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COMBINED SCIENCE**0653/61**

Paper 6 Alternative to Practical

May/June 2025**1 hour**

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].
- Notes for use in qualitative analysis are provided in the question paper.

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

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

Procedure

The student:

- step 1** adds 2 cm^3 of drink **A**, drink **B** and drink **C** to separate clean test-tubes
- step 2** adds a few drops of iodine solution to each of the test-tubes
- step 3** records the results
- step 4** repeats **step 1** to **step 3** but adds 1 cm^3 of biuret solution in **step 2** instead of iodine solution.

Fig. 1.1 shows the results the student records.

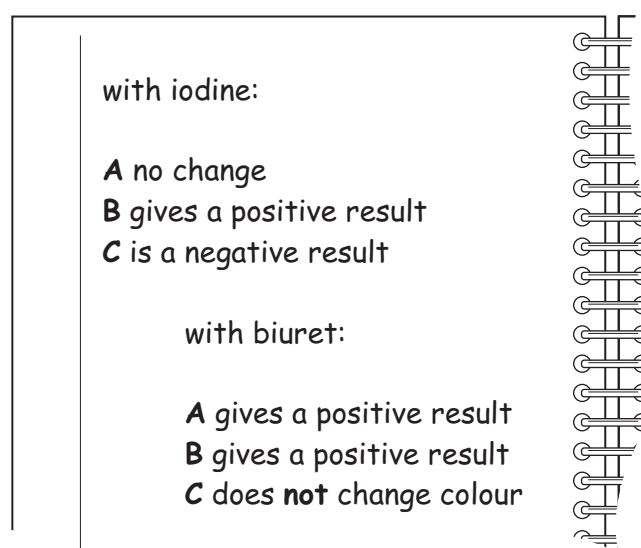


Fig. 1.1

- (a) Record in Table 1.1 the colours the student observes in each test-tube.

Table 1.1

drink	colour with iodine solution	colour with biuret solution
A		
B		
C		

[3]



(b) Use Table 1.1 to state conclusions about the nutrient content for each of the drinks.

drink **A**

.....

drink **B**

.....

drink **C**

.....

[3]

(c) State the reagent used to test for fats and oils.

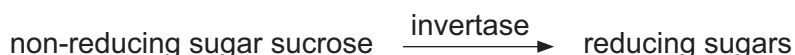
..... [1]

[Total: 7]



2 Invertase is an enzyme.

Invertase breaks down the non-reducing sugar sucrose into reducing sugars.



Benedict's solution is used to test for reducing sugars. The activity of invertase can be determined by measuring the time it takes for reducing sugars to form.

Plan an investigation to determine the relationship between the activity of invertase and temperature.

You are provided with:

- a solution of invertase enzyme
- a solution of sucrose
- Benedict's solution.

You may use any common laboratory apparatus.

In your plan, include:

- the apparatus you will need
- 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 results table (you are **not** required to enter any readings in the table).





[7]



3 A student investigates aqueous **H**.

(a) Investigating the rate of reaction of aqueous **H** with magnesium.

Procedure

The student:

- step 1** pours 25 cm³ of aqueous **H** into a beaker
- step 2** adds a 30 mm length of magnesium ribbon to the aqueous **H**
- step 3** immediately starts a stop-watch
- step 4** stirs the reaction mixture making sure that the magnesium ribbon is always under the surface of the aqueous **H**
- step 5** stops the stop-watch as soon as all of the magnesium ribbon has reacted
- step 6** records in Table 3.1 this reaction time
- step 7** empties the reaction mixture into a waste container and then rinses the beaker and stirrer with water
- step 8** pours 20 cm³ of aqueous **H** into the beaker
- step 9** adds 5 cm³ of water into the beaker of aqueous **H** and stirs the mixture
- step 10** repeats **step 2** to **step 7**
- step 11** repeats **step 8** to **step 10** using the volumes of aqueous **H** and water shown in Table 3.1.

Table 3.1

volume of aqueous H /cm ³	volume of water /cm ³	reaction time /s	rate of reaction in mm/s
25	0	12	2.5
20	5	18	1.7
15	10		
10	15		
5	20	280	0.11





- (i) Fig. 3.1 shows the readings from the stop-watch for 15 cm³ and 10 cm³ of aqueous H.

15 cm³ of aqueous H

10 cm³ of aqueous H

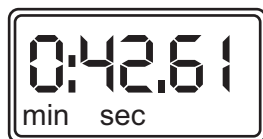


Fig. 3.1

Record in Table 3.1 these reaction times to the nearest second.

[2]

- (ii) State the relationship between the volume of aqueous H and the reaction time.

Use information from Table 3.1.

.....
 [1]

- (iii) Calculate the rate of reaction for 15 cm³ and 10 cm³ of aqueous H.

Use the equation shown.

$$\text{rate of reaction} = \frac{30}{\text{reaction time}}$$

Record in Table 3.1 these values to **two** significant figures.

[2]

- (iv) State the relationship between the volume of aqueous H and the rate of reaction.

Use information from Table 3.1.

.....
 [1]

- (v) State the name of a piece of apparatus suitable to measure the volumes of aqueous H.

..... [1]

- (vi) Explain why in **step 4** it is important that all the magnesium is under the surface of aqueous H.

.....
 [1]

- (vii) Explain why in **step 7** it is important the beaker and stirrer are rinsed.

.....
 [1]



(b) Investigation of some reactions of aqueous **H**.

Procedure

The student:

- pours 2 cm depth of aqueous **H** into each of four test-tubes
- does each of the tests shown in Table 3.2 to a different test-tube of aqueous **H**
- records the observations in Table 3.2.

Table 3.2

test	observation
add 1 cm depth of dilute nitric acid followed by 1 cm depth of aqueous barium nitrate	remains a colourless solution
add 1 cm depth of dilute nitric acid followed by 1 cm depth of aqueous silver nitrate	white precipitate
add 5 drops of universal indicator	red colour
add a small amount of copper(II) carbonate	mixture fizzes and a blue solution forms

(i) Identify the anion (negative ion) shown to be present in aqueous **H**.

..... [1]

(ii) Identify what type of substance is aqueous **H**.

Explain your answer using information from Table 3.2.

type of substance

explanation

..... [2]

(iii) State the name of the gas produced in the test with copper(II) carbonate.

..... [1]

[Total: 13]





4 A student investigates the period T of a pendulum.

- (a) Fig. 4.1 shows a bob attached to a string. The string is clamped so that the centre of the bob is a distance x above the bench.

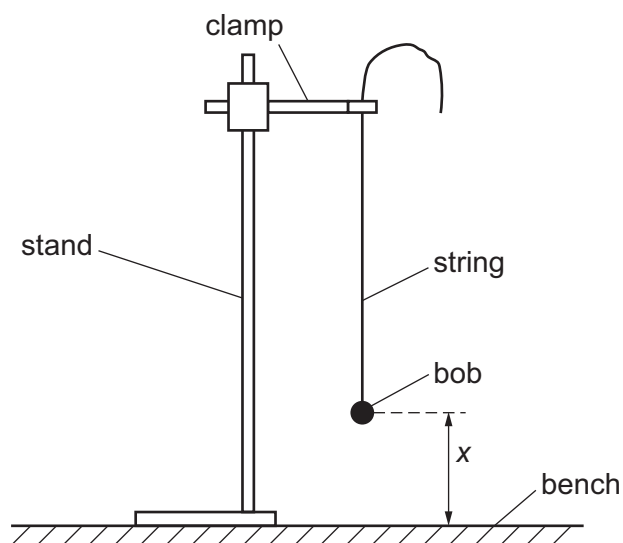


Fig. 4.1

- (i) Measure the distance x on Fig. 4.1.

Record your value to the nearest 0.1 cm.

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

- (ii) Fig. 4.1 is drawn to one-tenth scale.

Calculate the actual distance of the bob above the bench, X .

Record this value of X in Table 4.1.

Table 4.1

distance X /cm	time for 10 oscillations /s		average time for 10 oscillations for trial 1 and trial 2 /s	period T /s	T^2 /s ²
	trial 1	trial 2			
10.0	13.6	13.2	13.4	1.34	1.80
20.0	11.6	12.0	11.8	1.18	1.39
25.0	11.1	10.9	11.0	1.10	1.21
30.0	9.9	10.3	10.1	1.01	1.02



(b) Procedure

The student:

- measures the time for 10 complete oscillations of the pendulum for each of the values of X shown in Table 4.1
- repeats each measurement.

Fig. 4.2 shows repeated readings on the stop-watch, in seconds, for your value of X in **(a)(ii)**.

reading 1	reading 2	reading 3
12.78	10.08	12.42

Fig. 4.2

- (i)** Suggest **one** reason why the student needs to take the third reading.

.....
 [1]

- (ii)** The student decides to use reading 1 and reading 3.

Record in Table 4.1 these readings to **one** decimal place. [1]

- (iii)** Calculate the average time for 10 oscillations.

Record this time in Table 4.1. [1]

- (iv)** Calculate the period T .

Use the equation shown.

$$T = \frac{\text{average time for 10 oscillations}}{10}$$

Record in Table 4.1 this value of T .

Calculate T^2 .

Record in Table 4.1 this value of T^2 . [1]

- (v)** For $X = 30.0$ cm, the times for the trials are 9.9 s and 10.3 s.

Two values are considered equal within the limits of experimental accuracy if they are within 10% of each other.

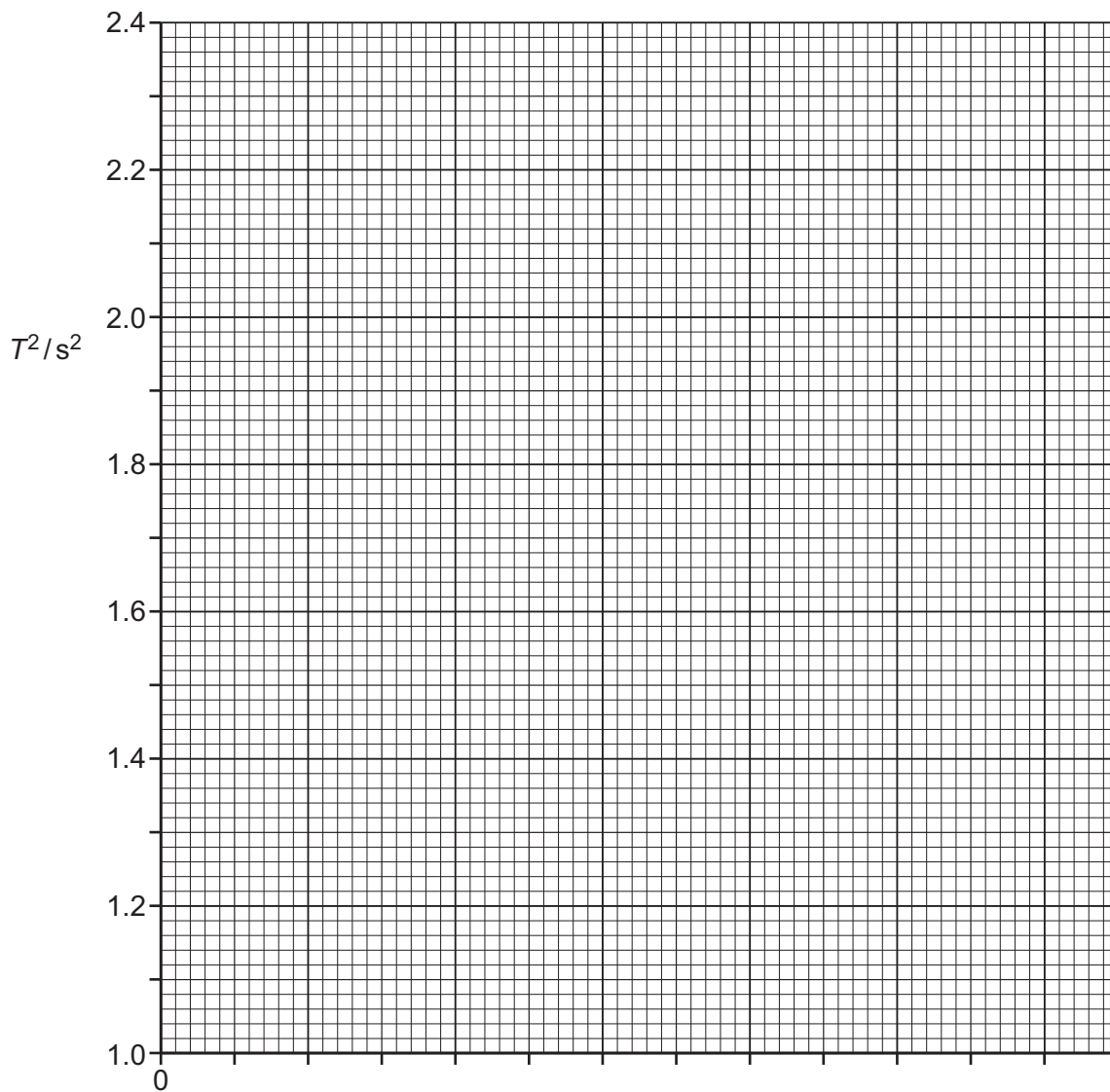
Explain if the two values are equal within the limits of experimental accuracy.

Include a calculation in your answer.

.....
 [2]



(c) (i) On the grid, plot a graph of T^2 (vertical axis) against X .



[2]

(ii) Draw the line of best fit.

[1]

(iii) Extend your line so that it meets the vertical axis.

Determine the value of T^2 at this point.

$T^2 = \dots\dots\dots s^2$ [1]



- (d) Your value in (c)(iii) represents the value of T^2 when the distance between the centre of the bob and the top of the bench is zero.

It is possible to take this reading by moving the apparatus to the end of the bench.

Fig. 4.3 shows the bench and some of the string.

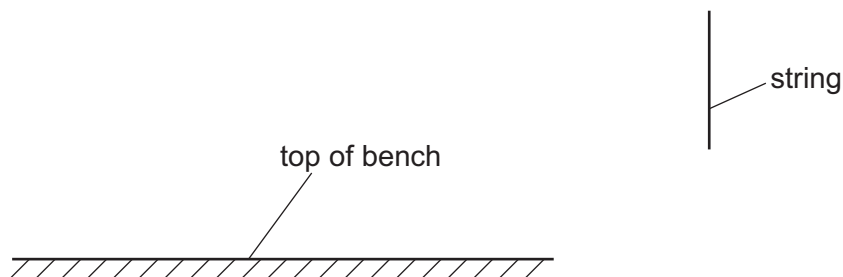


Fig. 4.3

On Fig. 4.3, draw the position of the bob and any extra string.

[1]

[Total: 13]







NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

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

Tests for aqueous cations

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

Tests for gases

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

Flame tests for metal ions

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

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- 1 A student investigates a root vegetable.

Fig. 1.1 shows a section cut through the root of a carrot.

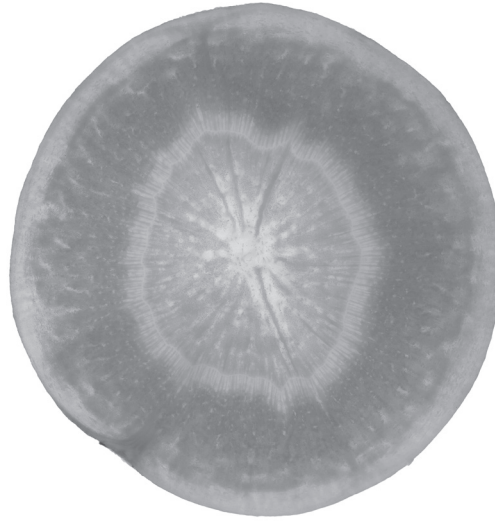


Fig. 1.1

- (a) In the box, make a large pencil drawing of the cut surface of the carrot root.



[3]



(b) Fig. 1.2 shows a magnified photograph of a section of a lotus root.

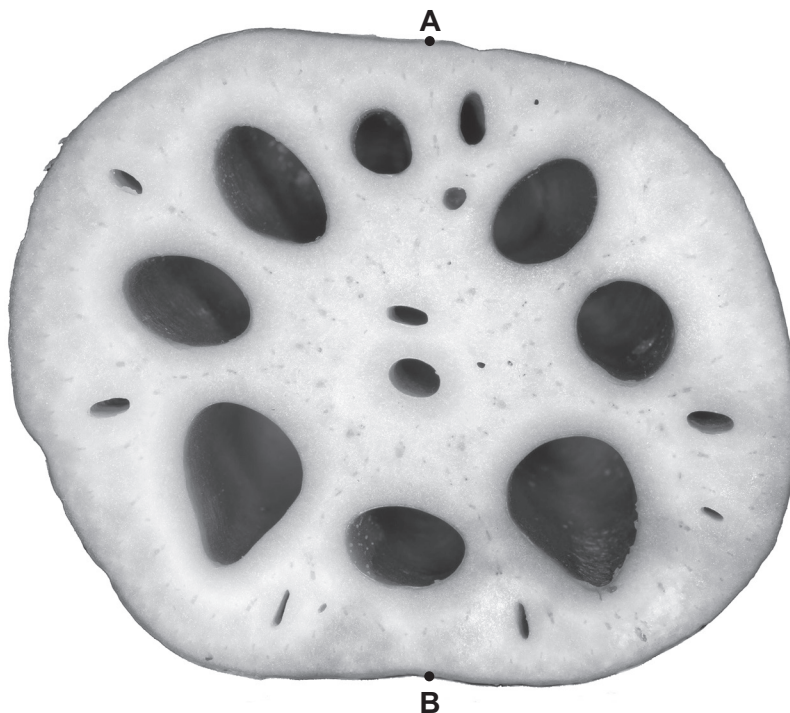


Fig. 1.2

- (i) The distance **AB** represents the diameter of the lotus root section.

Measure the distance **AB** on Fig. 1.2.

Record your answer to the nearest mm.

distance **AB** = ... mm [1]

- (ii) The actual diameter of the lotus root section is 75 mm.

Calculate the magnification of the photograph in Fig. 1.2.

Use the equation shown.

$$\text{magnification} = \frac{\text{length of line AB}}{\text{actual diameter of lotus root section}}$$

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

magnification = ... [2]



- (iii) Distance **AB** shows the smallest diameter of the lotus root section.

Describe how to determine the **average** diameter of the lotus root section.

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

- (c) (i) Describe **one** way that the section of lotus root in Fig. 1.2 is **similar** to the section of carrot root in Fig. 1.1.

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

- (ii) Describe **two** differences between the section of lotus root in Fig. 1.2 and the section of carrot root in Fig. 1.1.

difference 1

.....
.....

difference 2

.....
.....

[2]



(d) A student tests the section of carrot root and a piece of potato for the presence of starch.

The student:

step 1 places the piece of potato and the section of carrot root onto a white tile

step 2 adds a few drops of iodine solution to the surface of the carrot and of the potato

step 3 observes the colour of the iodine solution.

Fig. 1.3 shows the results the student records.

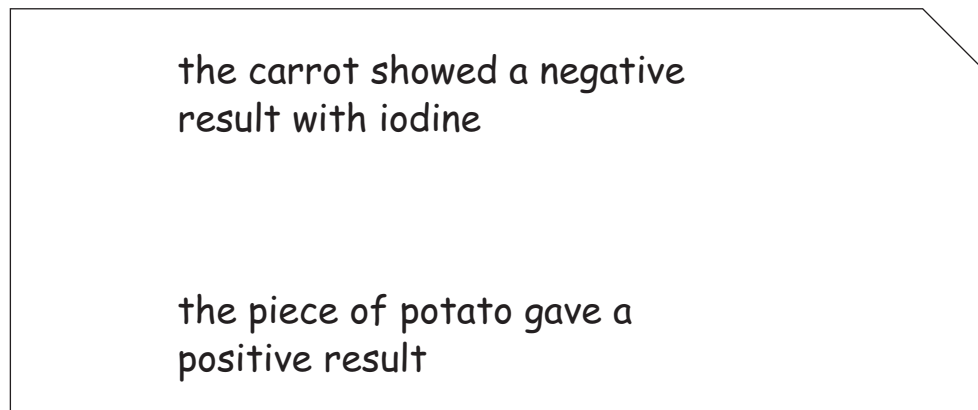


Fig. 1.3

Use the results in Fig. 1.3 to complete Table 1.1.

Table 1.1

	colour with iodine solution	conclusion
carrot		
potato		

[3]

[Total: 13]



- 2 A student investigates the reaction between aluminium and aqueous copper(II) chloride.
- Aqueous copper(II) chloride is a blue solution.
- Aluminium is a grey solid.

(a) Procedure

The student:

- assembles the apparatus shown in Fig. 2.1

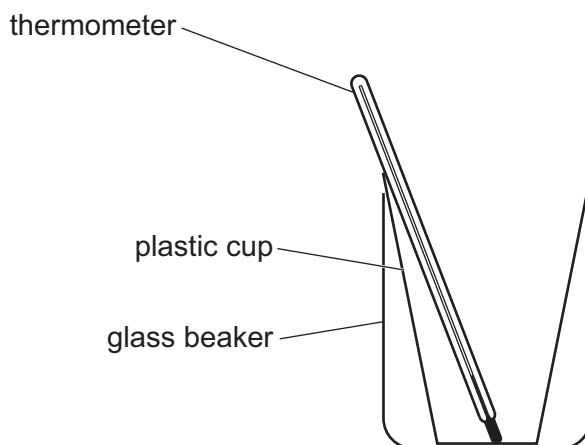
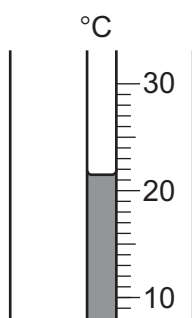


Fig. 2.1

- pours 25 cm^3 of aqueous copper(II) chloride into the plastic cup
- records in Table 2.1, the initial temperature of the aqueous copper(II) chloride
- adds 0.5 g of aluminium to the aqueous copper(II) chloride
- stirs the mixture in the plastic cup
- records in Table 2.1, the highest temperature reached by the reaction mixture.

(i) Fig. 2.2 shows the temperature readings for this experiment.

initial temperature



highest temperature reached

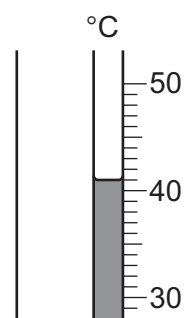


Fig. 2.2

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



Table 2.1

initial temperature of aqueous copper(II) chloride / °C	
highest temperature reached by reaction mixture / °C	
temperature increase / °C	

[2]

(ii) Calculate the temperature increase.

Record this value in Table 2.1.

[1]

(b) At the end of the experiment the plastic cup contains:

- a colourless solution
- a pink solid
- a grey solid.

Explain how these observations show that the reaction has finished and that aluminium is in excess in this experiment.

.....

.....

.....

..... [2]

(c) There is an error in the experiment that causes a smaller temperature increase than expected.

Identify this error.

Suggest **one** improvement to the experiment to minimise this error.

error

improvement

..... [2]



- (d) Another student repeats the procedure using six different concentrations of aqueous copper(II) chloride.

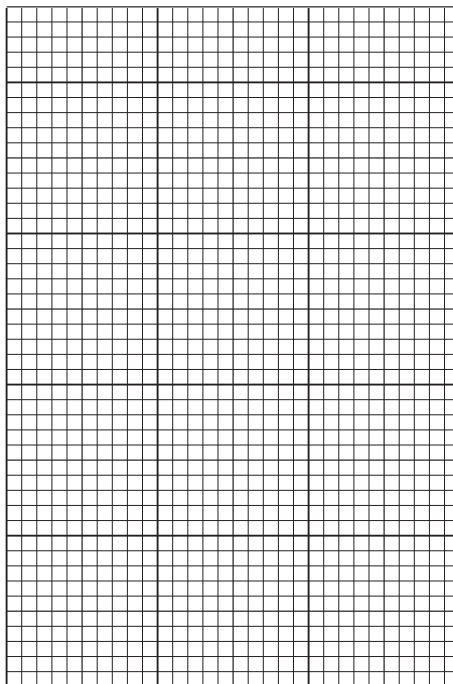
The unit of concentration is M.

Table 2.2 shows the results the student obtains.

Table 2.2

concentration of aqueous copper(II) chloride /M	temperature increase /°C
0.00	0
0.10	7.5
0.20	16.0
0.30	23.5
0.40	32.5
0.50	39.5

- (i) On the grid, plot temperature increase (vertical axis) against the concentration of aqueous copper(II) chloride.



- (ii) Draw the line of best fit.

[3]

[1]



- (e) Estimate using the graph, the concentration of aqueous copper(II) chloride that gives a temperature increase of 20.0°C.

Show your working on the graph.

concentration = ... M [2]

[Total: 13]



- 3 A student investigates an electrical circuit with two identical resistors in series.

Procedure

The student:

step 1 connects the circuit shown in Fig. 3.1

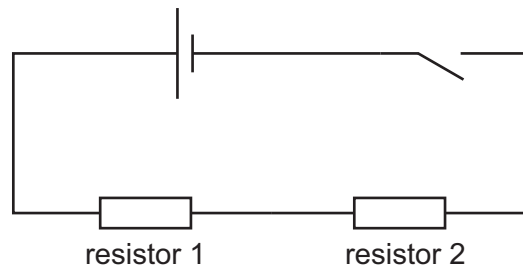


Fig. 3.1

step 2 connects a voltmeter to measure the voltage across resistor 1

step 3 closes the switch

step 4 records the voltmeter reading

step 5 opens the switch

step 6 moves the voltmeter to measure the voltage across resistor 2

step 7 repeats **step 3** to **step 5**.

- (a) Draw a voltmeter in Fig. 3.1 to show how the student measures the voltage across resistor 1 in **step 2**. [2]

- (b) Fig. 3.2 shows the voltmeter readings V_1 and V_2 .

Read and record V_1 and V_2 to the nearest 0.01 V.

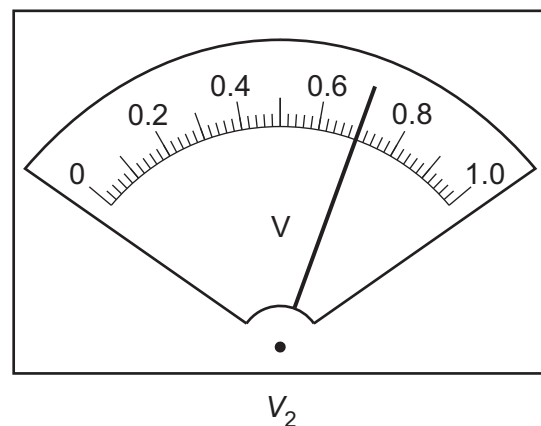
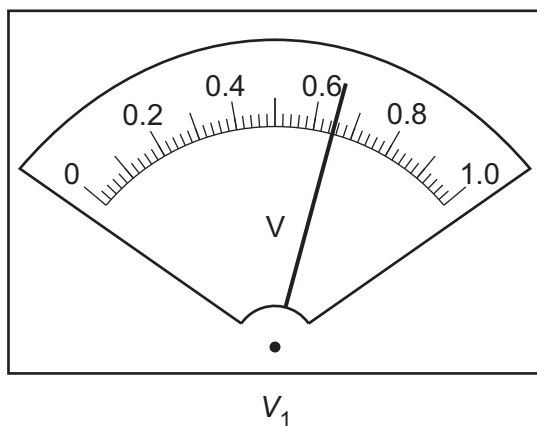


Fig. 3.2

$V_1 = \dots\dots\dots$ V

$V_2 = \dots\dots\dots$ V

[2]



- (c) A student suggests that if resistor 1 has the same resistance as resistor 2 then $V_1 = V_2$.

Two values are considered equal within the limits of experimental accuracy if they are within 10% of each other.

State if your values of V_1 and V_2 support the student's suggestion.

Justify your answer with a calculation.

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

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

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

[Total: 7]



4 Fig. 4.1 shows a metal rod placed in a box of sand.

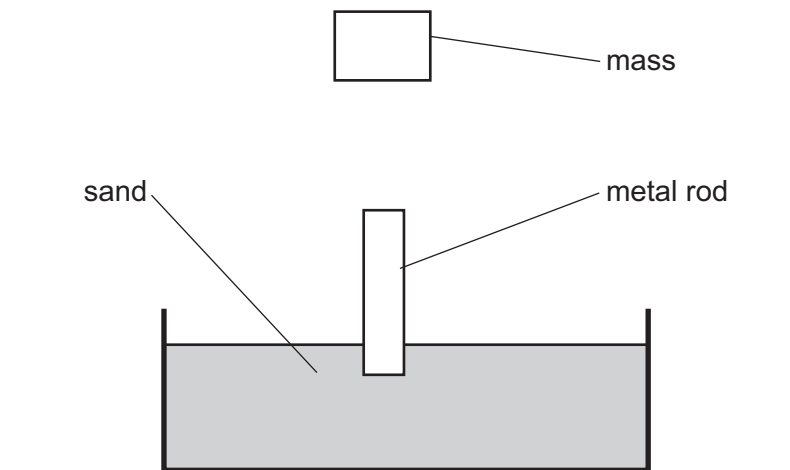


Fig. 4.1

When a mass is dropped onto the rod, the rod moves further into the sand.

A student predicts that the distance the rod moves into the sand is proportional to the mass dropped onto the rod.

Plan an investigation to test the student's prediction.

You are provided with:

- the apparatus in Fig. 4.1
- a number of different masses.

In your plan, include:

- any additional apparatus you will use
- a brief description of the method
- the variables you will control and the measurements you will take
- a table to record the results (you are **not** required to enter any readings in the table)
- how you will process your results to form a conclusion about the prediction.





[7]







NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

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

Tests for aqueous cations

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

Tests for gases

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

Flame tests for metal ions

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

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- 1 A student investigates the effect of oxygen concentration on the germination of pea seeds.

Fig. 1.1 shows a germinated pea seed.



Fig. 1.1

(a) Procedure

The student:

- assembles the apparatus as shown in Fig. 1.2 and leaves the five flasks for three days
- records in Table 1.1 the number of pea seeds that germinate.

Each flask contains a different percentage concentration of oxygen.

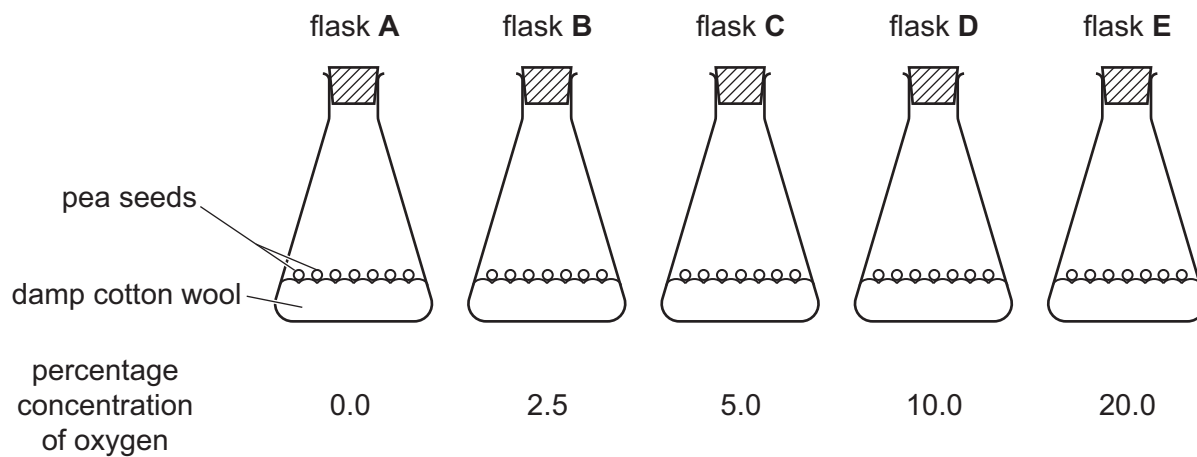


Fig. 1.2



(i) Fig. 1.3 shows the pea seeds from flask **B**.

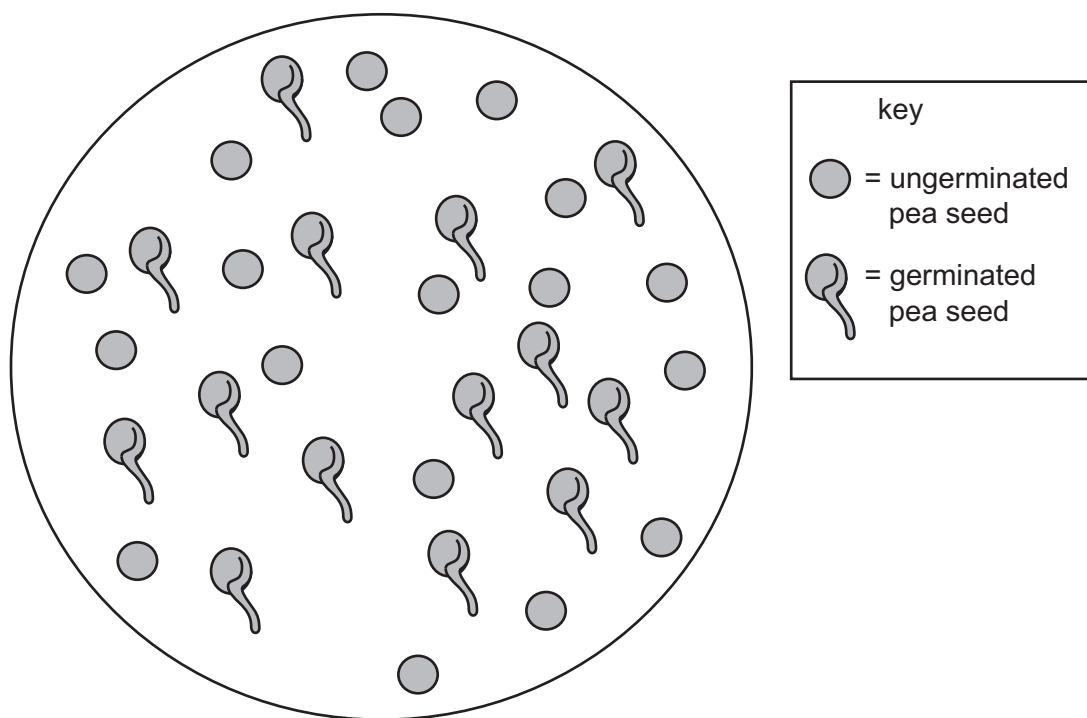


Fig. 1.3

Count the number of ungerminated pea seeds and the number of germinated pea seeds in Fig. 1.3.

Record these values in Table 1.1.

Table 1.1

flask	percentage concentration of oxygen	number of ungerminated pea seeds	number of germinated pea seeds	total number of pea seeds in flask	percentage of pea seeds that germinate
A	0.0	32	0	32	0
B	2.5			32	
C	5.0	6	25	31	81
D	10.0	2	28	30	93
E	20.0	0	34	34	100

[2]



- (ii) Calculate the percentage of pea seeds that germinate in flask **B**.

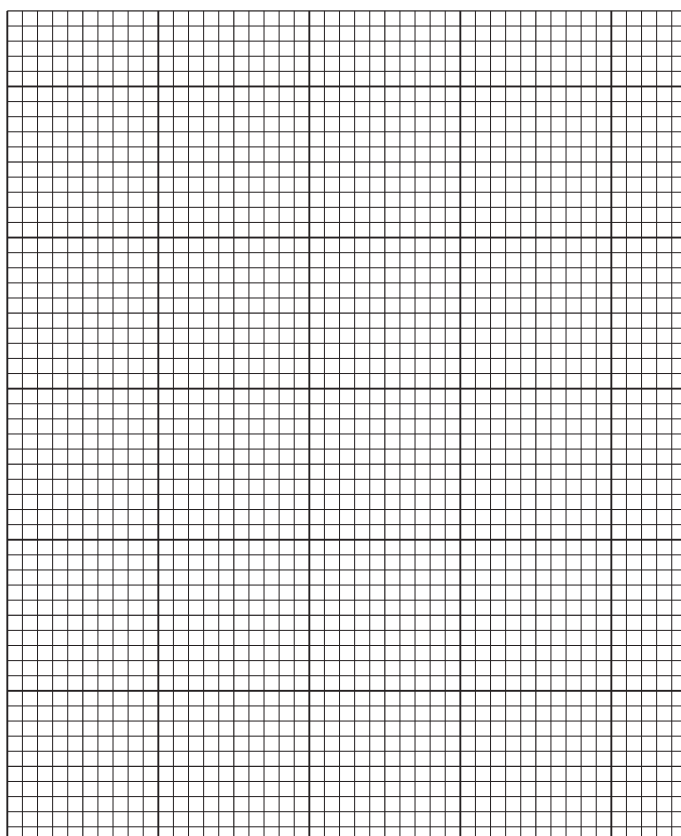
Use the equation shown.

$$\text{percentage of pea seeds that germinate} = \frac{\text{number of germinated pea seeds}}{\text{total number of pea seeds in flask}} \times 100$$

Record this value in Table 1.1.

[1]

- (iii) On the grid, plot the percentage of pea seeds that germinate (vertical axis) against the percentage concentration of oxygen.



[3]

- (iv) Draw the curve of best fit.

[1]

- (v) Describe the relationship between the percentage concentration of oxygen and the percentage of pea seeds that germinate.

.....

..... [1]





- (vi) Explain why the percentage of pea seeds that germinate is plotted and **not** the number of pea seeds that germinate.

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

- (vii) The student observes that the pea seeds produce heat when they germinate.

This means that the investigation is **not** a fair test.

Explain why.

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

- (viii) State **one** factor that is kept constant for all five flasks in this investigation.

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

- (b) As seeds germinate they produce reducing sugars.

State the reagent used to confirm the presence of reducing sugars.

..... [1]

[Total: 13]





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

(a) The student adds a sample of **H** to aqueous sodium hydroxide in a boiling tube.

The student carefully warms the boiling tube.

The student concludes that **H** contains the ammonium ion.

Describe the observations the student makes to form this conclusion.

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

(b) The student adds a sample of **H** to dilute hydrochloric acid.

The student concludes that **H** contains the carbonate ion.

Describe the observations the student makes to form this conclusion.

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

(c) Solid **H** reacts when it is heated.

Procedure

The student:

- puts some **H** into a test-tube
- uses a balance to measure the mass of the test-tube and **H**
- heats the test-tube for two minutes with a blue Bunsen burner flame
- allows the test-tube to cool down
- uses a balance to measure the mass of the test-tube and its contents.

(i) Explain why the student uses a blue Bunsen burner flame rather than a yellow flame.

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



- (ii) The total mass of the test-tube and **H** before heating is 15.7 g.

Fig. 2.1 shows the reading on the balance after heating for two minutes.

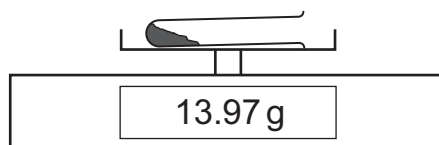


Fig. 2.1

State the total mass of the test-tube and its contents after heating for two minutes.

Give your answer to **one** decimal place.

mass after heating = ... g [1]

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

.....
 [1]

- (iv) Suggest why the total mass of the test-tube and its contents decreases during the heating.

.....
 [1]

- (v) The student thinks that some of the sample of **H** in the test-tube has **not** reacted.

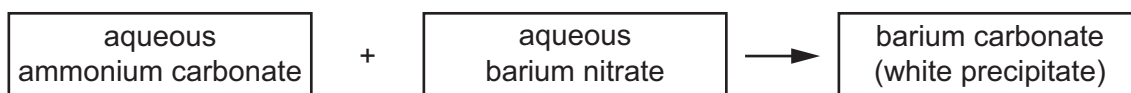
Explain how the student changes the procedure to ensure that all of **H** reacts.

.....
 [1]

[Total: 7]



- 3 Aqueous ammonium carbonate reacts with aqueous barium nitrate to form a white precipitate of barium carbonate.



The white precipitate is separated from the reaction mixture by filtration.

Plan an investigation to determine the relationship between the volume of aqueous ammonium carbonate used and the mass of barium carbonate made.

You are provided with:

- aqueous ammonium carbonate
- aqueous barium nitrate.

You may use any common laboratory apparatus in your plan.

In your plan include:

- any apparatus you will use
- a brief description of the method
- what you will measure and which variables you will control
- a table to record the results (you are **not** required to enter any readings in the table)
- how you will process your results to form a conclusion.





[7]



4 A student investigates the rate of cooling of hot water in two glass beakers **P** and **Q**.

(a) Each beaker has a circular open top with a different diameter.

Fig. 4.1 shows the water in beaker **P** as seen from above.

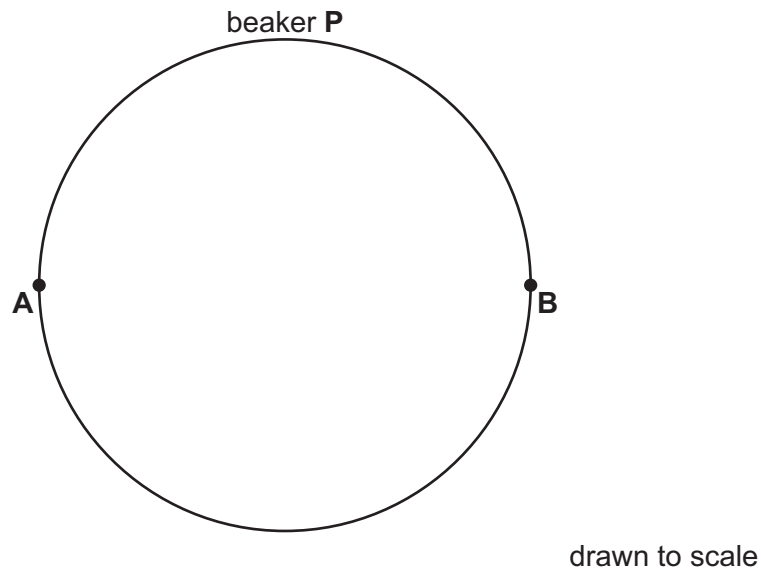


Fig. 4.1

(i) Measure the diameter **AB**.

Record this value to the nearest 0.1 cm.

diameter = ... cm [1]

(ii) Calculate the surface area of the top of the water in beaker **P**.

Use the equation shown.

$$\text{surface area} = \frac{3.1 \times (\text{diameter})^2}{4}$$

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

surface area = ... cm² [2]



(b) Fig. 4.2 shows glass beakers **P** and **Q**.

The student adds 250 cm^3 of hot water into **P**.

A thermometer measures the temperature of the water.

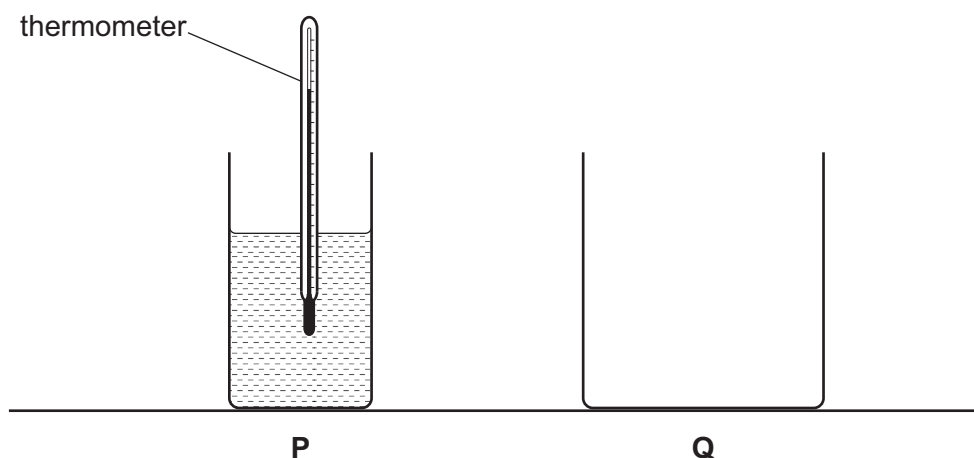


Fig. 4.2

- (i) State the name of a piece of apparatus suitable for measuring 250 cm^3 of water.

..... [1]

- (ii) Fig. 4.2 shows the water level and thermometer in **P**.

The student adds 250 cm^3 of hot water and a thermometer to **Q**.

Complete Fig. 4.2 by:

- drawing a line to estimate the level of water in **Q**
- drawing a thermometer to measure the temperature of the water in **Q**.

[2]



(c) The student:

- starts a stop-watch when the temperature of the water in **P** and **Q** is 80°C
- records in Table 4.1 the temperature of the water in **P** and **Q** every 60 seconds for 5 minutes.

Table 4.1

time / s	temperature of water in P / $^{\circ}\text{C}$	temperature of water in Q / $^{\circ}\text{C}$	difference between the temperature of water in P and Q / $^{\circ}\text{C}$
0	80.0	80.0	0.0
60	75.5	69.5	6.0
120	73.0	63.0	10.0
180	70.0	58.5	11.5
240			
300	65.5	52.5	13.0

(i) Fig. 4.3 shows the readings on each thermometer at 240 s.

thermometer in **P**

thermometer in **Q**

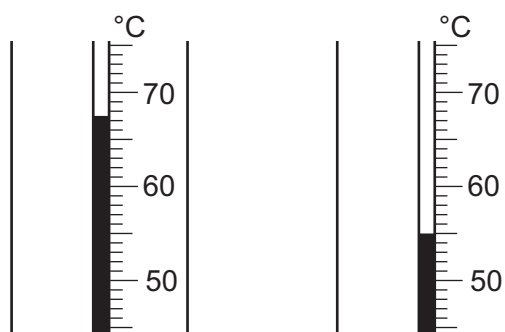


Fig. 4.3

Record in Table 4.1 these temperatures to the nearest 0.5°C .

[2]

(ii) Calculate the difference between the temperature of water in **P** and **Q** at 240 s.

Record your value in Table 4.1.

[1]

(iii) The student stirs the water before measuring each temperature.

Explain why stirring is important.

.....
 [1]





(d) Compare how the temperature of the water in **P** and in **Q** changes with time.

Use the data in Table 4.1 to help you.

.....

.....

.....

..... [2]

(e) The student wants to investigate the rate of cooling from the open top of the beaker only.

Suggest **one** change the student makes to the apparatus in Fig. 4.2.

.....

..... [1]

[Total: 13]



NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

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

Tests for aqueous cations

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

Tests for gases

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

Flame tests for metal ions

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

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