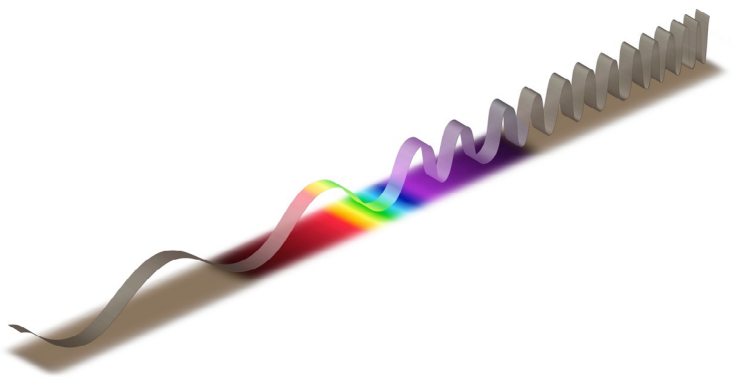
Cambridge Assessment International Education

Example Candidate Responses – Paper 6

Cambridge IGCSE™ / IGCSE (9-1)

Physics 0625 / 0972

For examination from 2021



Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge IGCSE™ / IGCSE (9-1) Physics 0625 / 0972, and to show how different levels of candidates' performance (high, middle and low) relate to the subject's curriculum and assessment objectives.

In this booklet, candidate responses have been chosen from the June 2021 series to exemplify a range of answers.

For each question, the response is annotated with a clear explanation of where and why marks were awarded or omitted. This is followed by examiner comments on how the answer could have been improved. In this way, it is possible for you to understand what candidates have done to gain their marks and what they could do to improve their answers. There is also a list of common mistakes candidates made in their answers for each question.

This document provides illustrative examples of candidate work with examiner commentary. These help teachers to assess the standard required to achieve marks beyond the guidance of the mark scheme. Therefore, in some circumstances, such as where exact answers are required, there will not be much comment

The questions and mark schemes used here are available to download from the School Support Hub. These files are:

0625 June 2021 Question Paper 61

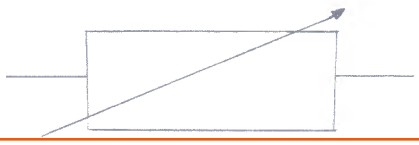
0625 June 2021 Mark Scheme 61

Past exam resources and other teaching and learning resources are available on the School Support Hub:

www.cambridgeinternational.org/support

How to use this booklet

This booklet goes through the paper one question at a time, showing you the high-, middle- and low-level response for each question. The candidate answers are set in a table. In the left-hand column are the candidate answers, and in the right-hand column are the examiner comments.

Example Candidate Response – low, continued	Examiner comments
(e) Describe how to extend part (c) of this experiment to investigate the relationship between the combined resistance of identical resistors connected in parallel and the number of resistors. She should add the resistors together but she already knows that the resisters in parrallel are equal so she must add Rp and Rs. [2] (f) In this type of electrical experiment, a variable resistor can be used to vary the current. Draw the circuit symbol for a variable resistor.  [1]	6 The candidate needs to clearly explain the use of adding resistors in the same circuit, one at a time. Mark for (e) = 0 out of 2 7 The candidate incorrectly draws a symbol that is part variable resistor and part thermistor. Mark for (f) = 0 out of 1

Answers are by real candidates in exam conditions. These show you the types of answers for each level. Discuss and analyse the answers with your learners in the classroom to improve their skills.

Examiner comments are alongside the answers. These explain where and why marks were awarded. This helps you to interpret the standard of Cambridge exams so you can help your learners to refine their exam technique.

How the candidate could have improved their answer

- **(e)** The candidate needed to describe adding at least another three resistors in parallel, one at a time. There were many ways in which this could have been worded and the candidate would have been given credit for showing that they understood the practical principles and techniques involved.
- **(f)** The candidate needed to draw the strike-through arro

This section explains how the candidate could have improved each answer. This helps you to interpret the standard of Cambridge exams and helps your learners to refine their exam technique.

Common mistakes candidates made in this question

- **(d)** The most common error was to place the voltmeter in series with the other components instead of in parallel with the resistors.
- **(e)** Vague answers were common here. Many candidates correctly suggested adding another resistor, but few suggested adding at least three more resistors (to give a good range of results). Candidates also needed to make it clear that these resistors should be connected in parallel with a set of readings taken each time another resistor was added.
- **(f)** Incorrect variable resistor symbols were common. So
ndidates
d the va

Often candidates were not awarded marks because they misread or misinterpreted the questions.

Lists the common mistakes candidates made in answering each question. This will help your learners to avoid these mistakes and give them the best chance of achieving the available marks.

Question 1

Example Candidate Response – high

1 A student investigates the period of a pendulum. Fig. 1.1 and Fig. 1.2 show the arrangement.

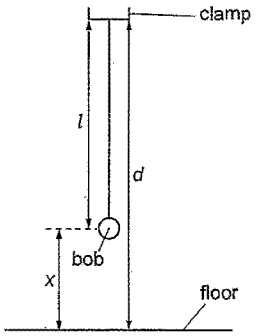


Fig. 1.1

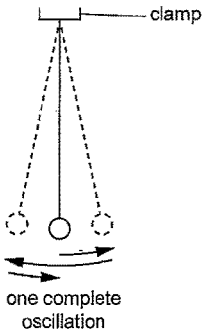


Fig. 1.2

(a) The student measures the distance *d* between the bottom of the clamp and the floor.

d = 120.0 cm

This distance *d* remains constant throughout the experiment.

He adjusts the length *l* of the pendulum to 70.0 cm.

Calculate the distance *x* between the centre of the pendulum bob and the floor. Record the value of *x* in the first row of Table 1.1. [1]

(b) The student displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

He measures, and records in the first row of Table 1.1, the time *t* for 10 complete oscillations.

(i) Calculate, and record in the first row of Table 1.1, the period *T* of the pendulum. The period is the time for one complete oscillation. [1]

(ii) Calculate, and record in the first row of Table 1.1, T^2. [2]

(iii) Complete the column headings in Table 1.1. [1]

Table 1.1

x/ cm	t/ s	T/ s	T^2/ s^2
50.0	16.7	1.67	2.79
45.0	17.3	1.73	2.99
40.0	17.9	1.79	3.20
35.0	18.4	1.84	3.39
30.0	19.0	1.90	3.61

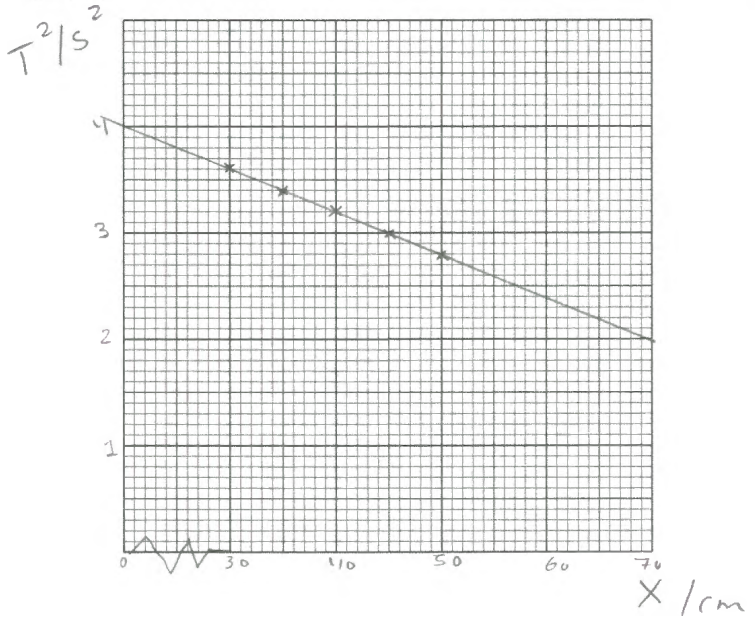
Examiner comments

Mark for (a) = 1 out of 1

Mark for (b)(i) = 1 out of 1

Mark for (b)(ii) = 2 out of 2

Mark for (b)(iii) = 1 out of 1

Example Candidate Response – high, continued	Examiner comments
(c) He repeats the procedure using x = 45.0 cm, 40.0 cm, 35.0 cm and 30.0 cm. He records the readings in Table 1.1. Plot a graph of T^2 (y-axis) against x (x-axis). You do **not** need to start your axes at the origin (0,0).  [4]	Mark for (c) = 3 out of 4
(d) State whether the graph line shows that T^2 is proportional to x. Give a reason for your answer. statement *it is not proportional to X* so indirectly proportional. reason *as T² decreases, x increases* [1]	Mark for (d) = 0 out of 1
(e) Explain why timing 10 oscillations gives a more accurate result for the period T than timing one oscillation. *reduces effect of error of reaction time: starting or stopping stopwatch. error spreads over the 10 oscillations* [1] [Total: 11]	Mark for (e) = 1 out of 1 **Total mark awarded = 9 out of 11**

How the candidate could have improved their answer

(c) Scales that produced plots that occupied at least half the graph grid in both directions were required.

Example Candidate Response – middle

Examiner comments

1 A student investigates the period of a pendulum. Fig. 1.1 and Fig. 1.2 show the arrangement.

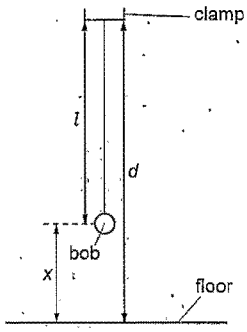


Fig. 1.1

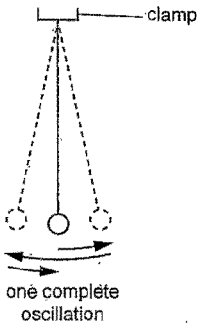


Fig. 1.2

(a) The student measures the distance d between the bottom of the clamp and the floor.

$d =$ 120.0 cm

This distance d remains constant throughout the experiment.

He adjusts the length l of the pendulum to 70.0 cm.

Calculate the distance x between the centre of the pendulum bob and the floor. Record the value of x in the first row of Table 1.1. [1]

(b) The student displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

He measures, and records in the first row of Table 1.1, the time t for 10 complete oscillations.

(i) Calculate, and record in the first row of Table 1.1, the period T of the pendulum. The period is the time for one complete oscillation. [1]

(ii) Calculate, and record in the first row of Table 1.1, T^2. [2]

(iii) Complete the column headings in Table 1.1. [1]

Table 1.1

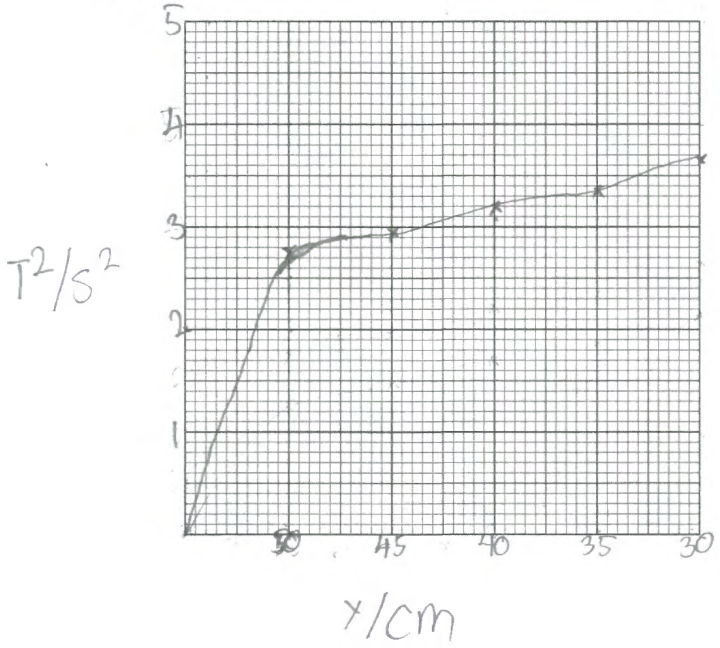
x/cm	t/s	T/s	T^2/s^2
50.0	16.7	1.67	2.79
45.0	17.3	1.73	2.99
40.0	17.9	1.79	3.20
35.0	18.4	1.84	3.39
30.0	19.0	1.90	3.61

Mark for (a) = 1 out of 1

Mark for (b)(i) = 1 out of 1

Mark for (b)(ii) = 2 out of 2

Mark for (b)(iii) = 1 out of 1

Example Candidate Response – middle, continued	Examiner comments
(c) He repeats the procedure using x = 45.0 cm, 40.0 cm, 35.0 cm and 30.0 cm. He records the readings in Table 1.1. Plot a graph of T^2 (y-axis) against x (x-axis). You do **not** need to start your axes at the origin (0,0).  [4]	Mark for (c) = 1 out of 4
(d) State whether the graph line shows that T^2 is proportional to x. Give a reason for your answer. statement No it does not reason It is not a straight line graph [1]	Mark for (d) = 0 out of 1
(e) Explain why timing 10 oscillations gives a more accurate result for the period T than timing one oscillation. Human error is less and it gives a better average of T [1] [Total: 11]	Mark for (e) = 1 out of 1 **Total mark awarded = 7 out of 11**

How the candidate could have improved their answer

(c) The candidate chose a vertical scale that was too compressed. A scale that produced plots that occupied at least half the graph grid in both directions was required. Also the horizontal scale went right to left instead of left to right. The line was not a best-fit straight line.

Example Candidate Response – low

Examiner comments

1 A student investigates the period of a pendulum. Fig. 1.1 and Fig. 1.2 show the arrangement.

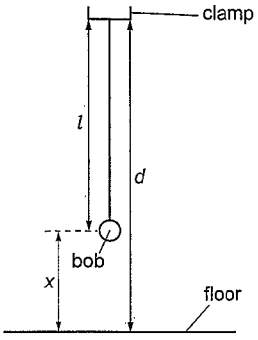


Fig. 1.1

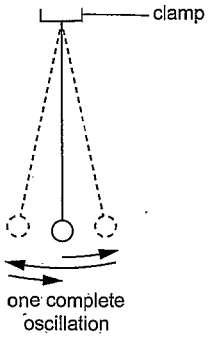


Fig. 1.2

(a) The student measures the distance d between the bottom of the clamp and the floor.

$d =$ 120.0 cm [1]

This distance d remains constant throughout the experiment.

He adjusts the length l of the pendulum to 70.0 cm.

Calculate the distance x between the centre of the pendulum bob and the floor. Record the value of x in the first row of Table 1.1. [1]

(b) The student displaces the bob slightly and releases it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

He measures, and records in the first row of Table 1.1, the time t for 10 complete oscillations.

(i) Calculate, and record in the first row of Table 1.1, the period T of the pendulum. The period is the time for one complete oscillation. [1]

(ii) Calculate, and record in the first row of Table 1.1, T^2. [2]

(iii) Complete the column headings in Table 1.1. [1]

Table 1.1

x/ cm	t/ s	T/ s	T^2/ s
2.0	16.7	1.67	2.79
45.0	17.3	1.73	2.99
40.0	17.9	1.79	3.20
35.0	18.4	1.84	3.39
30.0	19.0	1.90	3.61

1 The x value is miscalculated.
Mark for (a) = 0 out of 1

Mark for (b)(i) = 1 out of 1

Mark for (b)(ii) = 2 out of 2

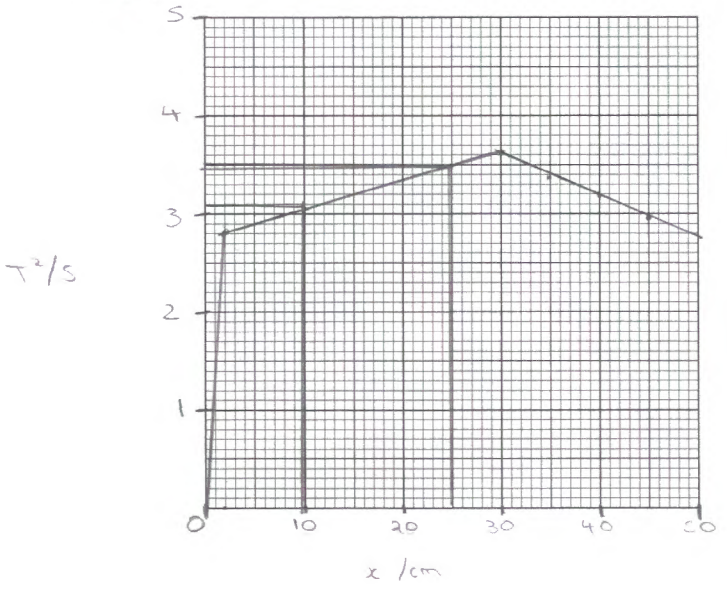
2 The candidate inserts the unit for T in place of the T^2 unit.
Mark for (b)(iii) = 0 out of 1

Example Candidate Response – low, continued

(c) He repeats the procedure using x = 45.0 cm, 40.0 cm, 35.0 cm and 30.0 cm.

He records the readings in Table 1.1.

Plot a graph of T^2 (y-axis) against x (x-axis). You do **not** need to start your axes at the origin (0,0).



3

[4]

(d) State whether the graph line shows that T^2 is proportional to x. Give a reason for your answer.

statement The graph line does not show that $T^2 \propto x$

reason $3.1 \div 10 = 0.31$ and $4 \div 25 = 0.16$ (different values show no proportion)

[1]

(e) Explain why timing 10 oscillations gives a more accurate result for the period T than timing one oscillation.

It's easier for the student to time 10 oscillations than one as its less likely for an error to occur. [1]

[Total: 11]

Examiner comments

3 The candidate chooses an unsuitable vertical scale and needs to draw a single best-fit straight line.
Mark for (c) = 1 out of 4

Mark for (d) = 0 out of 1

Mark for (e) = 1 out of 1

Total mark awarded = 5 out of 11

How the candidate could have improved their answer

- **(b)(iii)** The candidate should have given the unit for T^2 as s^2.
- **(c)** The candidate chose a vertical scale that was too compressed. A scale that produced plots that occupied at least half the graph grid in both directions was required. The data in the table were plotted accurately, but the candidate needed to draw a single best-fit straight line.
- **(e)** The reason why timing 10 oscillations would have given a more accurate result than timing one oscillation was that the reaction time error in starting and stopping the stopwatch would have been a smaller percentage of the time taken. The candidate needed to make this clear.

Common mistakes candidates made in this question

- **(b)(iii)** A common error was for candidates to give the unit of T^2 as s.
- **(c)** A common error was for candidates to draw graphs with compressed scales (usually the vertical scale) such that the plotted points did not occupy at least one half of the graph grid. The question stated that the axes did not have to start at the origin (0,0) but this advice was not always heeded.
- **(d)** Many candidates missed the fact that the line did not pass through the origin.
- **(e)** Many candidates suggested that the greater accuracy was due to 'taking an average' rather than realising that the reason for the time for one oscillation being less accurate was that the reaction time error in starting and stopping the stopwatch would be more significant when timing one oscillation compared with when timing 10 oscillations. When timing 10 oscillations, this reaction time error at the beginning and end of the oscillations would be a much smaller percentage of the time taken.

Question 2

Example Candidate Response – high

2 A student investigates resistance.

Fig. 2.1 shows the circuit she uses.

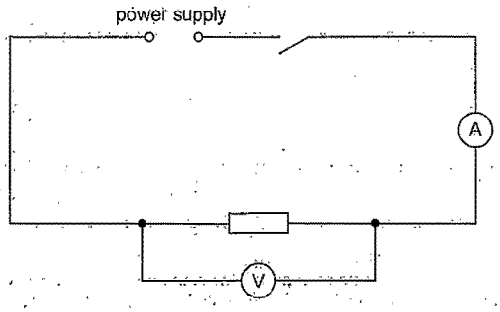


Fig. 2.1

(a) She records the potential difference (p.d.) V_1 across the resistor and the current I_1 in the circuit.

The meters are shown in Fig. 2.2 and Fig. 2.3.

(i) Write down the readings. Include the units for potential difference, current or resistance where appropriate in all parts of the question.

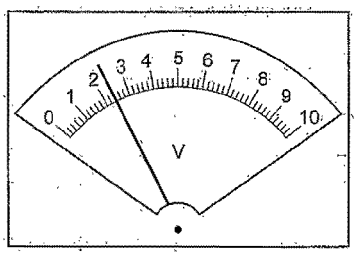


Fig. 2.2

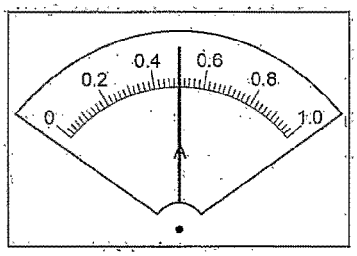


Fig. 2.3

V_1 = 2.4 V

I_1 = 0.5A [3]

(ii) Calculate the resistance R_1 of the resistor using the equation $R_1 = \frac{V_1}{I_1}$.

R_1 = 4.8Ω [1]

Examiner comments

Mark for (a)(i) = 3 out of 3

Mark for (a)(ii) = 1 out of 1

Example Candidate Response – high, continued

(b) She connects a second resistor in series with the first resistor. She connects the voltmeter across both resistors and records the potential difference V_2 across both resistors and the current I_2 in the circuit.

V_2 = 2.6

I_2 = 0.28

Calculate the resistance R_S of the resistors in series using the equation $R_S = \frac{V_2}{I_2}$.

R_S = 9.29Ω [1]

(c) She connects the second resistor in parallel with the first resistor. She connects the voltmeter across both resistors. She records the potential difference V_3 across the resistors and the current I_3 in the circuit.

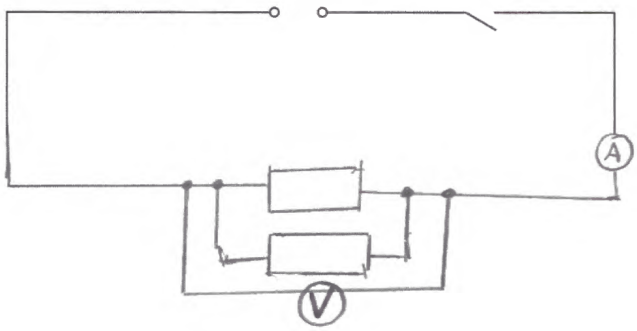
V_3 = 2.4

I_3 = 0.99

Calculate the resistance R_P of the resistors in parallel using the equation $R_P = \frac{V_3}{I_3}$. Give your answer to a suitable number of significant figures for this experiment.

R_P = 2.42Ω [1]

(d) Complete the circuit diagram to show the circuit she uses in part **(c)**.



1

[2]

(e) Describe how to extend part **(c)** of this experiment to investigate the relationship between the combined resistance of identical resistors connected in parallel and the number of resistors.

Combine 3 resistor in series and record the p.d and current and then repeat the experiment with the resistors connected in parallel. Finally, compare the data. 2

[2]

(f) In this type of electrical experiment, a variable resistor can be used to vary the current.

Draw the circuit symbol for a variable resistor.

[1]

[Total: 11]

Examiner comments

Mark for (b) = 1 out of 1

Mark for (c) = 1 out of 1

1 The circuit diagram is drawn correctly, but the way the voltmeter symbol is displayed is incorrect.
Mark for (d) = 1 out of 2

2 The candidate correctly suggests using additional resistors but needs to be clear whether they are to be placed in series or parallel.
Mark for (e) = 1 out of 2

Mark for (f) = 1 out of 1

Total mark awarded = 9 out of 11

How the candidate could have improved their answer

- **(d)** The candidate needed to draw the voltmeter symbol with care so that there was no line through it.
- **(e)** The candidate correctly suggested using more resistors but needed to make it clear that at least three more resistors had to be added, one at a time, and that these resistors needed to be connected in parallel and not in series.

Example Candidate Response – middle

Examiner comments

2 A student investigates resistance.

Fig. 2.1 shows the circuit she uses.

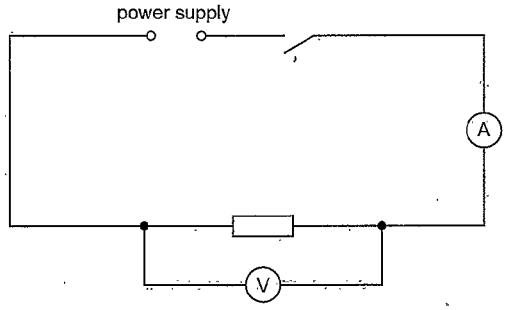


Fig. 2.1

(a) She records the potential difference (p.d.) V_1 across the resistor and the current I_1 in the circuit.

The meters are shown in Fig. 2.2 and Fig. 2.3.

(i) Write down the readings. Include the units for potential difference, current or resistance where appropriate in all parts of the question.

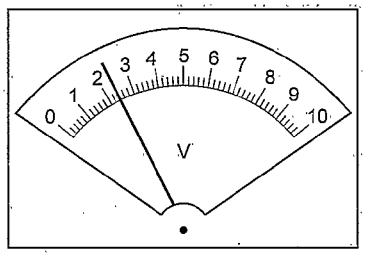


Fig. 2.2

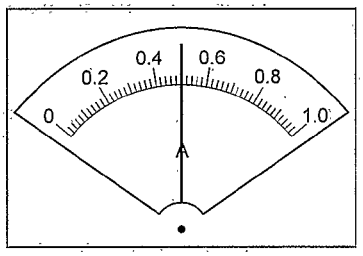


Fig. 2.3

V_1 = 2.4 V

I_1 = 0.5 A

[3]

Mark for (a)(i) = 3 out of 3

(ii) Calculate the resistance R_1 of the resistor using the equation $R_1 = \frac{V_1}{I_1}$.

2.4 / 0.5

R_1 = 4.8 Ω [1]

Mark for (a)(ii) = 1 out of 1

Example Candidate Response – middle, continued

(b) She connects a second resistor in series with the first resistor. She connects the voltmeter across both resistors and records the potential difference V_2 across both resistors and the current I_2 in the circuit.

V_2 = 2.6

I_2 = 0.28

Calculate the resistance R_S of the resistors in series using the equation $R_S = \frac{V_2}{I_2}$.

2.6 / 0.28

R_S = 9.28 Ω [1]

(c) She connects the second resistor in parallel with the first resistor. She connects the voltmeter across both resistors. She records the potential difference V_3 across the resistors and the current I_3 in the circuit.

V_3 = 2.4

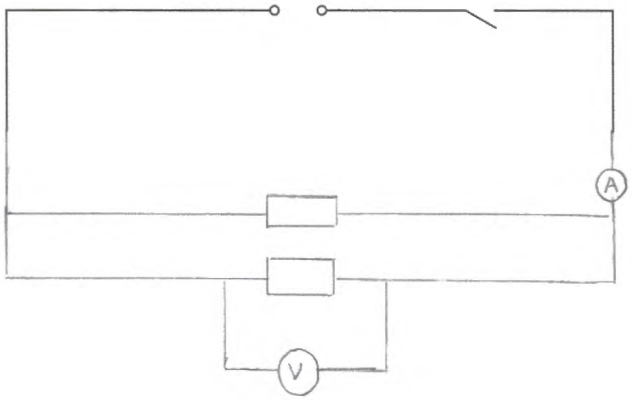
I_3 = 0.99

Calculate the resistance R_P of the resistors in parallel using the equation $R_P = \frac{V_3}{I_3}$. Give your answer to a suitable number of significant figures for this experiment.

2.4 / 0.99 = 2.4242...

R_P = 2.42 Ω [1]

(d) Complete the circuit diagram to show the circuit she uses in part **(c)**.



[2]

(e) Describe how to extend part **(c)** of this experiment to investigate the relationship between the combined resistance of identical resistors connected in parallel and the number of resistors.

Calculate the resistance of both resistors and divide them by the number of resistors, and observe the different resistances compared to the number of resistors.

[2]

(f) In this type of electrical experiment, a variable resistor can be used to vary the current.

Draw the circuit symbol for a variable resistor.

[1]

[Total: 11]

Examiner comments

1 The candidate rounds 9.2857 wrongly.
Mark for (b) = 0 out of 1

Mark for (c) = 1 out of 1

Mark for (d) = 2 out of 2

2 The candidate needs to clearly explain the use of adding resistors in the same circuit, one at a time.
Mark for (e) = 0 out of 2

3 The candidate incorrectly draws a symbol that is part variable resistor and part thermistor.
Mark for (f) = 1 out of 1

Total mark awarded = 7 out of 11

How the candidate could have improved their answer

- **(b)** The candidate performed the correct substitution and calculation but made a rounding error. 9.2857 needed to be rounded to 9.29 instead of 9.28.
- **(e)** The candidate needed to describe adding at least another three resistors in parallel, one at a time. There were many ways in which this could have been worded and the candidate would have been given credit for showing that they understood the practical principles and techniques involved.

Example Candidate Response – low

Examiner comments

2 A student investigates resistance.

Fig. 2.1 shows the circuit she uses.

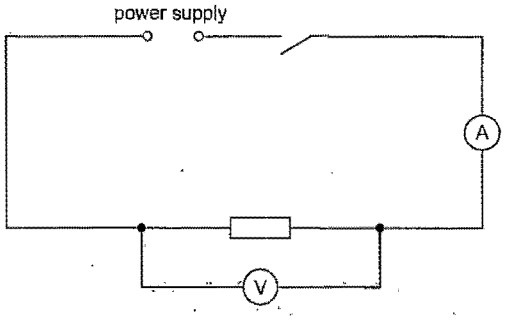


Fig. 2.1

(a) She records the potential difference (p.d.) V_1 across the resistor and the current I_1 in the circuit.

The meters are shown in Fig. 2.2 and Fig. 2.3.

(i) Write down the readings. Include the units for potential difference, current or resistance where appropriate in all parts of the question.

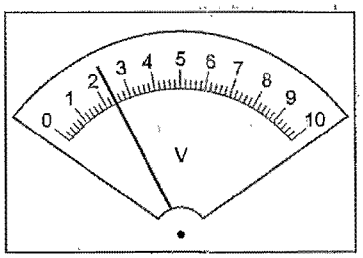


Fig. 2.2

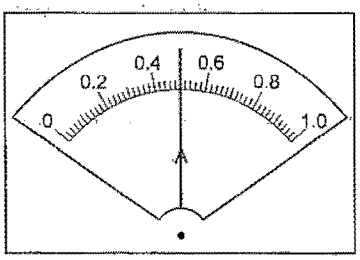


Fig. 2.3

V_1 = 2.4 Ω

I_1 = 0.45 A [3]

(ii) Calculate the resistance R_1 of the resistor using the equation $R_1 = \frac{V_1}{I_1}$.

$R_1 = \frac{2.4}{0.46}$

R_1 = 5.33 Ω [1]

1 The candidate gives the unit for ohm (crossed out) instead of the unit V for the potential difference. The candidate misreads the ammeter.
Mark for (a)(i) = 1 out of 3

Mark for (a)(ii) = 1 out of 1

Example Candidate Response – low, continued

Examiner comments

(b) She connects a second resistor in series with the first resistor. She connects the voltmeter across both resistors and records the potential difference V_2 across both resistors and the current I_2 in the circuit.

V_2 = 2.6

I_2 = 0.28

Calculate the resistance R_S of the resistors in series using the equation $R_S = \frac{V_2}{I_2}$.

$R_S = \frac{2.6}{0.28}$

R_S = 9.3 Ω [1]

Mark for (b) = 1 out of 1

(c) She connects the second resistor in parallel with the first resistor. She connects the voltmeter across both resistors. She records the potential difference V_3 across the resistors and the current I_3 in the circuit.

V_3 = 2.4

I_3 = 0.99

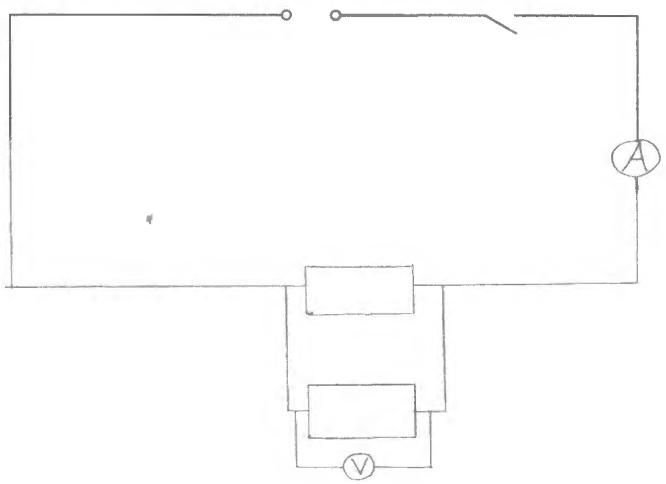
Calculate the resistance R_P of the resistors in parallel using the equation $R_P = \frac{V_3}{I_3}$. Give your answer to a suitable number of significant figures for this experiment.

$R_P = \frac{2.4}{0.99}$

R_P = 2.4 Ω [1]

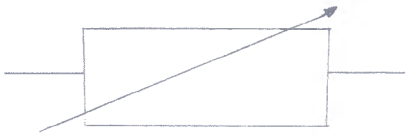
Mark for (c) = 1 out of 1

(d) Complete the circuit diagram to show the circuit she uses in part **(c)**.



[2]

Mark for (d) = 2 out of 2

Example Candidate Response – low, continued	Examiner comments
(e) Describe how to extend part (c) of this experiment to investigate the relationship between the combined resistance of identical resistors connected in parallel and the number of resistors. She should add the resistors together but she already knows that the resisters in parrallel are equal so she must add Rp and Rs. [2] 2 (f) In this type of electrical experiment, a variable resistor can be used to vary the current. Draw the circuit symbol for a variable resistor.  3 [1] [Total: 11]	2 The candidate needs to clearly explain the use of adding resistors in the same circuit, one at a time. Mark for (e) = 0 out of 2 3 The candidate incorrectly draws a symbol that is part variable resistor and part thermistor. Mark for (f) = 0 out of 1 **Total mark awarded = 6 out of 11**

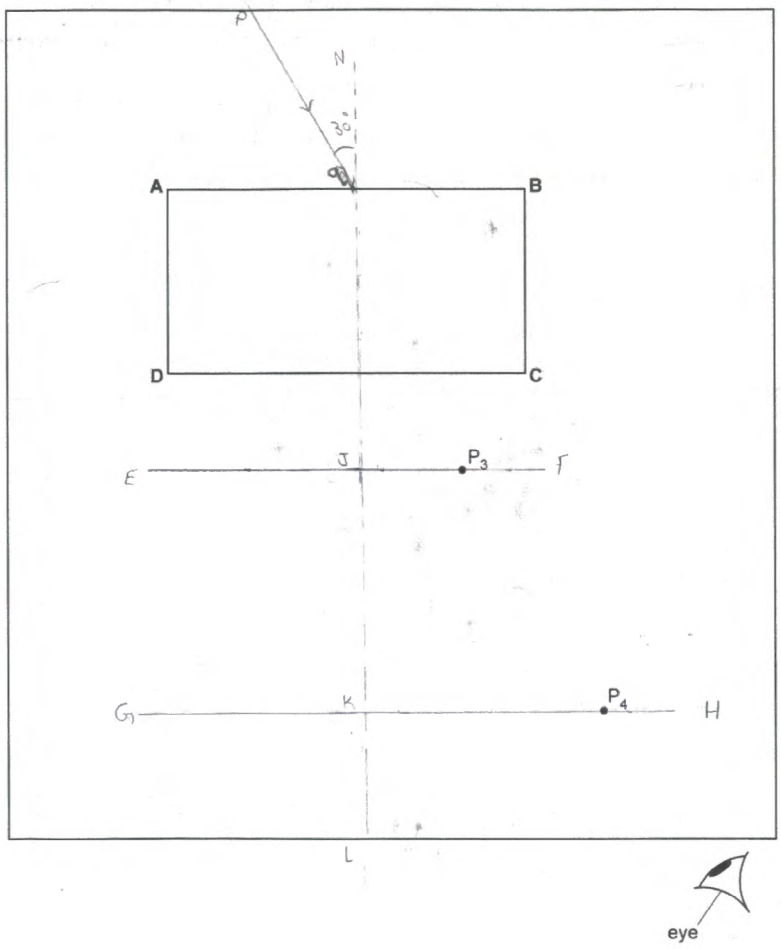
How the candidate could have improved their answer

- **(e)** The candidate needed to describe adding at least another three resistors in parallel, one at a time. There were many ways in which this could have been worded and the candidate would have been given credit for showing that they understood the practical principles and techniques involved.
- **(f)** The candidate needed to draw the strike-through arrow through each of the long sides of the rectangle.

Common mistakes candidates made in this question

- **(d)** The most common error was to place the voltmeter in series with the other components instead of in parallel with the resistors.
- **(e)** Vague answers were common here. Many candidates correctly suggested adding another resistor, but few suggested adding at least three more resistors (to give a good range of results). Candidates also needed to make it clear that these resistors should be connected in parallel with a set of readings taken each time another resistor was added.
- **(f)** Incorrect variable resistor symbols were common. Some of these were due to careless positioning of the strike-through arrow. A more common error was for candidates to draw the thermistor symbol or a symbol that appeared to be a combination of the thermistor symbol and the variable resistor symbol.

Question 3

Example Candidate Response – high	Examiner comments
3 A student investigates the refraction of light through a transparent block. Fig. 3.1 shows the transparent block **ABCD** on the student's ray-trace sheet.  **Fig. 3.1** **(a)** • Draw a normal at the centre of side **AB**. Continue the normal so that it reaches the bottom of the ray-trace sheet. Label the normal **NL**. • Label the point **Q** where **NL** crosses **AB**. [1]	Mark for (a) = 1 out of 1

Example Candidate Response – high, continued

(b)
- Draw a line **EF** parallel to **CD** and 2.0 cm below **CD**.
- Label the point **J** where **NL** crosses **EF**.
- Draw a line **GH** parallel to **CD** and 7.0 cm below **CD**.
- Label the point **K** where **NL** crosses **GH**.

[1]

(c) (i) Draw a line **PQ** at an angle $i = 30°$ to the normal and on the left-hand side of the normal above the block. [1]

(ii) The student places two pins P_1 and P_2 on line **PQ**. Fig. 3.1 is not drawn full size. Suggest a suitable distance apart for pins P_1 and P_2 in this type of experiment.

distance apart ..... 58 mm ..... [1]

(d) The student observes the images of P_1 and P_2 through side **CD** of the block. She adjusts her line of sight until the images of P_1 and P_2 appear one behind the other.
She places a pin P_3 on line **EF** and a pin P_4 on line **GH** so that P_3, and the images of P_1 and P_2 seen through the block, appear behind pin P_4.

(i) On Fig. 3.1, measure the length *a* of the line from **J** to P_3.

$a =$ ..... 21 mm ..... [1]

1

(ii) On Fig. 3.1, measure the length *b* of the line from **K** to P_4.

$b =$ ..... 49 mm ..... [1]

2

(iii) Calculate $\frac{b}{a}$.

49 / 21

$\frac{b}{a} =$ ..... 2.33 ..... [2]

3

(e) State **one** precaution that you would take in this type of experiment in order to produce an accurate ray trace.

- Draw using thin pencil lines

..... [1]

(f) A student plans to test the suggestion that, in this experiment, $\frac{b}{a}$ is a constant for all possible values of *i*. List suitable values of *i* that the student could use.

20°, 25°, 35°, 40°, 45° ..... [2]

4

[Total: 11]

Examiner comments

Mark for (b) = 1 out of 1

Mark for (c)(i) = 1 out of 1

Mark for (c)(ii) = 1 out of 1

1 The candidate gives a value that is just out of the range of acceptable responses.
Mark for (d)(i) = 0 out of 1

2 The candidate gives a value that is just out of the range of acceptable responses.
Mark for (d)(ii) = 0 out of 1

3 The candidate incorrectly draws a symbol that is part variable resistor and part thermistor.
Mark for (d)(iii) = 2 out of 2

Mark for (e) = 1 out of 1

4 The candidate suggests sufficient additional angles of incidence, but the range is too restricted.
Mark for (f) = 1 out of 2

Total mark awarded = 8 out of 11

How the candidate could have improved their answer

- **(d)(i), (d)(ii)** The candidate gave values just out of the range of acceptable responses. The position of normal drawn by the candidate on Fig. 3.1 was close enough to obtain the mark for **(a)**, but not close enough to produce sufficient accuracy for **(d)(i)** or **(d)(ii)**.
- **(f)** The candidate suggested a sufficient number of additional angles of incidence but a range of values of at least 30° was needed.

Example Candidate Response – middle

Examiner comments

3 A student investigates the refraction of light through a transparent block.

Fig. 3.1 shows the transparent block **ABCD** on the student's ray-trace sheet.

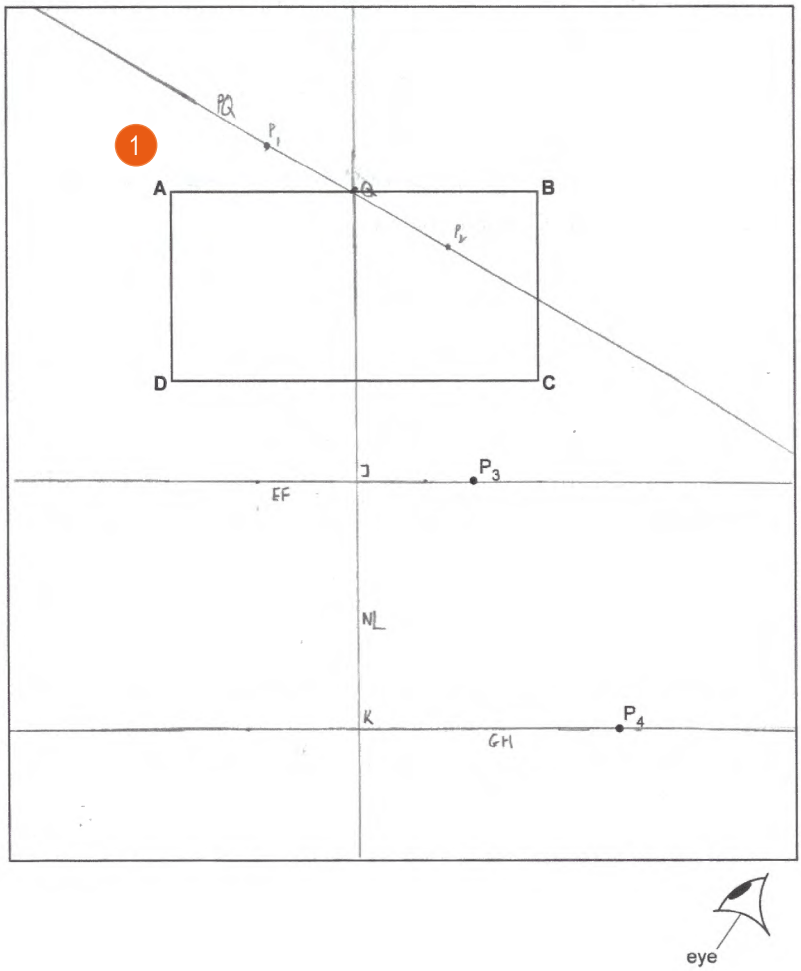


Fig. 3.1

(a) • Draw a normal at the centre of side **AB**. Continue the normal so that it reaches the bottom of the ray-trace sheet. Label the normal **NL**.

• Label the point **Q** where **NL** crosses **AB**.

[1]

1 The candidate needs to draw an incident ray at 30°, not 60°. Mark for (a) = 1 out of 1

Example Candidate Response – middle, continued	Examiner comments
(b) • Draw a line **EF** parallel to **CD** and 2.0 cm below **CD**. • Label the point **J** where **NL** crosses **EF**. • Draw a line **GH** parallel to **CD** and 7.0 cm below **CD**. • Label the point **K** where **NL** crosses **GH**. [1]	Mark for (b) = 1 out of 1
(c) (i) Draw a line **PQ** at an angle $i = 30°$ to the normal and on the left-hand side of the normal above the block. [1]	Mark for (c)(i) = 0 out of 1
(ii) The student places two pins P_1 and P_2 on line **PQ**. Fig. 3.1 is not drawn full size. Suggest a suitable distance apart for pins P_1 and P_2 in this type of experiment. distance apart ..4.2cm.. 2 [1]	2 The candidate needs to suggest a distance apart of at least 5 cm, so cannot be awarded the mark. Mark for (c)(ii) = 0 out of 1
(d) The student observes the images of P_1 and P_2 through side **CD** of the block. She adjusts her line of sight until the images of P_1 and P_2 appear one behind the other. She places a pin P_3 on line **EF** and a pin P_4 on line **GH** so that P_3, and the images of P_1 and P_2 seen through the block, appear behind pin P_4.	
(i) On Fig. 3.1, measure the length *a* of the line from **J** to P_3. $a =$ ..2.4cm.. [1]	Mark for (d)(i) = 1 out of 1
(ii) On Fig. 3.1, measure the length *b* of the line from **K** to P_4. $b =$ ..5.3cm.. [1]	Mark for (d)(ii) = 1 out of 1
(iii) Calculate $\frac{b}{a}$. $\frac{5.3}{2.4}$ $\frac{b}{a} =$ ..2.2.. [2]	Mark for (d)(iii) = 2 out of 2
(e) State **one** precaution that you would take in this type of experiment in order to produce an accurate ray trace. Draw the lines with care on the help of a protractor to avoid angle errors when drawing lines so a perpendicular line needs to be ensured is measured at 90° with the help of a protractor. 3 [1]	3 The candidate does not suggest a valid precaution that overcomes a difficulty in carrying out the experiment. Mark for (e) = 0 out of 1
(f) A student plans to test the suggestion that, in this experiment, $\frac{b}{a}$ is a constant for all possible values of *i*. List suitable values of *i* that the student could use. i = 40°, i = 45, i = 60°, i = 30° [2]	4 The candidate needs to suggest at least 4 values of angle of incidence in addition to the original 30°. Mark for (f) = 1 out of 2
4 [Total: 11]	**Total mark awarded = 7 out of 11**

How the candidate could have improved their answer

- **(c)(i)** The candidate needed to draw the incident ray at 30° to the normal. In this case, the candidate had drawn the ray at 30° to the surface of transparent block.
- **(c)(ii)** The candidate needed to suggest placing the pins further apart. The further apart the pins, the more accurately they can be judged to be exactly in line. Candidates should be advised, when doing practical work of this nature, to place the pins as far apart as practicable. The minimum spacing allowed in this case was 5.0 cm.
- **(e)** The candidate needed to suggest an important precaution. For example, viewing the bases of the pins would have been a valid precaution as this overcomes the difficulty of trying to ensure that the pins are vertical.
- **(f)** The candidate needed to suggest at least 4 angles (in addition to the original 30°). This would have indicated that the candidate understood that a sufficient number of results are required to draw a valid conclusion.

Example Candidate Response – low

Examiner comments

3 A student investigates the refraction of light through a transparent block.

Fig. 3.1 shows the transparent block **ABCD** on the student's ray-trace sheet.

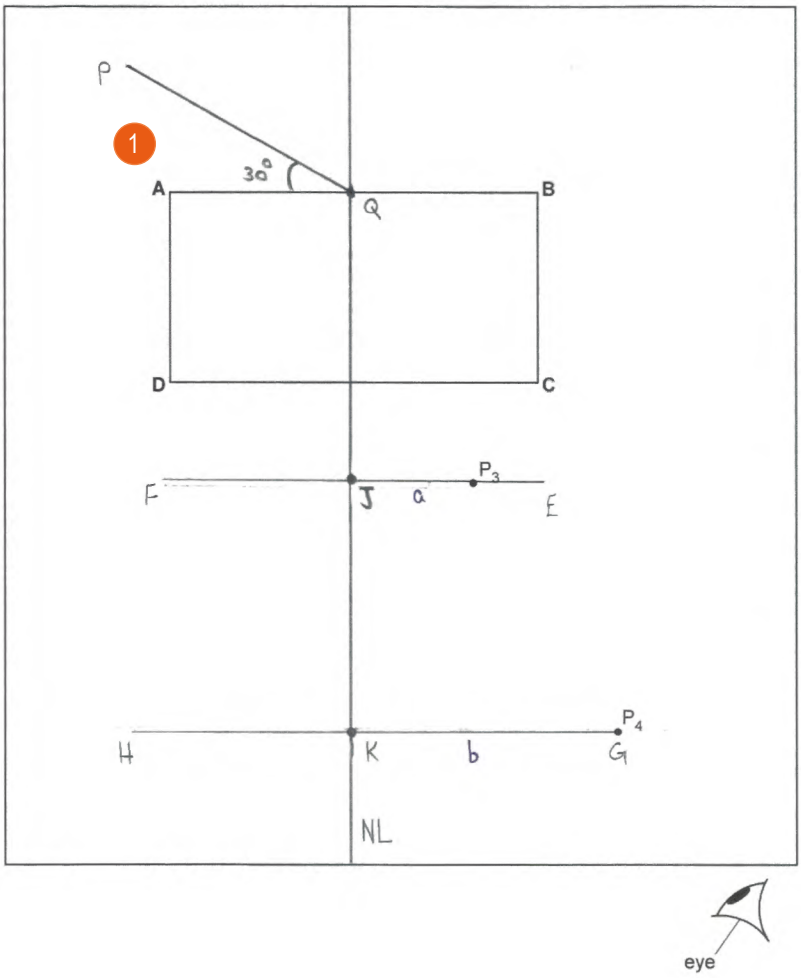


Fig. 3.1

(a)
- Draw a normal at the centre of side **AB**. Continue the normal so that it reaches the bottom of the ray-trace sheet. Label the normal **NL**.
- Label the point **Q** where **NL** crosses **AB**.

[1]

1 The candidate needs to draw an incident ray at 30°, not 60°. Mark for (a) = 1 out of 1

Example Candidate Response – low, continued

(b)
- Draw a line **EF** parallel to **CD** and 2.0 cm below **CD**.
- Label the point **J** where **NL** crosses **EF**.
- Draw a line **GH** parallel to **CD** and 7.0 cm below **CD**.
- Label the point **K** where **NL** crosses **GH**.

[1]

(c) (i) Draw a line **PQ** at an angle $i = 30°$ to the normal and on the left-hand side of the normal above the block. [1]

(ii) The student places two pins P_1 and P_2 on line **PQ**. Fig. 3.1 is not drawn full size. Suggest a suitable distance apart for pins P_1 and P_2 in this type of experiment.

distance apart ..1.25cm.. 2 [1]

(d) The student observes the images of P_1 and P_2 through side **CD** of the block. She adjusts her line of sight until the images of P_1 and P_2 appear one behind the other.
She places a pin P_3 on line **EF** and a pin P_4 on line **GH** so that P_3, and the images of P_1 and P_2 seen through the block, appear behind pin P_4.

(i) On Fig. 3.1, measure the length a of the line from **J** to P_3.

$a =$ ..2.5cm.. [1]

(ii) On Fig. 3.1, measure the length b of the line from **K** to P_4.

$b =$ ..5.4.. [1]

(iii) Calculate $\frac{b}{a}$.

$\frac{5.4}{2.5} = 2.16$cm $\frac{b}{a} =$ ..2.16cm.. 3 [2]

(e) State **one** precaution that you would take in this type of experiment in order to produce an accurate ray trace.

..Try to make the lines (drawings) as thin as possible.. 4 [1]

(f) A student plans to test the suggestion that, in this experiment, $\frac{b}{a}$ is a constant for all possible values of i. List suitable values of i that the student could use.

..40° & 20°.. 5 [2]

[Total: 11]

Examiner comments

Mark for (b) = 1 out of 1

Mark for (c)(i) = 0 out of 1

2 The candidate needs to suggest a distance apart of at least 5 cm.
Mark for (c)(ii) = 0 out of 1

Mark for (d)(i) = 1 out of 1

Mark for (d)(ii) = 1 out of 1

3 The ratio is within the tolerance allowed, but the candidate incorrectly includes a unit.
Mark for (d)(iii) = 1 out of 2

4 The candidate does not suggest a valid precaution that overcomes a difficulty in carrying out the experiment.
Mark for (e) = 1 out of 1

5 The candidate needs to suggest at least 4 values of angle of incidence in addition to the original 30°, with a wide range.
Mark for (f) = 0 out of 2

Total mark awarded = 6 out of 11

How the candidate could have improved their answer

- **(c)(i)** The candidate needed to draw the incident ray at 30° to the normal. In this case, the candidate drew the ray at 30° to the surface of transparent block.
- **(c)(ii)** The candidate needed to suggest placing the pins further apart. The further apart the pins, the more accurately they can be judged to be exactly in line. Candidates should be advised, when doing practical work of this nature, to place the pins as far apart as practicable. The minimum spacing allowed in this case was 5.0 cm.
- **(d)(iii)** The value for the ratio was correctly calculated and within the allowed tolerance, but the candidate also needed to identify that the ratio had no unit.
- **(f)** The candidate needed to suggest at least 4 angles (in addition to the original 30°). This would have indicated that the candidate understood that a sufficient number of results are required to draw a valid conclusion. The angles stated also needed to cover as wide a range as possible, but all under 90 degrees.

Common mistakes candidates made in this question

- **(c)(i)** The most common error was to draw the line PQ at 60° to the normal instead of 30°.
- **(c)(ii)** A common error was to suggest placing the pins too close together (less than 5.0 cm).
- **(d)(iii)** The most common error was candidates giving the unit cm for the ratio.
- **(e)** Some candidates suggested inappropriate precautions such as using a darkened room (appropriate for a ray box experiment but not this experiment).
- **(f)** Common errors made by candidates included:
    - suggesting too few additional angles and/or
    - stating too narrow a range of angles stating too narrow a range of angles.

Question 4

Example Candidate Response – high	Examiner comments

4 A student investigates the rate of cooling, in air, of heated blocks made of different metals. The temperature of each block is increased by placing it in hot water.

Plan an experiment to investigate how the rate of cooling depends on the metal from which each block is made.

The following apparatus is available to the student:

cylindrical blocks of different metals, each with a hole for a thermometer, as shown in Fig. 4.1
a thermometer.

Other apparatus normally available in a school laboratory can also be used.

In your plan, you should:

- list any additional apparatus required
- explain briefly how you would carry out the investigation, including the measurements you would take
- state the key variables to be kept constant
- draw a suitable table, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use the results to reach a conclusion.

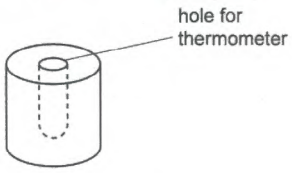
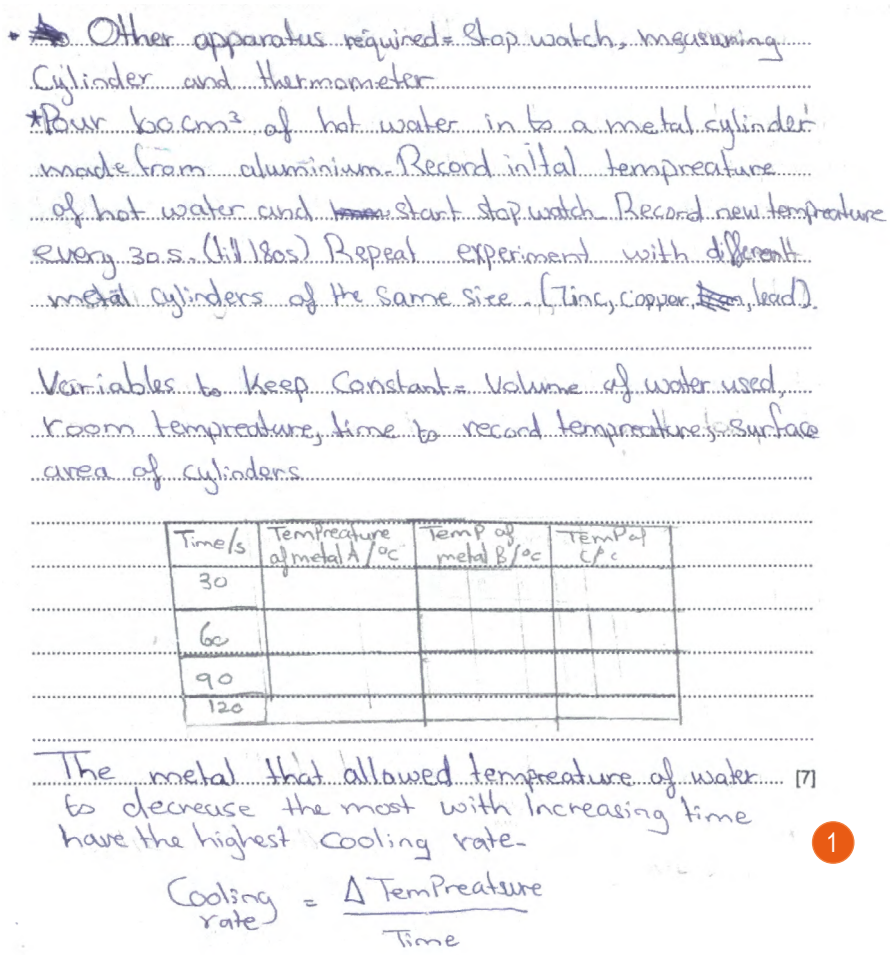
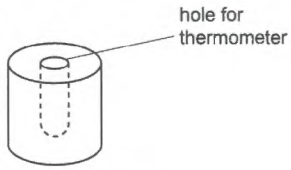


Fig. 4.1

Example Candidate Response – high, continued	Examiner comments
	1 The candidate successfully covers all marking points other than marking point 2. **Total mark awarded = 6 out of 7**

How the candidate could have improved their answer

The candidate was required to state clearly that each block needed to be immersed in the hot water and then removed to allow it to cool down in air (marking point 2). In spite of this, all the other marking points were successfully covered.

Example Candidate Response – middle	Examiner comments
4 A student investigates the rate of cooling, in air, of heated blocks made of different metals. The temperature of each block is increased by placing it in hot water. Plan an experiment to investigate how the rate of cooling depends on the metal from which each block is made. The following apparatus is available to the student: cylindrical blocks of different metals, each with a hole for a thermometer, as shown in Fig. 4.1 a thermometer. Other apparatus normally available in a school laboratory can also be used. In your plan, you should: • list any additional apparatus required • explain briefly how you would carry out the investigation, including the measurements you would take • state the key variables to be kept constant • draw a suitable table, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table) • explain how you would use the results to reach a conclusion.  **Fig. 4.1**	

Example Candidate Response – middle, continued	Examiner comments

Rate of cooling diffirent metals:

Beaker, diffirent metals cylenders, water, bunsen burner, thermometer and stop watch.

- Pour water in beaker 1
- Place beaker above bunsen burner to heat up
- Check tempreture of water with thermometer
- Put the metal cylenders one at a time and take them out when it's heated
- records the results and use stop watch to take the time taken to cool.

- Keep tempreture the same/constant
- Same amount of water and weight of metal

2

[7]

metal	Time taken	Temp before	Temp

3

1 The candidate does not include a clear statement of the method (marking point 3).

2 The candidate does not provide a conclusion.

3 The candidate produces a table, but does not include the correct units for temperature (°C) and time (s) (marking point 6).

Total mark awarded = 4 out of 7

How the candidate could have improved their answer

- The candidate was required to give a fuller account of the method, including the need to record temperatures over a fixed time, or record the time for a fixed temperature drop, or record the temperatures at regular time intervals (marking point 3).
- In the table, the candidate needed to use the correct units for temperature (°C) and time (s) (marking point 6).
- The candidate needed to write a conclusion consistent with the method. For example, comparing temperature drops if a fixed time had been used or comparing times if a fixed temperature drop had been used (marking point 7).

Example Candidate Response – low	Examiner comments

4 A student investigates the rate of cooling, in air, of heated blocks made of different metals. The temperature of each block is increased by placing it in hot water.

Plan an experiment to investigate how the rate of cooling depends on the metal from which each block is made.

The following apparatus is available to the student:

cylindrical blocks of different metals, each with a hole for a thermometer, as shown in Fig. 4.1
a thermometer.

Other apparatus normally available in a school laboratory can also be used.

In your plan, you should:

- list any additional apparatus required
- explain briefly how you would carry out the investigation, including the measurements you would take
- state the key variables to be kept constant
- draw a suitable table, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use the results to reach a conclusion.

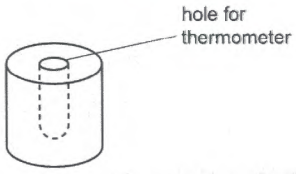
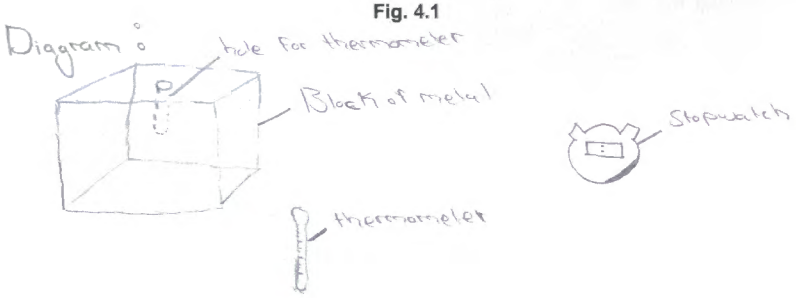


Fig. 4.1



Example Candidate Response – low, continued

Methodology:

1.) Place any block of metals in a room of normal (room) temperature,

2.) Place the hole of for the thermometer in the metal Block, After record the initial temperature of the block and after a fixed time interval e.g 100s check the temperature again

Key variables to be kept constant - Quantity (mass) of each metal block used, the interval for the temperature check, environment where all metals are being tested should be the same.

Type of metal (block)	temp difference after 100s

I would use these results to reach a conclusion by observing the metal with the largest difference after 100s this will help me to reach a judgement of how the rate of cooling depends on the type of metal ~~from which~~ block. [7]

Examiner comments

1 The candidate does not include a reference to using a stopwatch (marking point 1).

2 The candidate does not explain that the blocks are to be removed from the hot water to allow them to cool (Marking point 2). Additionally, the candidate needs to state that the method is repeated with the other metal blocks (marking point 4).

3 The candidate's table is incomplete.

4 The candidate does not write a clear conclusion (marking point 7).

Total mark awarded = 2 out of 7

How the candidate could have improved their answer

- The candidate did identify key variables to control but the method needed more detail: the answer needed to include reference to using a stopwatch or other suitable timing device (marking point 1).
- The candidate was required to explain that the blocks needed to be removed from the hot water before allowing them to cool (marking point 2).
- The candidate also needed to state clearly that the procedure had to be repeated with the other metal blocks (marking point 4).
- This table should have included columns for initial and final temperatures, together with the unit °C (marking point 6).
- The account also required a clear conclusion. This could have involved either suggesting plotting a graph of temperature against time for each block or comparing temperature drops or times for the different metals. How this was expressed would have depended upon whether the candidate had used a fixed temperature drop or a fixed cooling time (marking point 7).

Common mistakes candidates made in this question

- Most candidates described a cooling experiment but did not state the need for a stopwatch (or other suitable timing device).
- Some candidates described pouring hot water into the hole in the block for the thermometer rather than immersing the block in hot water.
- Candidates referred to immersing the blocks in hot water, but then did not describe removing the blocks from the hot water to start the cooling process. This was a very common error.
- Candidates wrote vague conclusions, and some gave no conclusions.
- The bullet points in the question were provided to help candidates organise their answers. Candidates should be encouraged to use these points to structure their responses. Successful candidates often wrote a concise account addressing the bullet points in order.

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