Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

7045972801

PHYSICAL SCIENCE **0652/61**

Paper 6 Alternative to Practical **October/November 2018**

1 hour

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **26** printed pages and **2** blank pages.

DC (ST/JG) 154774/3

CAMBRIDGE
International Examinations

[Turn over

1 Solid **H** is a mixture of element **J** and compound **K**.

Compound **K** is soluble in water whereas element **J** is not soluble in water.

A student separates element **J** and compound **K** from the mixture **H** and identifies the two substances.

(a) • She places the solid **H** in a beaker, adds 20 cm^3 of distilled water and stirs well.

• She filters the mixture and keeps the filtrate and the residue for testing in **(b)** and **(c)**.

• She records the appearance of the filtrate and residue. Her observations are shown in Fig. 1.1.

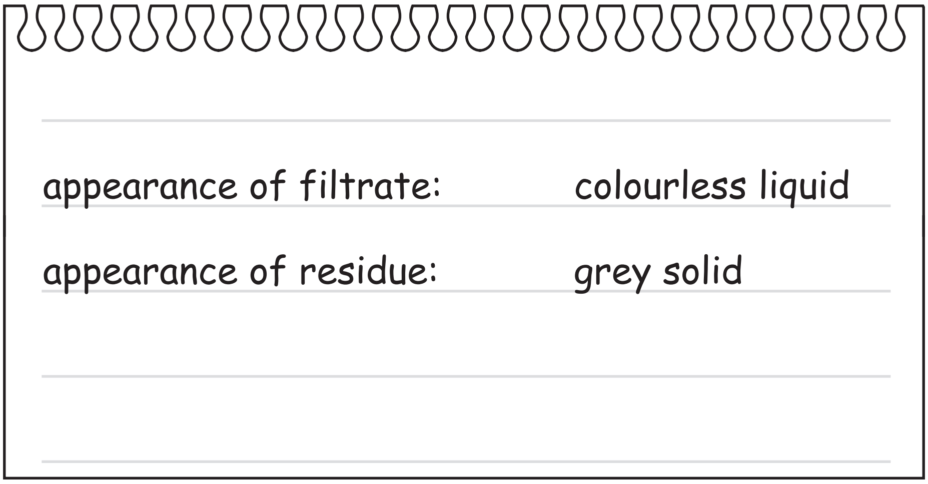


Fig. 1.1

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

[2]

(ii) Explain why she needs to stir well after adding the distilled water.

....

....[1]

(b) testing the filtrate

- She places 1 cm depth of the filtrate from **(a)** in a test-tube.
- She slowly adds sodium hydroxide solution until there is no further change.
- She records her observations.

Her observations are shown in Fig. 1.2.

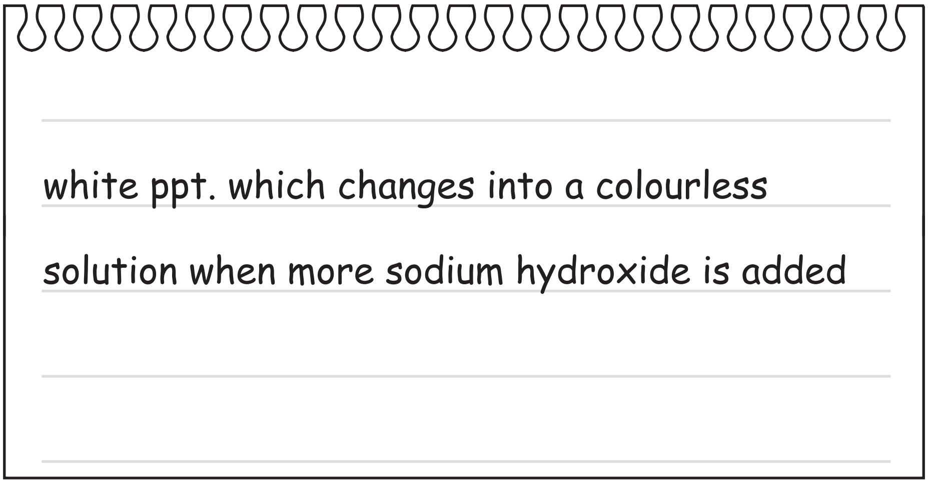


Fig. 1.2

(i) Use the observations in Fig. 1.2 to identify the cation present in the filtrate.

cation is .... [1]

(ii) On the answer lines, outline a plan for the tests the student needs to carry out to determine whether the filtrate contains the carbonate, chloride or sulfate anion.

You also need to plan the order in which she would carry out these tests.

The following reagents are available:

barium nitrate solution
dilute nitric acid
silver nitrate solution

For each test state the observation which would confirm the presence of the anion.

first test ....

....

anion tested for ....

observation for a positive result ....

....

second test ....

....

anion tested for ....

observation for a positive result ....

....

third test ....

....

anion tested for ....

observation for a positive result ....

....
[3]

(c) **testing the residue**

- She places the filter paper and residue from **(a)** in a test-tube.
- She adds dilute hydrochloric acid.
- She holds a lighted splint at the mouth of the test-tube.
- She records her observations.

Her observations are shown in Fig. 1.3.

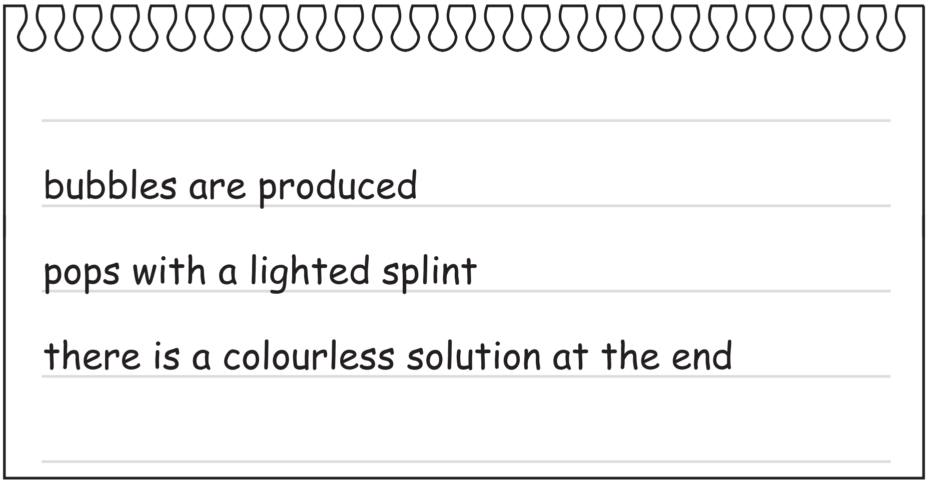


Fig. 1.3

(i) Use the observations in Fig. 1.3 to deduce the identity of the gas and the nature of the element **J** left in the residue.

gas is ....

type of element ....
[2]

(ii) Suggest one test which she could carry out on the solution produced in **(c)(i)** in order to identify the element **J**.

....

....[1]

[Total: 10]

2 A student investigates the resistance and the power output of two lamps, **L** and **M**, first connected in series and then in parallel.

He sets up the circuit shown in Fig. 2.1. The lamps are connected in series.

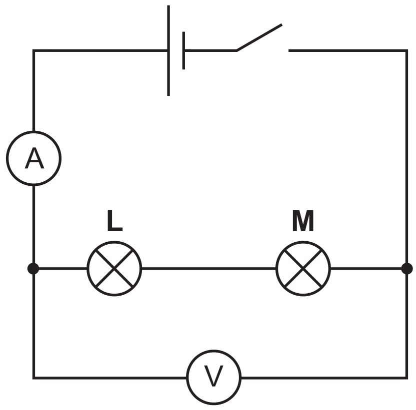


Fig. 2.1

- He closes the switch.
- He measures the current I flowing through lamps **L** and **M**.
- He measures the potential difference V across the lamps.
- He opens the switch.

Fig. 2.2 shows the scales of the ammeter and the voltmeter when the measurements are taken.

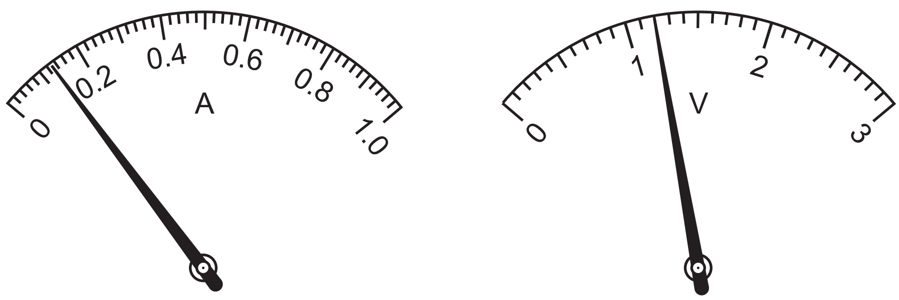


Fig. 2.2

(a) Read the scales in Fig. 2.2 and record your readings in Table 2.1. [2]

Table 2.1

	I/A	V/V	resistance R_S /Ω	power P_S /W
lamps **L** and **M** in series	....	....	....	....

(b) State why it is important to open the switch after taking readings.

....[1]

(c) (i) Calculate the combined resistance R_S of lamps **L** and **M** when connected in series. Use the equation shown.

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

Record your answer in Table 2.1. [1]

(ii) Calculate the combined power output P_S of lamps **L** and **M** when connected in series. Use the equation shown.

$$P = V \times I$$

Record your answer in Table 2.1. [1]

(d) He rearranges the circuit and sets it up as shown in Fig. 2.3. Lamps **L** and **M** are now connected in parallel with the power supply.

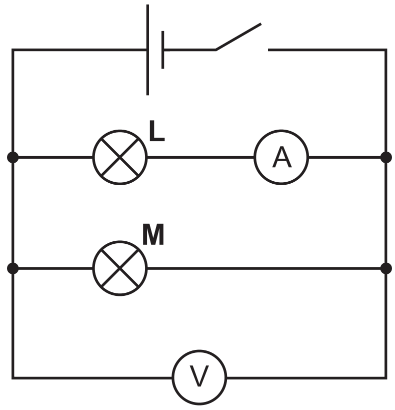


Fig. 2.3

- He closes the switch.
- He measures the current I flowing through lamp **L**.
- He measures the potential difference V across lamp **L**.
- He opens the switch.

He records his readings in Table 2.2.

Table 2.2

	I/A	V/V	resistance R /Ω	power P /W
lamp **L** in parallel	0.21	1.3	6.2	0.27
lamp **M** in parallel	0.20	1.3	6.5	0.26

- He disconnects the ammeter.
- He reconnects the ammeter so that it is now in series with lamp **M** as shown in Fig. 2.4.

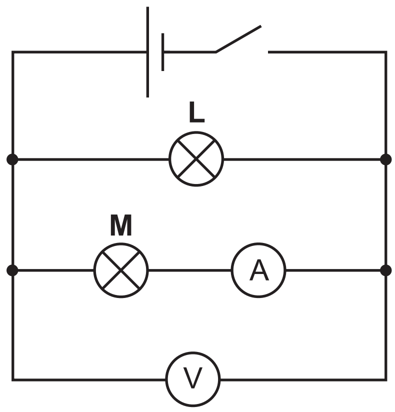


Fig. 2.4

- He closes the switch.
- He measures the current I flowing through lamp **M**.
- He measures the potential difference V across lamp **M**.
- He opens the switch.

He records his readings in Table 2.2.

(i) He calculates the resistance of each lamp and records the results in Table 2.2.

Calculate R_P, the sum of the resistances of lamps **L** and **M** in parallel.

R_P = ... Ω [1]

(ii) He calculates the power output of each lamp and records the results in Table 2.2.

Calculate the total power output P_P of lamps **L** and **M** in parallel.

P_P = ... W [1]

(e) A student says that the combined resistance R_S of the lamps in the series circuit should be equal to the sum of the resistances R_P in the parallel circuit.

State whether your values of R_S and R_P from **(c)(i)** and **(d)(i)** support the suggestion made by the student.

Justify your statement by referring to the values you have calculated.

....

....

....[1]

(f) **(i)** The student notices that the lamps in the series circuit in Fig. 2.1 are less bright than the lamps in the parallel circuits in Figs. 2.3 and 2.4.

Suggest **one** reason for this observation. Refer to the results in Tables 2.1 and 2.2.

....

....[1]

(ii) Suggest a change to the circuit in Fig. 2.1 which would cause the two lamps **in series** to have the same brightness as the lamps in Figs. 2.3 and 2.4.

....

....[1]

[Total: 10]

Please turn over for Question 3.

3 A student investigates the rate of reaction between calcium carbonate and hydrochloric acid.

Fig. 3.1 shows the apparatus she uses.

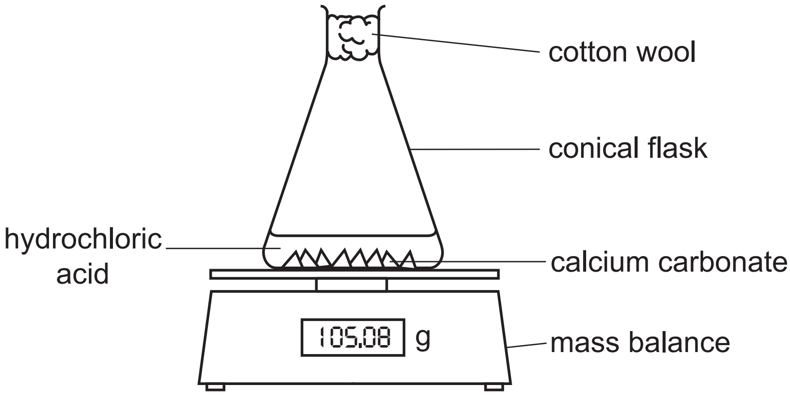


Fig. 3.1

She uses the following method:

- She places a conical flask on a mass balance.
- She adds 5.00 g of calcium carbonate pieces (an excess) to the flask.
- She adds 50 cm^3 hydrochloric acid to the flask.
- She places a piece of cotton wool in the neck of the conical flask as shown in Fig. 3.1.
- She starts a stopclock and records in Table 3.1 the mass *m* for time *t* = 0.
- She records in Table 3.1 the mass *m* every 15 seconds until there is no further change in mass.

Table 3.1

time t / s	mass m / g
0	106.11
15	105.73
30	105.35
45	105.16
60	....
75	105.03
90	105.01
105	104.99
120	104.99

(a) Fig. 3.1 shows the reading on the balance at t = 60 seconds.

Record this mass in Table 3.1. [1]

(b) **(i)** Plot a graph of mass m (vertical axis) against time t.
The vertical axis does not need to start at zero. [3]

(ii) Draw the best-fit line, which must be straight for the first 30 seconds and then should be the best-fit curve. [1]

(c) **(i)** Calculate the gradient of the straight line part of your graph. Show all working and indicate on your graph the values you chose.

gradient = ... g / s [2]

(ii) The gradient represents the rate of reaction at the start of the experiment.

A second experiment is performed using acid of double the concentration and using the same mass of calcium carbonate and the same volume of acid as in **(a)**.

Draw a second line on the graph to show the rate of the reaction in this second experiment. Label the line **S**. [1]

(d) **(i)** Suggest why the piece of cotton wool is placed in the neck of the conical flask.

....

....[1]

(ii) Explain why a tight fitting bung is **not** used instead of cotton wool.

....

....

....[1]

[Total: 10]

Please turn over for Question 4.

4 A student uses optics pins to trace the path of light through a rectangular block of transparent plastic in order to determine the refractive index of the plastic.

She sets up the experiment shown in Fig. 4.1.

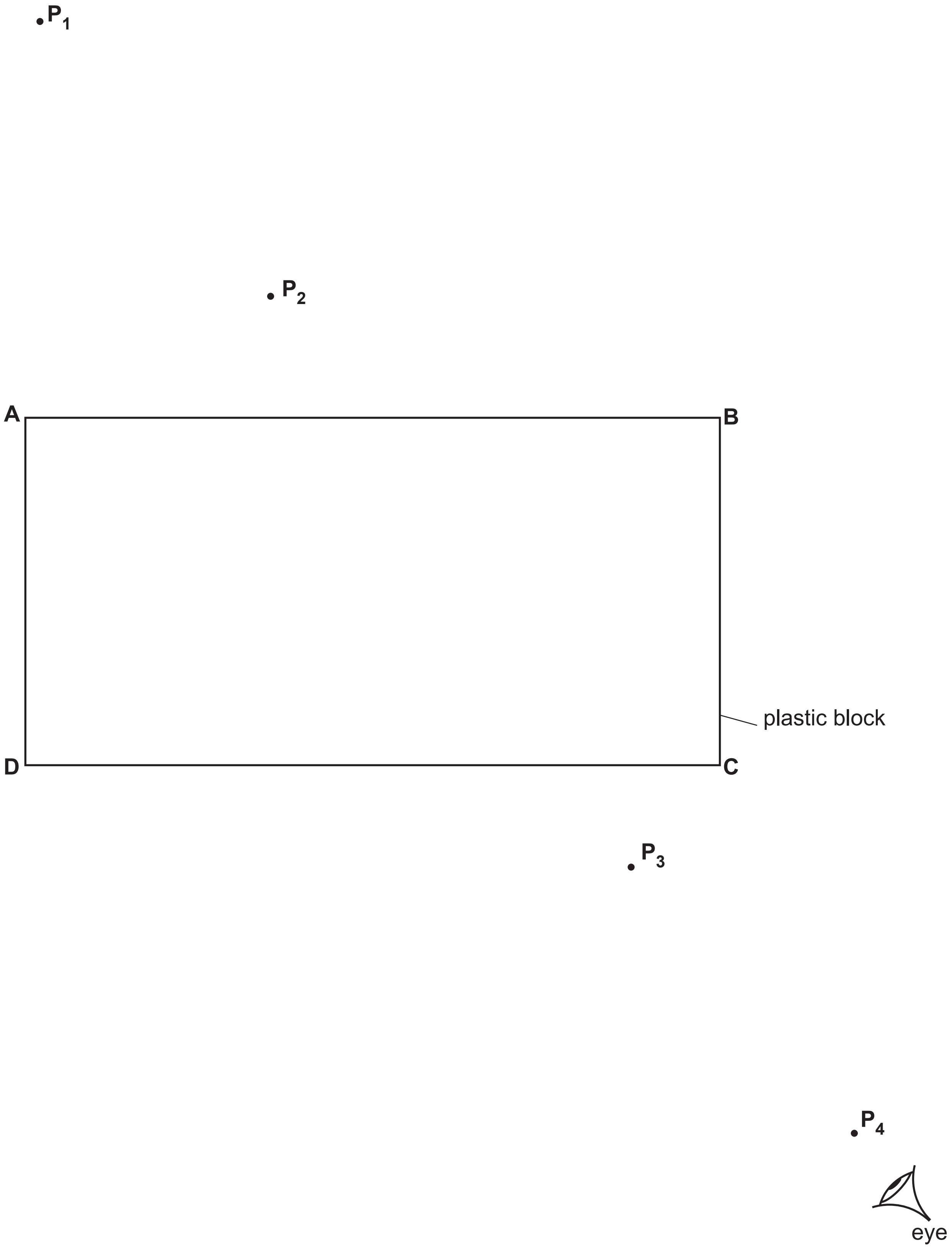


Fig. 4.1

- She places the plastic block on a sheet of white paper on a cork mat.
- She places two optics pins $\mathbf{P_1}$ and $\mathbf{P_2}$ as shown in Fig. 4.1.

(a) **(i)** Measure the distance $\mathbf{P_1P_2}$. Record your answer to the nearest millimetre.

$\mathbf{P_1P_2}$ = ... mm [1]

(ii) On Fig. 4.1, draw a line joining pins $\mathbf{P_1}$ and $\mathbf{P_2}$.

Continue this line until it reaches the block at side **AB**.

Label the point where the line meets side **AB** with the letter **N**. [1]

(iii) On Fig. 4.1 draw a line at 90° to side **AB** at **N**.

Extend this line until it crosses side **CD**.

Label with the letter **M** the point at which this line crosses side **CD**. [1]

(b)
- The student looks through side **CD** of the block from the direction shown by the eye in Fig. 4.1.
- She places two more optics pins $\mathbf{P_3}$ and $\mathbf{P_4}$ below side **CD** and adjusts their positions until $\mathbf{P_3}$, $\mathbf{P_4}$ and the images of $\mathbf{P_1}$ and $\mathbf{P_2}$ seen through the block appear in a straight line, one behind the other.

The positions of $\mathbf{P_3}$ and $\mathbf{P_4}$ are shown in Fig. 4.1.

(i) On Fig. 4.1, draw a line joining $\mathbf{P_3}$ and $\mathbf{P_4}$.

Continue this line until it meets **NM**.

Label the point where the line crosses **NM** with the letter **Q**.

Label the point where the line crosses **CD** with the letter **R**.

Draw a straight line from **N** to **R**.

Measure the length *a* of **NR**.

a = ... mm [1]

(ii) Measure the length *b* of **QR**.

b = ... mm [1]

(c) Calculate the refractive index n of the plastic. Use the equation shown and your answers to **(b)(i)** and **(b)(ii)**.

$$n = \frac{a}{b}$$

n = ... [1]

(d) The student repeats the experiment three more times using different positions of pins $\mathbf{P_1}$ and $\mathbf{P_2}$. She obtains the following values for the refractive index n of the plastic.

1.57 1.60 1.54

Use your value of n from part **(c)** and the values calculated by the student to determine a mean value for the refractive index of plastic. Give your answer to three significant figures.

mean value for n = ... [2]

(e) The student states that, allowing for experimental error, the refractive index of the plastic is constant, whatever the positions of pins $\mathbf{P_1}$ and $\mathbf{P_2}$.

Use the results from **(c)** and **(d)** to state whether you agree with the student and justify your answer.

statement ....

justification ....

....
[1]

(f) When looking through the plastic block to line up pins $\mathbf{P_3}$ and $\mathbf{P_4}$ with the images of pins $\mathbf{P_1}$ and $\mathbf{P_2}$, it is good experimental technique to view the part of each pin closer to the paper while lining them up.

Suggest a reason for this.

....

....[1]

[Total: 10]

5 A student investigates the three alcohol fuels, ethanol, propanol and butanol, to find out which of them supplies the most energy per kilogram when they burn in air.

He uses the apparatus shown in Fig. 5.1.

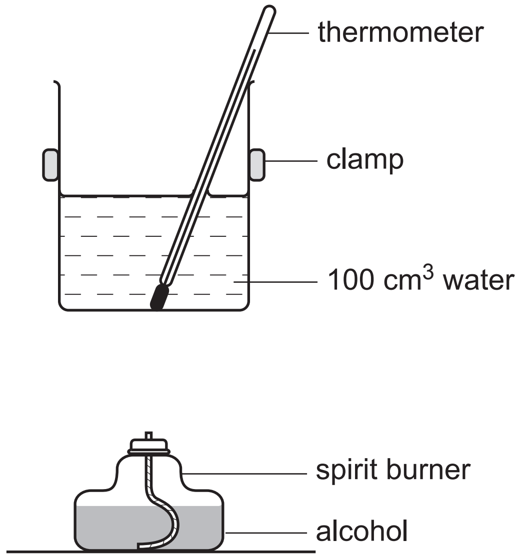


Fig. 5.1

- He measures the mass m_1 of the spirit burner and ethanol before burning. He records this mass m_1 in Table 5.1.
- He places $100\,cm^3$ of water into the beaker and clamps the beaker above the spirit burner as shown in Fig. 5.1.
- He measures the temperature T_1 of the water to the nearest 0.5 °C. He records this value in Table 5.2.
- He lights the burner.
- He extinguishes the burner when the temperature rises above 50 °C.
- He stirs the water and records in Table 5.2 the highest temperature T_2.
- He then measures the mass m_2 of the spirit burner and ethanol after burning. He records this value in Table 5.1.
- He repeats the procedure for propanol and butanol.

Table 5.1

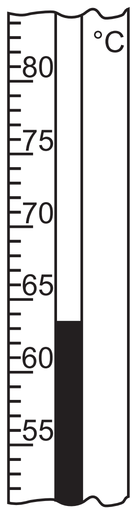
alcohol	m_1 / g	m_2 / g	mass of alcohol burned m / g
ethanol	188.48	187.41	1.07
propanol	175.63	174.67	0.96
butanol	191.03	190.10	0.93

Table 5.2

alcohol	T_1 / °C	T_2 / °C	change in temp ΔT / °C
ethanol	22.0	60.0	38.0
propanol	23.0	61.5	38.5
butanol	23.5	....	....

(a) **(i)** Fig. 5.2 shows the thermometer for the highest temperature T_2 observed for the burning of butanol.

Record in Table 5.2 the reading to the nearest 0.5 °C. [1]



highest temperature T_2 for butanol

Fig. 5.2

(ii) Calculate the change in temperature ΔT for butanol. Record this value in Table 5.2. [1]

(b) (i) State and explain one safety precaution that should be taken when carrying out this experiment.

precaution ....

....

explanation ....

....
[1]

(ii) The student uses the same volume of water for all three alcohols. State another variable that must be kept constant to make this a fair test.

....

....[1]

(iii) Name a piece of apparatus suitable for measuring the volume of water.

....[1]

(c) (i) Calculate the thermal energy *E* transferred into the water when ethanol is burned. Use the equation shown.

$$E = \text{volume of water (cm}^3\text{)} \times 4.2 \times \Delta T$$

Record your answer in Table 5.3 to 3 significant figures.

[2]

Table 5.3

alcohol	*E* / J	energy per gram of alcohol / J per g
ethanol	....	14 900
propanol	16 200	16 900
butanol	16 800	18 100

(ii) The third column in Table 5.3 shows the thermal energy transferred into the water per gram of alcohol burned.

Write an equation to show how the student calculates the numbers in this column.

[1]

(iii) Use the energy per gram values in Table 5.3 to state and explain which alcohol provides the most thermal energy per kilogram burned.

....

....[1]

(d) Suggest one reason why the thermal energy *E* values in Table 5.3 are lower than the expected values.

....

....[1]

[Total: 10]

6 A teacher sets up the apparatus shown in Fig. 6.1 to determine the half-life of a radioactive source.

She uses a detector connected to a counter to measure the count rate of the radioactive radiation emitted by the source.

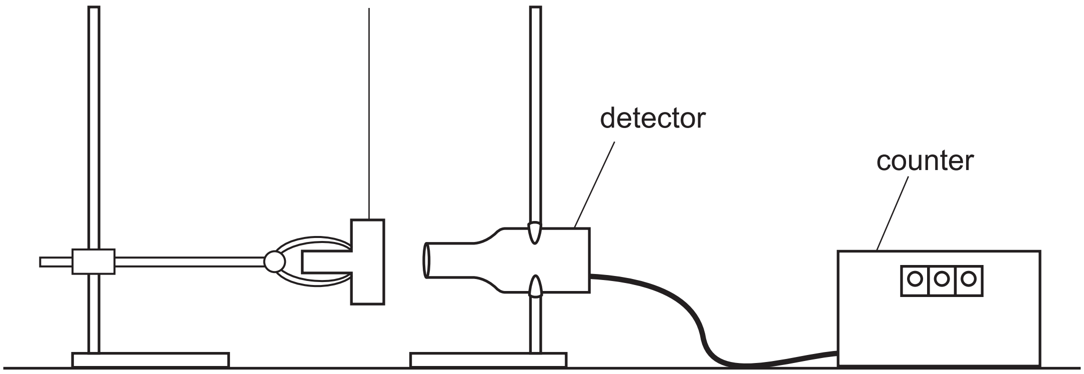


Fig. 6.1

(a) Before the teacher starts the experiment, she sets up the detector and the counter without the radioactive source present.

She measures the background count in 1 minute and repeats this three times.

Her results are shown in Table 6.1.

Table 6.1

count rate / counts per minute			
20	24	18	19

Calculate the average count rate due to background radiation. Give your answer **to the nearest whole number**.

average background count rate = ... counts per minute [1]

(b) The radioactive source used in the experiment is a beta (β) emitter.

- The teacher places the detector close to the source.
- She switches on the counter and measures the initial count rate.
- She then measures the count rate at intervals of 30 seconds for 3 minutes.
- She records her results in Table 6.2.

Table 6.2

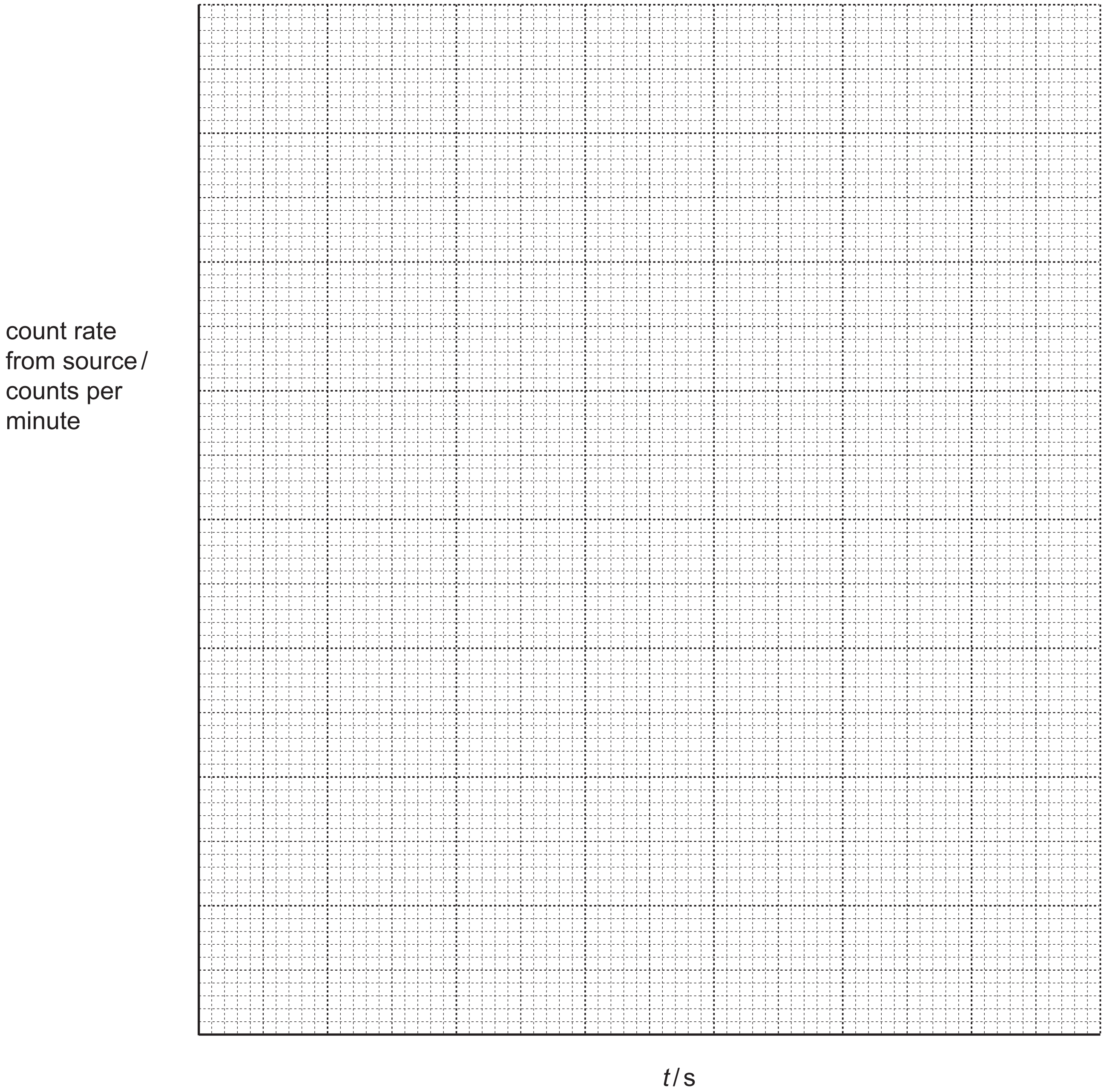
time t / s	measured count rate / counts per minute	count rate from source / counts per minute
0	770	750
30	557	....
60	434	414
90	327	307
120	249	229
150	190	....
180	146	126

Use your answer from part **(a)** and the measured count rates in Table 6.2 to calculate the actual count rates from the source at t = 30 s and t = 150 s.

Record your answers in Table 6.2. [1]

(c) (i) Plot a graph of count rate from source (vertical axis) against time *t*. Start your graph at the origin (0,0). [2]

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



(d) The half-life of a radioactive source is the time taken for the count rate from the source to halve.

(i) Use your graph to determine the time when the count rate from the source is at 600 counts per minute and at 300 counts per minute.

Record the times below.

600 counts per minute at time t = ... s

300 counts per minute at time t = ... s [1]

(ii) Deduce the half-life of the source.

half-life = ... s [1]

(e) The teacher uses the apparatus in Fig. 6.1 and sheets of paper and aluminium foil to show that the radioactive source emits beta particles only.

(i) Describe how the teacher uses the sheets of paper and aluminium foil with the apparatus.

....

....[1]

(ii) State and explain the results you would expect if the source emits beta particles only.

....

....

....[2]

[Total: 10]

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