- (c) The filtrate contains magnesium ions and sulfate ions.

Describe the test to identify sulfate ions.

State the observation for a positive result.

test

.....

observation

[2]

- (d) Describe, in detail, how to make crystals of magnesium sulfate from the filtrate.

.....

.....

.....

.....

.....

..... [3]

- (e) The student heats 2.46 g of magnesium sulfate crystals in a test-tube for 10 minutes.

The student allows the test-tube and its contents to cool down.

The mass of the solid left in the test-tube is 1.20 g.

- (i) Suggest why the mass of the magnesium sulfate crystals decreases when heated.

.....

..... [1]

- (ii) The student uses a blue Bunsen burner flame to heat the test-tube rather than a yellow Bunsen burner flame.

Explain why the student uses a blue Bunsen burner flame.

.....

..... [1]

[Total: 13]

- 3 A student uses a simple pendulum to determine the acceleration due to gravity g .

Procedure

The student:

- sets up the apparatus shown in Fig. 3.1

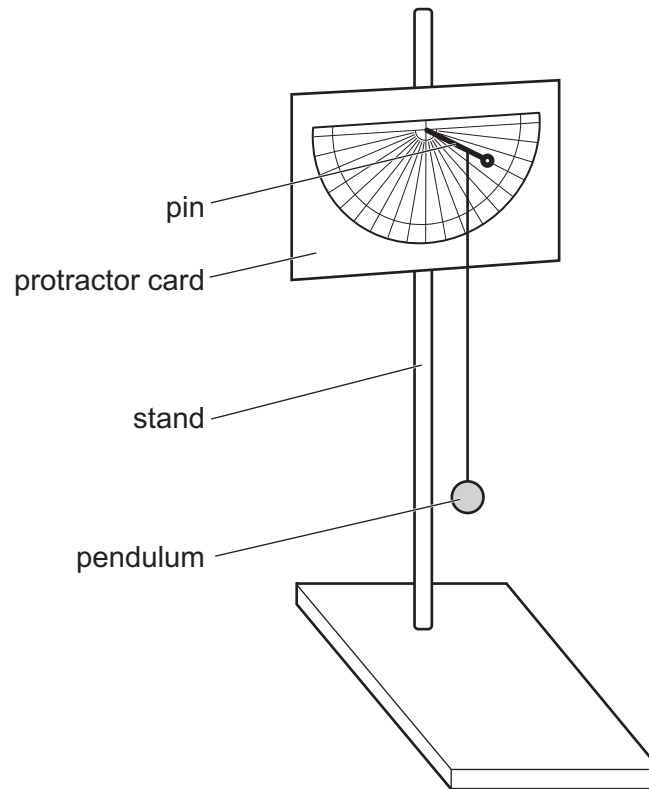


Fig. 3.1

- pulls back the pendulum to an angle of 10° from vertical
- releases the pendulum
- records in Table 3.1 the time for 10 complete oscillations of the pendulum
- repeats the experiment four more times.

(a) Fig. 3.2 shows the stop-watch readings for experiments 4 and 5.

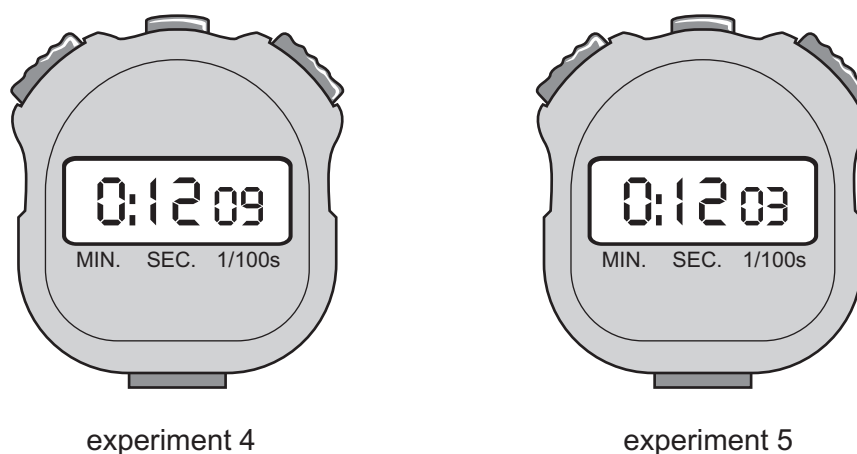


Fig. 3.2

Record in Table 3.1 these times to the nearest 0.1 s.

Table 3.1

experiment	time for 10 oscillations /s
1	12.3
2	12.0
3	14.6
4	
5	

[2]

(b) The teacher says that one experiment has an anomalous result.

State which experiment has the anomalous result.
Explain your answer.

experiment

explanation

..... [1]

(c) Calculate an accurate value for the average time for 10 oscillations.

average time for 10 oscillations = ... s [1]

- (d) The period T is the time for one oscillation of the pendulum.

Use your answer to (c) to calculate the period T .

$$T = \dots\dots\dots \text{ s [1]}$$

- (e) Calculate the acceleration due to gravity g . Use the equation shown.

$$g = \frac{14}{T^2}$$

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

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

[Total: 7]

- 4 Fig. 4.1 shows a wool cloth being rubbed on a rod made of insulating material. When the rod is rubbed, it becomes charged.

The charged rod attracts small pieces of paper. The more charge the rod gains, the more pieces of paper that stick to the rod.

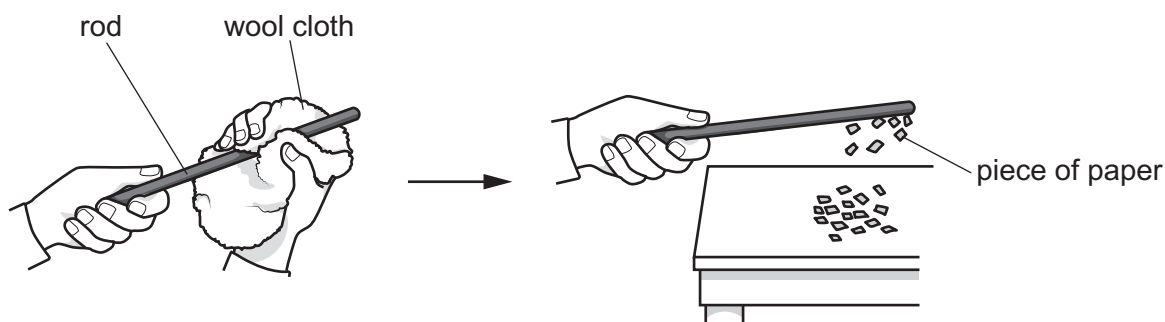


Fig. 4.1

Three rods are made from three different insulating materials: rod A is made from poly(ethene), rod B is made from Perspex and rod C is made from nylon.

Plan an investigation to find out which rod, A, B or C, gains most charge when rubbed with a wool cloth.

You are provided with:

- the three rods, A, B and C
- a wool cloth
- A4 graph paper
- scissors.

You may use any common laboratory apparatus in your plan.

Include in your plan:

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

You may include a labelled diagram.

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

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