Cambridge Assessment International Education

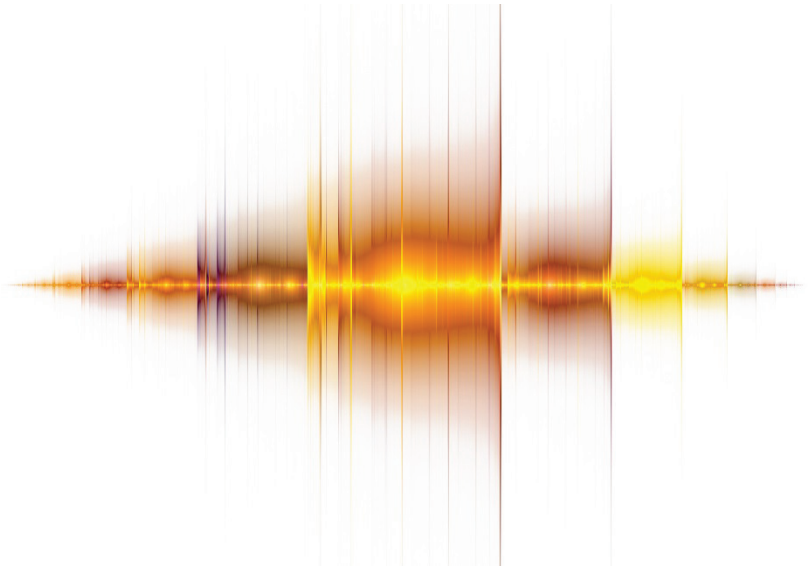
Example Candidate Responses

Paper 5

Cambridge IGCSE®

Physics 0625

For examination from 2016



Version 2.0

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Introduction

The main aim of this booklet is to exemplify standards for those teaching IGCSE Physics (0625), 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 to exemplify a range of answers. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For each question, response is annotated with clear explanation of where and why marks were awarded or omitted. This, in turn, 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 will have to do to improve their marks. At the end there is a list of common mistakes candidates made in their answers for each question.

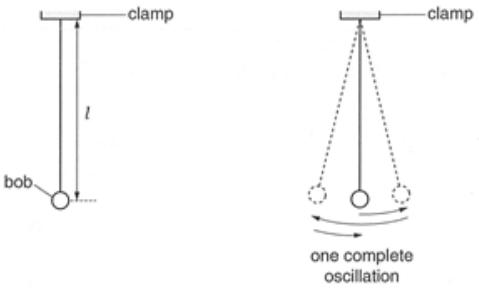
This document provides illustrative examples of candidate work. These help teachers to assess the standard required to achieve marks, beyond the guidance of the mark scheme. Some question types where the answer is clear from the mark scheme, such as short answers and multiple choice, have therefore been omitted.

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

Question Paper 3, June 2016	
Question paper	0625_s16_qp_31.pdf
Mark scheme	0620_s16_ms_31.pdf
Question Paper 4, June 2016	
Question paper	0620_s16_qp_41.pdf
Mark scheme	0620_s16_ms_41.pdf
Question Paper 5, November 2016	
Question paper	0620_w16_qp_52.pdf
Mark scheme	0620_w16_ms_52.pdf
Question Paper 6, June 2016	
Question paper	0620_s16_qp_61.pdf
Mark scheme	0620_s16_ms_61.pdf

Other past papers, Examiner Reports and other teacher support materials are available on the School Support Hub at www.cambridgeinternational.org/support

How to use this booklet

Example Candidate Response – high	Examiner comments
1 In this experiment, you will use a pendulum to determine a value for the acceleration of free fall *g*. Carry out the following instructions, referring to Figs. 1.1 and 1.2.  measured to the centre of the hen measuring the length *l*. along the el eye	**Examiner annotations:** Each response is annotated with clear explanation of where and why marks were awarded or omitted. In this way it is possible for you to understand what candidates have done to gain their marks. **1** The candidate shows understanding of perpendicular viewing of the scale on the metre rule.

Answers 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.

How the candidate could have improved the answer

(d) (ii) The candidate could have suggested two
experiment using different lengths, repeating the
repeating the timing of the 20 oscillations several
that merely suggesting repeats, without specifyin

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

Common mistakes candidates made in this question

The most common mistakes were to miss the unit
equation in part **(c) (ii)** and not to be able to sugge

Common mistakes a list of common mistakes candidates made in their answers for each question.

Assessment at a glance

All candidates take three papers.

Candidates who have studied the Core subject content, or who are expected to achieve a grade D or below, should be entered for Paper 1, Paper 3 and either Paper 5 or Paper 6. These candidates will be eligible for grades C to G.

Candidates who have studied the Extended subject content (Core and Supplement), and who are expected to achieve a grade C or above, should be entered for Paper 2, Paper 4 and either Paper 5 or Paper 6. These candidates will be eligible for grades A* to G.

Core candidates take:

Paper 1 45 minutes
Multiple Choice 30%
40 marks
40 four-choice multiple-choice questions
Questions will be based on the Core subject content
Assessing grades C–G
Externally assessed

Extended candidates take:

Paper 2 45 minutes
Multiple Choice 30%
40 marks
40 four-choice multiple-choice questions
Questions will be based on the Extended subject content (Core and Supplement)
Assessing grades A*–G
Externally assessed

and Core candidates take:

Paper 3 1 hour 15 minutes
Theory 50%
80 marks
Short-answer and structured questions
Questions will be based on the Core subject content
Assessing grades C–G
Externally assessed

and Extended candidates take:

Paper 4 1 hour 15 minutes
Theory 50%
80 marks
Short-answer and structured questions
Questions will be based on the Extended subject content (Core and Supplement)
Assessing grades A*–G
Externally assessed

All candidates take either:

Paper 5 1 hour 15 minutes
Practical Test 20%
40 marks
Questions will be based on the experimental skills in Section 4
Assessing grades A*–G
Externally assessed

or:

Paper 6 1 hour
Alternative to Practical 20%
40 marks
Questions will be based on the experimental skills in Section 4
Assessing grades A*–G
Externally assessed

Teachers are reminded that the latest syllabus is available on our public website at www.cambridgeinternational.org and the School Support Hub at www.cambridgeinternational.org/support

Paper 5 – Practical Test

Question 1

Example candidate response – high	Examiner comments

1 In this experiment, you will use a pendulum to determine a value for the acceleration of free fall *g*.

Carry out the following instructions, referring to Figs. 1.1 and 1.2.

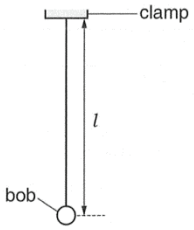


Fig. 1.1

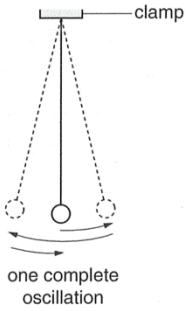


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1.

(a) Adjust the pendulum until its length $l = 50.0$ cm. The length l is measured to the centre of the bob.

Explain briefly how you avoided a parallax (line of sight) error when measuring the length l.

Place the meter rule vertically along the pendelum and horizontally level eye with the 50 cm mark and 0cm mark when measuring length of L. 1 [1]

(b) Displace the pendulum bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

(i) Measure the time t for 20 complete oscillations.

$t =$ 28.3 s 2 [1]

(ii) Calculate the period T of the pendulum. The period is the time for one complete oscillation.

$\frac{28.3}{20} = 1.415$

$= 1.42$ s

$T =$ 1.42 s 3 [2]

1 The candidate shows understanding of perpendicular viewing of the scale on the metre rule.

Mark awarded for (a) = 1 out of 1

2 The time t is within the tolerance allowed, showing that the candidate has followed the instructions carefully, adjusting the pendulum to the required length and counting the correct number of oscillations.

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

3 The calculation is correct and the unit *s* is used.

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

Example candidate response – high, continued	Examiner comments

(iii) Measuring the time for a large number of oscillations, rather than for 1 oscillation, gives a more accurate value for T.

Suggest one practical reason why measuring the time for 200 oscillations, rather than 20 oscillations, may not be suitable.

The number of oscillation may be too large and the speed may change after a while thus the result may not be accurate for T. [1] 4

(c) (i) Calculate T^2.

T^2 = 2.0164 s^2 [1] 5

(ii) Calculate the acceleration of free fall g using the equation $g = \frac{4\pi^2 l}{T^2}$. Give your answer to a suitable number of significant figures for this experiment.

$\frac{4\pi^2 \times 50}{2.0164} = 978.93...$

$= 979$ cm/s²

$= 9.79$ m/s²

g = 9.79 m/s² [2] 6

(d) A student checks the value of the acceleration of free fall g in a text book. The value in the book is 9.8 m/s².

(i) Suggest a practical reason why the result obtained from the experiment may be different.

Because we cannot exactly start and stop the timer during the oscillation period because of humans have a reaction rate of 0.04s. [1] 7

(ii) Suggest two improvements to the experiment.

1. .....

.....

2. .....

..... 8

[2]

[Total: 11]

4 The candidate makes a sensible suggestion. Note that the suggestion in this case does not necessarily have to be theoretically correct since that would require knowledge beyond the core curriculum.

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

5 The candidate shows attention to detail and good understanding of units, giving s^2 for the unit of T^2.

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

6 The candidate shows good attention to detail, converting from *cm*/s² to *m*/s² to arrive at a value, given to three significant figures, within the tolerance allowed.

Mark awarded for (c) (ii) = 2 out of 2

7 The candidate correctly identifies a possible reason related to reaction time.

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

8 The candidate does not suggest any improvements.

Mark awarded for (d) (ii) = 0 out of 2

Total mark awarded = 9 out of 11

How the candidate could have improved the answer

(d) (ii) The candidate could have suggested two possible improvements. For example, repeating the experiment using different lengths, repeating the experiment using an increased number of oscillations, repeating the timing of the 20 oscillations several times and taking an average, using a fiducial marker. No credit is given for simply suggesting repeats without specifying details.

Example candidate response – middle	Examiner comments

1 In this experiment, you will use a pendulum to determine a value for the acceleration of free fall *g*.

Carry out the following instructions, referring to Figs. 1.1 and 1.2.

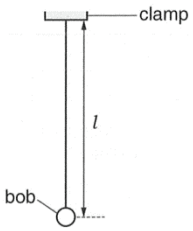


Fig. 1.1

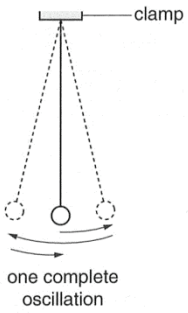


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1.

(a) Adjust the pendulum until its length $l = 50.0\,\text{cm}$. The length l is measured to the centre of the bob.

Explain briefly how you avoided a parallax (line of sight) error when measuring the length l.

View the ruler at right angles

1

.....[1]

(b) Displace the pendulum bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

(i) Measure the time t for 20 complete oscillations.

2 $t =$ 28 ~~15~~ seconds .....[1]

(ii) Calculate the period T of the pendulum. The period is the time for one complete oscillation.

20/15 = ~~1.333...~~ 28/20 = 1.4

3 $T =$ 1.4 ~~1.33~~ seconds .....[2]

1 The candidate shows understanding of perpendicular viewing of the scale on the metre rule.

Mark awarded for (a) = 1 out of 1

2 The time *t* is within the tolerance allowed. This shows the candidate has followed the instructions carefully, adjusting the pendulum to the required length and counting the correct number of oscillations.

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

3 The calculation is correct and the unit *s* is used.

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

Example candidate response – middle, continued	Examiner comments

(iii) Measuring the time for a large number of oscillations, rather than for 1 oscillation, gives a more accurate value for T.

Suggest one practical reason why measuring the time for 200 oscillations, rather than 20 oscillations, may not be suitable.

It will take too long ~~and~~ to measure the time for 200 oscillations ④ [1]

(c) (i) Calculate T^2.

1.777....

1.96

T^2 = ~~1.78 seconds~~ ⑤ [1]

(ii) Calculate the acceleration of free fall g using the equation $g = \frac{4\pi^2 l}{T^2}$. Give your answer to a suitable number of significant figures for this experiment.

$\frac{4 \times \pi^2 \times \frac{0.5}{50}}{1.78}$ = ~~H0.330~~ ~~11.10366~~ ~~H08.44315~~

= 10.07

10.1

g = ~~11109~~ ~~11.1~~ ⑥ m/s² [2]

(d) A student checks the value of the acceleration of free fall g in a text book. The value in the book is 9.8 m/s².

(i) Suggest a practical reason why the result obtained from the experiment may be different.

There was no air resistance accounted for in my results ⑦ [1]

(ii) Suggest two improvements to the experiment.

1. Repeat the experiment to get the average

2. Measure the length from centre of bob ⑧ [2]

[Total: 11]

④ This is too vague to score a mark.

Mark awarded for (b) (iii) = 0 out of 1

⑤ The candidate does not give the unit s^2.

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

⑥ The candidate shows good attention to detail using 0.5 *m* rather than 50 *cm* to arrive at a value, given to three significant figures, within the tolerance allowed.

Mark awarded for (c) (ii) = 2 out of 2

⑦ The candidate does not identify a good practical reason.

Mark awarded for (d) (i) = 0 out of 1

⑧ The candidate does not suggest suitable improvements.

Mark awarded for (d) (ii) = 0 out of 2

Total mark awarded = 6 out of 11

How the candidate could have improved the answer

(c) (i) The candidate should have included a unit and worked out that since the unit of time is *s*, the unit of a time squared must be s^2.

(b) (iii) and **(d) (i)** and **(ii)** The candidate could have used the experience of practical work gained during the IGCSE course to carefully consider the experiment and suggest suitable practical reasons for the difficulty in recording a very large number of oscillations, the experimental result being different to the accepted value and improvements to the experiment.

Example candidate response – low	Examiner comments

1 In this experiment, you will use a pendulum to determine a value for the acceleration of free fall g.

Carry out the following instructions, referring to Figs. 1.1 and 1.2.

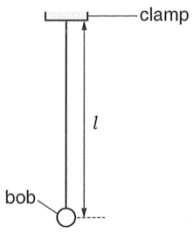


Fig. 1.1

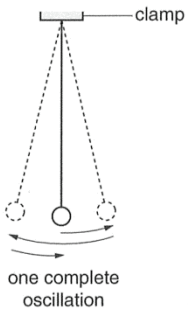


Fig. 1.2

A pendulum has been set up for you as shown in Fig. 1.1.

(a) Adjust the pendulum until its length $l = 50.0\,\text{cm}$. The length l is measured to the centre of the bob.

Explain briefly how you avoided a parallax (line of sight) error when measuring the length l.

I used a ruler to align the middle of the bob to the rule of measurement as this could avoid error. [1]

(b) Displace the pendulum bob slightly and release it so that it swings. Fig. 1.2 shows one complete oscillation of the pendulum.

(i) Measure the time t for 20 complete oscillations.

$t =$ 37.0 seconds. [1]

(ii) Calculate the period T of the pendulum. The period is the time for one complete oscillation.

$\frac{37.0\text{ s}}{20}$

$T =$ 1.85 [2]

1 The candidate writes just enough to convey the idea of using a horizontal straight edge.

Mark awarded for (a) (i) = 1 out of 1

2 The time t is beyond the tolerance allowed, showing that the candidate has either adjusted the pendulum to the wrong length or counted the wrong number of oscillations.

Mark awarded for (b) (i) = 0 out of 1

3 The calculation is correct but the unit s is missing.

Mark awarded for (b) (ii) = 1 out of 2

Example candidate response – low, continued	Examiner comments
(iii) Measuring the time for a large number of oscillations, rather than for 1 oscillation, gives a more accurate value for T. Suggest one practical reason why measuring the time for 200 oscillations, rather than 20 oscillations, may not be suitable. *It would be more accurate as a persons time delay needs to be countered for and it is difficult to count for for oscillations* [1] **(c) (i)** Calculate T^2. $(1.85)^2 = 3.4225$ (3 S.F) $T^2 = 3.4225$ [1] **(ii)** Calculate the acceleration of free fall g using the equation $g = \frac{4\pi^2 l}{T^2}$. Give your answer to a suitable number of significant figures for this experiment. $g = \frac{4\pi^2 \times 50.0}{3.4225} = 183.584$ 3 (S.F) $= 184$ $g = 184$ m/s² [2] **(d)** A student checks the value of the acceleration of free fall g in a text book. The value in the book is 9.8 m/s². **(i)** Suggest a practical reason why the result obtained from the experiment may be different. *Because the value of accelaration of freefall may differ slightly from place to place.* [1] **(ii)** Suggest two improvements to the experiment. 1. *To get accurate results we could have made use of a sensor which starts and end time on pendulum crossing it.* 2. *Don More number of oscillations should be taken.* [2] [Total: 11]	4 The candidate does not give a valid practical reason. Mark awarded for (b) (iii) = 0 out of 1 5 The unit s^2 is missing. Mark awarded for (c) (i) = 0 out of 1 6 The value is outside the tolerance allowed but it is given to a sensible three significant figures. Mark awarded for (c) (ii) = 1 out of 2 7 The candidate does not give a valid practical reason. Mark awarded for (d) (i) = 0 out of 1 8 The candidate gives one suitable suggestion. Mark awarded for (d) (ii) = 1 out of 2 **Total mark awarded = 4 out of 11**

How the candidate could have improved the answer

The candidate could have paid more attention to the details of the experiment in order to obtain a value of t within tolerance and to use correct units throughout.

(b) (iii) and **(d) (i)** and **(ii)** The candidate could have used the experience of practical work gained during the IGCSE course to carefully consider the experiment and suggest suitable practical reasons for the difficulty in recording a very large number of oscillations, the experimental result being different to the accepted value.

Common mistakes candidates made in this question

- Missing the unit s^2 for T^2 (or using s).
- **(c) (ii)**.Using 50 cm instead of 0.5 m in the equation.
- **(d) (ii)** Being unable to suggest suitable improvements to the experiment.

Question 2

Example candidate response – high	Examiner comments
2 In this experiment, you will investigate the cooling of water. (a) • Pour 100 cm^3 of the hot water provided into beaker **A**. • Measure the temperature θ_H of the water in beaker **A**. θ_H = 86 °C • Pour 100 cm^3 of the cold water provided into beaker **B**. • Measure the temperature θ_C of the water in beaker **B**. θ_C = 30 °C • Calculate the average temperature θ_{AV} using the equation $\theta_{AV} = \frac{\theta_H + \theta_C}{2}$. $\frac{86 + 30}{2}$ θ_{AV} = 58 °C 1 [3] (b) Add the water from beaker **B** to the hot water in beaker **A**. Stir briefly. Measure the temperature θ_M of the mixture. θ_M = 51 °C 2 [1] (c) State one precaution that you took to ensure that the temperature readings are as reliable as possible. Make sure that I take the readings from eye level to prevent parallex error [1] 3	1 The candidate records temperature values within tolerance and correctly calculates the average temperature. The correct unit °C is used throughout. Mark awarded for (a) = 3 out of 3 2 The candidate records a temperature for the mixture that is within tolerance. Mark awarded for (b) = 1 out of 1 3 The candidate's wording is just sufficient to convey the idea of perpendicular viewing of the thermometer scale. Mark awarded for (c) = 1 out of 1

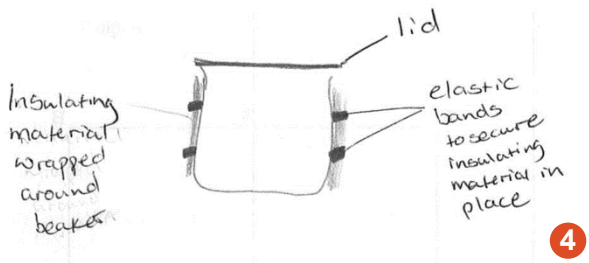
Example candidate response – high, continued	Examiner comments

(d) Empty both beakers.

You are provided with

- a lid, with a hole for the thermometer,
- some insulating material,
- two elastic bands.

(i) In the space below, draw a labelled diagram to show how you will use these items to reduce the loss of thermal energy when the procedure is repeated.



4

[2]

(ii) Using the improvements shown in your diagram, repeat the procedure in parts **(a)** and **(b)**.

θ_H = ~~62°~~ 73°C

θ_C = 31°C

θ_{AV} = 52°C

θ_M = 50°C

5

[1]

(iii) Comment on whether the improvements made to the apparatus have significantly changed the value of the temperature θ_M. Use your results to justify your answer.

~~No~~ The value of θM has not significantly changed, because there is only a 1°C difference between both experiments

6

[1]

(iv) Suggest two conditions that should be kept constant for all parts of this experiment.

1. The amount of water used

2. ~~The external environment~~ room temperature must be maintained

7

[2]

[Total: 11]

4 The diagram is clear.

Mark awarded for (d) (i) = 2 out of 2

5 The candidate records a realistic set of readings.

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

6 The candidate makes a clear statement and justifies it by reference to the results, correctly quoting the difference in the two values for θ_M.

Mark awarded for (d) (iii) = 1 out of 1

7 The candidate gives two conditions that should be kept constant.

Mark awarded for (d) (iv) = 2 out of 2

Total mark awarded = 11 out of 11

How the candidate could have improved the answer

This answer gained full marks. However, the answer to **(c)** includes the rather vague phrase 'from eye level'. This would be more clearly expressed as 'view the thermometer scale perpendicularly' or similar wording.

Example candidate response – middle	Examiner comments

2 In this experiment, you will investigate the cooling of water.

(a)
- Pour 100 cm^3 of the hot water provided into beaker **A**.
- Measure the temperature θ_H of the water in beaker **A**.

θ_H = 78°

- Pour 100 cm^3 of the cold water provided into beaker **B**.
- Measure the temperature θ_C of the water in beaker **B**.

θ_C = 32°

- Calculate the average temperature θ_{AV} using the equation $\theta_{AV} = \frac{\theta_H + \theta_C}{2}$.

$\theta_{AV} = \frac{78 + 32}{2}$

θ_{AV} = 55

θ_{AV} = 55° 1 [3]

(b) Add the water from beaker **B** to the hot water in beaker **A**. Stir briefly.

Measure the temperature θ_M of the mixture.

θ_M = 52° 2 [1]

(c) State one precaution that you took to ensure that the temperature readings are as reliable as possible.

keep room temperature constant. Use the same volume of water for both hot and cold water 3 [1]

1 The candidate records temperature values within tolerance and correctly calculates the average temperature. An incorrect unit ° is used throughout.

Mark awarded for (a) = 2 out of 3

2 The candidate records a temperature for the mixture that is within tolerance.

Mark awarded for (b) = 1 out of 1

3 The candidate does not answer the question. (This answer would have scored both marks if given for d (iv)).

Mark awarded for (c) = 0 out of 1

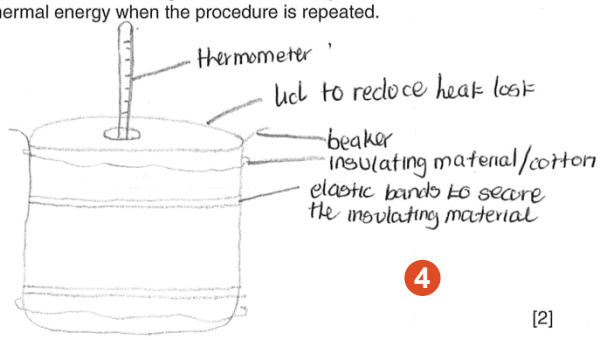
Example candidate response –middle, continued	Examiner comments

(d) Empty both beakers.

You are provided with

- a lid, with a hole for the thermometer,
- some insulating material,
- two elastic bands.

(i) In the space below, draw a labelled diagram to show how you will use these items to reduce the loss of thermal energy when the procedure is repeated.



4

[2]

(ii) Using the improvements shown in your diagram, repeat the procedure in parts **(a)** and **(b)**.

θ_H = 77°

θ_C = 32°

θ_{AV} = 54.5°

θ_M = 56° 5

[1]

(iii) Comment on whether the improvements made to the apparatus have significantly changed the value of the temperature θ_M. Use your results to justify your answer.

~~56 − 52 / 56 × 100 = 7.14%, Yes it has No it has~~ Yes it has changed the value, because it ~~the change~~ increased by 4° from 52° to 56° 6 [1]

(iv) Suggest two conditions that should be kept constant for all parts of this experiment.

1. Initial temperature
2. room temperature 7

[2]

[Total: 11]

4 The diagram is clear.

Mark awarded for (d) (i) = 2 out of 2

5 The candidate records a realistic set of readings.

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

6 The candidate identifies the change in value but does not state whether or not the change is significant.

Mark awarded for (d) (iii) = 0 out of 1

7 The candidate gives one condition that should be kept constant.

Mark awarded for (d) (iv) = 1 out of 2

Total mark awarded = 7 out of 11

How the candidate could have improved the answer

The candidate needed to use the correct temperature unit, °*C*, not simply ° which is the unit of angle.

(c) The candidate should have read the question more carefully. The response given would have scored two marks had it been given as the answer to **(d) (iv)**.

(d) (iii) The candidate should have stated that the change is significant, not merely stating that there is a change.

(d) (iv) The candidate should have specified that the initial temperature referred to is of either the hot water or the cold water (or both).

Common mistakes candidates made in this question

- **(d) (iii)** and **(iv)** Giving vague answers.

Question 3

Example candidate response – high	Examiner comments

3 In this experiment, you will investigate refraction using a transparent block.

Carry out the following instructions, using the separate ray-trace sheet provided. You may refer to Fig. 3.1 for guidance.

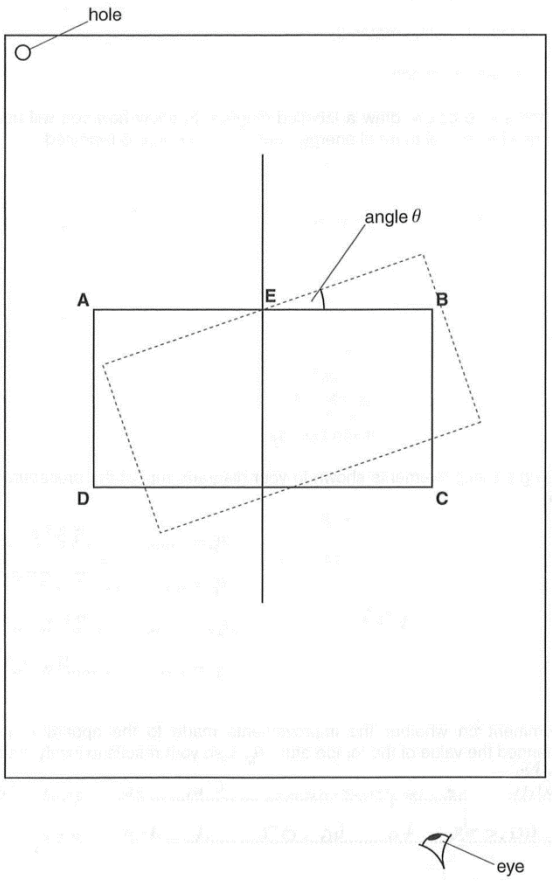


Fig. 3.1

Example candidate response – high, continued	Examiner comments

(a)
- Place the transparent block, largest face down, on the ray-trace sheet supplied. The block should be approximately in the middle of the paper. Draw the outline of the block **ABCD**.
- Remove the block and draw a normal at the centre of side **AB**. Label the point **E** where the normal crosses **AB**.
- Draw a line **FE** to the left of the normal and at an angle $i = 20°$ to the normal.
- Place a pin P on the line **FE**, at a suitable distance from the block for producing an accurate ray trace.
- There are vertical lines L_1 and L_2 drawn on the block. Replace the block so that line L_1 is at point **E**.
- Observe the images of L_1 and P through side **CD** of the block. Carefully move the block, keeping line L_1 at point **E**, until the vertical line L_2 and the images of L_1 and P appear one behind the other. This is indicated by the dashed position of the block shown in Fig. 3.1.
- Draw a line along side **AB** of the block to mark its new position.
- Remove the block.
- Measure the angle θ between the original position of **AB** and the new position of **AB**, as indicated in Fig. 3.1.
- Record $i = 20°$ and θ in Table 3.1.
- Repeat the procedure using values of $i = 30°$, 40°, 50° and 60°.

Table 3.1

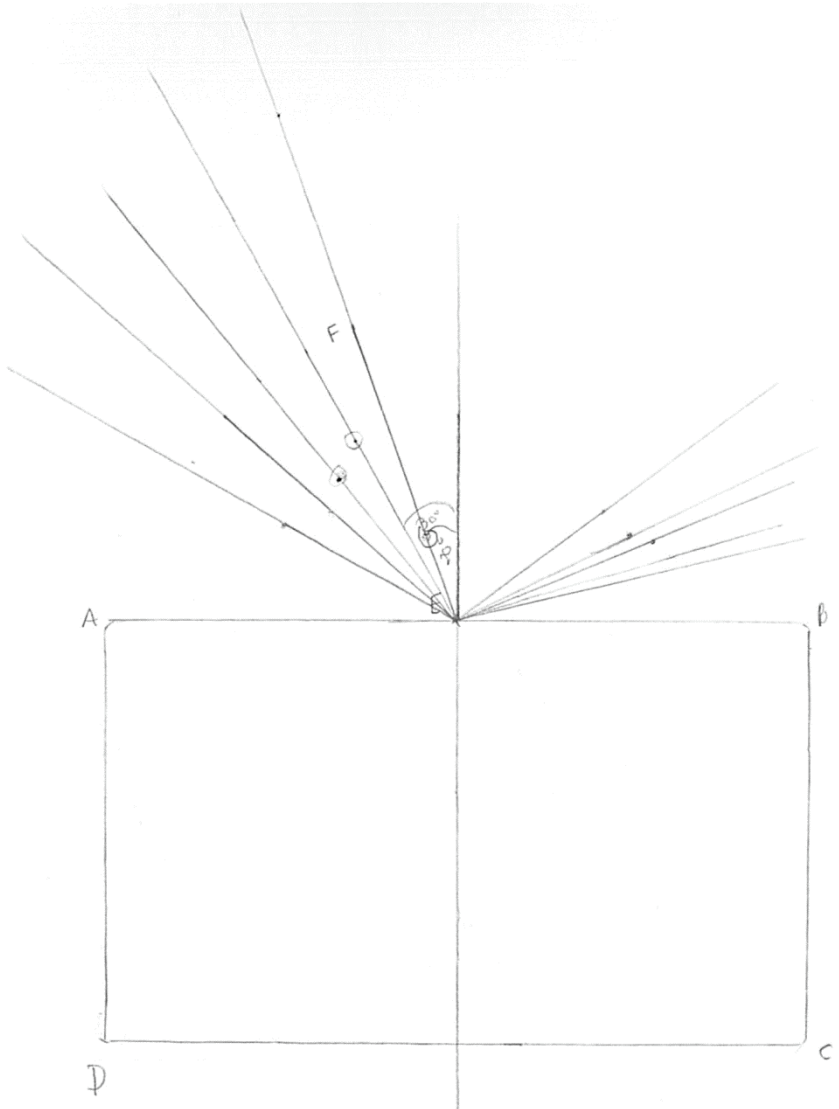
i/°	θ/°
20	15
30	17
40	23
50	25
60	37

1

[4]

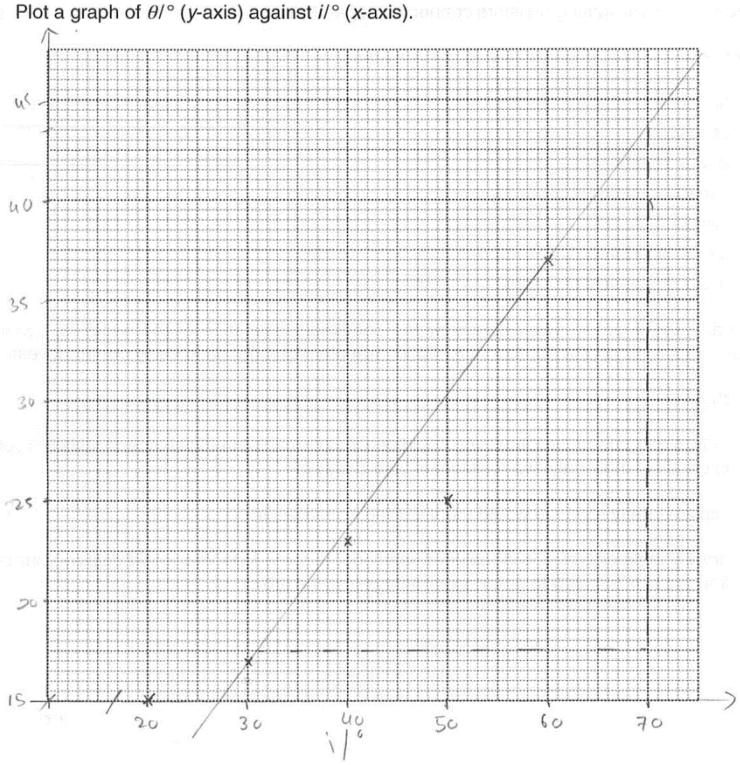
1 The ray-trace is carefully drawn and shows the rays correctly positioned with the first position for pin P about 8 cm from **E**. The candidate has sensibly placed the pin a large distance from the block. The angles recorded are within the tolerance allowed, showing that the candidate has used the protractor correctly. Some of the values show that the candidate has not carried out the experiment quite as accurately as required.

Mark awarded for (a) = 3 out of 4

Example candidate response – high, continued	Examiner comments
	

Example candidate response – high, continued	Examiner comments

(b) Plot a graph of θ/° (y-axis) against i/° (x-axis).



2

[4]

(c) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

$g = \frac{v}{h}$ $= 0.6666...7$

$= \frac{43.5 - 17.5}{70 - 31}$

$G =$ 0.667 3 [2]

(d) Referring to your graph, comment on the quality of your measurements.

The measurements are not very accurate because they is no equal distribution of point on line of best fit. [1]

Tie your ray-trace sheet into this Booklet between pages 8 and 9. 4

[Total: 11]

2 The graph axes are correctly set up with suitable scales and labelling. The plots are correctly positioned. The mark for the best-fit line is awarded because the candidate draws a sensible line although the results have produced a large scatter.

Mark awarded for (b) = 4 out of 4

3 The candidate draws a large triangle but the value obtained for the gradient is outside the tolerance allowed.

Mark awarded for (c) = 1 out of 2

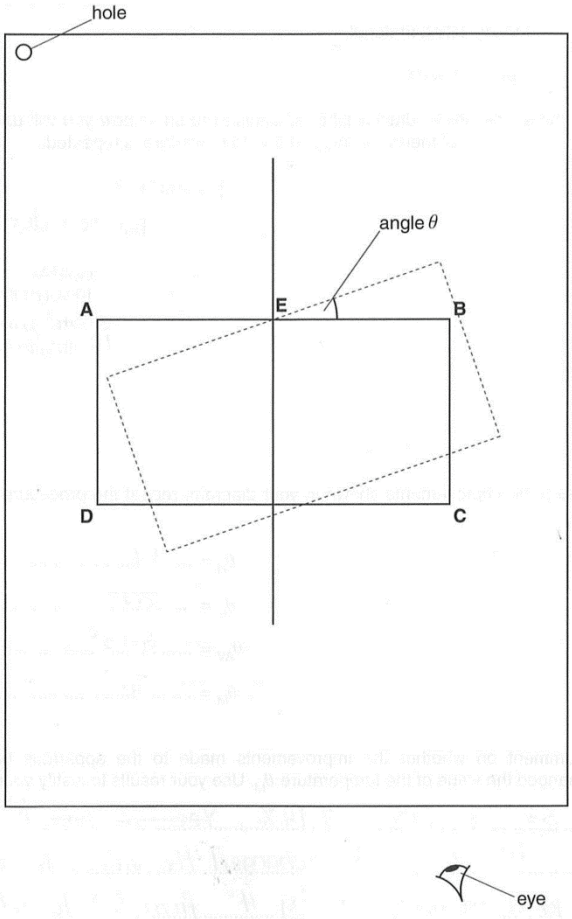
4 The candidate successfully conveys the idea of the large scatter of plots around the best-fit line indicating the poor quality of the measurements.

Mark awarded for (d) = 1 out of 1

Total mark awarded = 9 out of 11

How the candidate could have improved the answer

The candidate needed to take more care lining up the pin and the lines on the block and keeping the block in the correct position in order to obtain accurate values for the angle θ.

Example candidate response – middle	Examiner comments
3 In this experiment, you will investigate refraction using a transparent block. Carry out the following instructions, using the separate ray-trace sheet provided. You may refer to Fig. 3.1 for guidance.  Fig. 3.1	

Example candidate response – middle, continued	Examiner comments

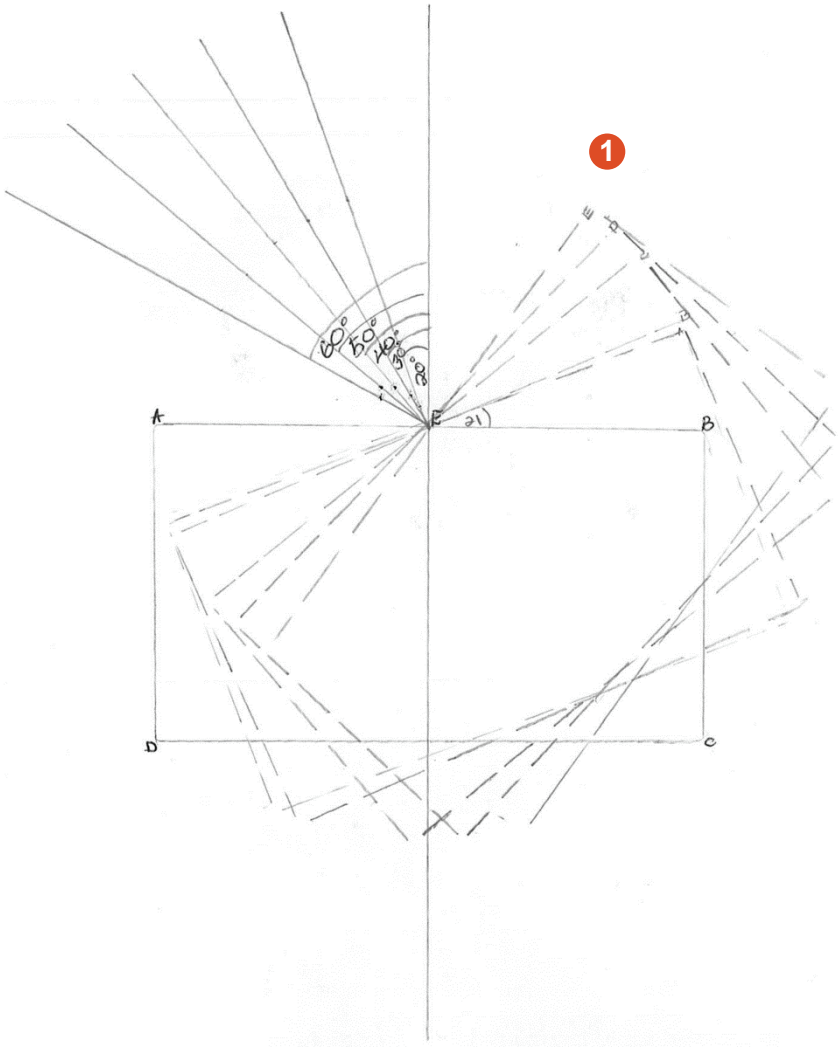
(a)

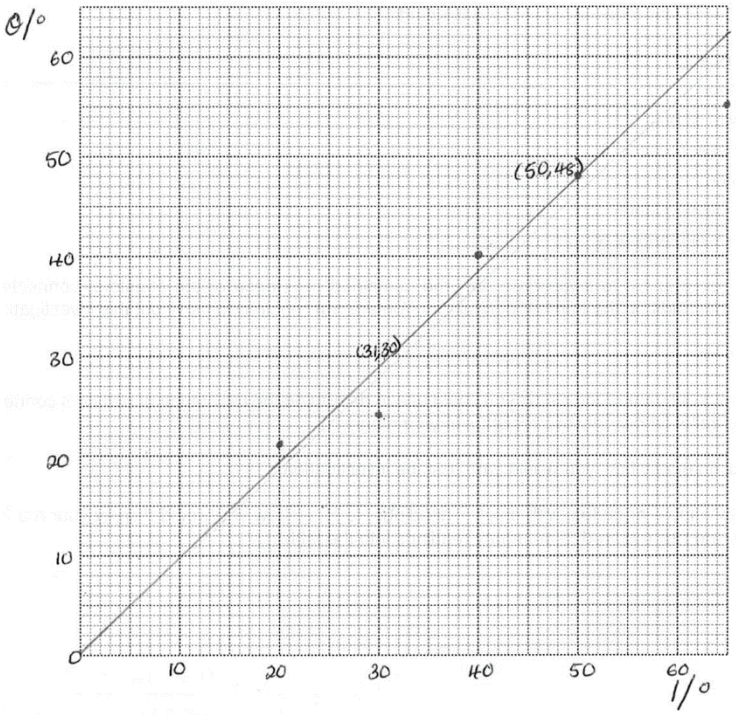
- Place the transparent block, largest face down, on the ray-trace sheet supplied. The block should be approximately in the middle of the paper. Draw the outline of the block **ABCD**.
- Remove the block and draw a normal at the centre of side **AB**. Label the point **E** where the normal crosses **AB**.
- Draw a line **FE** to the left of the normal and at an angle $i = 20°$ to the normal.
- Place a pin P on the line **FE**, at a suitable distance from the block for producing an accurate ray trace.
- There are vertical lines L_1 and L_2 drawn on the block. Replace the block so that line L_1 is at point **E**.
- Observe the images of L_1 and P through side **CD** of the block. Carefully move the block, keeping line L_1 at point E, until the vertical line L_2 and the images of L_1 and P appear one behind the other. This is indicated by the dashed position of the block shown in Fig. 3.1.
- Draw a line along side **AB** of the block to mark its new position.
- Remove the block.
- Measure the angle θ between the original position of **AB** and the new position of **AB**, as indicated in Fig. 3.1.
- Record $i = 20°$ and θ in Table 3.1.
- Repeat the procedure using values of $i = 30°$, 40°, 50° and 60°.

Table 3.1

i/°	θ/°
20	21
30	24
40	40
50	48
60	55

[4]

Example candidate response – middle, continued	Examiner comments
	1 The ray-trace is carefully drawn and shows the rays correctly positioned with the first position for pin P at least 5 cm from **E**. The angles recorded are within the tolerance allowed, showing that the candidate has used the protractor correctly. Some of the values show that the candidate has not carried out the experiment quite as accurately as required. Mark awarded for (a) = 3 out of 4

Example candidate response – middle, continued	Examiner comments
(b) Plot a graph of θ/° (y-axis) against i/° (x-axis).  [4] **(c)** Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information. (31, 30) (50, 48) $G = \frac{x_2 - x_1}{y_2 - y_1} = \frac{50-31}{48-30} = 1.0555$ G = 1.06 [2] **(d)** Referring to your graph, comment on the quality of your measurements. Accurate, as they have a large difference in between ~~the~~ each other [1] **Tie your ray-trace sheet into this Booklet between pages 8 and 9.** [Total: 11]	**2** The graph axes are correctly set up with suitable scales and labelling. The plots are correctly positioned. The plots are larger than they should be and this is penalised by not awarding the final graph mark. Mark awarded for (b) = 3 out of 4 **3** A triangle is indicated on the graph but it uses less than half of the candidate's line. The value for G is within the tolerance allowed. Mark awarded for (c) = 1 out of 2 **4** The candidate writes a vague statement and does not comment on the line or the plots. Mark awarded for (d) (i) = 0 out of 1 **Total mark awarded = 7 out of 11**

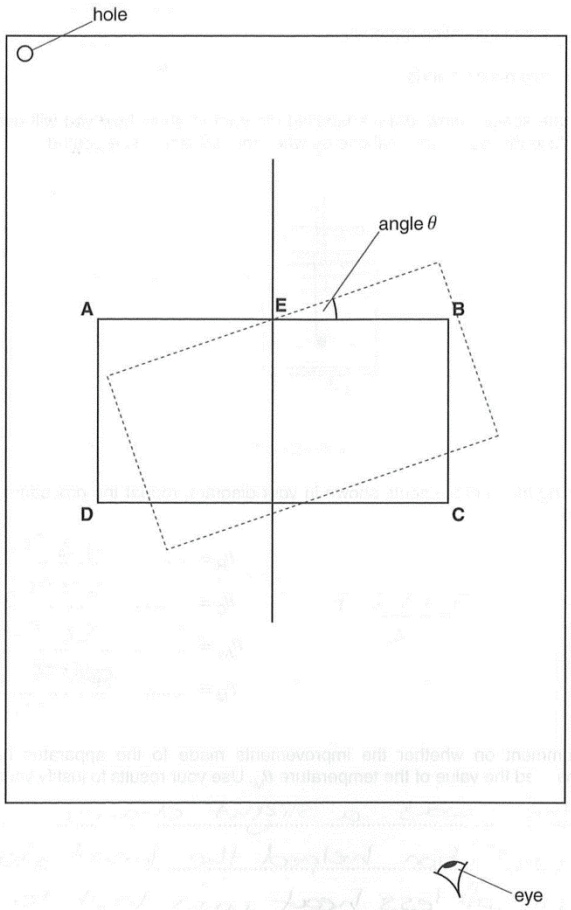
How the candidate could have improved the answer

The candidate needed to take more care lining up the pin and the lines on the block and keeping the block in the correct position in order to obtain accurate values for the angle θ.

The candidate should have used neat crosses instead of 'blobs' to plot the points on the graph.

A large triangle using at least half of the line should have been used for determining the gradient.

(d) The candidate needed to refer clearly to the scatter of points around the best-fit line, stating that the number of points not close to the line suggests poor quality measurements.

Example candidate response – low	Examiner comments
3 In this experiment, you will investigate refraction using a transparent block. Carry out the following instructions, using the separate ray-trace sheet provided. You may refer to Fig. 3.1 for guidance.  Fig. 3.1	

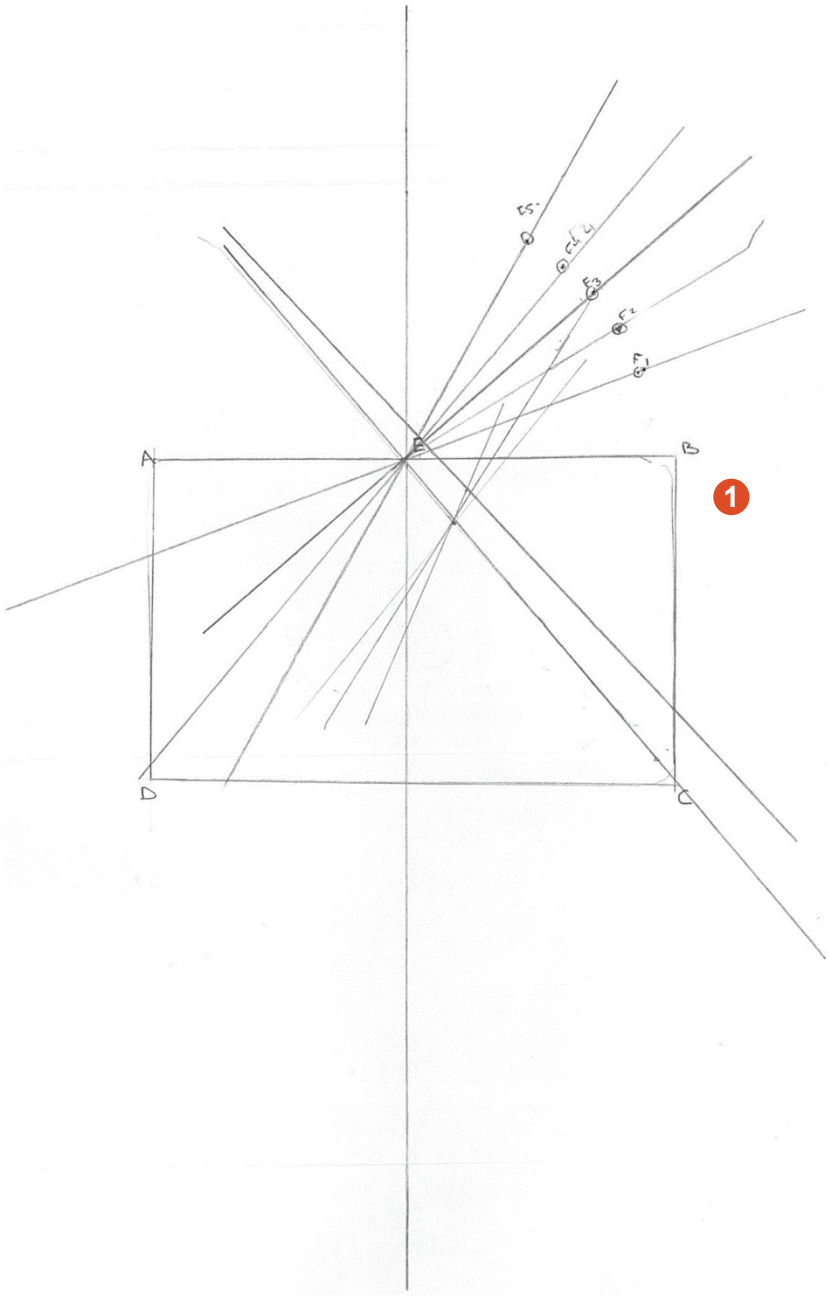
Example candidate response – low, continued	Examiner comments

(a)
- Place the transparent block, largest face down, on the ray-trace sheet supplied. The block should be approximately in the middle of the paper. Draw the outline of the block **ABCD**.
- Remove the block and draw a normal at the centre of side **AB**. Label the point **E** where the normal crosses **AB**.
- Draw a line **FE** to the left of the normal and at an angle $i = 20°$ to the normal.
- Place a pin P on the line **FE**, at a suitable distance from the block for producing an accurate ray trace.
- There are vertical lines L_1 and L_2 drawn on the block. Replace the block so that line L_1 is at point **E**.
- Observe the images of L_1 and P through side **CD** of the block. Carefully move the block, keeping line L_1 at point **E**, until the vertical line L_2 and the images of L_1 and P appear one behind the other. This is indicated by the dashed position of the block shown in Fig. 3.1.
- Draw a line along side **AB** of the block to mark its new position.
- Remove the block.
- Measure the angle θ between the original position of **AB** and the new position of **AB**, as indicated in Fig. 3.1.
- Record $i = 20°$ and θ in Table 3.1.
- Repeat the procedure using values of $i = 30°$, 40°, 50° and 60°.

Table 3.1

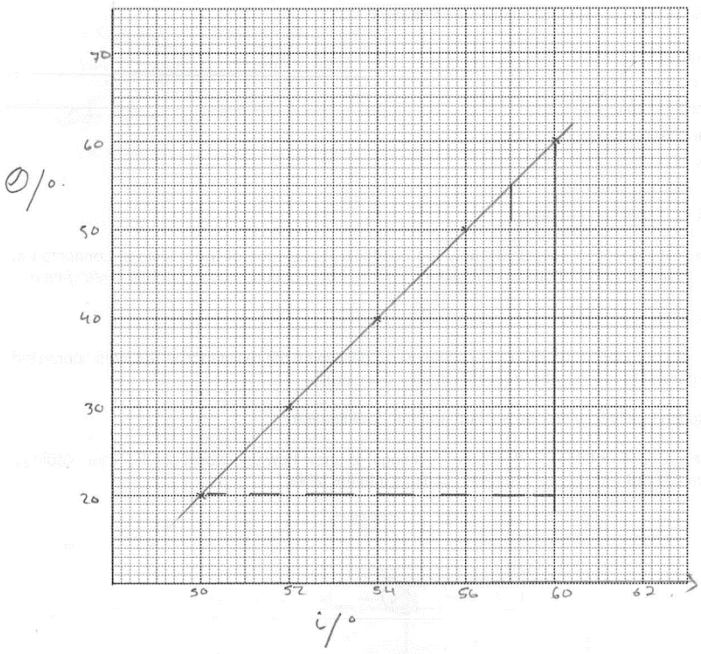
i/°	θ/°
20	50
30	52
40	54
50	36
60	60

[4]

Example candidate response – low, continued	Examiner comments
 1	1 The ray-trace shows that the candidate has not followed the instructions with care. The incident rays are on the wrong side of the normal and lines showing the new positions of the block are inconsistent. The distance between the first position for pin P and the point **E** is just within the tolerance allowed. Mark awarded for (a) = 1 out of 4

Example candidate response – low, continued	Examiner comments

(b) Plot a graph of θ/° (*y*-axis) against *i*/° (*x*-axis).



2

[4]

(c) Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

$g = \frac{y_2 - y_1}{x_2 - x_1}$ $\frac{60-20}{60-50} = \frac{40}{10}$

$G =$ 4 ..... 3 .....[2]

(d) Referring to your graph, comment on the quality of your measurements.

As the angle increases so does the angle of ... incidence. 4 .....[1]

Tie your ray-trace sheet into this Booklet between pages 8 and 9.

[Total: 11]

2 The graph axes are the wrong way round and the scale on the x-axis is inconsistent.
The *i* readings are equally spaced along the x-axis. This results in the candidate not being able to demonstrate plotting skills or judgement of the best-fit straight line.

Mark awarded for (b) = 0 out of 4

3 A large triangle is drawn but the value for *G* is outside the tolerance allowed.

Mark awarded for (c) = 1 out of 2

4 The candidate writes a vague statement and does not comment on the line or the plots.

Mark awarded for (d) = 0 out of 1

Total mark awarded = 2 out of 11

How the candidate could have improved the answer

The candidate needed to follow the instructions step-by-step and with care.

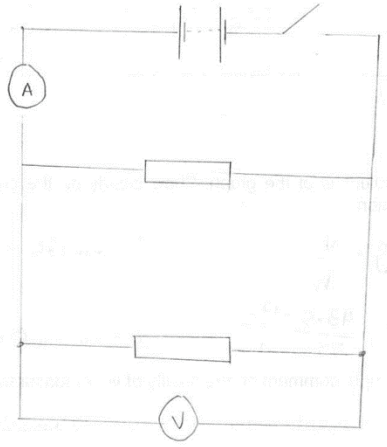
The graph should have been plotted with the θ and i values on the correct axes and the scale on the i axis should have been continuous.

(d) The candidate needed to refer clearly to the scatter of points around the best-fit line.

Common mistakes candidates made in this question

- Taking insufficient care to keep the centre of the side **AB** of the block at point **E** and to line up the pin and lines on the block to obtain accurate readings.
- **(d)** Giving vague answers instead of referring clearly to the scatter of points around the best-fit line.

Question 4

Example candidate response – high	Examiner comments
4 A student is investigating resistors connected in parallel. The following apparatus is available to the student: ammeter voltmeter power supply variable resistor switch connecting leads a box of identical resistors. Plan an experiment to investigate how the combined resistance of the resistors, connected in parallel, depends on the number of resistors. You are **not** required to carry out this investigation. You should: • draw a diagram of the circuit you could use to determine the resistance of resistors connected in parallel (show only two resistors in your diagram) • explain briefly how you would carry out the investigation • draw a table or tables, with column headings, to show how you would display your readings. You are **not** required to enter any readings into the table.  Set the circuit as above, with two resistors. Close the switch and measure the current and voltage. Repeat experiment by adding a resistor every time, until a total of 6 resistors	1 The circuit diagram is well drawn and correct in all respects. The concise method includes use of two resistors and measurement of current and voltage followed by repeats using an additional resistor each time.

Example candidate response – high, continued	Examiner comments

are added.

No. of resistor	Voltage /V	Current /A	Resistance /Ω
2			
3			
4			
5			
6			

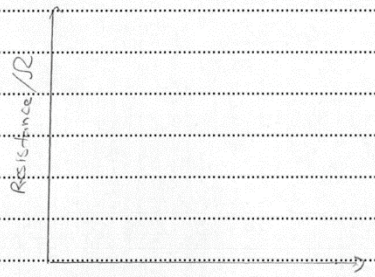
After measuring the voltage and current calculate Resistance using the formula

V=IR

Resistance = Voltage / Current

2

Plot a graph for resistance against number of resistors.



3

[7]

[Total: 7]

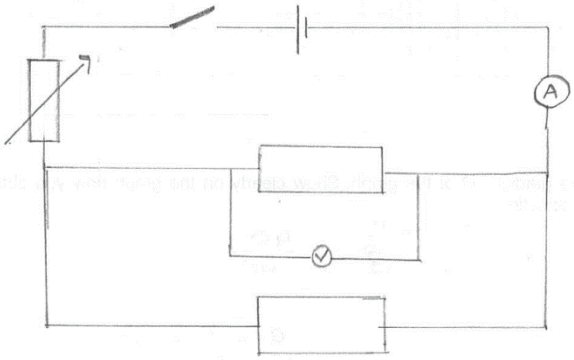
2 The table shows all the required elements – columns for the number of resistors, voltage and current with correct units. The candidate shows in the table and writes clearly that the resistance is calculated from the voltage and current readings.

3 The candidate uses five combinations of resistors and suggests a suitable graph that could be plotted.

Total mark awarded = 7 out of 7

How the candidate could have improved the answer

This answer gained full marks. The candidate understood the task and wrote a very clear and concise plan.

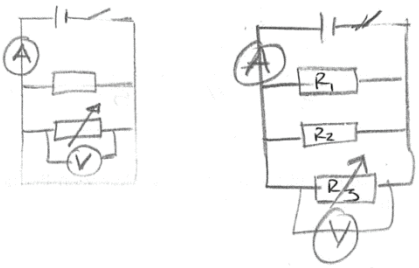
Example candidate response – middle	Examiner comments
4 A student is investigating resistors connected in parallel. The following apparatus is available to the student: ammeter voltmeter power supply variable resistor switch connecting leads a box of identical resistors. Plan an experiment to investigate how the combined resistance of the resistors, connected in parallel, depends on the number of resistors. You are **not** required to carry out this investigation. You should: • draw a diagram of the circuit you could use to determine the resistance of resistors connected in parallel (show only two resistors in your diagram) • explain briefly how you would carry out the investigation • draw a table or tables, with column headings, to show how you would display your readings. You are **not** required to enter any readings into the table.  1 Set up the apparatus as shown Method 1) & Use the variable resistor to control the amount of current	1 The circuit diagram is well drawn and correct in all respects. The method includes reference to repeating the measurements with different numbers of resistors.

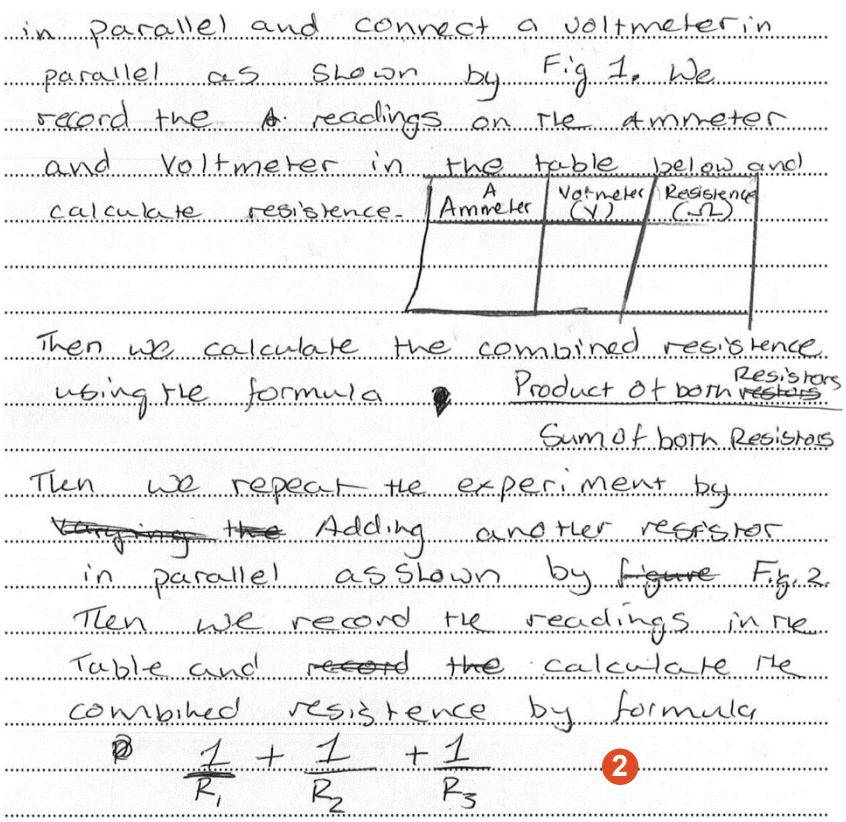
Example candidate response – middle, continued	Examiner comments
(unless exam) 2) Use a voltmeter to measure voltage (V) 3) Switch on Use 2 resistors 4) Switch on 5) Measure the current using the ammeter and voltage using voltmeter. Record these values 6) Repeat steps (3 – 5) using 3, 4, 5 and 5 resistors respectively 7) M. Record your values and use the equation $R = \frac{V}{I}$ to measure the resistance Plot a graph of voltage, V (x-axis) and current, A (y-axis) V/V | I/A | R/Ω ← Table 2 Conclusion The highest resistance will have the lowest current, the and the highest voltage [7] [Total: 7]	2 The table does not include a column for the number of resistors used. The candidate clearly states that the readings are used to calculate the combined resistance of the resistors. The candidate does not make any other points about the investigation to gain further credit. **Total mark awarded = 5 out of 7**

How the candidate could have improved the answer

The table required a column for the number of resistors used.

The candidate needed to make one more valid suggestion relating to precautions (e.g. using a low current to prevent resistors becoming too hot) or an aspect of good practice (e.g. using at least five different resistor combinations).

Example candidate response – low	Examiner comments
4 A student is investigating resistors connected in parallel. The following apparatus is available to the student: ammeter voltmeter power supply variable resistor switch connecting leads a box of identical resistors. Plan an experiment to investigate how the combined resistance of the resistors, connected in parallel, depends on the number of resistors. You are **not** required to carry out this investigation. You should: • draw a diagram of the circuit you could use to determine the resistance of resistors connected in parallel (show only two resistors in your diagram) • explain briefly how you would carry out the investigation • draw a table or tables, with column headings, to show how you would display your readings. You are **not** required to enter any readings into the table. Fig 1  1 We connect the apparatus as shown above Fig 1, we switch on the power, we connect a resistor (with known resistance) then we connect ~~one~~ a variable resistor	1 The circuit diagram shows a voltmeter in parallel with a component. A variable resistor is wrongly shown in parallel with the fixed resistors. The voltmeter and ammeter symbols are not correct because they have lines through the middle. The method includes reference to repeating the measurements with different numbers of resistors.

Example candidate response – low	Examiner comments
	2 The table does not include a column for the number of resistors used. The candidate shows that the readings are used to calculate the combined resistance of the resistors. The candidate does not make any other points about the investigation to gain further credit. **Total mark awarded = 2 out of 11**

How the candidate could have improved the answer

The candidate needed to take more care drawing the circuit diagram so that the voltmeter and ammeter did not have lines through the middle. Also the position of the variable resistor should not have been part of the parallel combination.

The table required a column for the number of resistors used and the current column should have been headed *I*/*A*.

The candidate needed to make one more valid suggestion relating to precautions (e.g. using a low current to prevent resistors becoming too hot) or an aspect of good practice (e.g. using at least five different resistor combinations).

Common mistakes candidates made in this question

- Describing a standard experiment to investigate the resistance of a resistor using a variable resistor to give a range of potential difference and current readings.
- Describing a combination of this type of standard experiment with the investigation stated in the question which resulted in a confusing account.

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