CAMBRIDGE
International Examinations

Cambridge IGCSE

Example Candidate Responses
(Standards Booklet)

Cambridge IGCSE®
Physics
0625

Cambridge Secondary 2

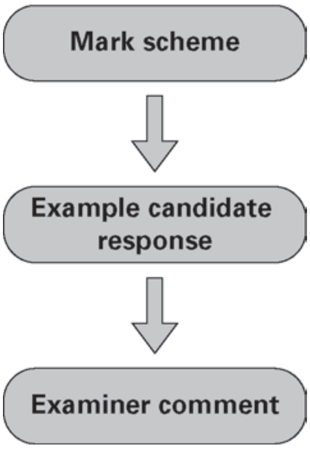
Contents

Introduction

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

In this booklet a range of candidate responses has been chosen as far as possible to exemplify grades C and E for Paper 2 and grades A, C and E for Papers 3, 5 and 6. Each response is accompanied by a brief commentary explaining the strengths and weaknesses of the answers.

For ease of reference the following format for each paper has been adopted:



The mark scheme, used by examiners, is followed by examples of marked candidate responses, each with an examiner comment on performance. Comments are given to indicate where and why marks were awarded, and how additional marks could have been obtained. In this way, it is possible to understand what candidates have done to gain their marks and what they still have to do to improve their grades.

In this booklet a grade is given to each question but in the examination each question paper (whole candidate script) is graded on the overall mark awarded, not on each question or part question. It is therefore possible that, on some questions, lower grade candidate scripts are awarded the same or higher marks than higher grade candidate scripts.

Past papers, examiner reports and other teacher support materials are available on Teacher Support at http://teachers.cie.org.uk.

Assessment at a glance

All candidates take:		
Paper 1 45 minutes Multiple choice question paper Weighted at 30% of total available marks		
and either:	**or:**	
Paper 2 1 hour 15 minutes Core theory paper Weighted at 50% of total available marks	**Paper 3** 1 hour 15 minutes Extended theory paper Weighted at 50% of total available marks	
and either:	**or:**	**or:**
Paper 4 Coursework Weighted at 20% of total available marks	**Paper 5** 1 hour 15 minutes Practical Test Weighted at 20% of total available marks	**Paper 6** 1 hour Alternative to Practical Weighted at 20% of total available marks

Teachers are reminded that the full syllabus is available at www.cie.org.uk.

Paper 2 – Core theory

Paper 2 is a written, core theory paper consisting of short-answer and structured questions. Questions are based on the Core curriculum and will be of a difficulty appropriate to grades C to G. Candidates aiming for grades A* to C must follow the Extended curriculum. Questions will test skills mainly in assessment objectives A (Knowledge with understanding) and B (Handling information and problem solving).

Question 1

Mark scheme

1 (a) (i) BC	B1	
(ii) AB	B1	
(b) area under graph	C1	
$0.5 \times 15 \times 5$	C1	
37.5 (m)	A1	[5]

Example candidate response – grade C

1 Fig. 1.1 shows the speed-time graph of a moving object.

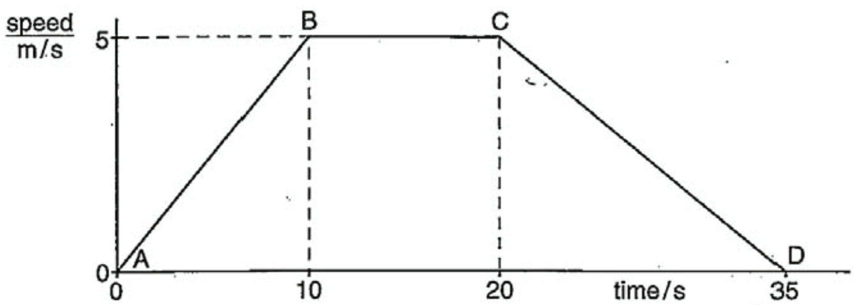


Fig. 1.1

(a) Which part, or parts, of Fig. 1.1 indicate when the object is

(i) travelling at uniform speed, ...B–C, BC........[1]

(ii) accelerating? ....AB, CD........[1]

(b) Calculate the distance travelled in the last 15 s.

D = S x T   D = 5 x 15

distance = ...75........ m [3]

[Total: 5]

Examiner comment – grade C

The candidate is able to correctly identify the regions of uniform speed and acceleration. The identification of CD as a region of acceleration is perfectly acceptable, especially as in this case, AB has also been named. In common with large numbers of other candidates, no marks are scored in part **(b)** because no indication about average speed has been given and the candidate does not know the formula for the area of a triangle. Simply indentifying the distance with the area would have earned one mark, but the candidate has failed to do even this.

Mark awarded = 2 out of 5

Example candidate response – grade E

1 Fig. 1.1 shows the speed-time graph of a moving object.

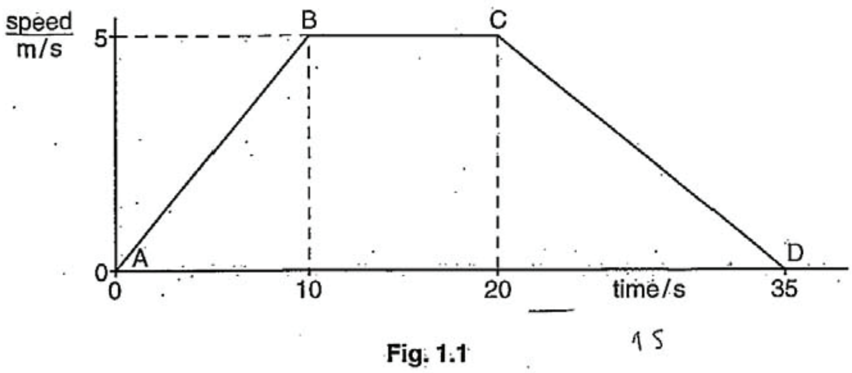


Fig. 1.1

(a) Which part, or parts, of Fig. 1.1 indicate when the object is

(i) travelling at uniform speed, From B to C ....[1]

(ii) accelerating? From A to B ....[1]

(b) Calculate the distance travelled in the last 15 s.

distance = 75 .... m [3]

[Total: 5]

Examiner comment – grade E

Even the lower grade candidates were able to identify the regions of uniform speed and acceleration. However, even the better candidates were not good at answering part **(b)**, so it is not surprising that this grade E candidate cannot do so. In this case, the candidate has obviously done some working on his calculator, but has given a wrong answer with no working shown. In such cases, it is impossible to award any marks.

Mark awarded = 2 out of 5

Question 2

Mark scheme

2	(a)		tape <u>measure</u> OR trundle wheel OR laser measure IGNORE metre rule	B1	
	(b)	(i)	clock OR watch (any sort)	B1	
		(ii)	set clock/watch to zero OR note start time OR start clock/watch/timing	B1	
			(start clock/watch/timing) when wood seen to fall or equivalent	B1	
			stop clock/watch/note time when wood reaches bridge 2	B1	
		(iii)	speed = distance/ time in any form, letters, words, numbers	C1	
			50/400	C1	
			0.125	A1	
			m/s	B1	[9]

Example candidate response – grade C

2 Two girls attempt to measure the speed of the water in a river, as shown in Fig. 2.1.

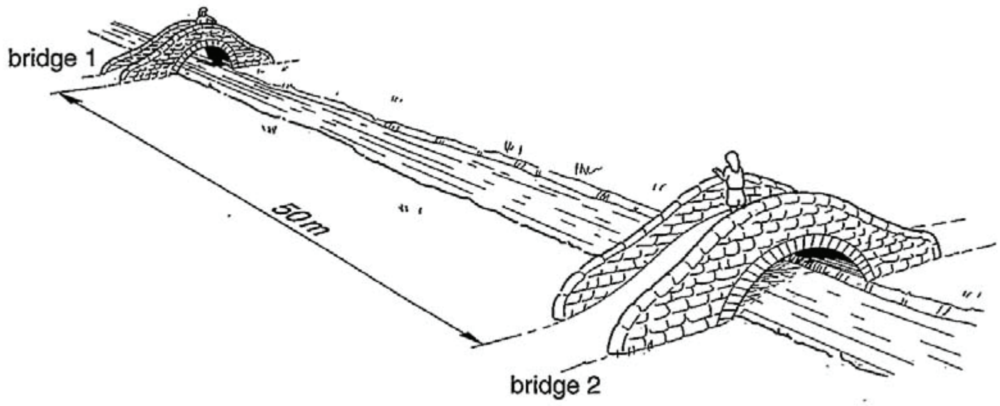


Fig. 2.1

(a) The distance between the two bridges is measured as 50 m.

Suggest an appropriate instrument that they might use to measure this distance.

a tape rule ....[1]

(b) The girl on bridge 1 drops a piece of wood into the water. The girl on bridge 2 measures how long it takes for the piece of wood to reach bridge 2. It takes 400 s to travel between the two bridges.

(i) Name an appropriate instrument that could be used to measure this time.

a stopwatch ....[1]

(ii) Describe the procedure for measuring this time.

the moment the ~~bridge~~ wood touches the water the stopwatch is started and once it reaches brigde 2 it is stopped, ~~this could b~~ and the time is recorded, this could be repeated to get an average result ....[3]

(iii) Calculate the speed of the water.

$$\frac{50}{400}$$

speed = 0.125 m/s ....[4]

[Total: 9]

Examiner comment – grade C

This is an excellent answer that scores all the marks. The two measuring instruments are correctly identified. The description of measuring the time is concise and contains nice details that many candidates do not think to include, such as 'the moment the wood touches the water.' The calculation is competently performed, with the working clearly shown.

Mark awarded = 9 out of 9

Example candidate response – grade E

2 Two girls attempt to measure the speed of the water in a river, as shown in Fig. 2.1.

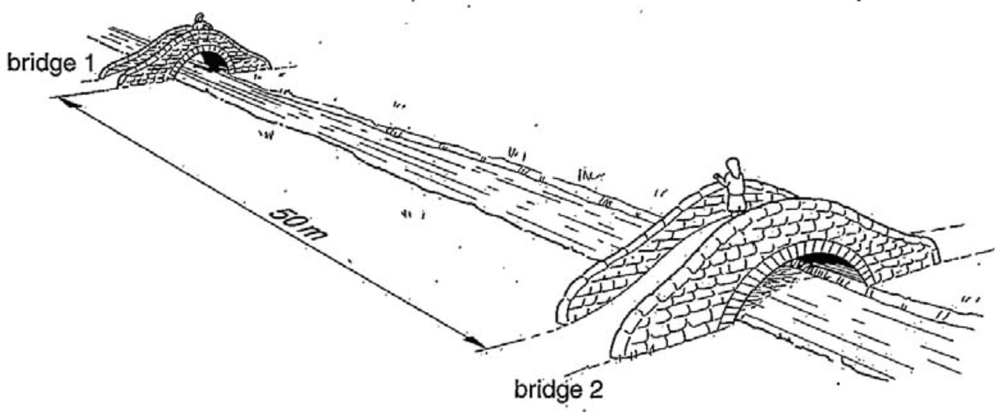


Fig. 2.1

(a) The distance between the two bridges is measured as 50 m.

Suggest an appropriate instrument that they might use to measure this distance.

tape measure ....[1]

(b) The girl on bridge 1 drops a piece of wood into the water. The girl on bridge 2 measures how long it takes for the piece of wood to reach bridge 2. It takes 400 s to travel between the two bridges.

(i) Name an appropriate instrument that could be used to measure this time.

Stop clock ....[1]

(ii) Describe the procedure for measuring this time.

As the piece off wood hits the water
girl 2 starts the Stop clock and as the
Piece of Wood reach's bridge 2 She Stop's
~~the~~ timing
..................................[3]

(iii) Calculate the speed of the water.

$\frac{50}{40} = 1.25$

speed = 1.25 km/h ....[4]

[Total: 9]

Examiner comment – grade E

This candidate does well, in that he correctly identifies both measuring instruments, whereas many grade E candidates are happy with metre rule for part **(a)**. The description of the method contains the important details, and scores full marks. The calculation shows that the candidate knows that speed = distance/time, but the numerical error loses marks. A mark would have been scored for the correct unit, regardless of the maths, but an inappropriate unit is quoted.

Mark awarded = 6 out of 9

Question 3

Mark scheme

3	**(a)**	(i)	plumb-line (name or description) OR try-square and (horiz.) bench OR spirit level	B1	
		(ii)	line joining **A** and **D**	M1	
			line joining **B** and **E**	M1	
			intersection clearly labelled **G** (dependent on scoring both M marks)	A1	
	(b)		X clearly on centre line	B1	
			X clearly within semicircular portion, but not on surface	B1	[6]

Example candidate response – grade C

3 **(a)** In a laboratory experiment to find the centre of mass of a triangular piece of card, the card is suspended first from point A and then from point B, as shown in Figs. 3.1 and 3.2.

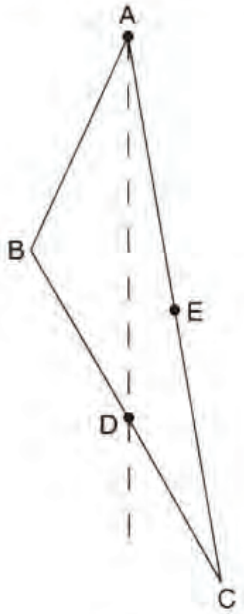


Fig. 3.1

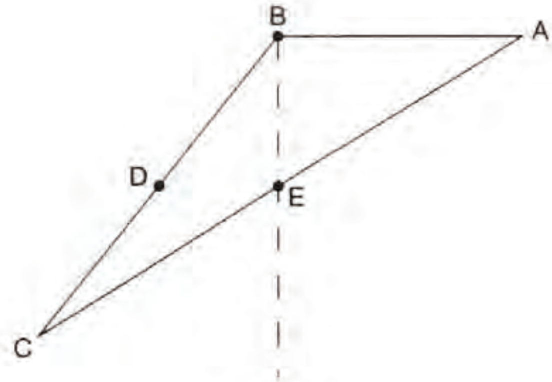


Fig. 3.2

When suspended from A, point D is found to be vertically below A.

When suspended from B, point E is vertically below B.

(i) What piece of apparatus might be used to determine the vertical lines through A and B?

a metre rule [1]

(ii) **On Fig. 3.3 below**, draw construction lines to find the position of the centre of mass of the triangular card. Label this point clearly with the letter G.

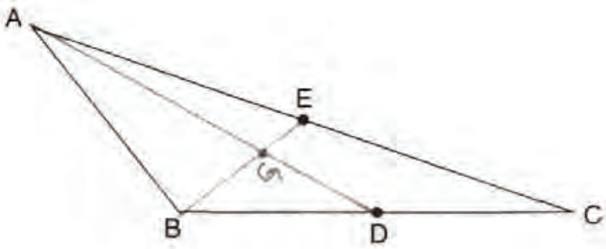


Fig. 3.3

[3]

(b) Fig. 3.4 illustrates a toy that always returns to the upright position, whatever position it is put in to start with.

Fig. 3.4

On one of the three positions of the toy shown in Fig. 4.3, clearly mark X at a possible position for the centre of mass of the toy. [2]

[Total: 6]

Examiner comment – grade C

The candidate shows no knowledge of the use of a plumb line for determining the vertical, but the diagram showing the location of G is clearly and accurately drawn. In part **(b)**, the mark for knowing X is on the centre line is scored, although it is not precisely positioned. If it had been much further from the line, the mark would have been lost. The candidate does not appreciate that X should be much lower down, within the semicircular region.

Mark awarded = 4 out of 6

Example candidate response – grade E

3 **(a)** In a laboratory experiment to find the centre of mass of a triangular piece of card, the card is suspended first from point A and then from point B, as shown in Figs. 3.1 and 3.2.

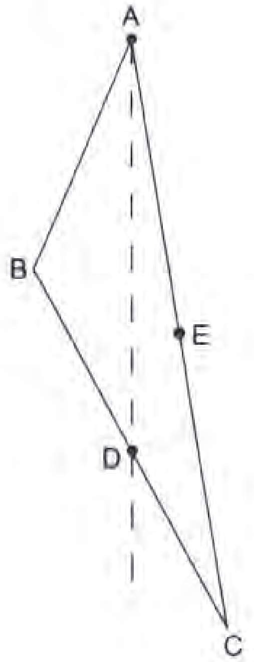


Fig. 3.1

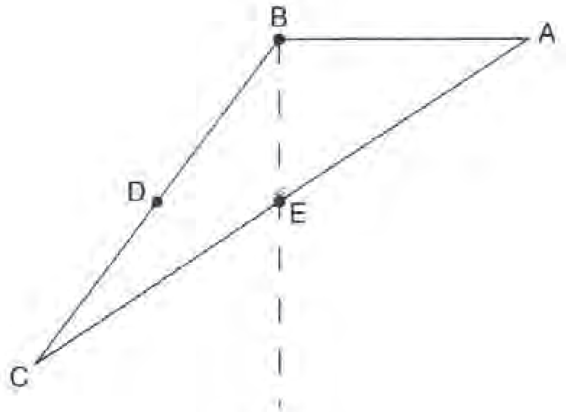


Fig. 3.2

When suspended from A, point D is found to be vertically below A.

When suspended from B, point E is vertically below B.

(i) What piece of apparatus might be used to determine the vertical lines through A and B?

A Straight edge ....[1]

(ii) **On Fig. 3.3 below**, draw construction lines to find the position of the centre of mass of the triangular card. Label this point clearly with the letter G.

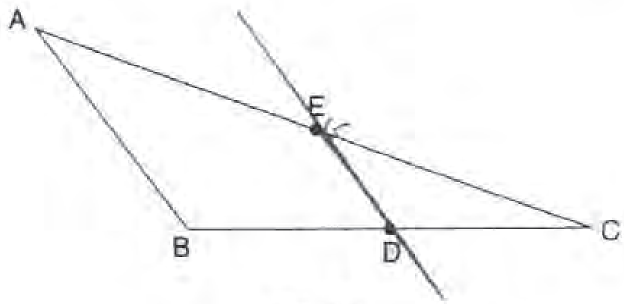


Fig. 3.3

[3]

(b) Fig. 3.4 illustrates a toy that always returns to the upright position, whatever position it is put in to start with.

Fig. 3.4

On one of the three positions of the toy shown in Fig. 4.3, clearly mark X at a possible position for the centre of mass of the toy. [2]

[Total: 6]

Examiner comment – grade E

No understanding is shown of an appropriate method of finding the vertical, and the candidate clearly has no knowledge of how to locate G. The candidate is rewarded for knowing that X is on the centre line. The candidate also seems to realise that it should be low down, but it is not acceptable to show it actually on the surface, so only one mark is scored for this part.

Mark awarded = 1 out of 6

Question 4

Mark scheme

4	**(a)**	dark specks OR bright specks NOT molecules/particles	B1	
		moving	C1	
		randomly/zigzag OR dancing about	A1	
	(b)	Brownian motion/movement	B1	
	(c)	invisible/too small to see/very small	B1	
		moving fast/high kinetic energy	B1	
		moving randomly/all directions	B1	[7]

Example candidate response – grade C

4 In Fig. 4.1, the smoke cell consists of an illuminated glass box into which some smoke has been injected.

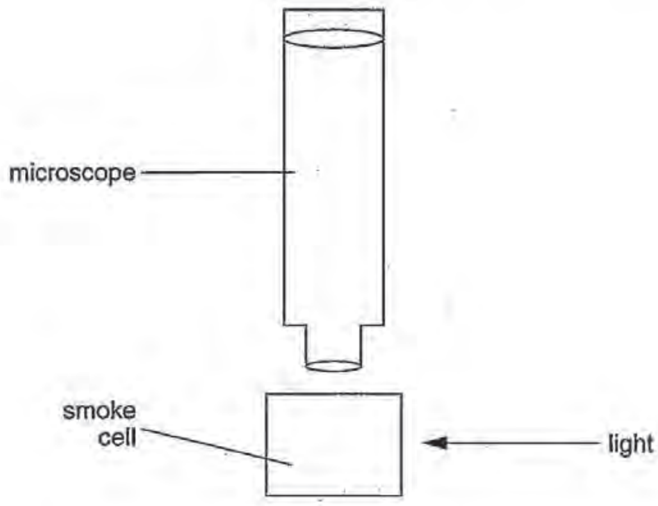


Fig. 4.1

(a) Describe briefly what is seen when the contents of the smoke cell are viewed through the focused microscope.

~~particles~~ molecules moving in a random motion, wide spread and may bump against each other, they are arranged randomly

.... [3]

(b) State the name we normally give to what is seen.

brownian motion .... [1]

(c) What deductions about the properties and behaviour of air molecules can be made from these observations?

air molecules move randomly and are not arranged in a specific pattern

....

.... [3]

[Total: 7]

Examiner comment – grade C

This is quite a good answer. Often grade C candidates find this topic hard to cope with. The candidate has an understanding that something is moving, and moving randomly. The question asks about what is seen. It is not the molecules that are seen moving, so a mark is lost. The candidate knows that this is Brownian motion, but cannot make any sensible deductions about the behaviour of the air molecules other than random movement. In questions like this, if the candidate has not been clearly taught such deductions, he/she must be prepared to think hard about the situation, and apply what they do know. The mark allocation should give some idea of the degree of detail/number of scoring points expected by the examiner.

Mark awarded = 4 out of 7

Example candidate response – grade E

4 In Fig. 4.1, the smoke cell consists of an illuminated glass box into which some smoke has been injected.

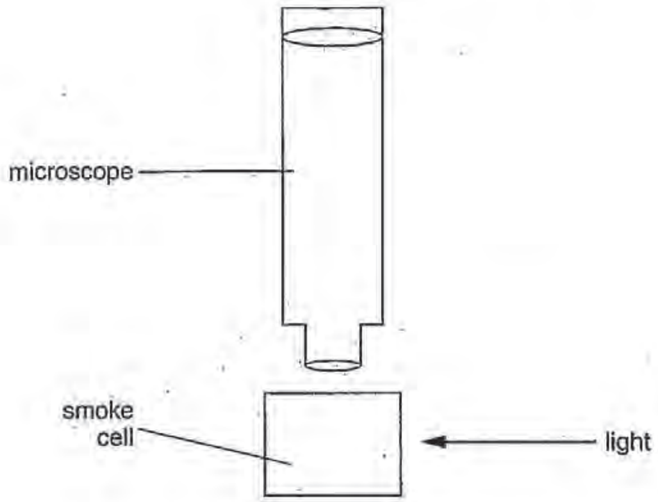


Fig. 4.1

(a) Describe briefly what is seen when the contents of the smoke cell are viewed through the focused microscope.

There are seen particles of The smoke moving very fast & freely

....[3]

(b) State the name we normally give to what is seen.

....[1]

(c) What deductions about the properties and behaviour of air molecules can be made from these observations?

That they are always moving (at bigger temperature faster) freely in the area They are.

....[3]

[Total: 7]

Examiner comment – grade E

In common with many weaker candidates, this candidate has very little understanding of the topic. There is an understanding that something is moving, which scores a mark, but nothing else. No attempt has been made to name the phenomenon.

Mark awarded = 2 out of 7

Question 5

Mark scheme

5	(a)	150 × 3 450 (Hz)	C1 A1	
	(b)	any figure between 20 and 50 inclusive AND any figure between 15,000 and 25,000 inclusive	B1	
	(c)	increases/rises	B1	[4]

Example candidate response – grade C

5 A card is held against a rotating toothed wheel, as shown in Fig. 5.1.

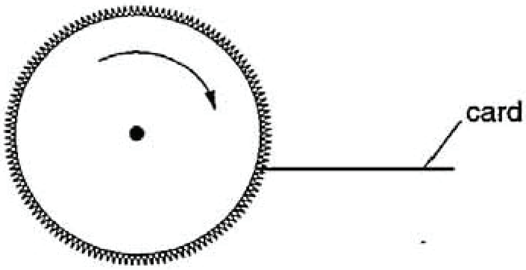


Fig. 5.1

The wheel has 150 teeth and rotates 3 times per second.

(a) Calculate the frequency of the sound produced.

frequency = 450 Hz [2]

(b) State the approximate range of frequencies that can be heard by a healthy human ear.

lowest frequency = ~~K0~~ 100 Hz

highest frequency = 900 Hz [1]

(c) The speed of rotation of the wheel is increased.

What happens, if anything, to the pitch of the sound that is heard?

The sound pitch increases. [1]

[Total: 4]

Examiner comment – grade C

The candidate scores both marks for the calculation, but is unwise not to show the working. Candidates are usually very competent at using their calculators, but had he made a mistake, perhaps by pressing the wrong button, he would have lost both marks, as there would have been no evidence that he knew the physics behind the numbers. The audible range of frequencies is not known, but the effect of increasing the speed of the wheel is known.

Mark awarded = 3 out of 4

Example candidate response – grade E

5 A card is held against a rotating toothed wheel, as shown in Fig. 5.1.

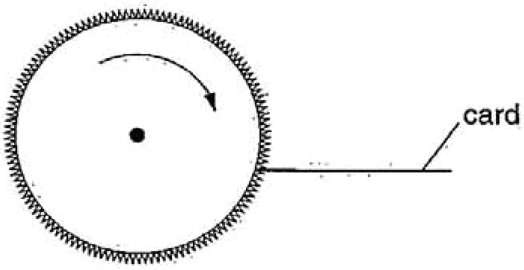


Fig. 5.1

The wheel has 150 teeth and rotates 3 times per second.

(a) Calculate the frequency of the sound produced.

150 ÷ 3 = 50

frequency = ...50...... Hz [2]

(b) State the approximate range of frequencies that can be heard by a healthy human ear.

lowest frequency = ...20...... Hz

highest frequency = ...20 000...... Hz [1]

(c) The speed of rotation of the wheel is increased.

What happens, if anything, to the pitch of the sound that is heard?

It is increased ......[1]

[Total: 4]

Examiner comment – grade E

The candidate divides instead of multiplies in the calculation, but answers all the rest of the question correctly. He clearly has some understanding about the production of sound, even if he cannot cope with the mathematics.

Mark awarded = 2 out of 4

Question 6

Mark scheme

6	**(a)**	ultrasound	B1	
	(b) (i)	infra-red visible ultra-violet X-rays all 4 correct (any 2 correct B1)	B2	
	(ii)	radio OR the top/first one	B1	
	(iii)	infra-red	B1	
	(iv)	X-rays OR gamma rays	B1	[6]

Example candidate response – grade C

6 The list below contains the names of the various regions of the electromagnetic spectrum, but they are in the wrong order and an extra, non-electromagnetic type of wave motion has been included.

infra-red radiation

X-rays

gamma-rays

visible light

radio waves

ultrasound waves

ultra-violet radiation

(a) Which one of these is not electromagnetic?

visible light. ....[1]

(b) (i) In the boxes below, list the various regions of the electromagnetic spectrum in order of wavelength. The first and last boxes have been filled in for you.

radio waves
~~tot~~ infra-red radiation
ultrasound waves
ultra~~sound~~ violet waves
x-rays
gamma rays

[2]

(ii) Which of these has the longest wavelength?

~~gamma~~ radio-waves ....[1]

(iii) Which of these produces a significant heating effect?

infra-red radition ....[1]

(iv) Which of these may be used to obtain a picture of a broken bone inside the body?

x-ray. ....[1]

[Total: 6]

Examiner comment – grade C

Not being able to identify the non-electromagnetic wave actually costs this candidate two marks in this question. The first mark is lost for the incorrect answer to **(a)**. The second is lost because ultra-sound is included in the list in **(b)(i)**. The rest of the list is correct, however, so one mark is still scored. Candidates with a lack of knowledge often resort to guessing the answers to the remaining parts of **(b)**, but this candidate has clearly learned his electromagnetic spectrum well, because all three remaining parts are correctly answered.

Mark awarded = 4 out of 6

Example candidate response – grade E

6 The list below contains the names of the various regions of the electromagnetic spectrum, but they are in the wrong order and an extra, non-electromagnetic type of wave motion has been included.

infra-red radiation

X-rays

gamma rays

visible light

radio waves

ultrasound waves

ultra-violet radiation

(a) Which one of these is not electromagnetic?

Visible light ....[1]

(b) **(i)** In the boxes below, list the various regions of the electromagnetic spectrum in order of wavelength. The first and last boxes have been filled in for you.

radio waves
ultra violet radiation
infra-red radiation
ultra soundwaves
xrays
gamma rays

[2]

(ii) Which of these has the longest wavelength?

radio waves ....[1]

(iii) Which of these produces a significant heating effect?

infrared radiation ....[1]

(iv) Which of these may be used to obtain a picture of a broken bone inside the body?

X-rays ....[1]

[Total: 6]

Examiner comment – grade E

In common with many others, this candidate thinks that visible light is not electromagnetic. The list has no resemblance to the correct list, and scores no marks, but the remaining three parts are all correct. To be sure of scoring well on questions like this one, the candidate needs to have done some careful memorising. Teachers should not be afraid of insisting that key parts of the syllabus should be memorised and therefore candidates are able to recall. Answers cannot always be worked out from scratch. Actual knowledge is required.

Mark awarded = 3 out of 6

Question 7

Mark scheme

7	**(a)**	**(i)**	needle inside coil	B1	
			current through coil OR connect battery/power supply	M1	
			direct current OR d.c. OR a.c. and switch off before removing needle/ magnet	A1	
		(ii)	freely suspend/pivot and see which end points N (or equivalent) OR see which end is <u>repelled</u> by N pole of a magnet	B1	
	(b)		4+ smooth curves leaving one end and going to the other (ignore any arrows)	B1	
			no lines crossing or meeting, even at ends	B1	[6]

Example candidate response – grade C

7 The pivoted steel arrow from a small compass has become demagnetised.

The coil shown in Fig. 7.1 is to be used to magnetise it again.

Fig. 7.1

(a) Describe carefully

(i) how the coil is used to magnetise the steel arrow,

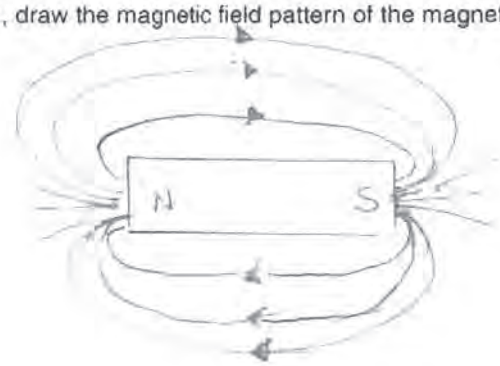
the steel arrow is inserted into the coil, the switch is closed, that is connected to the coil it is kept for a few minutes, then it is open again. The steel arrow becomes magnetised

....[3]

(ii) how the polarity of the magnetised needle may be checked.

it should be brought in contact with a magnet with known polarity. the part that repels the north pole of the magnet is the north pole of the steel rod and the part that attracts the north pole of the magnet is south pole [1]

(b) On Fig. 7.1, draw the magnetic field pattern of the magnetised needle. [2]



[Total: 6]

Examiner comment – grade C

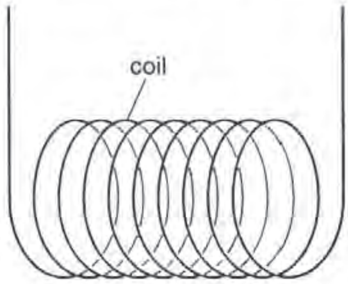
This is a good answer to a question that candidates often struggle with, partly because of the topic and partly because of the requirement to supply a descriptive answer. Part **(a)(i)** scores the mark for putting the needle in the coil. It was expected that the candidate would state that a current would be passed through the coil. In this answer, that statement is not made, but the mention of closing the switch in the circuit is taken as sufficient evidence that a current would be passed. The mark for d.c. is not scored. A score of 2/3 was reasonable for an answer that shows understanding, but is not complete. In **(a)(ii)**, repulsion of like poles is what the mark is awarded for. Attraction of unlike poles is irrelevant, and it would have been wiser not to mention it. The drawing of the magnetic field pattern shows some understanding, and is better than the attempts of many other candidates. However, the field lines should not cross or touch anywhere, so the final mark is lost. Candidates need to understand that accuracy in drawings is just as important as accuracy in calculations. Examiners do not ignore inaccuracy just because it appears in a diagram.

Mark awarded = 4 out of 6

Example candidate response – grade E

7 The pivoted steel arrow from a small compass has become demagnetised.

The coil shown in Fig. 7.1 is to be used to magnetise it again.



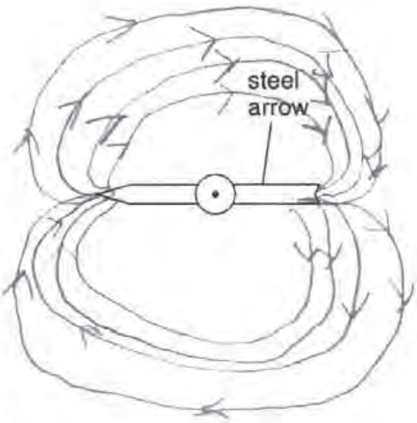


Fig. 7.1

(a) Describe carefully

(i) how the coil is used to magnetise the steel arrow,

The coil has a Alternating current running threw it, Wich will magnitize the steel Arrow Once it is placed in the middle of the coil

....[3]

(ii) how the polarity of the magnetised needle may be checked.

~~[illegible]~~ by seeing if it works correctly and accuratly in a compass again

....[1]

(b) On Fig. 7.1, draw the magnetic field pattern of the magnetised needle. [2]

[Total: 6]

Examiner comment – grade E

In a sense, this candidate is fortunate to have scored as many marks as he/she does. Nothing about the answer inspires confidence that the candidate really knows what is happening. The candidate knows that the needle is put in the coil, and that a current is flowing. However, a.c. is specified, which one would not normally use, although it could be done if the a.c. were switched off before removing the needle. The candidate does not mention this. The answer to **(a)(ii)** is nonsense. So little care is taken over the drawing of the magnetic field pattern in **(b)** that it would have been tempting to give 0/2 for it. However, poor though the drawing is, it does show some knowledge, and so is awarded one mark. Candidates need to understand that accuracy in drawings is just as important as accuracy in calculations. Examiners do not ignore inaccuracy just because it appears in a diagram.

Mark awarded = 3 out of 6

Question 8

Mark scheme

8	**(a)**		battery/ammeter connected wrong way round OR negative of battery should go to negative of ammeter	B1	
	(b)		correct symbols for battery, ammeter and rheostat (allow common variants on battery/cell symbol) all components in series	M1 A1	
	(c)		voltmeter (any recognisable symbol) clearly in parallel with coil	B1	
	(d)	**(i)**	2.8 (A) and 12 (V) both	B1	
		(ii)	ammeter increases voltmeter increases	B1 B1	
		(iii)	1.4 (A) OR half candidate's original reading 6 (V) OR half candidate's original reading	B1 B1	[9]

Example candidate response – grade C

8 A student learning about electric circuits connects up the circuit shown in Fig. 8.1.

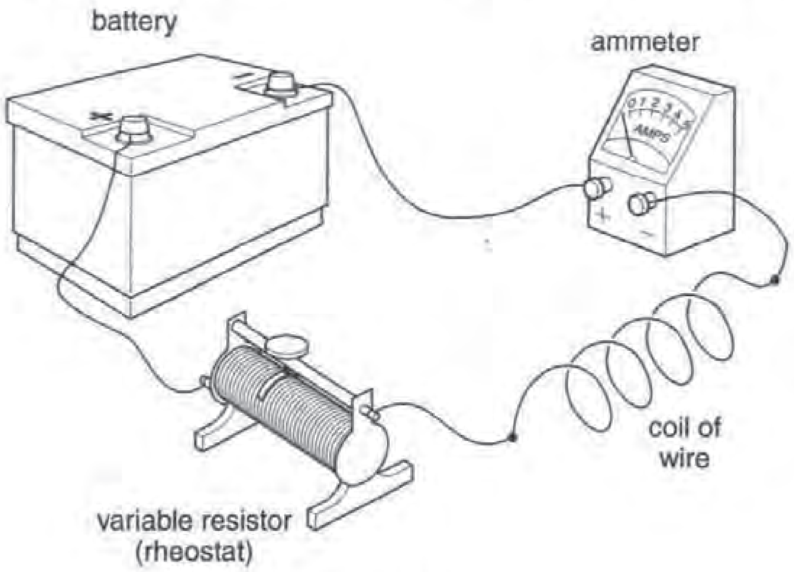


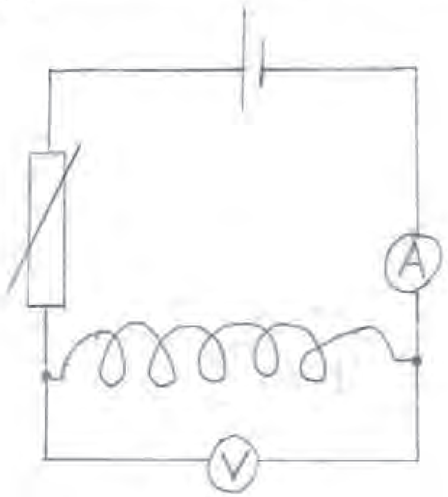
Fig. 8.1

(a) The student has already made one mistake with his connections.

What is his mistake?

the rheostat should be connected before the ammeter. [1]

(b) In the space below, draw the circuit diagram of the arrangement shown in Fig. 8.1, using standard symbols. [2]



(c) The student now connects a voltmeter to the circuit, so that readings can be taken to find the resistance of the coil of wire. **On your circuit diagram**, draw the voltmeter, connected to measure the potential difference across the coil. [1]

(d) Having obtained a correctly-working circuit, the readings on the two meters for one setting of the variable resistor are as shown in Figs. 8.2 and 8.3.

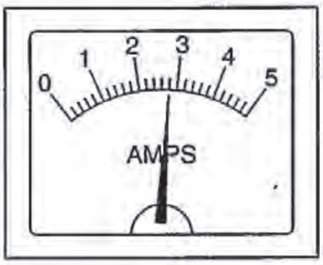


Fig. 8.2

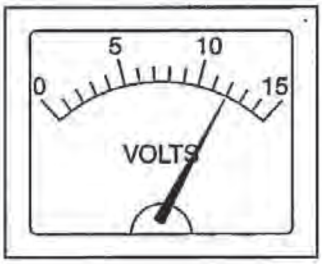


Fig. 8.3

(i) Record these two readings.

ammeter reading = ...2,8... A

voltmeter reading = ...12... V [1]

(ii) The slider on the variable resistor (see Fig. 8.1) is moved a small distance to the left, reducing its resistance.

State what happens to the readings on the two meters.

ammeter reading ...This reading ~~decreasing~~ decreases....

voltmeter reading ...This reading increases... [2]

(iii) The slider is adjusted so that the total resistance in the circuit is double that which gave the readings in Figs. 8.2 and 8.3.

Calculate the new values of the readings on the meters.

$\frac{2,8}{2} = 1,4 \quad \frac{12}{2} = 6 \qquad R = \frac{V}{I} =$

ammeter reading = ...1,4... A

voltmeter reading = ...6... V [2]

[Total: 9]

Examiner comment – grade C

The candidate does not spot that either the battery or the ammeter is connected the wrong way round, but is able to draw a good, clear circuit diagram, even as far as putting "blobs" at the points where wires join. The arrow-head is missed from the rheostat symbol, but this is not penalised. The clarity of the diagram is a good example of what is looked for in diagrams drawn by the candidates themselves. The meters are correctly read, but uncertainty is shown about what happens to these readings when the rheostat slider is moved. The fact that the current and potential difference are both halved, when the circuit resistance is doubled, is clearly understood, and it is pleasing that the candidate shows the working that led to the answers.

Mark awarded = 7 out of 9

Example candidate response – grade E

8 A student learning about electric circuits connects up the circuit shown in Fig. 8.1.

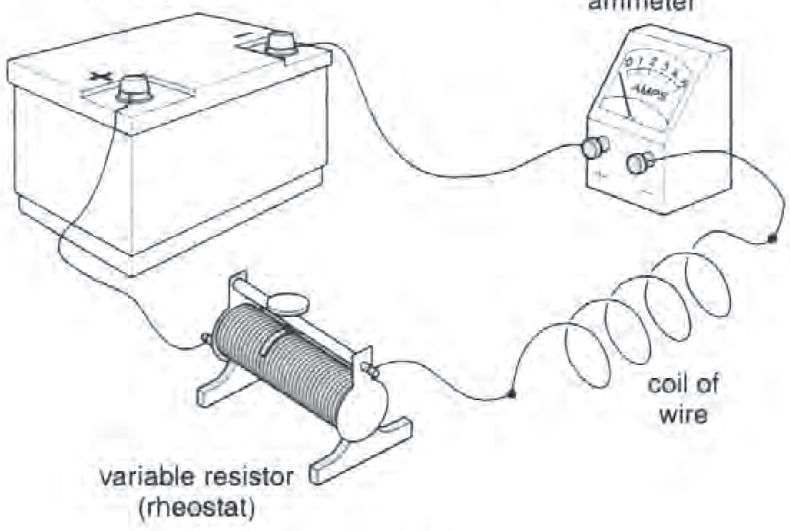


Fig. 8.1

(a) The student has already made one mistake with his connections.

What is his mistake?

The circuit must start and finish in the same place. [1]

(b) In the space below, draw the circuit diagram of the arrangement shown in Fig. 8.1, using standard symbols. [2]

(c) The student now connects a voltmeter to the circuit, so that readings can be taken to find the resistance of the coil of wire. **On your circuit diagram**, draw the voltmeter, connected to measure the potential difference across the coil. [1]

(d) Having obtained a correctly-working circuit, the readings on the two meters for one setting of the variable resistor are as shown in Figs. 8.2 and 8.3.

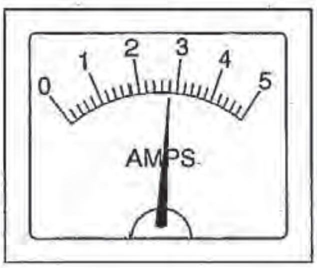


Fig. 8.2

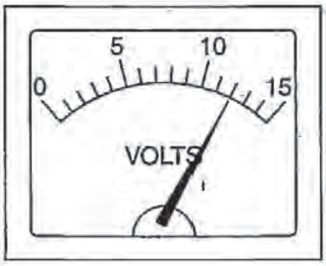


Fig. 8.3

(i) Record these two readings.

ammeter reading = ...2.8.......... A

voltmeter reading = ...12.......... V [1]

(ii) The slider on the variable resistor (see Fig. 8.1) is moved a small distance to the left, reducing its resistance.

State what happens to the readings on the two meters.

ammeter reading ......will....reduce..........

voltmeter reading ......will....increase..........[2]

(iii) The slider is adjusted so that the total resistance in the circuit is double that which gave the readings in Figs. 8.2 and 8.3.

Calculate the new values of the readings on the meters.

ammeter reading = ...5.6.......... A

voltmeter reading = ...24.......... V [2]

[Total: 9]

Examiner comment – grade E

The answer to **(a)** makes no sense, and it is impossible to imagine what the candidate is thinking of. No attempt is made to answer parts **(b)** and **(c)**. It is hard to believe that the candidate knows absolutely nothing about circuit diagrams, so it is a pity that he/she makes no attempt at all – this is bound to score zero marks, whereas even a poor attempt might be worth something. The candidate reads the two meters correctly, but is uncertain about what happens when the rheostat setting is changed. In the calculation, the candidate appears to have doubled his earlier values, but as no working is shown, no marks can be awarded for wrong answers.

Mark awarded = 2 out of 9

Question 9

Mark scheme

9	(a)	transformer (ignore step-up/down)	B1
	(b)	132,000/22,000 OR 240/132,000 X: 6 Y: 0.001818 to at least 4 dec. pl. OR 1/550 NOT 550	C1 A1 A1
	(c)	less heat/energy loss thinner/smaller cables less copper used less cable weight less massive pylons cheaper smaller current any 2 use ✓ + × = 0 for incorrect extras	B1+B1
			[6]

Example candidate response – grade C

9 **(a)** The circuit symbol shown in Fig. 9.1 represents a device often used in electrical equipment.

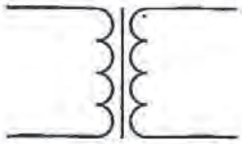


Fig. 9.1

State the name of this device.

electrical motor. ....[1]

(b) Fig. 9.2 shows, in simplified form, the essential parts of a grid system for distributing electrical energy from a power station to domestic consumers. The device in part **(a)** is used both at X and at Y.

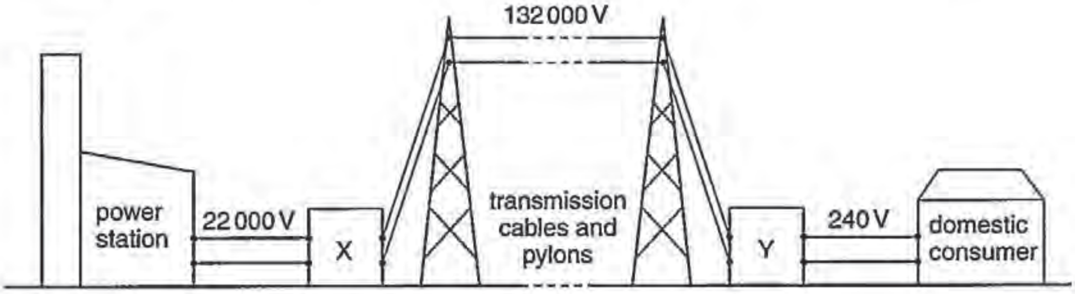


Fig. 9.2

(i) Using information from Fig. 9.2, deduce the ratio $\frac{\text{secondary turns}}{\text{primary turns}}$ necessary at X and at Y.

$X = \frac{V_s}{V_p} = \frac{132\,000}{22\,000} = 6$ turns

$Y = V_s = \frac{132\,000}{240} = 550$ turns

turns ratio at X = 6 ....

turns ratio at Y = 550 ....[3]

(ii) State two reasons why power transmission is cheaper if the voltage across the cables is very high.

1. Not too much voltage is used e.g. in domestic areas, they use less.

2. it is ~~distrubuted~~ distributed according to value of the voltage needed. ....[2]

[Total: 6]

Examiner comment – grade C

The candidate knows to use the transformer equation in **(b)**, but he does not reason out what the symbol shown in **(a)** represents. However, the incorrect attempt is more reasonable than many given by other candidates. The calculation is sensibly attempted and the working shown. It is a pity that the second ratio is inverted, otherwise all three marks could have been awarded. If X and Y in the working are turns ratios, then they should not be given the unit 'turns', but this is not penalised, nor is the statement Y = Vs in the second line of working. In common with most other candidates, the reasons for high voltage are not understood, at least not in connection with cheapness.

Mark awarded = 2 out of 6

Example candidate response – grade E

9 **(a)** The circuit symbol shown in Fig. 9.1 represents a device often used in electrical equipment.

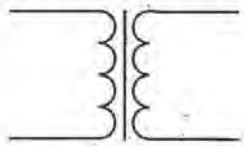


Fig. 9.1

State the name of this device.

A transformer .... [1]

(b) Fig. 9.2 shows, in simplified form, the essential parts of a grid system for distributing electrical energy from a power station to domestic consumers. The device in part **(a)** is used both at X and at Y.

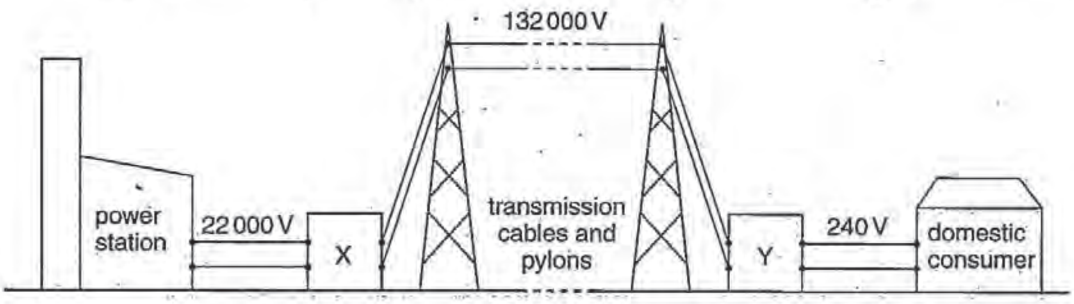


Fig. 9.2

(i) Using information from Fig. 9.2, deduce the ratio $\frac{\text{secondary turns}}{\text{primary turns}}$ necessary at X and at Y.

turns ratio at X = 1:99

turns ratio at Y = 6 [3]

(ii) State two reasons why power transmission is cheaper if the voltage across the cables is very high.

1. It saves costs of the transmission cables

2. It does not require installation of many transformers. [2]

[Total: 6]

Examiner comment – grade E

The candidate can identify the symbol. The answers to **(b)** are wrong, but inspection of them suggests that the candidate has got them the wrong way round and has made an error of the power of 10 in one calculation. However, no working is shown, so no marks are scored. If working had been shown, it is quite possible that two marks could have been scored. In the last part nothing worth any marks is given.

Mark awarded = 1 out of 6

Question 10

Mark scheme

10	**(a)**	(electric) charge OR charged body force	B1 B1	
	(b)	**A** and **B** closer together allow touching threads straight and equal angle (by eye) to vertical	M1 A1	
	(c)	**E** horizontal to left **W** vertically down **T** up thread } all 3 marked on his diagram −1 e.e.o.o.	B2	
	(d)	zero or 0 or nothing	B1	[7]

Example candidate response – grade C

10 (a) Complete the following statement about an electric field.

An electric field is a region in which ...a charged object...........

experiences a ...force... [2]

(b) Fig. 10.1 shows two identical light uncharged balls suspended on thin nylon threads.

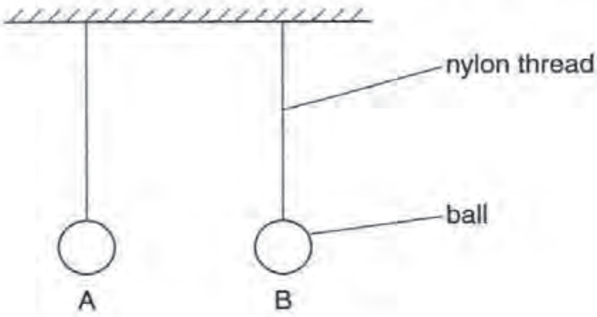
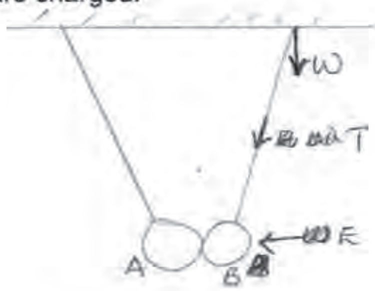


Fig. 10.1

Ball A is given a positive charge and ball B is given a negative charge.

In the space below, draw a diagram showing the positions that the balls and threads will take, now that the balls are charged.



[2]

(c) On ball B in your diagram, use labelled arrows to show the directions of

(i) the electrostatic force on the ball (label it E),

(ii) the weight of the ball (label it W),

(iii) the tension force of the thread on the ball (label it T). [2]

(d) Ball B is in equilibrium. State the value of the resultant of forces E, W and T.

resultant = ...0...[1]

[Total: 7]

Examiner comment – grade C

This is a very good answer, showing a good grasp of the principles of electrostatics. The definition of an electric field has clearly been learned, enabling both marks to be scored. The drawing of the positions of the charged balls is done carefully, with the threads at equal angles to the vertical. The balls would probably not have touched, but this is not penalised. One mark is allowed for the positions and directions of the forces. W should be shown on the ball and the tension force should be up the thread from the ball. However, this is a much better attempt than most, and is worth one mark. The fact is known that the resultant force on a body in equilibrium is zero.

Mark awarded = 6 out of 7

Example candidate response – grade E

10 **(a)** Complete the following statement about an electric field.

An electric field is a region in which ....a body....................................

experiences a ..electric current............ [2]

(b) Fig. 10.1 shows two identical light uncharged balls suspended on thin nylon threads.

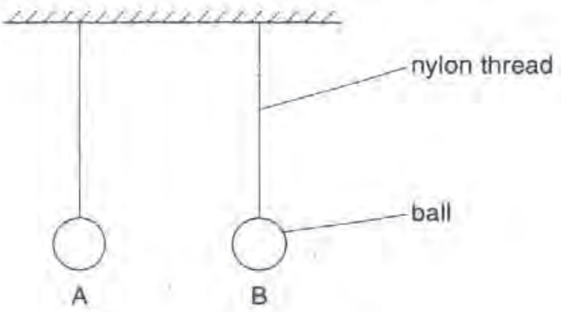
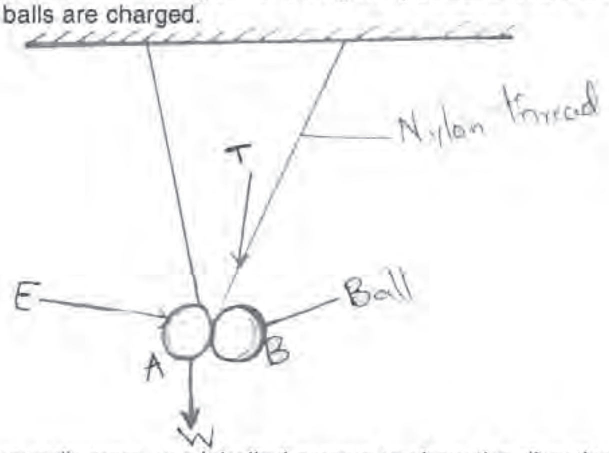


Fig. 10.1

Ball A is given a positive charge and ball B is given a negative charge.

In the space below, draw a diagram showing the positions that the balls and threads will take, now that the balls are charged.



[2]

(c) On ball B in your diagram, use labelled arrows to show the directions of

(i) the electrostatic force on the ball (label it E),

(ii) the weight of the ball (label it W),

(iii) the tension force of the thread on the ball (label it T). [2]

(d) Ball B is in equilibrium. State the value of the resultant of forces E, W and T.

resultant = ...resultant=E+W+T............[1]

[Total: 7]

Examiner comment – grade E

Typical of candidates at this grade, very little understanding of electrostatics is shown. It is true that all candidates find electrostatics intellectually demanding, but such things as are contained in this question are fairly standard and can be learned. The definition in part **(a)** is nonsense. The drawing of the positions of the charged balls is inaccurate, even though a ruler has been used. The touching balls are not penalised, but the fact that the threads are not shown at equal angles to the vertical is penalised, so the only mark scored is (for the balls being closer together than the uncharged ones). No marks are scored for the forces on ball B, partly because two out of three of them are in the wrong direction, and none of them is actually shown from B anyway. The resultant force is wrong, but at least an intelligent attempt has been made.

Mark awarded = 1 out of 7

Question 11

Mark scheme

11	**(a)**	**(i)**	filament/cathode clearly and correctly labelled	B1	
		(ii)	anode clearly and correctly labelled	B1	
	(b)	**(i)**	battery shown connected across filament (no e.c.f.)	B1	
		(ii)	power supply connected between filament & anode (no e.c.f.)	B1	
		(iii)	straight path shown along axis (no e.c.f.)	B1	
	(c)		bright spot (or equivalent)	B1	
	(d)		spot moves down	B1	[7]

Example candidate response – grade C

11 Fig. 11.1 shows a tube that can be used to produce cathode rays. Metal plates above and below the tube have zero potential difference between them.

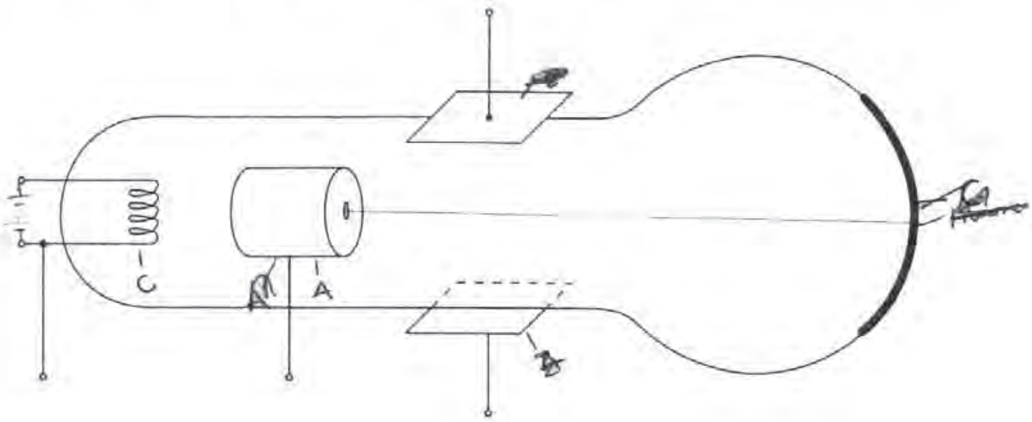


Fig. 11.1

(a) On Fig. 11.1, clearly label

(i) the filament cathode (label it C),

(ii) the anode (label it A). [2]

(b) On Fig. 11.1, draw

(i) a battery (label it B), connected to cause thermionic emission of electrons,

(ii) a 1000 V power supply (label it P), connected to cause a beam of cathode rays along the tube,

(iii) the path of the beam of cathode rays along the tube.

[3]

(c) What is seen when the beam of cathode rays hits the screen?

A ~~light~~ bright spot is seen on the screen in the middle [1]

(d) A high potential difference is now connected between the two metal plates, so that the lower plate is positive and the upper plate is negative.

What change is seen on the screen?

the cathode ray is deflected so a spot is seen on the bottom of the screen [1]

[Total: 7]

Examiner comment – grade C

This is a competent answer. The cathode and anode are correctly labelled for part **(a)**. Part **(b)** is not quite so well answered, because although the battery is shown correctly across the filament, the power supply is not shown at all and the beam of cathode rays is incomplete. Concise, clear and correct answers are given to parts **(c)** and **(d)**.

Mark awarded = 5 out of 7

Example candidate response – grade E

11 Fig. 11.1 shows a tube that can be used to produce cathode rays. Metal plates above and below the tube have zero potential difference between them.

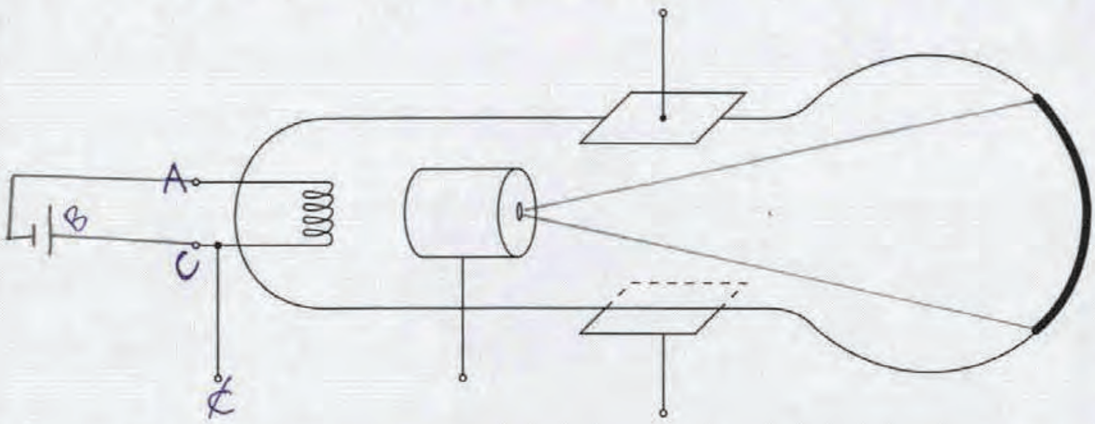


Fig. 11.1

(a) On Fig. 11.1, clearly label

(i) the filament cathode (label it C),

(ii) the anode (label it A). [2]

(b) On Fig. 11.1, draw

(i) a battery (label it B), connected to cause thermionic emission of electrons,

(ii) a 1000 V power supply (label it P), connected to cause a beam of cathode rays along the tube,

(iii) the path of the beam of cathode rays along the tube.

[3]

(c) What is seen when the beam of cathode rays hits the screen?

The flourescent screen glows and produces Images

....[1]

(d) A high potential difference is now connected between the two metal plates, so that the lower plate is positive and the upper plate is negative.

What change is seen on the screen?

The screen starts producing dim images.

....[1]

[Total: 7]

Examiner comment – grade E

The candidate does not understand much about cathode rays. The fact that A and C are put on opposite ends of the same part of the diagram indicates that the candidate does not know what the cathode and anode are or do. The battery is correctly shown across the filament, but the power supply is not shown and the beam of cathode rays is shown diverging (or is it intended to be two rays in different directions?). It is true that the screen glows, but the mark is scored for it glowing at one spot, and the reference to images make the answer even less acceptable. Further reference to images in **(d)** is no more acceptable.

Mark awarded = 1 out of 7

Question 12

Mark scheme

12	**(a)**		points correctly plotted (±½ small square) –1 e.e.o.o.	B2	
			smooth curve through candidate's points (by eye)	B1	
	(b)	**(i)**	**1.** in range 2.2–3.0	B1	
			2. in range 18.0–19.0	B1	
		(ii)	2 half-lives	C1	
			(candidate's **2** – candidate's **1**)/2	C1	
			7.5–8.6 (days) e.c.f.	A1	[8]

Example candidate response – grade C

12 The count-rate from a sample of radioactive material is investigated by a team of scientists in a laboratory.

(a) With the radioactive sample in place, the count-rate from the sample is determined every 7 days, with the results shown below. The background count-rate has already been subtracted.

time/days	0	7	14	21	28
count-rate / counts/s	1000	550	300	160	90

On Fig. 12.1, plot a graph of count-rate from the sample against time. [3]

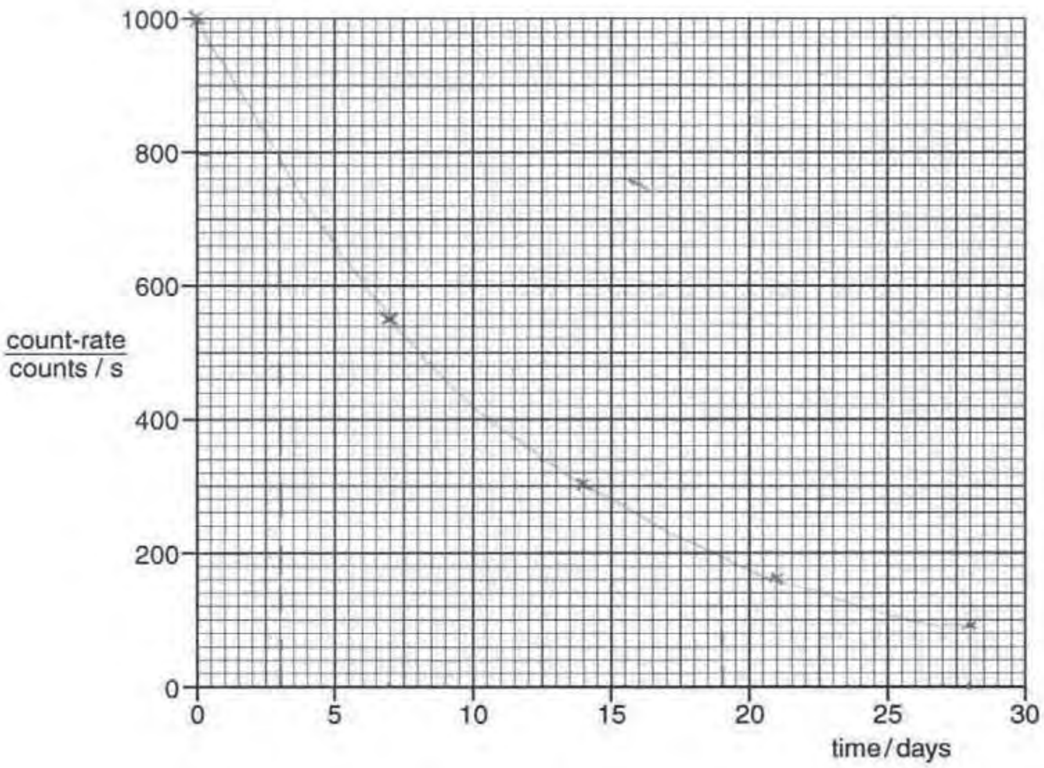


Fig. 12.1

(b) (i) From your graph, find the time at which the count-rate is

1. 800 counts/s, ...3... days

2. 200 counts/s. ....19.... days [2]

(ii) From the figures in (b)(i), find the value of the half-life of the substance.

19 + 3 = 21 days
800 + 200 = 1 000 counts.

$\frac{1000}{2} = 500$ $\frac{21}{2} = 10,5$

half-life = ...10,5. days [3]

[Total: 8]

Examiner comment – grade C

This is a nicely plotted graph, with clear points and a distinct curve drawn through them. The values of the times are correctly read from the curve, without falling into the trap of misreading the scale. When it comes to finding the half-life, the candidate does indeed use the values from the previous part, as instructed, but uses them incorrectly and gets the wrong answer. It is good that the working is shown, as there might have been something there that was worth marks. Actually, in this case, no marks can be given for the working. The correct approach was to use the fact that from 800 counts/s to 200 counts/s is 2 half lives, so that the half-life is half of the interval between 19 days and 3 days i.e. 8 days.

Mark awarded = 5 out of 8

Example candidate response – grade E

12 The count-rate from a sample of radioactive material is investigated by a team of scientists in a laboratory.

(a) With the radioactive sample in place, the count-rate from the sample is determined every 7 days, with the results shown below. The background count-rate has already been subtracted.

time / days	0	7	14	21	28
$\frac{\text{count-rate}}{\text{counts / s}}$	1000	550	300	160	90

On Fig. 12.1, plot a graph of count-rate from the sample against time. [3]

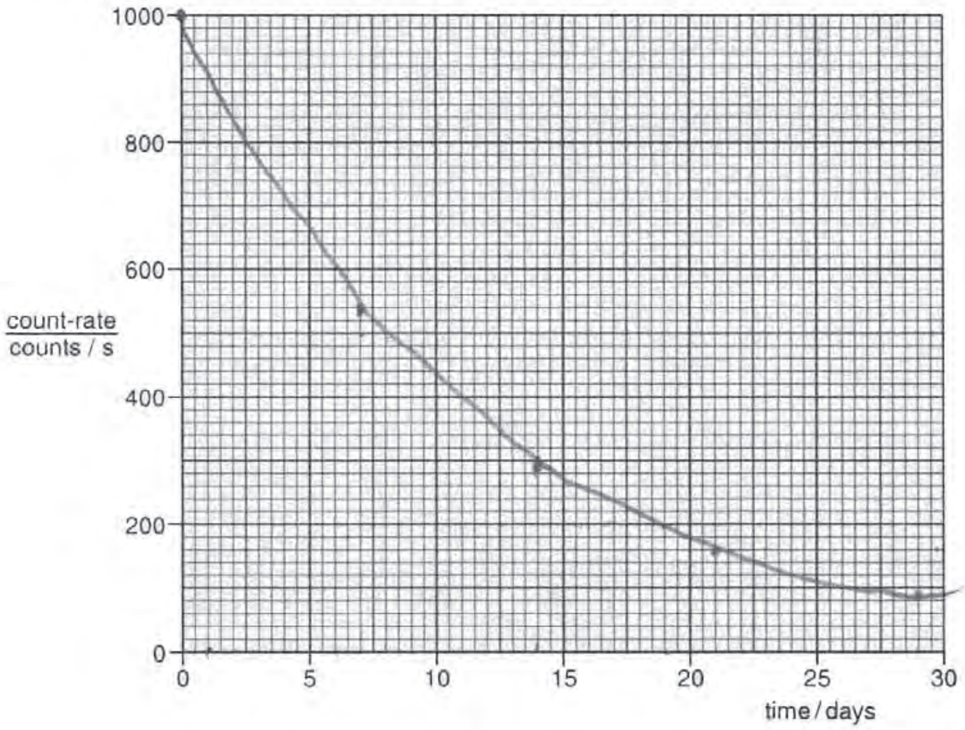


Fig. 12.1

(b) (i) From your graph, find the time at which the count-rate is

1. 800 counts / s, ...2.5.......... days

2. 200 counts / s. ....18.......... days [2]

(ii) From the figures in **(b)(i)**, find the value of the half-life of the substance.

18 ÷ 2.5

= 7.2

half-life = ... ~~8~~ 7.2 .... days [3]

[Total: 8]

Examiner comment – grade E

It is possible that this candidate was running out of time and rushed the drawing of this graph. Whatever the reason, the graph is poorly drawn, with the last point incorrectly plotted and a very poor line drawn through the points. When plotting graphs, it is expected that plotted points should be within half a small square of the correct position and that the curve or line should be thin and accurately drawn. The values of the times are within tolerance levels, but have not been correctly used to find the half-life. The candidate has used his values and shown his working, but there is nothing in the working that is worth marks.

Mark awarded = 3 out of 8

Paper 3 – Extended theory

Paper 3 is a written, extended theory paper consisting of short-answer and structured questions. Questions will be based on the Extended curriculum and will be of a difficulty appropriate to the higher grades. Questions will test skills mainly in assessment objectives A (Knowledge with understanding) and B (Handling information and problem solving). A quarter of the marks available will be based on Core material and the remainder on the Supplement.

Question 1

Mark scheme

1 (a) acceleration = $\frac{v-u}{t}$ OR $\frac{\Delta v}{t}$ (symbols used to be explained)
OR change of velocity ÷ time
OR rate of change of velocity
OR change of velocity per second / in 1 sec (allow 'in a certain time') — B1
accept speed for velocity

(b) (i) use of any area under graph — C1
750 m — A1

(ii) time = change of speed ÷ acceleration OR 30/0.60 — C1
= 50 (s) — A1
if working for t = 50 s not shown, allow 2 marks for correct use of 50 s
graph: along y-axis to 180 s / rise starts at 180 s — B1
from x-axis rises to 30 m/s at 230 s / candidate's calculated time — B1
horizontal from top of slope to 280 s — B1 [8]
allow ½ square tolerance at 180 s where relevant
allow ecf from wrong t

Example candidate response – grade A

1 **(a)** Define *acceleration*. Explain any symbols in your definition.

The rate of increase in speed; ~~mea~~ gradient of a speed/time graph measured in meters per second × second [1]

(b) Fig. 1.1 shows a graph of speed against time for a train. After 100 s the train stops at a station.

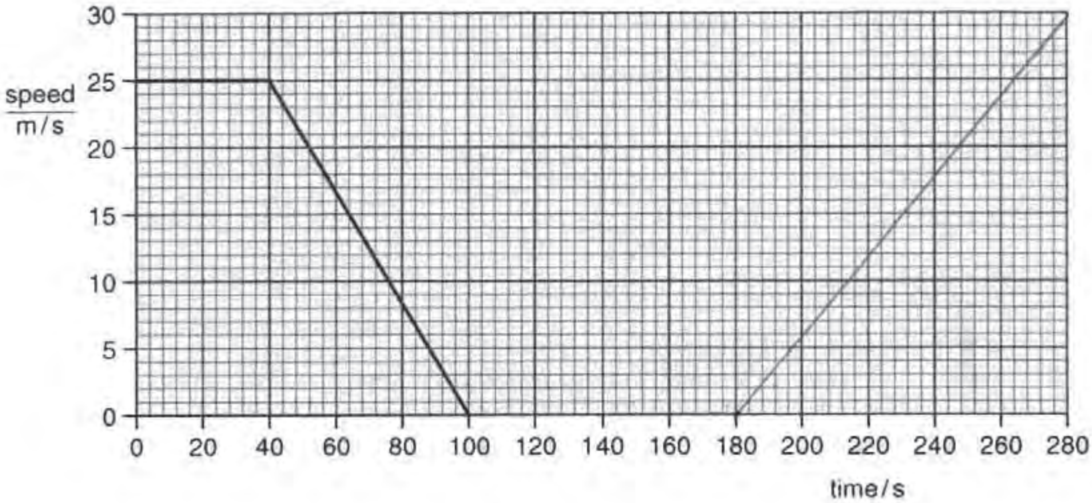


Fig. 1.1

(i) For the time interval between 40 s and 100 s, calculate the distance travelled by the train.

Dist = area under graph

$= \frac{1}{2} \times 60 \times 25$

$= 750$

distance = 750 m [2]

(ii) The train stops for 80 s, then accelerates to 30 m/s with an acceleration of 0.60 m/s^2. It then travels at constant speed.

$30 = u + at$

Complete the graph for the interval 100 s to 280 s, showing your calculations in the space below.

$v = u + at$

$30 = 0 + 0,6(t)$

$\frac{30 = 0,6t}{0,6}$

$50 = t$

[5]

[Total: 8]

Examiner comment

(a) The answer 'rate of change of speed' is an acceptable variation of the definition of acceleration, though 'velocity' rather than 'speed' would have been a better alternative. The added material was unnecessary, but did not contradict the previous work.

(b) An appropriate approach was used and the correct value calculated.

(c) Two marks could be given for the calculation of the time during which acceleration took place and a further mark for starting the upward slope at the correct time. However, the time calculated was not used correctly in the completion of the graph, and no further marks were awarded.

Mark awarded = 6 out of 8

Example candidate response – grade C

1 **(a)** Define *acceleration*. Explain any symbols in your definition.

This is when speed is changing when an object increases in speed it is said to be accelerating ....[1]

(b) Fig. 1.1 shows a graph of speed against time for a train. After 100 s the train stops at a station.

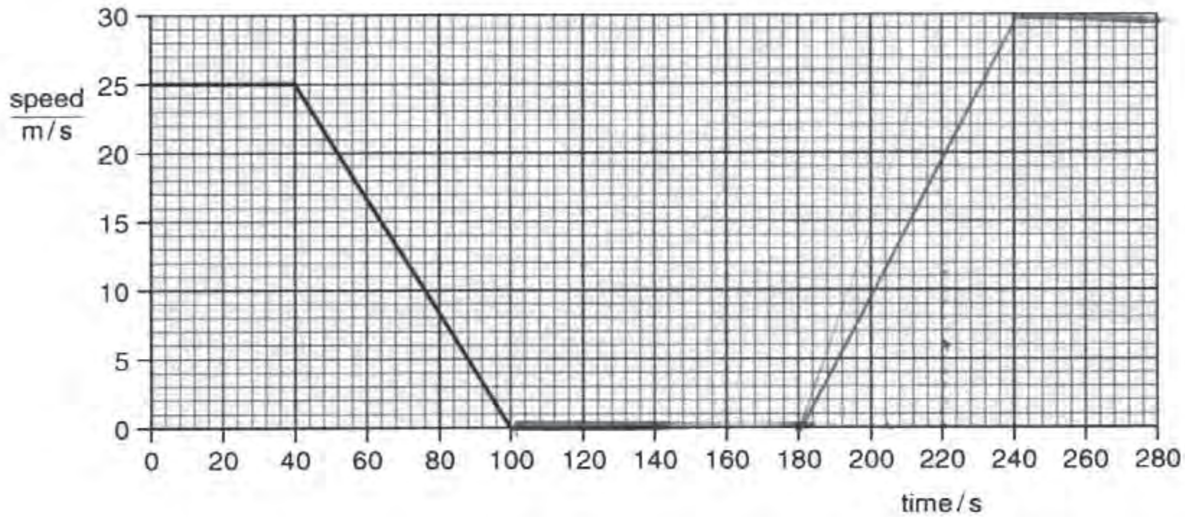


Fig. 1.1

(i) For the time interval between 40 s and 100 s, calculate the distance travelled by the train.

Distance = area under graph

$= \frac{1}{2} bh$

$= \frac{1}{2}(60)(25)$

$= 750$

distance = 750 m ....[2]

(ii) The train stops for 80 s, then accelerates to 30 m/s with an acceleration of 0.60 m/s^2. It then travels at constant speed.

Complete the graph for the interval 100 s to 280 s, showing your calculations in the space below.

$s = \frac{d}{t}$

[5]

[Total: 8]

Examiner comment – grade C

(a) The answer given suggests that the candidate has a knowledge of the concept of acceleration but did not know a definition of the term, or realise that writing a definition requires, in this case, a precise mathematical expression in words or explained symbols.

(b) A correct approach was used and the right value calculated.

(c) No meaningful attempt at a calculation of the time of acceleration was given. Marks were awarded for starting the upward slope at the correct time, and for the final constant speed section of the graph.

Mark awarded = 4 out of 8

Example candidate response – grade E

1 **(a)** Define *acceleration*. Explain any symbols in your definition.

This is the increase in Speed (distance over time) at any given movement which may cause a change in direction [1]

(b) Fig. 1.1 shows a graph of speed against time for a train. After 100 s the train stops at a station.

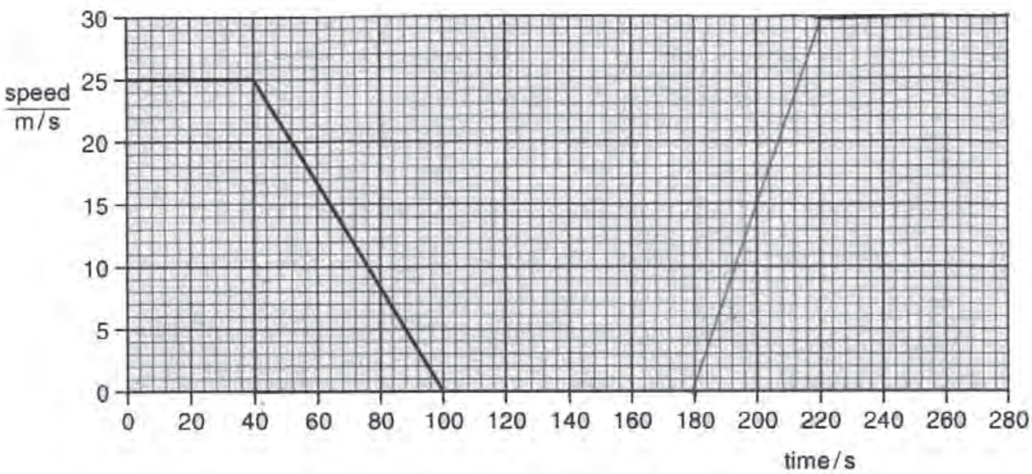


Fig. 1.1

(i) For the time interval between 40 s and 100 s, calculate the distance travelled by the train.

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

distance = Speed × time $= 25 \times 60$

distance = 1500 [2]

(ii) The train stops for 80 s, then accelerates to 30 m/s with an acceleration of 0.60 m/s^2. It then travels at constant speed.

Complete the graph for the interval 100 s to 280 s, showing your calculations in the space below.

6 $\quad \dfrac{30 - 25}{280}$

$= 0.017$

[5]

[Total: 8]

Examiner comment – grade E

(a) Change of speed was mentioned but only vague and incorrect work followed. No credit was possible.

(b) The candidate did not take account of the varying speed, using distance = speed x time and the initial speed in the calculation. Finding the area under the appropriate section of the graph would have been the best option.

(c) An unsuccessful attempt to find the time of acceleration was made. Marks were only awarded for starting the upward slope at the correct time, and for the final constant speed section of the graph.

Mark awarded = 2 out of 8

Question 2

Mark scheme

2	**(a)**		two processes from: vapour rising condensation rain falling water falling from lake / through pipes water turns turbine / generator electricity generated.	max B2	
			energy changes: PE to KE matched to a process KE to electricity energy for turbine / power station	 B1 B1	
	(b)	**(i)**	(PE =) mgh OR $2 \times 10^5 \times 10 \times 120$ allow $g = 9.8$ or 9.81 2.4×10^8 J	C1 A1	
		(ii)	(KE of water =) $\frac{1}{2}mv^2$ OR $\frac{1}{2} \times 2 \times 10^5 \times 14^2$ 1.96×10^7 J OR 2.0×10^7 J	C1 A1	 [8]

Example candidate response – grade A

2 **(a)** Energy from the Sun evaporates water from the sea. Some of this water eventually drives a hydroelectric power station. Give an account of the processes and energy changes involved.

It a change of energy from potential to kinetic. As the water falls from a high distance it converts P.E. to kinetic and then the hydraulic power station converts it to electrical energy.

[4]

(b) In a hydroelectric power station, 200 000 kg of water per second fall through a vertical distance of 120 m. The water passes through turbines to generate electricity, and leaves the turbines with a speed of 14 m/s.

(i) Calculate the gravitational potential energy lost by the water in 1 second. Use $g = 10\,\text{m/s}^2$.

P.E. = ~~m~~ mgh

200 000 × 10 × 120 = 240 000 000

ω = Fd = 2000 × 120 = 240 000 =

potential energy lost = 2400 000 J [2]

(ii) Calculate the kinetic energy of the water leaving the turbines in 1 second.

K.E. = ½ mv²

0.5 × 200 000 × 14 =

kinetic energy = 19600 000 J [2]

[Total: 8]

Examiner comment – grade A

(a) Two processes, water falling and electricity generated, allowed the award of one mark. An associated energy change, kinetic energy to electrical energy allowed another.

(b) **(i)** The correct formula was quoted. The formula was initially used correctly, but a contradictory calculation followed so only a single mark was possible.

(ii) The kinetic energy formula was stated and used correctly, giving full marks.

Mark awarded = 5 out of 8

Example candidate response – grade C

2 (a) Energy from the Sun evaporates water from the sea. Some of this water eventually drives a hydroelectric power station. Give an account of the processes and energy changes involved.

Sun produces heat energy to the water on the surface of the sea they gain kinetic energy which helps them to evaporate water evaporated are used ~~to~~ in dam stations to be used to produce electric energy according the speed of water it ~~mov~~ generates turbines to produce ~~electric~~ huge electric power.

[4]

(b) In a hydroelectric power station, 200 000 kg of water per second fall through a vertical distance of 120 m. The water passes through turbines to generate electricity, and leaves the turbines with a speed of 14 m/s.

(i) Calculate the gravitational potential energy lost by the water in 1 second. Use $g = 10\,\text{m/s}^2$.

~~PE = KE~~

~~$mgh = \frac{1}{2} \times m \times V^2$~~

PE = mgh

200 000 × 10 × 120

potential energy lost = 2400 00000 KJ [2]

(ii) Calculate the kinetic energy of the water leaving the turbines in 1 second.

$\frac{1}{2} \times m \times v^2$

$\frac{1}{2} \times 200000 \times 14^2 = 196\ 00\ 000$ KJ

kinetic energy = 196 00 000 KJ [2]

[Total: 8]

Examiner comment – grade C

(a) The candidate showed insufficient precise knowledge of the processes involved, and did not write a clear statement of any energy change taking place made. No marks were possible.

(b) (i) The correct formula was quoted and used correctly, but a mark was lost because the wrong unit was given.

(ii) The correct formula was quoted and used correctly. Again, the wrong unit was given, but since only one unit penalty is applied per question, full marks could be awarded.

Mark awarded = 3 out of 8

Example candidate response – grade E

2 (a) Energy from the Sun evaporates water from the sea. Some of this water eventually drives a hydroelectric power station. Give an account of the processes and energy changes involved.

The Sun has ~~heat~~ energy which heats up the ~~wat~~ sea water, making the most energetic molecules (rises up to the surface) breaking the bond to rise up to the surface to escape, ~~and~~ evaporate leaving the ~~water~~ sea water to cool down, energy of the sun is orginaelly nuclear "fission" that changes in heat energy. [4]

(b) In a hydroelectric power station, 200 000 kg of water per second fall through a vertical distance of 120 m. The water passes through turbines to generate electricity, and leaves the turbines with a speed of 14 m/s.

(i) Calculate the gravitational potential energy lost by the water in 1 second. Use $g = 10\,\text{m/s}^2$.

$P.E = mgh$

$= 200000 \times 10 \times 120$

potential energy lost = 2.4×10^8 KJ [2]

(ii) Calculate the kinetic energy of the water leaving the turbines in 1 second.

$K.E = \frac{1}{2} mv^2$

$= \frac{1}{2} \times 200000 \times 14$

kinetic energy = 1.4×10^6 KJ [2]

[Total: 8]

Examiner comment – grade E

(a) The answer given suggested that the candidate has no knowledge of hydroelectric power generation. No marks could be given for the processes or for the energy changes involved.

(b) (i) The correct formula was quoted and used correctly, but a mark was lost because the wrong unit was given.

(ii) Having correctly stated the formula, the candidate failed to square the speed in the calculation and lost a mark. No penalty was applied for the wrong unit.

Mark awarded = 2 out of 8

Question 3

Mark scheme

3	**(a)** 1.	no resultant force acts / no net force acts OR total force up / in any direction = total force down / in opposite direction allow sum of forces or resultant force for total force	B1	
	2.	no resultant moment / couple / torque acts OR (sum of) clockwise moments and (sum of) anti-clockwise moments (about any point / axis) balance	B1	
	(b) (i)	(anti-clockwise moment =) $F \times 2$ (total clockwise moment =) $(120 \times 33) + (20 \times 15) = 4260$ (N cm) 2130 N	C1 C1 A1	
	(ii)	1990 N OR candidate's **(b)(i)** – 140 N force is downwards	B1 B1	[7]

Example candidate response – grade A

3 **(a)** State the two conditions required for the equilibrium of a body acted upon by a number of forces.

1. Clockwise moment about a point is equal to the anticlockwise moment about the same point.

2. Forces acting in one direction is equal to forces acting in the same direction. [2]

(b) Fig. 3.1 shows a diagram of an arm with the hand holding a weight of 120 N.

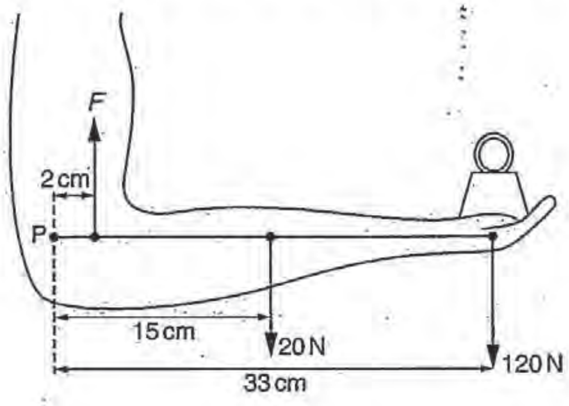


Fig. 3.1

The 20 N force is the weight of the forearm, acting at its centre of mass. *F* is the force in the muscle of the upper arm. P is the point in the elbow about which the arm pivots. The distances of the forces from point P are shown.

(i) By taking moments about point P, calculate the force *F*.

moment = ~~d~~ perpendicular distance × force

moment = 15 cm × 20 N
moment = 300 Ncm
moment = 18 cm × 120 N
= 2160 Ncm

~~mom~~ 2160 + 300 = 2460 Ncm
2460 = 2 × force
force = 1230 N

force *F* = 1230 N [3]

(ii) A force acts on the forearm at point P. Calculate this force and state its direction.

force = 120 N

direction = Downwards [2]

[Total: 7]

Examiner comment – grade A

(a) The simplest acceptable statement about moments is that clockwise moments and anticlockwise moments balance or are equal. The candidate included the words 'about a point', expressing an even more thorough understanding of the concept. Unfortunately, possibly through a slip, in the statement about forces, the use of the words 'same direction' instead of 'opposite direction' meant that the mark for this was forfeited.

(b) **(i)** The mistake in calculating one of the clockwise moments was treated as an arithmetic error, resulting in the loss of a mark.

(ii) The difference between the upward force and the total downward force had to be calculated. There was no indication that this had been attempted. The downward direction was clearly stated and gained a mark.

Mark awarded = 4 out of 7

Example candidate response – grade C

3 **(a)** State the two conditions required for the equilibrium of a body acted upon by a number of forces.

1. clockwise moment should be equal to the anti-clockwise moment

2. the upward forces and the downward forces should be balanced, to give a resultant force of zero [2]

(b) Fig. 3.1 shows a diagram of an arm with the hand holding a weight of 120 N.

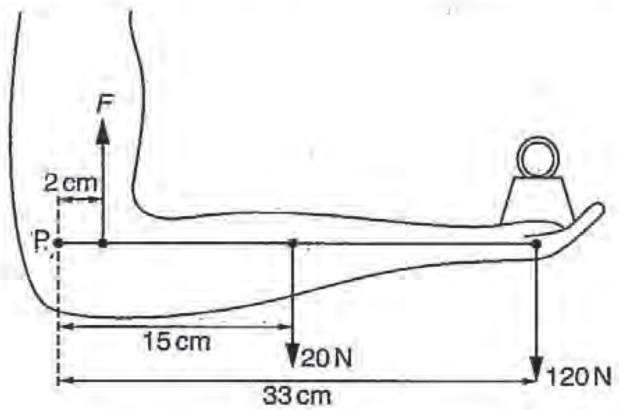


Fig. 3.1

The 20 N force is the weight of the forearm, acting at its centre of mass. *F* is the force in the muscle of the upper arm. P is the point in the elbow about which the arm pivots. The distances of the forces from point P are shown.

(i) By taking moments about point P, calculate the force *F*.

clockwise moment = anti-clockwise moment

$20 \times 0,15 = 0,02 \times x$

$x = \frac{20 \times 0,15}{0,02}$

$x = 150N$

force *F* = 150N [3]

(ii) A force acts on the forearm at point P. Calculate this force and state its direction.

clockwise

$120N \times 0,33 = 0,02 \times x$

$x = \frac{120 \times 0,33}{0,02}$

$x = 1980N$

force = 1980

direction = upwards [2]

[Total: 7]

Examiner comment – grade C

(a) Both conditions for equilibrium were satisfactorily stated.

(b) **(i)** The clockwise moment was calculated correctly, but only one of the anticlockwise moments was identified. Only one mark could be awarded.

(ii) The candidate attempted a further solution using the principle of moments, which could have been successful if correctly carried out. However, the point about which to take moments was not identified and three forces, not two, had to be included in the equation.

Mark awarded = 3 out of 7

Example candidate response – grade E

3 **(a)** State the two conditions required for the equilibrium of a body acted upon by a number of forces.

1. Masses should be equal to each other

2. Forces should be equal to each other [2]

(b) Fig. 3.1 shows a diagram of an arm with the hand holding a weight of 120 N.

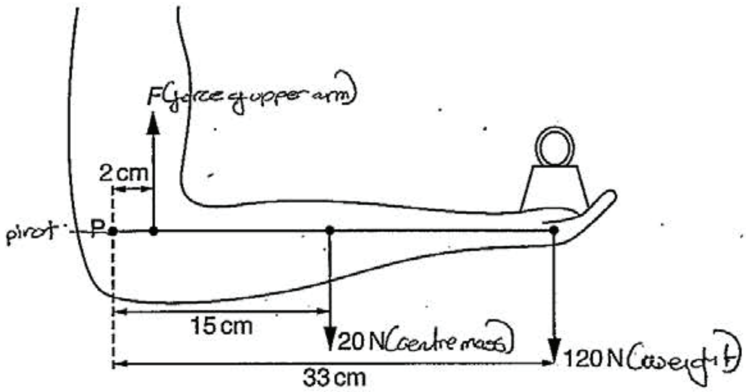


Fig. 3.1

The 20 N force is the weight of the forearm, acting at its centre of mass. *F* is the force in the muscle of the upper arm. P is the point in the elbow about which the arm pivots. The distances of the forces from point P are shown.

(i) By taking moments about point P, calculate the force *F*.

~~Force = mg~~

a) Moment = Force x distance
= 20 x 0,15
= 3Nm

b) Moment = Force x distance
= 120 x 33
= 120 x 0,33
= 39,6Nm

\+

force *F* = 42,6N [3]

(ii) A force acts on the forearm at point P. Calculate this force and state its direction.

force = ...

direction = ... [2]

[Total: 7]

Examiner comment – grade E

(a) The candidate appreciated that forces were involved, but the statement about forces made no reference to their direction. Neither part of the answer involved moments of forces. No marks could be awarded.

(b) (i) The clockwise moments were both calculated correctly and added together, and gained a mark. No further work followed.

(b) (ii) There was no response to this section.

Mark awarded = 1 out of 7

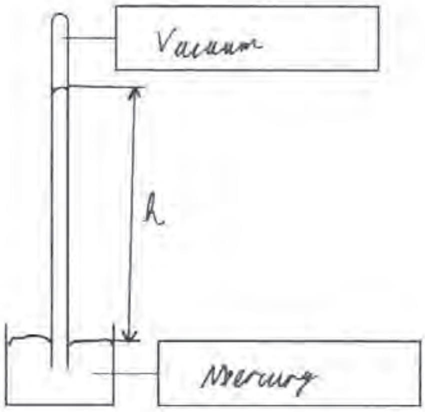
Question 4

Mark scheme

4	**(a)**	surfaces shown at realistic levels in dish and tube AND vertical height *h* between levels clearly shown	B1	
		top label: vacuum / mercury vapour	B1	
		bottom label: mercury	B1	
	(b)	(P =) hdg OR 0.73 × 13600 × 10	C1	
		99280 Pa at least 2 s.f.	B1	
	(c)	one from: abnormal weather / atmospheric conditions o.w.t.t.e. air in space above mercury in tube barometer is in a high altitude location o.w.t.t.e. space above mercury is not a vacuum ignore atmospheric pressure varies ignore temperature	B1	[6]

Example candidate response – grade A

4 **(a)** Complete Fig. 4.1 to show a simple mercury barometer. Insert the correct labels in the boxes. Label with the letter h the measurement required to calculate the pressure of the atmosphere.



[3]

Fig. 4.1

(b) The value of h taken using this barometer is 0.73 m. The density of mercury is 13 600 kg/m^3. Calculate the value of the atmospheric pressure suggested by this measurement. Use g = 10 m/s^2.

P = ρgh

= 13600 × 10 × 0.73

P = 99280

atmospheric pressure = 99280 kPa [2]

(c) Standard atmospheric pressure is 0.76 m of mercury. Suggest a reason why the value of h in **(b)** is lower than this.

There is lower atmospheric pressure as on a cloudless day. [1]

[Total: 6]

Examiner comment – grade A

(a) The answer was complete in all respects.

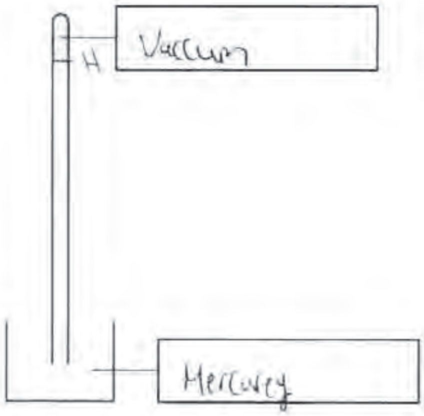
(b) The correct formula was quoted and used correctly, but a mark was lost because the wrong unit was given.

(c) Various suggestions were possible, but the one made by the candidate is not a valid one.

Mark awarded = 5 out of 6

Example candidate response – grade C

4 (a) Complete Fig. 4.1 to show a simple mercury barometer. Insert the correct labels in the boxes. Label with the letter *h* the measurement required to calculate the pressure of the atmosphere.



[3]

Fig. 4.1

(b) The value of *h* taken using this barometer is 0.73 m. The density of mercury is 13 600 kg/m^3. Calculate the value of the atmospheric pressure suggested by this measurement. Use g = 10 m/s^2.

atmospheric pressure = ...[2]

(c) Standard atmospheric pressure is 0.76 m of mercury. Suggest a reason why the value of *h* in **(b)** is lower than this.

The mercury have a lower temperature in this exprement

....[1]

[Total: 6]

Examiner comment – grade C

(a) In general in this question, candidates showed little knowledge of the details of a mercury barometer. This candidate labelled the mercury and the vacuum correctly. However, 'h' was indicated as a level of mercury rather than a height to be measured, so a mark was lost.

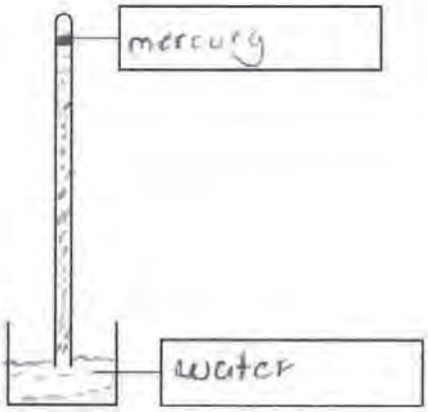
(b) There was no response to this section.

(c) The mistaken suggestion that the mercury has a lower temperature indicates a possible confusion between a thermometer and a barometer, a common feature of answers to this question.

Mark awarded = 2 out of 6

Example candidate response – grade E

4 **(a)** Complete Fig. 4.1 to show a simple mercury barometer. Insert the correct labels in the boxes. Label with the letter *h* the measurement required to calculate the pressure of the atmosphere.



[3]

Fig. 4.1

(b) The value of *h* taken using this barometer is 0.73 m. The density of mercury is 13 600 kg/m^3. Calculate the value of the atmospheric pressure suggested by this measurement. Use g = 10 m/s^2.

P = dgh

P = 10 × 13,600 × 0·73

= 99,280

atmospheric pressure = 99,280 [2]

(c) Standard atmospheric pressure is 0.76 m of mercury. Suggest a reason why the value of *h* in **(b)** is lower than this.

because probably the experiments was in an area of ~~higher~~ lower temperatures causing ~~ex~~ less expansion of the liquid [1]

[Total: 6]

Examiner comment – grade E

(a) The label 'water' in the lower box suggests little understanding of the mercury barometer and its structure. No marks could be awarded.

(b) By calculating the pressure due to the given height of mercury, the candidate had clearly made the correct inference from the details given. The omission of the unit from a correct value meant the forfeit of a mark.

(c) The suggestion of a lower temperature of the mercury causing less expansion and therefore a smaller 'h' indicates a possible confusion between a thermometer and a barometer.

Mark awarded = 1 out of 6

Question 5

Mark scheme

5 (a)	(i)	most: gas least: solid both required	B1	
	(ii)	because change of pressure (also) causes volume change (in a gas) NOT 'gas can be compressed'	B1	
(b)	(i)	two from: expands uniformly (over required range) remains liquid over required range expands more than glass / has high expansivity / expansion has (reasonably) low specific heat capacity. has low freezing point / lower freezing point than mercury	max B2	
	(ii)	make (capillary) tube narrower (and longer) / thinner / smaller diameter make bulb larger (and tube longer) allow 'bore' for tube ignore 'smaller' ignore narrow <u>thermometer</u>	B1 B1	
(c)		allows fast(er) flow of heat to / from alcohol OR allows fast response (to temperature change) OR because glass is a poor conductor / good insulator (so needs to be thin for fast response) OR heat transfer more efficient / faster OR glass takes up less heat ignore reference to sensitivity ignore 'easier'	B1	[7]

Example candidate response – grade A

5 (a) Equal volumes of a gas held at constant pressure, a liquid and a solid undergo the same temperature rise.

(i) State which of the three, solid, liquid or gas,

1. expands the most, ...gas..........

2. expands the least. ......Solid..........

(ii) Explain why the pressure of the gas must be kept constant for this comparison.

....Because as pressure increase, temperature..............

....increase and it will expand more..................................[2]

(b) Fig. 5.1 shows an alcohol thermometer.

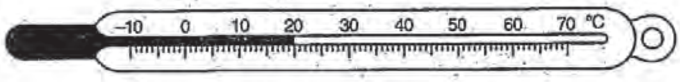


Fig. 5.1

(i) State two properties of alcohol which make it suitable for use in a thermometer.

1. ....Can be used to measure arctic temperatures........

....

2. ~~Has a wide expensivity~~ Has a higher

........~~expesivity~~ .... Expensivity.........................[2]

(ii) State **two** changes to the design of this thermometer which would make it more sensitive.

1. ....Increase length of the Bulb..

....

2. ....Decrease the Capilary..

....[2]

(c) Explain why it is an advantage for the glass surrounding the alcohol in the bulb of the thermometer to be very thin.

prevent alchol from getting out...

....[1]

[Total: 7]

Examiner comment – grade A

(a) **(i)** The candidate identified that gas expands the most and liquid the least, as did most candidates answering this question.

(ii) This question proved to be difficult for most candidates. The idea that a change in pressure, as well as change in temperature, also causes the volume of a gas to change, had to be expressed in some way. This candidate's reference to increase of pressure causing increase of temperature could not be rewarded.

(b) **(i)** The mark scheme allowed several possible reasons for the suitability of alcohol as a thermometric liquid. The candidate's statements were accepted as agreeing or being equivalent to two of these reasons.

(ii) The concept of the sensitivity of a measuring instrument is a difficult one for many candidates. The answer 'decrease the capillary', with the benefit of some doubt, was taken to imply 'make the capillary bore thinner' and given a mark. The answer 'increase length of the bulb' was not rewarded, volume being the relevant factor.

(c) No reference to faster heat flow or faster response or their causes was made.

Mark awarded = 4 out of 7

Example candidate response – grade C

5 **(a)** Equal volumes of a gas held at constant pressure, a liquid and a solid undergo the same temperature rise.

(i) State which of the three, solid, liquid or gas,

1. expands the most, ...Solid...........

2. expands the least. ...gas..............

P V T

(ii) Explain why the pressure of the gas must be kept constant for this comparison.

......As by increasing the pressure of gas, the..........

....Volume of gas will decrease...[2]

(b) Fig. 5.1 shows an alcohol thermometer.

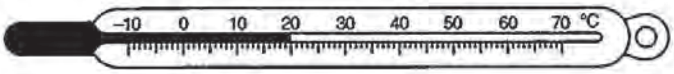


Fig. 5.1

(i) State two properties of alcohol which make it suitable for use in a thermometer.

1. ....As it ~~has low densi~~ can detect the..................

....change in temperature easily...

2. ....have low thermal capacity...

....[2]

(ii) State two changes to the design of this thermometer which would make it more sensitive.

1. ...decrease the surface area of glass tube..........

....

2. ....

....[2]

(c) Explain why it is an advantage for the glass surrounding the alcohol in the bulb of the thermometer to be very thin.

....As to allow all the alcohol to take the heat, to...

....detect small changes...[1]

[Total: 7]

Examiner comment – grade C

(a) **(i)** The choices of most expansion for solid and least for gas was wrong.

(ii) This was a good answer.

(b) **(i)** 'Can detect change of temperature easily' with no reason given, was not rewarded. A mark was allowed for the correct idea expressed by the words 'has low thermal capacity'.

(ii) There was no material worthy of credit in this answer.

(c) No reference was made to faster heat flow or faster response or their causes.

Mark awarded = 2 out of 7

Question 6

Mark scheme

6	**(a)**	**(i)**	**1.** compressions and/or rarefactions closer together OR more compressions and/or rarefactions ignore wavelength shorter	B1	
			2. layers closer together at compressions	B1	
			layers farther apart at rarefactions	B1	
			OR		
			compressions narrower	(B1)	
			rarefactions wider	(B1)	
			ignore wavelength shorter ignore 'amplitude greater' ignore 'maximum displacement greater'		
		(ii)	distance between 2 compressions or 2 rarefactions shown with reasonable accuracy	B1	
	(b)		time taken by sound in air = 200 / 343 = 0.583 s	C1	
			time taken by sound in steel = 0.583 – 0.544 = 0.039 s	C1	
			5128 m/s	A1	[7]

Example candidate response – grade A

6 **(a)** Fig. 6.1 shows the position of layers of air, at one moment, as a sound wave of constant frequency passes through the air. Compressions are labelled C. Rarefactions are labelled R.

Fig. 6.1

(i) State how Fig. 6.1 would change if

1. the sound had a higher frequency,

More ~~corr~~ compressions and rarefactions [1]

2. the sound were louder.

It would have a higher amplitude and the distance between ~~the~~ two ~~crests~~ compressions will increase [2]

(ii) On Fig. 6.1, draw a line marked with arrows at each end to show the wavelength of the sound. [1]

(b) In an experiment to measure the speed of sound in steel, a steel pipe of length 200 m is struck at one end with a hammer. A microphone at the other end of the pipe is connected to an accurate timer. The timer records a delay of 0.544 s between the arrival of the sound transmitted by the steel pipe and the sound transmitted by the air in the pipe.

The speed of sound in air is 343 m/s. Calculate the speed of sound in steel.

D
S T

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

$0.583 - 0.544 = 0.039$

$$T = \frac{D}{S}$$

$$S = \frac{D}{T}$$

$$T = \frac{200}{343}$$

$$S = \frac{200}{0.039}$$

$T = 0.583$

(Time in air)

speed of sound in steel = 5128.21 [3]

[Total: 7]

Examiner comment – grade A

(a) **(i)** 1. The answer 'more compressions and rarefactions' was acceptable and gained the mark. It implies that a greater number of compressions and rarefactions occur in the distance shown on the figure, so they must be closer together.

2. The candidate knows that a louder sound means that waves have a greater amplitude. However, the rather difficult idea as to how this changes the spacing of air layers in the compressions and rarefactions was not addressed.

(ii) The distance between two successive compressions was accurately shown as the wavelength.

(b) The omission of the unit from the correct answer in this rather difficult, multi-step calculation meant that the candidate could not gain the final mark for the question.

Mark awarded = 4 out of 7

Example candidate response – grade C

6 **(a)** Fig. 6.1 shows the position of layers of air, at one moment, as a sound wave of constant frequency passes through the air. Compressions are labelled C. Rarefactions are labelled R.

Fig. 6.1

(i) State how Fig. 6.1 would change if

1. the sound had a higher frequency,

There would be a smaller distance between compressions ....[1]

2. the sound were louder.

The amplitude would be greater the waves would

be ~~air~~ ~~concentrated~~ be longer

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

(ii) On Fig. 6.1, draw a line marked with arrows at each end to show the wavelength of the sound. [1]

(b) In an experiment to measure the speed of sound in steel, a steel pipe of length 200 m is struck at one end with a hammer. A microphone at the other end of the pipe is connected to an accurate timer. The timer records a delay of 0.544 s between the arrival of the sound transmitted by the steel pipe and the sound transmitted by the air in the pipe.

The speed of sound in air is 343 m/s. Calculate the speed of sound in steel.

$S = \frac{D}{T} = \frac{200}{0,544}$

$= 367,6$

speed of sound in steel = 367,056 ....[3]

[Total: 7]

Examiner comment – grade C

(a) **(i)** 1. The answer given met the requirements of the mark scheme and gained the mark.

2. The candidate knows that a louder sound means that waves have a greater amplitude, but the effect of this increase on the spacing of air layers in the compressions and rarefactions was not addressed.

(ii) The distance between two successive compressions was shown as the wavelength with acceptable accuracy.

(b) The candidate used the delay in the time as the time taken for the sound to travel through the steel and no marks could be awarded. The suggestion is that the question was not read with sufficient care.

Mark awarded = 2 out of 7

Example candidate response – grade E

6 **(a)** Fig. 6.1 shows the position of layers of air, at one moment, as a sound wave of constant frequency passes through the air. Compressions are labelled C. Rarefactions are labelled R.

Fig. 6.1

(i) State how Fig. 6.1 would change if

1. the sound had a higher frequency,

There would be more compressions than rafractions ....[1]

2. the sound were louder.

The compressions ~~woo~~ and rarefractions would be longer.

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

(ii) On Fig. 6.1, draw a line marked with arrows at each end to show the wavelength of the sound. [1]

(b) In an experiment to measure the speed of sound in steel, a steel pipe of length 200 m is struck at one end with a hammer. A microphone at the other end of the pipe is connected to an accurate timer. The timer records a delay of 0.544 s between the arrival of the sound transmitted by the steel pipe and the sound transmitted by the air in the pipe.

The speed of sound in air is 343 m/s. Calculate the speed of sound in steel.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{200\text{m}}{0.544\text{s}}$$

$$= 367.64$$

speed of sound in steel = 367.64 m/s ....[3]

[Total: 7]

Examiner comment – grade E

(a) **(i)** 1. The fact that compressions must be equally spaced means that the answer 'more compressions than rarefactions' misses this vital point.

2 The candidate's statement that the compressions would be longer could not be accepted without further explanation.

(ii) No attempt was made to show the wavelength on the figure.

(b) The candidate used the delay in the time as the time taken for the sound to travel through the steel and no marks could be awarded.

Mark awarded = 1 out of 7

Question 7

Mark scheme

7	**(a)**	**(i)**	light of a single wavelength / frequency ignore 'one colour'	B1	
		(ii)	$n = \sin i/\sin r$ OR $1.52 = \sin 50/\sin r$ OR $\sin r = \sin 50/1.52$ 30.26° at least 2 s.f.	C1 A1	
		(iii)	ray closer to normal in block ray parallel to incident ray emerging from block	B1 B1	
	(b)	**(i)**	$n = v_A/v_G$ OR $n = 1.54/v_G$ OR $v_G = 3 \times 10^8/1.54$ 1.948×10^8 m/s	C1 B1	
		(ii)	ray with smaller angle of refraction than red in block i.e. violet ray under red ray emerging ray parallel to incident ray	B1 B1	[9]

Example candidate response – grade A

7 (a) Fig. 7.1 shows a ray of monochromatic red light, in air, incident on a glass block at an angle of incidence of 50°.

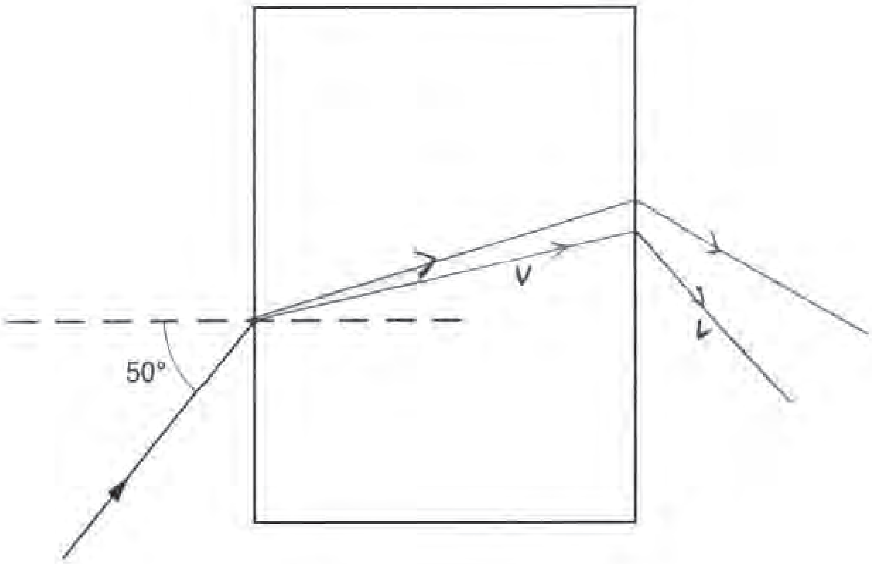


Fig. 7.1

(i) State what is meant by *monochromatic* light.

One beam of light [1]

(ii) For this red ray the refractive index of the glass is 1.52. Calculate the angle of refraction for the ray.

$$n = \frac{\sin i}{\sin r} \quad \sin r = \frac{\sin i}{n} = \frac{\sin 50}{1.52} = 0.504$$

$$\sin^{-1}(\text{Ans}) = 30.3$$

angle of refraction = 30.3° [2]

(iii) Without measuring angles, use a ruler to draw the approximate path of the ray in the glass block and emerging from the block. [2]

(b) The red ray in Fig. 7.1 is replaced by a ray of monochromatic violet light. For this violet ray the refractive index of the glass is 1.54. The speed of light in air is 3.00×10^8 m/s.

(i) Calculate the speed of the violet light in the glass block.

$n = \frac{\text{speed in air}}{\text{speed in gly.}} =$ Speed in gly $= \frac{3\times10^8}{1.54} =$

speed = 194805194 m/s [2]

(ii) Use a ruler to draw the approximate path of this violet ray in the glass block and emerging from the block. Make sure this path is separated from the path drawn for the red light in **(a)(iii)**. Mark both parts of this path with the letter V. [2]

[Total: 9]

Examiner comment – grade A

(a) **(i)** The candidate, in common with many others, was not able to recall the meaning of the term *monochromatic*.

(ii) The correct formula was quoted and used correctly.

(iii) The refraction of the ray on entering the block was shown correctly. The emerging ray, needing to be parallel to the incident ray, was entirely wrong, losing the second mark.

(b) **(i)** The correct formula was quoted and used correctly.

(ii) The refracted ray in the block was correctly shown with a larger angle of refraction than the red ray. The error made in **(a)(iii)** was then repeated, losing the second mark.

Mark awarded = 6 out of 9

Example candidate response – grade C

7 (a) Fig. 7.1 shows a ray of monochromatic red light, in air, incident on a glass block at an angle of incidence of 50°.

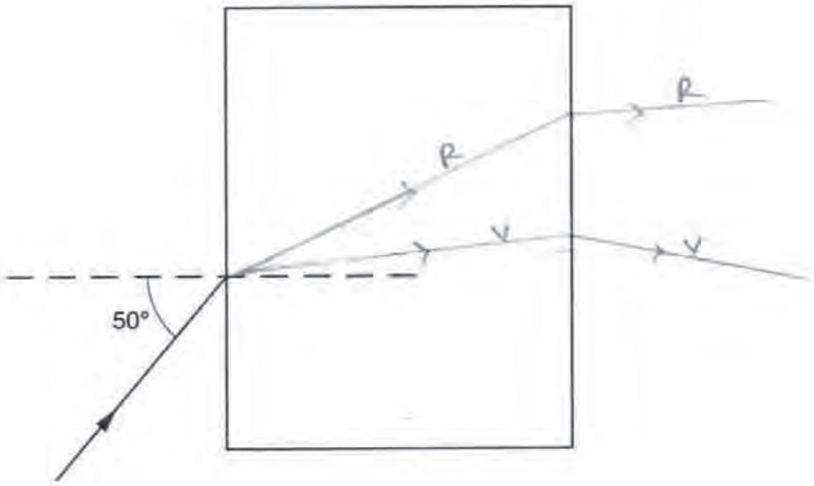


Fig. 7.1

(i) State what is meant by *monochromatic* light.

A light that has only one wavelength and color ....[1]

(ii) For this red ray the refractive index of the glass is 1.52. Calculate the angle of refraction for the ray.

$1.52 = \frac{\sin i}{\sin r} \Rightarrow 1.52 = \frac{\sin 50}{\sin r}$

$\therefore \sin r = \frac{\sin 50}{1.52} \Rightarrow \frac{0.7660}{1.52} = 0.5039$

$r = \sin^{-1} 0.5039 \Rightarrow 30.258 \approx 30.3$

angle of refraction = 30.3 ....[2]

(iii) Without measuring angles, use a ruler to draw the approximate path of the ray in the glass block and emerging from the block. [2]

(b) The red ray in Fig. 7.1 is replaced by a ray of monochromatic violet light. For this violet ray the refractive index of the glass is 1.54. The speed of light in air is 3.00×10^8 m/s.

(i) Calculate the speed of the violet light in the glass block.

$1.54 = \frac{x}{3.00 \times 10^8}$

$x = 1.54 \times 3.00 \times 10^8$

$\Rightarrow 462000000$

speed = 462000000 ....[2]

(ii) Use a ruler to draw the approximate path of this violet ray in the glass block and emerging from the block. Make sure this path is separated from the path drawn for the red light in **(a)(iii)**. Mark both parts of this path with the letter V. [2]

[Total: 9]

Examiner comment – grade C

(a) **(i)** 'A light that has only one wavelength' gained the mark. The added words 'and colour' were superfluous.

(ii) The omission of the unit from an otherwise correct answer meant that the candidate did not gain the second mark.

(iii) The refraction of the ray on entering the block was shown correctly. The emerging ray, needing to be parallel to the incident ray, was entirely wrong, losing the second mark.

(b) **(i)** The candidate had clearly remembered the principle of this calculation, but inverted the quantities substituted on the right-hand side of the equation. Failure to write down the formula before the substitution may have contributed to the mistake. No marks could be awarded.

(ii) The refracted ray in the block was correctly shown with a larger angle of refraction than the red ray. The error made in **(a)(iii)** was then repeated, losing the second mark.

Mark awarded = 4 out of 9

Example candidate response – grade E

7 **(a)** Fig. 7.1 shows a ray of monochromatic red light, in air, incident on a glass block at an angle of incidence of 50°.

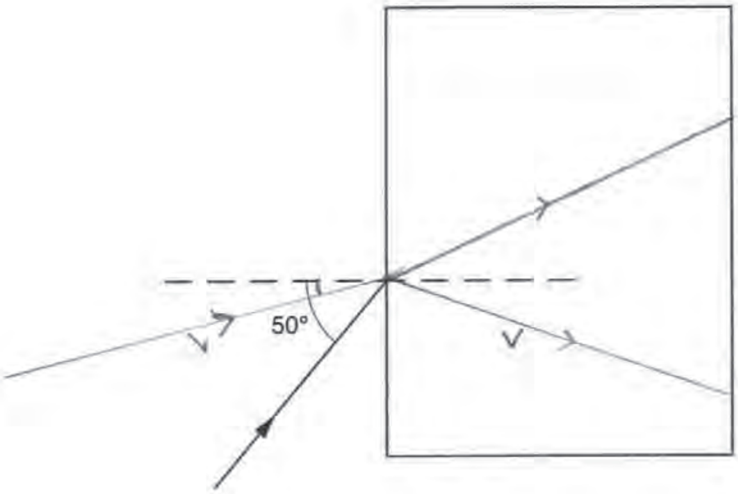


Fig. 7.1

(i) State what is meant by *monochromatic* light.

One coloured or single colour ....[1]

(ii) For this red ray the refractive index of the glass is 1.52. Calculate the angle of refraction for the ray.

$$\frac{50}{1,52} = 33°$$

angle of refraction = 33° ....[2]

(iii) Without measuring angles, use a ruler to draw the approximate path of the ray in the glass block and emerging from the block. [2]

(b) The red ray in Fig. 7.1 is replaced by a ray of monochromatic violet light. For this violet ray the refractive index of the glass is 1.54. The speed of light in air is 3.00×10^8 m/s.

(i) Calculate the speed of the violet light in the glass block.

$$\frac{3,00 \times 10^8}{1,54} = 1,95 \times 10^8$$

speed = $1,95 \times 10^8$ ....[2]

(ii) Use a ruler to draw the approximate path of this violet ray in the glass block and emerging from the block. Make sure this path is separated from the path drawn for the red light in (a)(iii). Mark both parts of this path with the letter V. [2]

[Total: 9]

Examiner comment – grade E

(a) **(i)** Reference only to a single colour did not gain the mark.

(ii) Division by the angle of incidence, rather than the sine of the angle, was wrong.

(iii) Failure to draw the emerging ray meant the loss of the second mark.

(b) **(i)** The correct calculation was carried out, but the unit of the answer was omitted, losing a mark.

(ii) The refracted violet ray was shown on the wrong side of the normal, with no emerging ray drawn.

Mark awarded = 2 out of 9

Question 8

Mark scheme

8 **(a)** any three from:
use a strong(er) magnet
increase the number of coils in the solenoid / turns of solenoid closer together
move the magnet fast(er).
place iron core in the solenoid
use thick(er) wire / low(er) resistance wire for solenoid — max B3

(b) **(i)** $N_P/N_S = V_P/V_S$ OR $200/800 = V_P/24$ OR $V_P = N_P V_S/N_S$
OR $V_P = 200 \times 24/800$ — C1
6.0 V — A1

(ii) $I_p V_p = I_s V_s$ OR $I_p N_p = I_s N_s$ OR $I_P = I_S V_S/V_P$ OR $I_P = I_S N_S/N_P$
OR $I_P = (0.5 \times 24)/6$ OR $I_P = (0.5 \times 800)/200$ — C1
2(.0) A
allow ecf from **(b)(i)** — A1 [7]

Example candidate response – grade A

8 (a) In Fig. 8.1, a magnet is moving towards one end of a solenoid connected to a sensitive centre-zero meter. During this movement a current is induced in the solenoid.

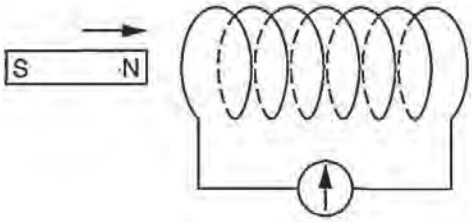


Fig. 8.1

Suggest **three** possible changes to the system in Fig. 8.1 that would increase the induced current.

1. the number of turns on the solenoid
2. a stronger magnet
3. moving the magnet faster [3]

(b) Fig. 8.2 shows a transformer. P is the primary coil. S is the secondary coil. The coils are wound on an iron core.

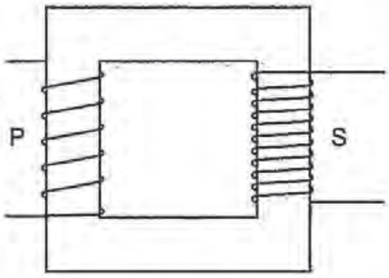


Fig. 8.2

P has 200 turns and S has 800 turns. The e.m.f. induced across S is 24 V. The current in S is 0.50 A. The transformer operates with 100% efficiency.

Calculate

(i) the voltage of the supply to P.

$\frac{V_1}{V_2} = \frac{N_1}{N_2}$

$\frac{V_1}{24} = \frac{200}{800}$

$800v = 4800$

$v = 6$

voltage = 6 ....[2]

(ii) the current in P.

$V_1 I_1 = V_2 I_2$

$6I = 24 \times 0{,}5$

$6I = 12$

$I = 2$

current = 2 ....[2]

[Total: 7]

Examiner comment – grade A

(a) One of the changes suggested referred to the number of turns on the solenoid, but not how the number should be changed, forfeiting a mark.

(b) **(i)** The correct calculation was carried out, but the unit of the answer was omitted, and lost a mark.

(ii) The candidate used the formula equating the powers in the two coils to calculate the correct current. No penalty was applied for the omission of the unit, a unit penalty having already been applied in **(b)(i)**.

Mark awarded = 5 out of 7

Example candidate response – grade C

8 **(a)** In Fig. 8.1, a magnet is moving towards one end of a solenoid connected to a sensitive centre-zero meter. During this movement a current is induced in the solenoid.

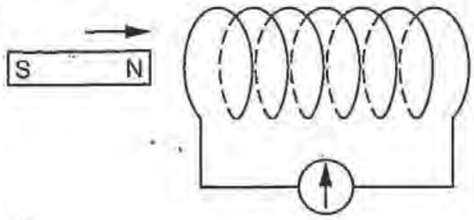


Fig. 8.1

Suggest **three** possible changes to the system in Fig. 8.1 that would increase the induced current.

1. ~~A~~ Increase number of coils

2. ~~Increase~~ Increase number of turns

3. ~~Increase~~ Bring a bigger magnet [3]

(b) Fig. 8.2 shows a transformer. P is the primary coil. S is the secondary coil. The coils are wound on an iron core.

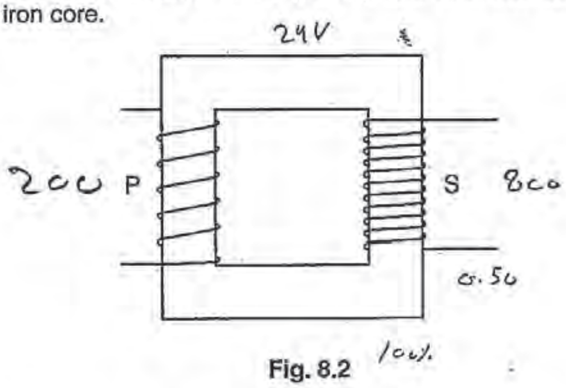


Fig. 8.2

P has 200 turns and S has 800 turns. The e.m.f. induced across S is 24V. The current in S is 0.50A. The transformer operates with 100% efficiency.

Calculate

(i) the voltage of the supply to P;

Ai

$$\frac{N_p}{N_s} = \frac{V_p}{V_s} \qquad \frac{200}{800} = \frac{24}{V_s}$$

200

$$\frac{200V_s}{200} = \frac{19200}{200}$$

voltage = 96 V [2]

(ii) the current in P.

$\cancel{V_1 I_1 = V_2 I_2}$

$$V_1 I_1 = V_2 I_2$$

$$\frac{24 \times 0.50}{96} = \frac{96 \times I_2}{96}$$

current = 0.125 A [2]

[Total: 7]

Examiner comment – grade C

(a) Two of the suggested changes made the same point with different wording, one mentioning more coils, the other more turns, The third change suggested 'bring a bigger magnet' did not necessarily mean a stronger one. One mark was awarded.

(b) **(i)** The correct formula was quoted and gained a mark. The data was substituted wrongly.

(ii) With the error from **(b)(i)** carried forward, the answer obtained was awarded with both marks.

Mark awarded = 3 out of 7

Example candidate response – grade E

8 (a) In Fig. 8.1, a magnet is moving towards one end of a solenoid connected to a sensitive centre-zero meter. During this movement a current is induced in the solenoid.

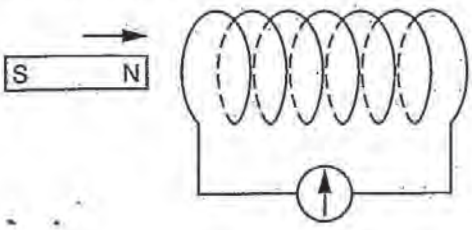


Fig. 8.1

Suggest **three** possible changes to the system in Fig. 8.1 that would increase the induced current.

1. electric Current

2. Magnet will lose it's magnetism

3. Solenoid becomes a non permanent magnet [3]

(b) Fig. 8.2 shows a transformer. P is the primary coil. S is the secondary coil. The coils are wound on an iron core.

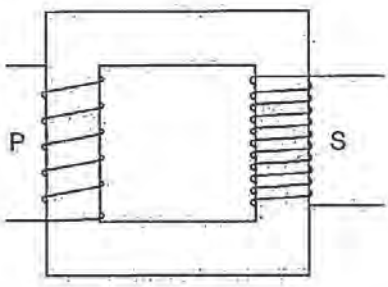


Fig. 8.2

P has 200 turns and S has 800 turns. The e.m.f. induced across S is 24 V. The current in S is 0.50 A. The transformer operates with 100% efficiency.

	200	800
V		24
		0.50

Calculate

(i) the voltage of the supply to P,

voltage = ...6 V......[2]

(ii) the current in P.

current = ...0.125......[2]

[Total: 7]

Examiner comment – grade E

(a) The three suggested changes gave the impression that the candidate did not understand the requirements of the question.

(b) **(i)** The candidate wrote down the correct numerical answer and unit with no formula or substitution shown. Both marks were gained.

(ii) The wrong current, with no unit, was written down, again with no preceding work. The answer shown could have been arrived by substituted wrongly into a correct formula. This emphasises the need to write down a formula before attempting a calculation.

Mark awarded = 2 out of 7

Question 9

Mark scheme

9	**(a)**	**(i)**	**1.**	resistance is constant / doesn't vary	B1	
			2.	resistance increases	B1	
		(ii)		7 V	B1	
	(b)			resistance of resistor = 4/2.6 (= 1.54 Ω)	C1	
				resistance of lamp = 4/3.6 (= 1.11 Ω)	C1	
				$1/R = 1/R_1 + 1/R_2$ *OR* $(R =)\ R_1R_2/(R_1 + R_2)$ OR either eq. with numbers	C1	
				0.645 or 0.65 Ω	A1	
				OR		
				current through resistor = 2.6 A	(C1)	
				current through lamp = 3.6 A	(C1)	
				total current = 2.6 + 3.6 = 6.2 A	(C1)	
				0.645 Ω OR 0.65 Ω OR *R* = 4/sum of candidate's currents	(A1)	[7]
				accept *R* value based on no. of sig. figs. for resistors used by candidate		

Example candidate response – grade A

9 The graphs in Fig. 9.1 show the relation between the current I and the potential difference V for a resistor and a lamp.

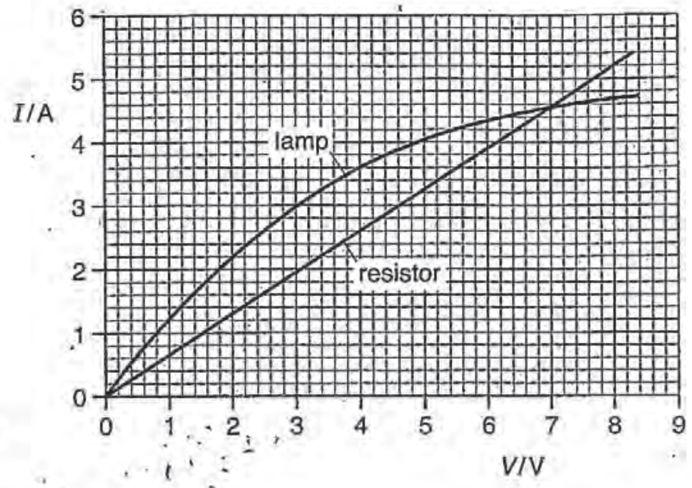


Fig. 9.1

(a) (i) Describe how, if at all, the resistance varies as the current increases in

1. the resistor, The resistance decreases

2. the lamp. The resistance increases [2]

(ii) State the value of the potential difference when the resistor and the lamp have the same resistance.

potential difference = 7V [1]

1·53 4

(b) The two components are connected **in parallel** to a supply of e.m.f. 4.0V. Calculate the total resistance of the circuit.

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$ where R_1 = resistance in lamp, R_2 = resistance in resistor

$R_2 = \frac{V_2}{I_2} = \frac{4}{2.5} = 1.6\,\Omega$

$R_1 = \frac{V_1}{I_1} = \frac{4}{3.6} = 1.1$

$\therefore \frac{1}{R} = \frac{1}{1.6} + \frac{1}{1.1}$

$\frac{1}{R} = \frac{1.1 + 1.6}{1.6 \times 1.1} = \frac{2.7}{1.76}$

$\frac{1.1 + 1.6}{1.76}$

total resistance = $R = \frac{1.76}{2.7} = 0.65\,\Omega$ [4]

[Total: 7]

Examiner comment – grade A

(a) (i) Many grade A answers displayed more difficulty than expected in describing how the resistance of one or other or both of the components varies. A simple approach would have been to calculate the resistance at two points on each of the graphs, using R = V/I, and draw the correct conclusions. This candidate decided that the resistance of the resistor decreases, and lost a mark, but correctly interpreted the graph for the lamp.

(ii) The correct value for the potential difference was stated.

(b) One of the graphs was read wrongly, so that one of the calculated values for a resistance was inaccurate. This error incurred a one mark penalty.

Mark awarded = 5 out of 7

Example candidate response – grade C

9 The graphs in Fig. 9.1 show the relation between the current I and the potential difference V for a resistor and a lamp.

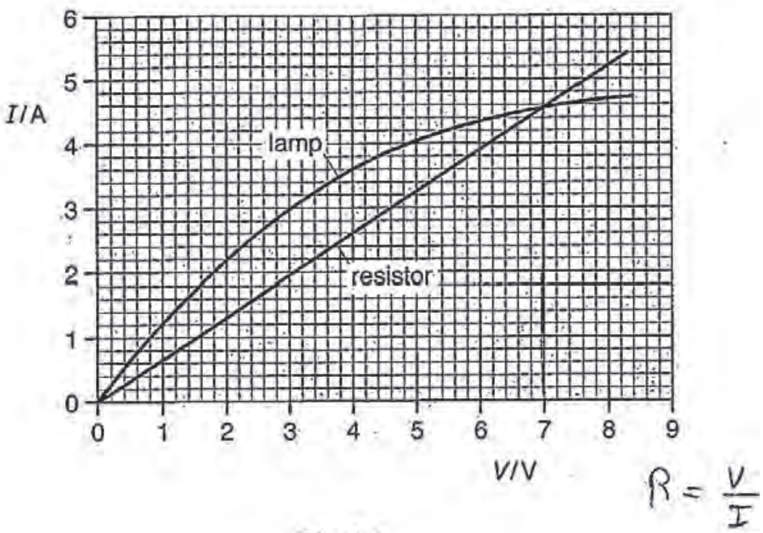


Fig. 9.1

(a) (i) Describe how, if at all, the resistance varies as the current increases in

1. the resistor, ...Resistance will decrease........

2. the lamp. ....Resistance will increase........[2]

(ii) State the value of the potential difference when the resistor and the lamp have the same resistance.

potential difference = ...7 v........[1]

(b) The two components are connected **in parallel** to a supply of e.m.f. 4.0 V. Calculate the total resistance of the circuit.

$$R_T = \frac{\text{Product}}{\text{Sum}} = \frac{4 \times 4}{4+4} = 2\ \Omega$$

total resistance = ...2 Ω........[4]

[Total: 7]

Examiner comment – grade C

(a) **(i)** It would be interesting to know how the candidate concluded, wrongly, that the resistance of the resistor decreases. A more common wrong answer, presumably based on the upward slope of the graph, is that the resistance rises. The candidate drew the correct conclusion from the graph for the lamp.

(ii) The correct value for the potential difference was stated.

(b) Credit could only be given for stating a relevant formula for the combination of two resistors in parallel.

Mark awarded = 3 out of 7

Example candidate response – grade E

9 The graphs in Fig. 9.1 show the relation between the current I and the potential difference V for a resistor and a lamp.

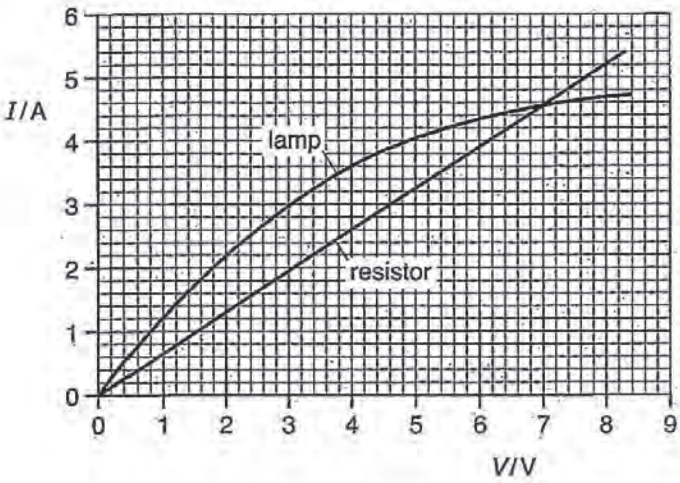


Fig. 9.1

(a) (i) Describe how, if at all, the resistance varies as the current increases in

1. the resistor, as the curren increases the Resistance increases

2. the lamp. as the curren increases the resistance decreases [2]

(ii) State the value of the potential difference when the resistor and the lamp have the same resistance.

potential difference = 0.035 [1]

(b) The two components are connected **in parallel** to a supply of e.m.f. 4.0V. Calculate the total resistance of the circuit.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R} = \frac{1}{3.6} + \frac{1}{2.6}$$

$$R = \frac{3}{6.2} = 0.4$$

total resistance = 0.4 Ω [4]

[Total: 7]

Examiner comment – grade E

(a) (i) The candidate made mistakes which were common for this question. The presumption is that in the case of the resistor, the upward slope of the graph led the candidate to suggest an increasing resistance, and for the lamp the decreasing gradient persuaded the candidate that its resistance was decreasing. No marks were awarded.

(ii) It is difficult to surmise how the candidate arrived at the wrong value for the potential difference.

(b) A mark was awarded for the formula for the combination of resistors in parallel. The candidate then substituted values for current rather than resistance in the formula and gained no further credit.

Mark awarded = 1 out of 7

Question 10

Mark scheme

10 (a) (i) thermistor B1

(ii) lamp is ON at 20 °C / low temperature <u>and</u> OFF at 100 °C / high temperature B1

p.d. across B is high at 20 °C / low temperature B1
p.d. across B is low at 100 °C / high temperature B1
OR as temperature rises, p.d. across B falls (B2)

transistor acts as a switch for the lamp at a certain temperature
OR lamp is ON if there is current in base / collector
OR potential of base is high
OR lamp is OFF if there is no current in base / collector
OR potential of base is too low B1

(b) to switch on a warning light when temperature (required for a process) becomes too low
OR to switch off a warning light when temperature (required for a process) becomes high enough B1 [6]
example (e.g. freezer or incubator) not needed, but if given, explanation required

Example candidate response – grade A

10 (a) In Fig. 10.1, A is a 1000Ω resistor, C is a transistor, and D is a lamp. S is a 9V supply.

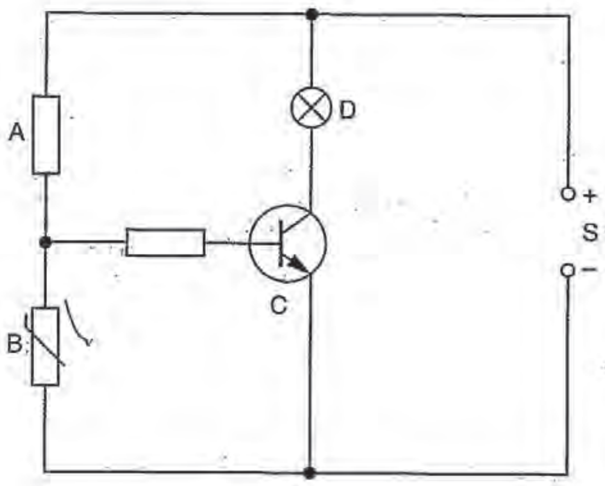


Fig. 10.1

(i) Name the component labelled B.

Thermistor ....[1]

(ii) At 20 °C the resistance of B is 800 Ω.
At 100 °C the resistance of B is 25 Ω.

In terms of the p.d. across B, explain what happens in the circuit as the temperature varies from 20 °C to 100 °C.

As the temp. rises the P.d. drops as the resistance drops. This is because the two resistors are acting as a potential divider and as the resistance drops the thermistor gets a smaller share of the voltage.

..........[4]

(b) Suggest a practical use for this circuit.

In a car engine if a component overheats ~~it~~ it turns ~~it~~ off a ~~w~~ ~~warning~~ toy light ....[1]

[Total: 6]

Examiner comment – grade A

(a) (i) The candidate could correctly name the component.

(ii) Two marks were awarded for the stating that as the temperature rises, the potential difference (across B) falls. The reason for this was also explained in terms of the behavior of a potential divider. There was no explanation, however, as to how this change affected the switching brought about by the transistor or the state of the lamp, so no further marks were gained.

(b) An acceptable example was given of how a lamp switches off when the temperature of an engine component becomes too high.

Mark awarded = 4 out of 6

Example candidate response – grade C

10 (a) In Fig. 10.1, A is a 1000 Ω resistor, C is a transistor, and D is a lamp. S is a 9 V supply.

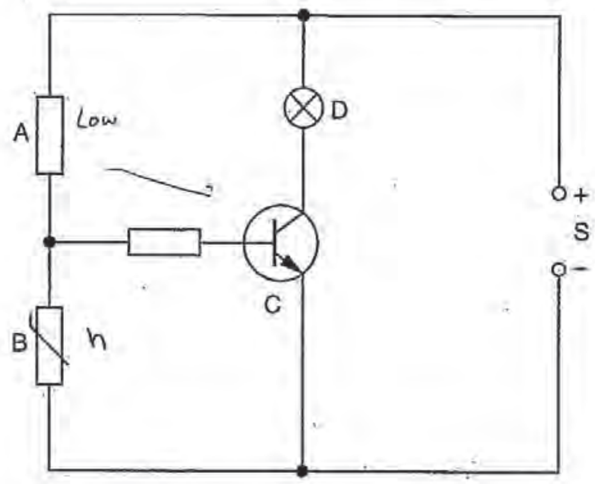


Fig. 10.1

(i) Name the component labelled B.

Thermistor ....[1]

(ii) At 20 °C the resistance of B is 800 Ω.
At 100 °C the resistance of B is 25 Ω.

In terms of the p.d. across B, explain what happens in the circuit as the temperature varies from 20 °C to 100 °C.

when the temperature increase the resistance of the thermistor decreases so their is no voltage drop in the circuit. when the temperature is low the resistance increases and their is voltage drop and that switches on the transistor so the lamp gets on

..........[4]

(b) Suggest a practical use for this circuit.

fire alarm

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

[Total: 6]

Examiner comment – grade C

(a) (i) The component was correctly named.

(ii) Although much of the answer gained no credit, a mark was awarded for stating that at low temperature the transistor switches on the lamp.

(b) In common with many answers, the candidate suggested a fire alarm, but did not add an explanation of its effect on the circuit in question.

Mark awarded = 2 out of 6

Example candidate response – grade E

10 (a) In Fig. 10.1, A is a 1000 Ω resistor, C is a transistor, and D is a lamp. S is a 9 V supply.

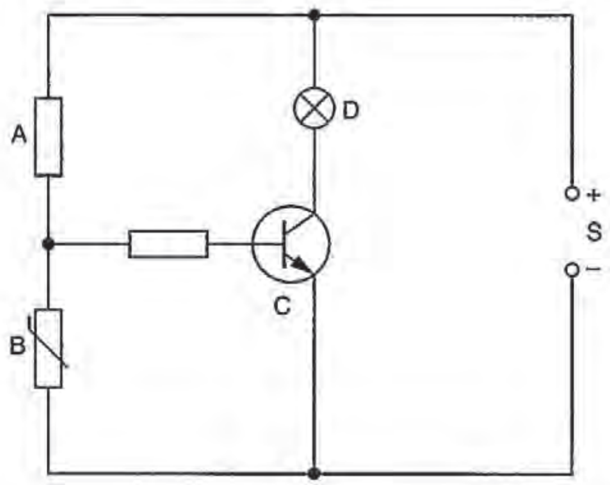


Fig. 10.1

(i) Name the component labelled B.

Thermistor ....[1]

(ii) At 20 °C the resistance of B is 800 Ω.
At 100 °C the resistance of B is 25 Ω.

In terms of the p.d. across B, explain what happens in the circuit as the temperature varies from 20 °C to 100 °C.

When heat is low the resistance is high but when the heat is increased resistance decreases. That is the principal of the resistor

..........[4]

(b) Suggest a practical use for this circuit.

Fire alarms.

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

[Total: 6]

Examiner comment – grade E

(a) **(i)** The component was correctly named.

(ii) The answer only succeeded in repeating information provided in the introduction to the question, and no marks could be awarded.

(b) A mark could not be awarded for the suggestion, with no further explanation, of a fire alarm.

Mark awarded = 1 out of 6

Question 11

Mark scheme

11	**(a)**	**(i)**	to heat the cathode / C	B1	
		(ii)	to emit electrons / to undergo thermionic emission (when heated)	B1	
		(iii)	to attract / accelerate electrons	B1	
			to allow the electrons / beam to pass through to the screen / to focus the beam / to direct the beam / produce a straight beam / to fix the beam current	B1	
	(b)	**(i)**	p.d. / voltage / battery / power supply applied between / across plates	B1	
			upper plate positive and lower plate negative	B1	
		(ii)	sketch showing: straight vertical lines from top plate to bottom plate	B1	
			arrows pointing downwards / from + to –	B1	[8]

Example candidate response – grade A

11 Fig. 11.1 shows the main components of a cathode-ray oscilloscope.

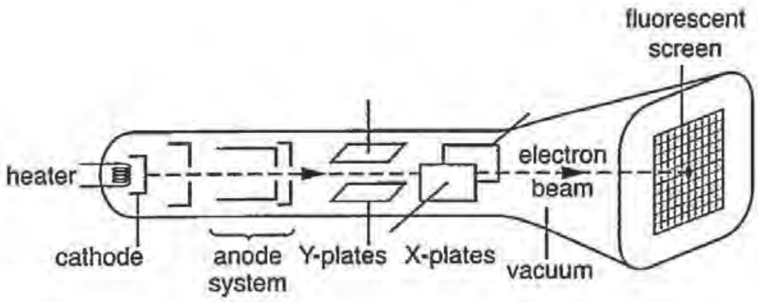


Fig. 11.1

(a) State the purpose of

(i) the heater,

It changes
~~converts~~ electrical energy into heat energy

(ii) the cathode,

~~when~~ To emit electrons when heated

(iii) the anode system.

To attract the electrons there by increasing their speeds

[4]

(b) Without deflection, the electron beam produces a spot at the centre of the fluorescent screen. A deflection of the spot towards the top of the screen is required.

(i) Describe how the Y-plates can be used to bring about this deflection.

the upper plate should be connected to the positive terminal

(ii) Fig. 11.2 shows the Y-plates.

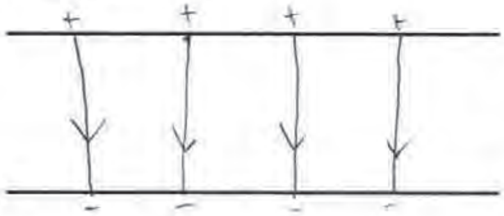


Fig. 11.2

On Fig. 11.2, sketch the pattern of the electric field produced between the plates.

[4]

[Total: 8]

Examiner comment – grade A

(a) **(i)** The candidate was correct in stating that the heater converts electrical energy into thermal energy, as do all electrical heaters, but its purpose, in this case to heat the cathode, was not stated. No credit was given.

(ii) The cathode's purpose, to emit electrons (when heated), was correctly stated and gained the mark.

(iii) Two aspects were required. The first is that of attracting or accelerating electrons. The second could have been expressed in a variety of ways, the best of which is to focus or direct the beam towards the screen. Only the first, which gained a mark, was addressed in the answer.

(b) **(i)** The essential point required was to express the idea that a potential difference has to be applied between the plates. The answer gave insufficient detail of this, but gained a mark for showing the upper plate as positively charged and the lower one as negatively charged.

(ii) The sketch showed the straight field lines between the plates, with sufficient accuracy to gain the first mark and the arrows on the field lines, pointing downwards, to gain the other.

Mark awarded = 5 out of 8

Example candidate response – grade C

11 Fig. 11.1 shows the main components of a cathode-ray oscilloscope.

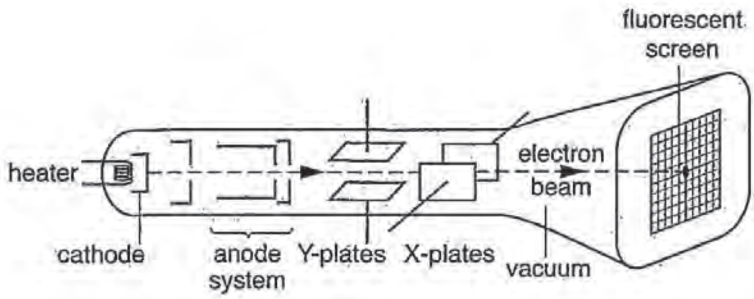


Fig. 11.1

(a) State the purpose of

(i) the heater,

This is ~~what produces~~ what emits the electrons due to the heat produced.

(ii) the cathode,

(iii) the anode system.

The electrons are attracted to the anode system

[4]

(b) Without deflection, the electron beam produces a spot at the centre of the fluorescent screen. A deflection of the spot towards the top of the screen is required.

(i) Describe how the Y-plates can be used to bring about this deflection.

The Y plates have positive and negative charges, so the electrons will be deflected/attracted towards the positive side

(ii) Fig. 11.2 shows the Y-plates.

Fig. 11.2

On Fig. 11.2, sketch the pattern of the electric field produced between the plates.

[4]

[Total: 8]

Examiner comment – grade C

In this question, among candidates at this level of achievement, little precise knowledge about the function of the components of a c.r.o. is often in evidence.

(a) (i) This candidate wrote that the heater emits electrons, rather than the fact that it heats the cathode. This was a common misconception.

(ii) No response was made as to the function of the cathode.

(iii) A mark was allowed for stating one of the functions of the anode system, that of attracting electrons. No reference was made to its other function, the production of a fine beam of electrons which passes through to the screen, a point which could have been made in several acceptable ways.

(b) (i) The placing of positive and negative charges on the plates in the figure sufficed to gain a mark. No mention was made as how a battery or voltage supply is used to bring about, so no further credit was given.

(ii) No attempt was made to sketch the pattern of field lines between the plates.

Mark awarded = 2 out of 8

Example candidate response – grade E

11 Fig. 11.1 shows the main components of a cathode-ray oscilloscope.

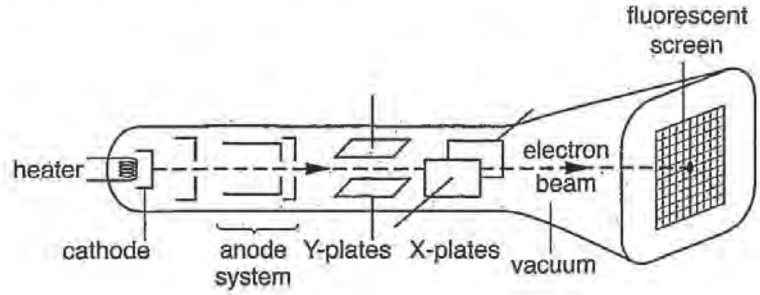


Fig. 11.1

(a) State the purpose of

(i) the heater,

To heat up the electrons

(ii) the cathode,

To release negative electrons

(iii) the anode system.

This disperses both negative and positive electrons onto the y and x plates respectively.

[4]

(b) Without deflection, the electron beam produces a spot at the centre of the fluorescent screen. A deflection of the spot towards the top of the screen is required.

(i) Describe how the Y-plates can be used to bring about this deflection.

It will emit gamma rays.

(ii) Fig. 11.2 shows the Y-plates.

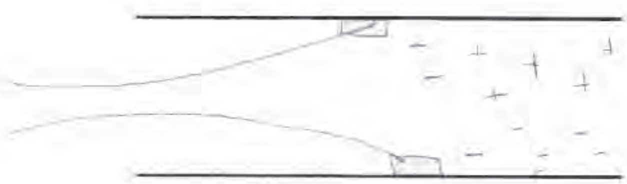


Fig. 11.2

On Fig. 11.2, sketch the pattern of the electric field produced between the plates.

[4]

[Total: 8]

Examiner comment – grade E

(a) **(i)** The candidate's answer 'to heat up the electrons' was common to many scripts, and gained no credit.

(ii) The answer complied with the mark scheme and gained the mark.

(iii) No knowledge of the function of the anode was shown.

(b) **(i)** The suggestion that the Y-plates emit gamma rays seemed to be no more than a random guess.

(ii) No attempt to sketch the field was made. The lines and symbols drawn suggested a follow-up of the spurious answer to **(a)(iii)**.

Mark awarded = 1 out of 8

Paper 5 – Practical Test

Paper 5 is the Practical Test which covers experimental and observational skills. The purpose of this component is to test appropriate skills in assessment objective C (Experimental skills and investigations). Candidates are not be required to use knowledge outside the Core curriculum.

Question 1

Mark scheme

1 **(a)** V_1 about 80, $V_2 > V_1$ [1]
V_G correct [1]
cm^3 (allow ml) at least once, not contradicted [1]

(b) V_3 about 70, $V_4 > V_3$ [1]
Difference correct [1]
V_A correct [1]

(c) V_W present and within ± 5 cm^3 of V_A [1]

(d) Three from:
V_A: Finger increases V_4 / tube not pushed in far enough
Some water in test-tube
V_W: Water remaining in tube / measuring cylinder
Either (accept only once):
Measuring cylinder readings not very sensitive
Subtraction produces large percentage uncertainty [3]

Example candidate response – grade A

1 The aim of this experiment is to determine the internal volume of a test-tube using two displacement methods.

Carry out the following instructions referring to Figs. 1.1, 1.2 and 1.3. You are supplied with a beaker of water.

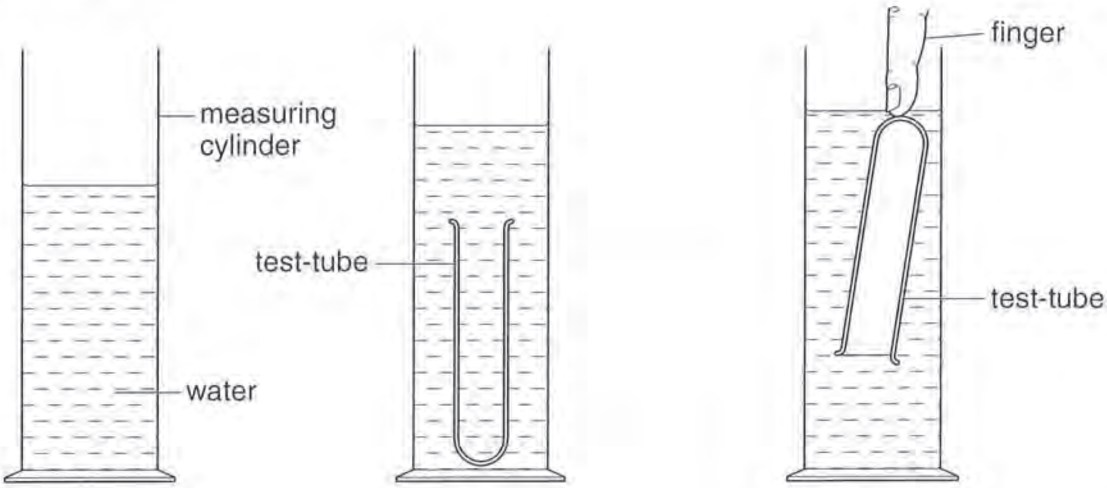


Fig. 1.1 **Fig. 1.2** **Fig. 1.3**

(a) **(i)** Pour approximately 80 cm³ of water from the beaker into the measuring cylinder. Record the volume V_1 of water.

V_1 = ...80 cm³.... ✓

(ii) Lower the test-tube, closed end first, into the water in the measuring cylinder and push it down until it is filled with water, as shown in Fig. 1.2. Record the new water level V_2.

V_2 = ...85.0 cm³.... ✓

(iii) Calculate the volume V_G of the glass of the test-tube using the equation $V_G = (V_2 - V_1)$. ✓

85 − 80 = 5

V_G = ...5 cm³....

[3]

(b) Remove the test-tube from the measuring cylinder and pour the water from the tube and the measuring cylinder into the beaker.

(i) Pour approximately 70 cm³ of water from the beaker into the measuring cylinder. Record the volume V_3 of water.

V_3 = ...70 cm³.... ✓

(ii) Gently put the test-tube, open end first, into the water in the measuring cylinder and carefully push it down with your finger or pencil until it is just covered with water, as shown in Fig. 1.3. Record the new water level V_4.

V_4 = ...95 cm³....

For Examiner's Use

(iii) Calculate the increase in water level ($V_4 - V_3$).

95 − 70 = 25

$(V_4 - V_3) =$ 25 cm³

(iv) Calculate the volume V_A of air in the test-tube using the equation $V_A = (V_4 - V_3) - V_G$.

(95 − 70) − 5
25 − 5
= 20

$V_A =$ 20 cm³

[3]

(c) Remove the test-tube from the measuring cylinder and pour the water from the measuring cylinder into the beaker. Fill the test-tube to the top with water from the beaker. Pour the water from the test-tube into the measuring cylinder. Record the volume V_W of water from the tube.

$V_W =$ 21 cm³

[1]

(d) The aim of this experiment is to determine the internal volume of the test-tube by two methods. The two values are V_A (obtained from parts **(a)** and **(b)**) and V_W (obtained from part **(c)**). The values obtained from your readings may not be the same.

Assuming that the experiments have been carried out correctly and carefully, and that the measuring cylinder scale is accurate, suggest two reasons why the value V_A may be inaccurate and two reasons why the value V_W may be inaccurate.

V_A:

reason 1 It may be inaccurate because water might have gotten into the test tube when putting it in the mesuring cylinder.

reason 2 while pushing the testtube into the measuring cylinder a bit of your finger gets into the water

V_W:

reason 1 ~~Some water may~~ Not every drop of water in the test tube will ~~be put~~ fall into the measuring cylinder

reason 2 Some drops of water might spill away instead of getting it into the measuring cylinder.

[3]

[Total: 10]

Examiner comment – grade A

(a) The candidate records 80 cm^3 for V_1. The volume V_2 is greater than V_1 and the difference, V_G is correct. The correct unit, cm^3, is included each time.

(b) The candidate again works through the steps and answers correctly.

(c) The mark is scored because the candidate carries out the procedure with care and therefore the V_W value is within the tolerance allowed.

(d) The candidate makes three good suggestions that answer the question and therefore scores all three available marks. The first three reasons given focus on possible inaccuracies that are inherent in the experiment, rather than the result of careless technique. The final reason is not worthy of a mark because it describes careless spilling of some water. However, since three valid reasons have been given, there is no penalty for this.

Mark awarded = 10 out of 10

Example candidate response – grade C

1 The aim of this experiment is to determine the internal volume of a test-tube using two displacement methods.

Carry out the following instructions referring to Figs. 1.1, 1.2 and 1.3. You are supplied with a beaker of water.

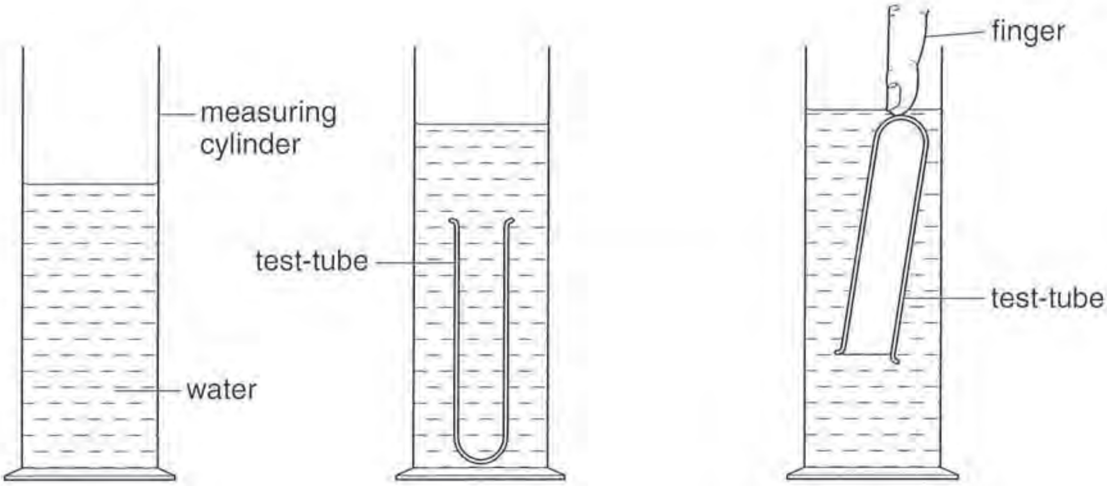


Fig. 1.1 **Fig. 1.2** **Fig. 1.3**

(a) **(i)** Pour approximately 80 cm^3 of water from the beaker into the measuring cylinder. Record the volume V_1 of water.

V_1 = 80 cm^3

(ii) Lower the test-tube, closed end first, into the water in the measuring cylinder and push it down until it is filled with water, as shown in Fig. 1.2. Record the new water level V_2.

V_2 = 95 cm^3

(iii) Calculate the volume V_G of the glass of the test-tube using the equation $V_G = (V_2 - V_1)$.

V_G = 15 cm^3

[3]

(b) Remove the test-tube from the measuring cylinder and pour the water from the tube and the measuring cylinder into the beaker.

(i) Pour approximately 70 cm^3 of water from the beaker into the measuring cylinder. Record the volume V_3 of water.

V_3 = 70 cm^3

(ii) Gently put the test-tube, open end first, into the water in the measuring cylinder and carefully push it down with your finger or pencil until it is just covered with water, as shown in Fig. 1.3. Record the new water level V_4.

V_4 = 90 cm^3

(iii) Calculate the increase in water level ($V_4 - V_3$).

$(V_4 - V_3)$ = 20 cm³ ✓

(iv) Calculate the volume V_A of air in the test-tube using the equation $V_A = (V_4 - V_3) - V_G$.

V_A = 5 cm³ ✓

[3]

(c) Remove the test-tube from the measuring cylinder and pour the water from the measuring cylinder into the beaker. Fill the test-tube to the top with water from the beaker. Pour the water from the test-tube into the measuring cylinder. Record the volume V_W of water from the tube.

V_W = 18 cm³ ✗

[1]

(d) The aim of this experiment is to determine the internal volume of the test-tube by two methods. The two values are V_A (obtained from parts **(a)** and **(b)**) and V_W (obtained from part **(c)**). The values obtained from your readings may not be the same.

Assuming that the experiments have been carried out correctly and carefully, and that the measuring cylinder scale is accurate, suggest two reasons why the value V_A may be inaccurate and two reasons why the value V_W may be inaccurate.

V_A:

reason 1 Additional weight applied on test-tube falsifying readings of the measuring cylinder ✗

reason 2 Improper readings due to transfer by mechanical loss. ~~Different volumes of water used to obtain volume of glass~~ ✗

V_W: ✗

reason 1 Improper readings due to transfer by mechanical loss.

reason 2 Error due to parallax while reading from meniscus of measuring cylinder

[3]

[Total: 10]

Examiner comment – grade C

(a) The candidate records 80 cm^3 for V_1. The volume V_2 is greater than V_1 and the difference, V_G is correct. The correct unit, cm^3, is included each time.

(b) The candidate again works through the steps and answers correctly.

(c) The value obtained for V_W is outside the tolerance allowed, showing that the experiment has not been carried out as carefully as expected. So, the mark is not awarded.

(d) The candidate is unable to make suitable suggestions, perhaps indicating a lack of personal experience with this type of experiment. The first three reasons given are very vague and the last reason is describing careless technique rather than a possible inaccuracy that is inherent in the experiment.

Mark awarded = 6 out of 10

Example candidate response – grade E

1 The aim of this experiment is to determine the internal volume of a test-tube using two displacement methods.

Carry out the following instructions referring to Figs. 1.1, 1.2 and 1.3. You are supplied with a beaker of water.

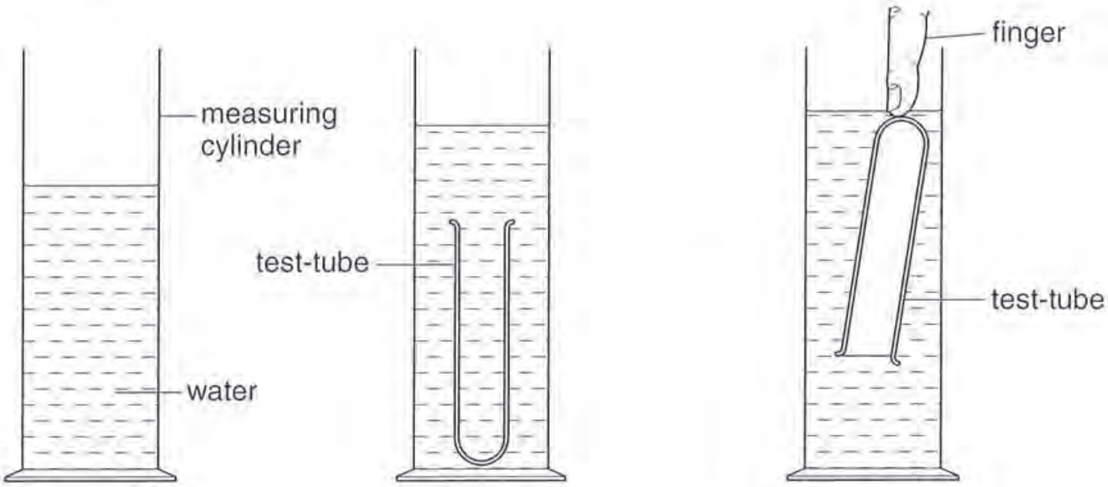


Fig. 1.1 **Fig. 1.2** **Fig. 1.3**

(a) **(i)** Pour approximately 80 cm^3 of water from the beaker into the measuring cylinder. Record the volume V_1 of water.

V_1 = 20

(ii) Lower the test-tube, closed end first, into the water in the measuring cylinder and push it down until it is filled with water, as shown in Fig. 1.2. Record the new water level V_2.

V_2 = 40

(iii) Calculate the volume V_G of the glass of the test-tube using the equation $V_G = (V_2 - V_1)$.

V_G = 20

[3]

(b) Remove the test-tube from the measuring cylinder and pour the water from the tube and the measuring cylinder into the beaker.

(i) Pour approximately 70 cm^3 of water from the beaker into the measuring cylinder. Record the volume V_3 of water.

V_3 = 65 just ok.

(ii) Gently put the test-tube, open end first, into the water in the measuring cylinder and carefully push it down with your finger or pencil until it is just covered with water, as shown in Fig. 1.3. Record the new water level V_4.

V_4 = 70

For Examiner's Use

(iii) Calculate the increase in water level ($V_4 - V_3$).

$(V_4 - V_3) =$ ....5........

(iv) Calculate the volume V_A of air in the test-tube using the equation $V_A = (V_4 - V_3) - V_G$.

5 - 20 = -15

$V_A =$ ....25........

[3]

(c) Remove the test-tube from the measuring cylinder and pour the water from the measuring cylinder into the beaker. Fill the test-tube to the top with water from the beaker. Pour the water from the test-tube into the measuring cylinder. Record the volume V_W of water from the tube.

$V_W =$ ....30........

[1]

(d) The aim of this experiment is to determine the internal volume of the test-tube by two methods. The two values are V_A (obtained from parts **(a)** and **(b)**) and V_W (obtained from part **(c)**). The values obtained from your readings may not be the same.

Assuming that the experiments have been carried out correctly and carefully, and that the measuring cylinder scale is accurate, suggest two reasons why the value V_A may be inaccurate and two reasons why the value V_W may be inaccurate.

V_A:

reason 1 ....because the water level ~~so~~ might be too low or too high....

reason 2 ....because the tube or beaker might be inaccurate....

V_W:

reason 1 ....beaker or tube might be ~~inaccurate, because~~ inaccurate....

reason 2 ....water level too high or too low....

[3]

[Total: 10]

Examiner comment – grade E

(a) The V_1 value should have been approximately 80 cm^3, but the candidate gave 20 cm^3. However, the V_G value is calculated correctly, so a mark is scored, but no units are given so the third mark is not awarded.

(b) The candidate gives a value of V_3 (65) that is just acceptable, V_4 is greater than V_3 and the difference calculation is correct. The V_4 value, however, is incorrect.

(c) Although the V_W and V_4 values are within 5 cm^3 of each other, the mark cannot be awarded as this is a mark for overall quality of the experimental work and the values do not come from correct work.

(d) The candidate is unable to make suitable suggestions, perhaps indicating a lack of personal experience with this type of experiment resulting in vague statements that do not address the question set.

Mark awarded = 3 out of 10

Question 2

Mark scheme

2	**(a)**	Sensible value for θ_R (15(°C) to 50(°C))	[1]
	(b)	Table:	
		mm, °C	[1]
		Correct *d* values 100, 80, 60, 40, 20, 10	[1]
		Temperatures increasing (accept first two readings identical)	[1]
		Evidence of temperatures to at least 1°C	[1]
	(c)	θ_V present and greater or equal to θ_H	[1]
		Correct difference AND higher, lower or same to match difference (expect higher)	[1]
	(d)	Draughts	[1]
		Room temperature / humidity	[1]
	(e)	One from: Avoidance of parallax explained	
		Waiting time between readings	[1]

Example candidate response – grade A

2 In this experiment, you will investigate the heating of a thermometer bulb.

Carry out the following instructions, referring to Figs. 2.1 and 2.2.

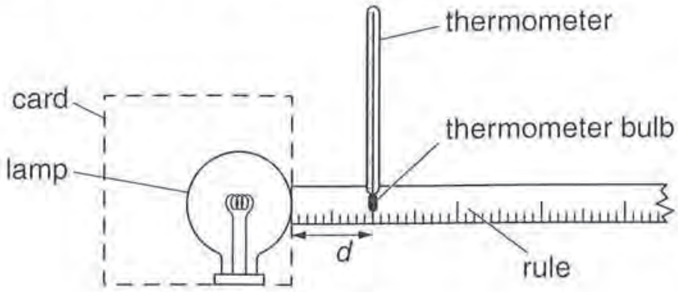


Fig. 2.1

You are provided with a lamp and a rule. Do not move the lamp or the rule. During the experiment, you will read temperature values from the thermometer. You should use the card provided to shield your eyes from the direct rays of the lamp.

(a) Record the value of room temperature θ_R shown on the thermometer.

θ_R = 22°C .... [1]

(b) Switch on the lamp. Leave the lamp switched on until you have completed all the readings.

(i) Place the thermometer so that its bulb is a horizontal distance d = 100 mm from the surface of the lamp, as shown in Fig. 2.1. Record in Table 2.1 the distance d between the thermometer bulb and the surface of the lamp. Also record the temperature θ shown on the thermometer.

(ii) Move the thermometer so that its bulb is a distance d = 80 mm from the surface of the lamp.

In the table, record the distance d and the temperature θ.

Table 2.1

d/mm	θ/°C
100	~~23 25~~ 24
80	24
60	24
40	24
20	25
10	30

(iii) Repeat the steps described in **(b)(ii)**, but using values of d of 60 mm, 40 mm, 20 mm and 10 mm.

(iv) Complete the column headings in the table.

[4]

(c) Move the thermometer away from the lamp and wait for about a minute for the thermometer to cool.

For Examiner's Use

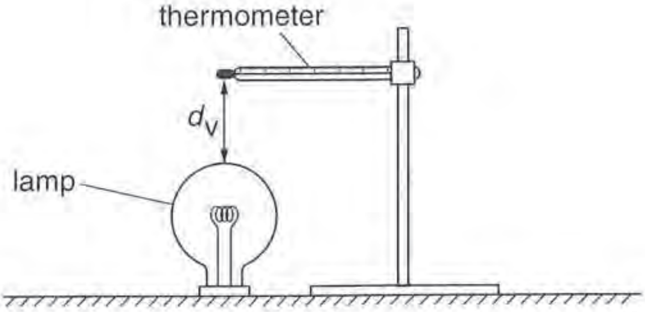


Fig. 2.2

(i) Place the thermometer so that its bulb is a vertical distance d_V = 100 mm from the top surface of the lamp, as shown in Fig. 2.2. Use the 100 mm rod provided to obtain the correct distance. Record the temperature θ_V shown on the thermometer.

θ_V = 26°C [1]

1

(ii) Calculate the difference between θ_V and the thermometer reading θ_H at a horizontal distance of 100 mm from the lamp. State whether θ_V is higher, lower or the same as θ_H.

temperature difference = 2°C

θ_V is higher [1]

1

(d) A student suggests that θ_V will be higher than the thermometer reading θ_H because thermal energy will travel by infra-red radiation and convection to the thermometer bulb above the lamp but by infra-red radiation only when the bulb is to one side of the lamp.

If the experiment were to be repeated in order to investigate this suggestion, it would be important to control the conditions. Suggest two such conditions, relevant to this investigation, that should be controlled.

1. wind (≡ draughts)

2. humidity

[2]

2

(e) Briefly describe a precaution that you took in this experiment in order to obtain a reliable result.

I waited for thermometer to stop decreasing / increasing temperature [1]

1

[Total: 10]

Examiner comment – grade A

(a) The candidate records a sensible value for room temperature.

(b) In the table, the candidate gives the correct units for *d* and θ. The values for *d* are also correct but the temperatures are not increasing as expected (it is possible that the candidate used distances of 100 cm, 80 cm, etc.) so a mark is lost. However, the temperatures are shown to at least 1 °C (they are not all given to the nearest 5 °C or 10 °C) so the final mark is gained.

(c) The candidate scores both marks as θ_V is greater than θ_H and the temperature difference is correctly calculated alongside the correct conclusion.

(d) The candidate suggests 'wind' and 'humidity' as the relevant conditions to be controlled. The first response is judged to be equivalent to a reference to avoidance of draughts and the second is allowed as an alternative to the expected reference to room temperature.

(e) The candidate suggests a sensible precaution involving allowing time for the thermometer to respond to the temperature changes before taking readings.

Mark awarded = 9 out of 10

Example candidate response – grade C

2 In this experiment, you will investigate the heating of a thermometer bulb.

Carry out the following instructions, referring to Figs. 2.1 and 2.2.

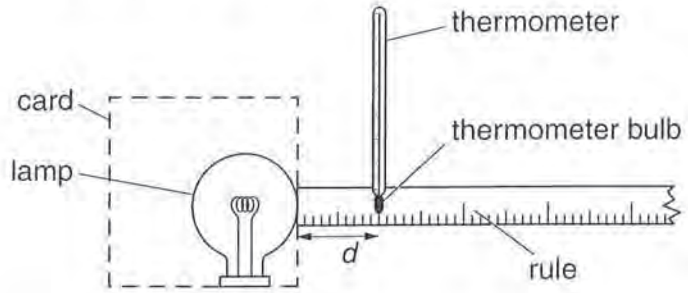


Fig. 2.1

You are provided with a lamp and a rule. Do not move the lamp or the rule. During the experiment, you will read temperature values from the thermometer. You should use the card provided to shield your eyes from the direct rays of the lamp.

(a) Record the value of room temperature θ_R shown on the thermometer.

θ_R = 27°C [1]

(b) Switch on the lamp. Leave the lamp switched on until you have completed all the readings.

(i) Place the thermometer so that its bulb is a horizontal distance d = 100 mm from the surface of the lamp, as shown in Fig. 2.1. Record in Table 2.1 the distance d between the thermometer bulb and the surface of the lamp. Also record the temperature θ shown on the thermometer.

(ii) Move the thermometer so that its bulb is a distance d = 80 mm from the surface of the lamp.

In the table, record the distance d and the temperature θ.

Table 2.1

d / mm	θ / °C
100.0	32.0
80.0	33.0
60.0	33.0
40.0	34.0
20.0	35.0
10.0	39.0

1 ✗

(iii) Repeat the steps described in **(b)(ii)**, but using values of d of 60 mm, 40 mm, 20 mm and 10 mm.

(iv) Complete the column headings in the table.

[4]

(c) Move the thermometer away from the lamp and wait for about a minute for the thermometer to cool.

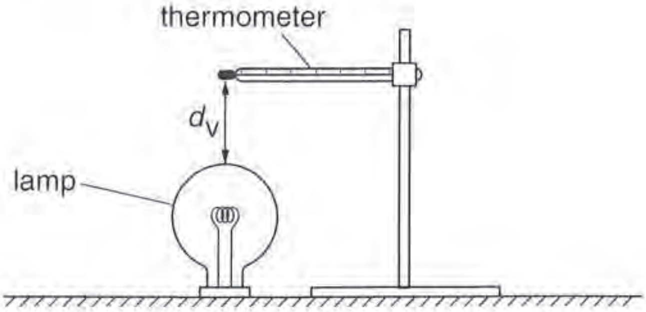


Fig. 2.2

(i) Place the thermometer so that its bulb is a vertical distance d_V = 100 mm from the top surface of the lamp, as shown in Fig. 2.2. Use the 100 mm rod provided to obtain the correct distance. Record the temperature θ_V shown on the thermometer.

θ_V = ...37°C.... [1]

(ii) Calculate the difference between θ_V and the thermometer reading θ_H at a horizontal distance of 100 mm from the lamp. State whether θ_V is higher, lower or the same as θ_H.

37 - 32

temperature difference = ...5....

θ_V is ....Higher.... [1]

(d) A student suggests that θ_V will be higher than the thermometer reading θ_H because thermal energy will travel by infra-red radiation and convection to the thermometer bulb above the lamp but by infra-red radiation only when the bulb is to one side of the lamp.

If the experiment were to be repeated in order to investigate this suggestion, it would be important to control the conditions. Suggest two such conditions, relevant to this investigation, that should be controlled.

1. ....The amount of Energy coming out from the bulb....

2. ....The Energy being supplied to the bulb.... [2]

(e) Briefly describe a precaution that you took in this experiment in order to obtain a reliable result.

....Made sure all the fans and airconditioners....

....were ~~of~~ to avoid error due to parallax.... [1]

[Total: 10]

Examiner comment – grade C

(a) The candidate records a sensible value for room temperature.

(b) In the table, the candidate gives the correct units for *d* and θ. The values for *d* are also correct but the temperatures are not increasing as expected, so a mark is lost. However, the temperatures are shown to at least 1 °C so the final mark is gained.

(c) The candidate scores both marks as θ_V is greater than θ_H and the temperature difference is correctly calculated alongside the correct conclusion.

(d) The candidate makes two vague statements that do not answer the question.

(e) A statement about how a parallax error could be avoided in this experiment would have scored a mark, but here the candidate makes a confused statement.

Mark awarded = 6 out of 10

Example candidate response – grade E

2 In this experiment, you will investigate the heating of a thermometer bulb.

Carry out the following instructions, referring to Figs. 2.1 and 2.2.

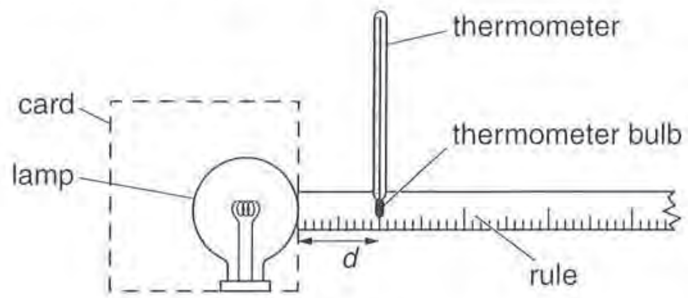


Fig. 2.1

You are provided with a lamp and a rule. Do not move the lamp or the rule. During the experiment, you will read temperature values from the thermometer. You should use the card provided to shield your eyes from the direct rays of the lamp.

(a) Record the value of room temperature θ_R shown on the thermometer.

θ_R = ...29.0 °C........ [1]

(b) Switch on the lamp. Leave the lamp switched on until you have completed all the readings.

(i) Place the thermometer so that its bulb is a horizontal distance d = 100 mm from the surface of the lamp, as shown in Fig. 2.1. Record in Table 2.1 the distance d between the thermometer bulb and the surface of the lamp. Also record the temperature θ shown on the thermometer.

(ii) Move the thermometer so that its bulb is a distance d = 80 mm from the surface of the lamp.

In the table, record the distance d and the temperature θ.

Table 2.1

d / mm	θ / °C
100.0	30.0
80.0	30.5
60.0	31.0
40.0	32.0
20.0	34.0
10.0	36.0

(iii) Repeat the steps described in **(b)(ii)**, but using values of d of 60 mm, 40 mm, 20 mm and 10 mm.

(iv) Complete the column headings in the table.

[4]

(c) Move the thermometer away from the lamp and wait for about a minute for the thermometer to cool.

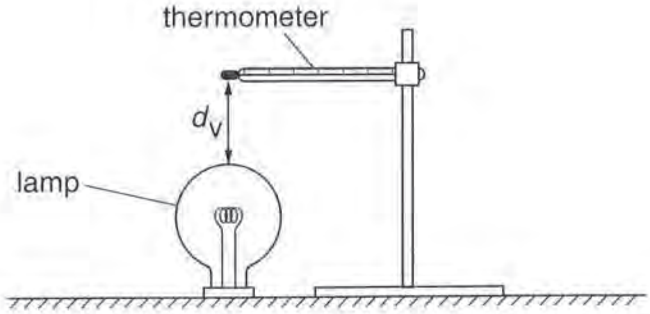


Fig. 2.2

(i) Place the thermometer so that its bulb is a vertical distance d_V = 100 mm from the top surface of the lamp, as shown in Fig. 2.2. Use the 100 mm rod provided to obtain the correct distance. Record the temperature θ_V shown on the thermometer.

θ_V = ...28.8° C...... ✗ [1]

(ii) Calculate the difference between θ_V and the thermometer reading θ_H at a horizontal distance of 100 mm from the lamp. State whether θ_V is higher, lower or the same as θ_H.

temperature difference = ...1.0 °C...... ✗

θ_V is ......lower than θ_H...... [1]

(d) A student suggests that θ_V will be higher than the thermometer reading θ_H because thermal energy will travel by infra-red radiation and convection to the thermometer bulb above the lamp but by infra-red radiation only when the bulb is to one side of the lamp.

If the experiment were to be repeated in order to investigate this suggestion, it would be important to control the conditions. Suggest two such conditions, relevant to this investigation, that should be controlled.

1. ......Infra-red radiation...... ✗

2. ......Convection...... ✗

[2]

(e) Briefly describe a precaution that you took in this experiment in order to obtain a reliable result.

I made sure that I read my reading on the thermometer ✗
from the eye level to get an accurate reading. [1]

[Total: 10]

Examiner comment – grade E

(a) The candidate records a sensible value for room temperature.

(b) The candidate records the units, *d* values and temperatures in the table and scores full marks.

(c) The candidate's value of θ_V is too low. The temperature difference is wrongly calculated and the conclusion is incorrect.

(d) The candidate is unable to make a suitable suggestion.

(e) The candidate attempts a suggestion about avoidance of parallax errors but a reference to 'eye level' is too vague.

Mark awarded = 5 out of 10

Question 3

Mark scheme

3	**(a)**	(cm, V, A) (no mark awarded) *V* to at least 1 d.p. and < 3 V *I* to at least 2 d.p. and < 1 A	 [1] [1]
	(b)	Graph: Axes correctly labelled and correct way around Suitable scales – plots occupy at least half the grid All plots correct to ½ small square Good line judgement AND thin, continuous line AND plots suitably shown (penalise large 'blobs')	 [1] [1] [1] [1]
	(c)	Triangle method using line drawn and shown (no line 1 max) Using at least half of line	[1] [1]
	(d)	2 or 3 significant figures, value matching G With unit Ω / ohm(s)	[1] [1]

Example candidate response – grade A

3 In this experiment, you will determine the resistance of a resistor in a circuit.

Carry out the following instructions referring to Fig. 3.1. The circuit is set up for you.

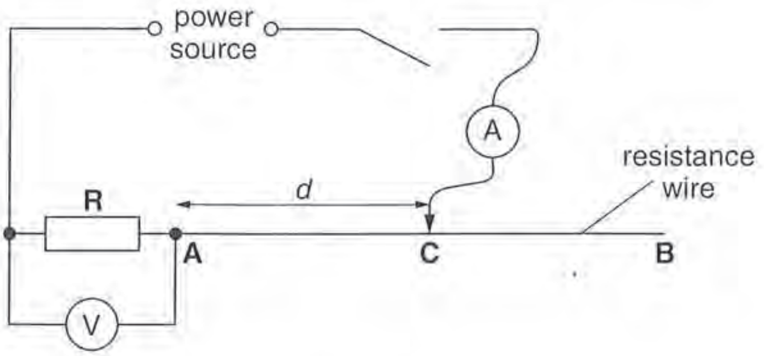


Fig. 3.1

(a) **(i)** Place the sliding contact **C** on the resistance wire at a distance d = 30.0 cm from point **A**. Switch on. Measure and record in Table 3.1 the current I in the circuit and the p.d. V across the resistor **R**. Switch off.

(ii) Repeat the procedure in step **(i)** using d values of 40.0 cm, 50.0 cm, 70.0 cm and 90.0 cm.

(iii) Complete the column headings in the table.

Table 3.1

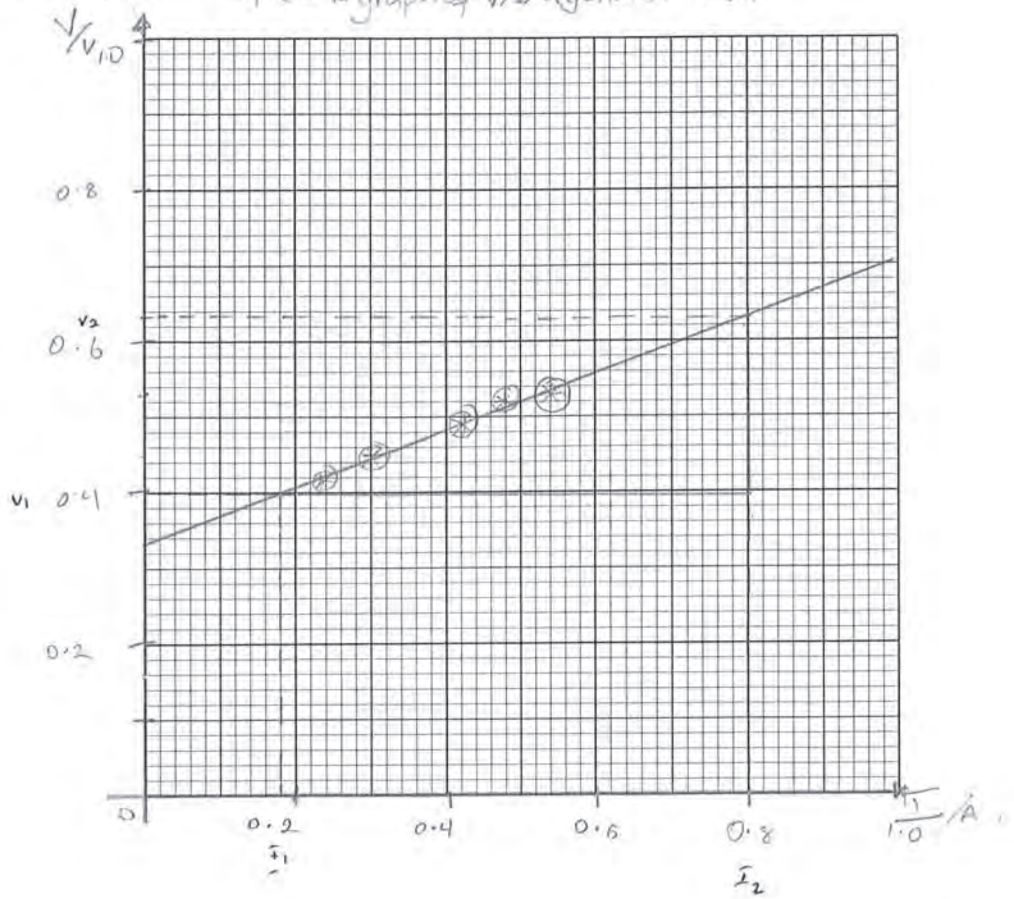
d / cm	V / V	I / A
30.0	0.53	0.54
40.0	0.52	0.48
50.0	0.49	0.42
70.0	0.45	0.30
90.0	0.42	0.24

✓ ✓

[2]

(b) Plot a graph of V/V (y-axis) against I/A (x-axis).

Topic – A graph of V/V against I/A



[4]

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

$$\frac{\Delta V/V}{\Delta I/A} = \frac{V_2 - V_1}{I_2 - I_1} = \frac{(0.63-0.4)\,V}{(0.8-0.18)\,A}$$

$$= \frac{0.23\,V}{0.62\,A} = 0.371$$

G = 0.371 VA^{-1} [2]

(d) The gradient G of the graph is numerically equal to the resistance R of the resistor **R**.

Write a value for the resistance R to a suitable number of significant figures for this experiment.

R = 0.371 Ω [2]

[Total: 10]

Examiner comment – grade A

(a) The candidate successfully completes the table.

(b) The candidate labels the graph axes correctly and plots the points accurately. The line drawn is a good, thin, best-fit line. A mark is lost, however, because the y-axis scale is very cramped.

(c) The candidate uses the triangle method correctly to determine the gradient and shows clearly on the graph a triangle that uses more than half the line.

(d) The candidate gives the value for resistance to three significant figures and includes the unit Ω , scoring both of the available marks.

Mark awarded = 9 out of 10

Example candidate response – grade C

3 In this experiment, you will determine the resistance of a resistor in a circuit.

Carry out the following instructions referring to Fig. 3.1. The circuit is set up for you.

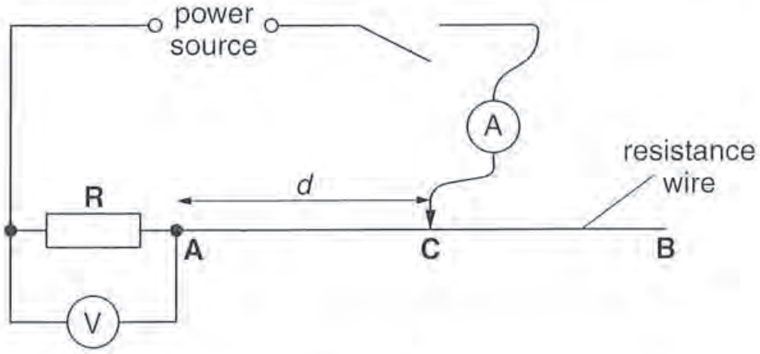


Fig. 3.1

(a) **(i)** Place the sliding contact **C** on the resistance wire at a distance d = 30.0 cm from point **A**. Switch on. Measure and record in Table 3.1 the current I in the circuit and the p.d. V across the resistor **R**. Switch off.

(ii) Repeat the procedure in step **(i)** using d values of 40.0 cm, 50.0 cm, 70.0 cm and 90.0 cm.

(iii) Complete the column headings in the table.

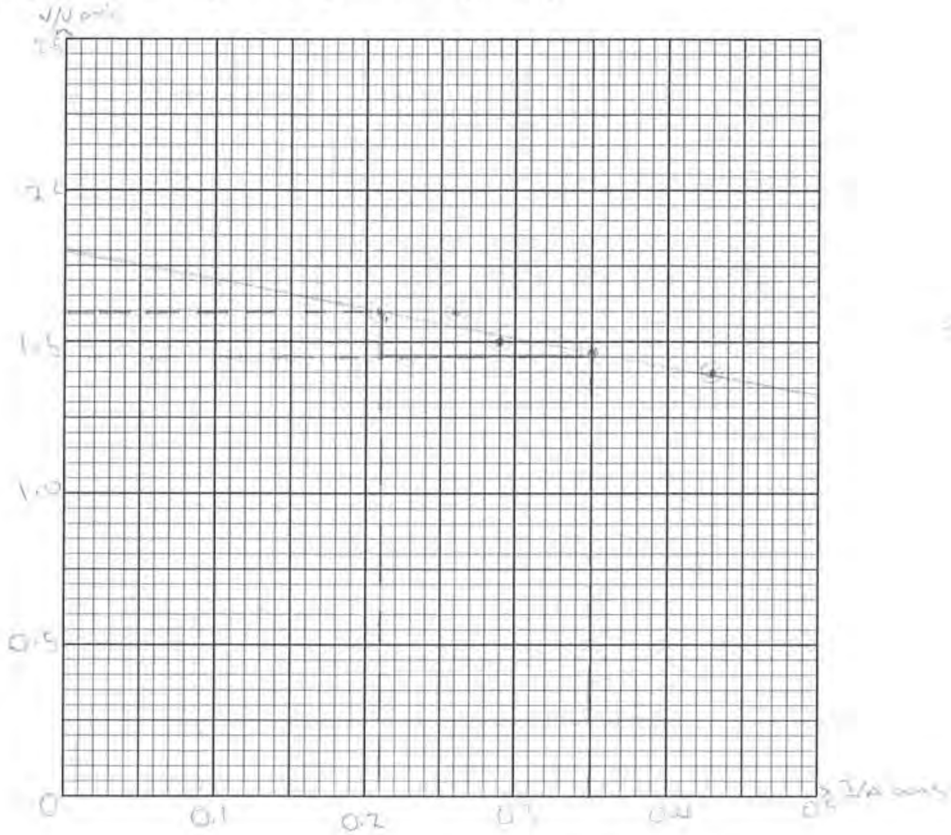
Table 3.1

d / cm	V / V	I / A
30.0	1.60	0.21
40.0	~~1.5~~ 1.60	0.26
50.0	1.50	0.29
70.0	1.45	0.35
90.0	1.40	0.43

✓ ✓

[2]

(b) Plot a graph of V/V (y-axis) against I/A (x-axis).



[4]

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

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{1.60 - 1.45}{0.35 - 0.21}$$

$$= \frac{0.15}{0.14}$$

$$= 1.071428571$$

G = ...1.07...... [2]

(d) The gradient G of the graph is numerically equal to the resistance R of the resistor **R**.

Write a value for the resistance R to a suitable number of significant figures for this experiment.

R = ...1.1...... [2]

[Total: 10]

Examiner comment – grade C

(a) The candidate successfully completes the table. The current values are not increasing, as expected, but a mark is not lost on this occasion.

(b) The candidate labels the graph axes correctly and plots the points accurately. The line drawn is a good, thin, best-fit line but a mark is lost because some of the plots are too large. A second mark is lost because the y-axis scale is very cramped.

(c) The candidate uses the triangle method correctly to determine the gradient but the triangle uses less than half the line.

(d) The candidate gives the value for resistance to two significant figures but does not include the unit Ω , scoring one of the two available marks.

Mark awarded = 6 out of 10

Example candidate response – grade E

3 In this experiment, you will determine the resistance of a resistor in a circuit.

Carry out the following instructions referring to Fig. 3.1. The circuit is set up for you.

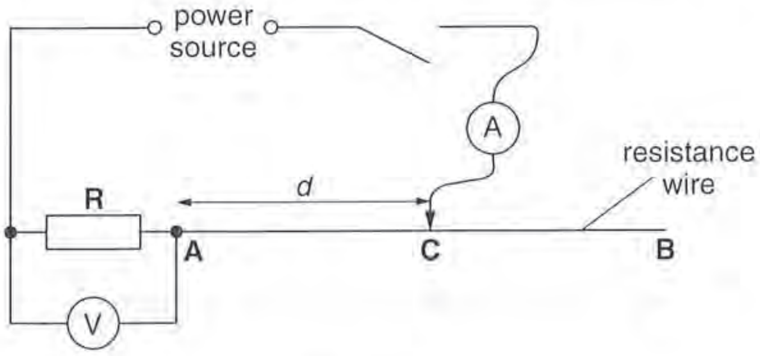


Fig. 3.1

(a) **(i)** Place the sliding contact **C** on the resistance wire at a distance $d = 30.0\,\text{cm}$ from point **A**. Switch on. Measure and record in Table 3.1 the current I in the circuit and the p.d. V across the resistor **R**. Switch off.

(ii) Repeat the procedure in step **(i)** using d values of 40.0 cm, 50.0 cm, 70.0 cm and 90.0 cm.

(iii) Complete the column headings in the table.

Table 3.1

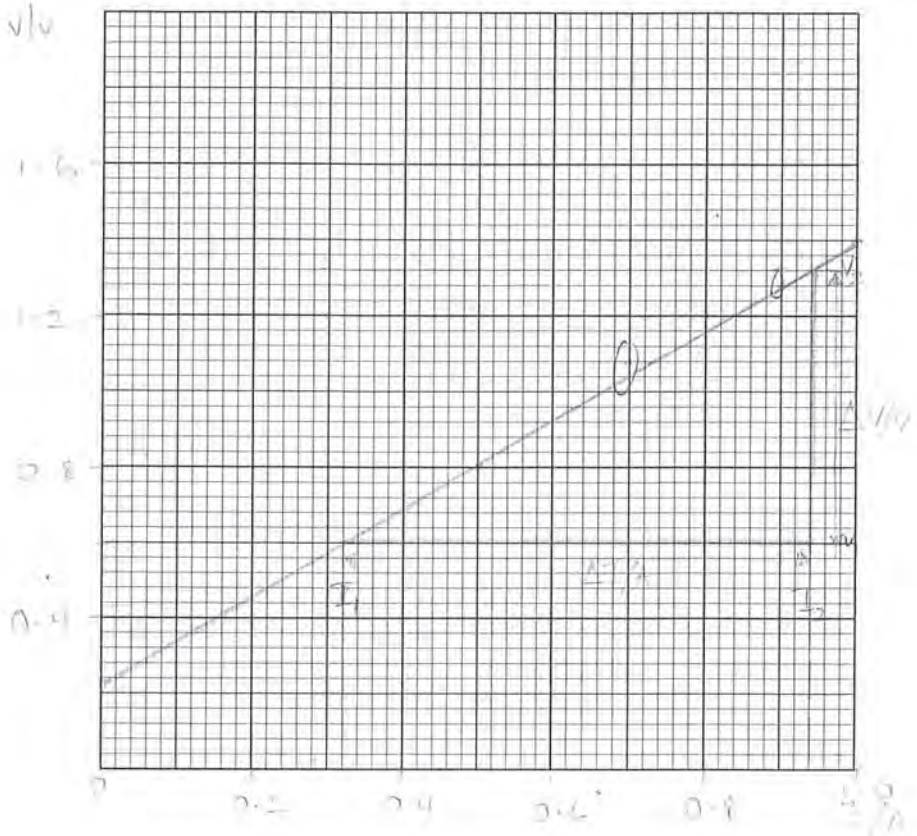
d /	V /	I /
30.0	1.4	1.0
40.0	1.3	0.9
50.0	1.2	0.8
70.0	1.1	0.7
90.0	0.8	0.5 A

✓ ✗

[2]

For Examiner's Use

(b) Plot a graph of V/V (y-axis) against I/A (x-axis).



th.

[4]

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

$$\frac{\Delta V}{\Delta I} = \frac{V_2 - V_1}{I_2 - I_1} = \frac{1.32 - 0.6\,\text{V}}{0.94 - 0.32\,\text{A}} = \frac{0.72\,\text{V}}{0.62\,\text{A}}$$

$G =$ 1.16 VA^{-1} [2]

(d) The gradient G of the graph is numerically equal to the resistance R of the resistor **R**.

Write a value for the resistance R to a suitable number of significant figures for this experiment.

$R =$ 1 Ω [2]

[Total: 10]

Examiner comment – grade E

(a) The candidate records the potential difference values to 1 decimal place but does not record the current values to at least 2 decimal places, as required.

(b) The graph axes are labelled correctly but the scale on the y-axis is too cramped. The plotting is inaccurate and the line drawn is not the best-fit line, it appears to join the first and last plots, ignoring those in between.

(c) The candidate uses the triangle method correctly to determine the gradient and shows clearly on the graph a triangle that uses more than half the line.

(d) The candidate gives the resistance value to only one significant figure, losing a mark, but the unit Ω is correctly given.

Mark awarded = 5 out of 10

Question 4

Mark scheme

4	**(c)**	*x* recorded and < 40 cm	[1]
	(e)	*y* recorded > 40 cm *x* and *y* in m, cm or mm	[1] [1]
	(f)	*f* correct	[1]
	(g)	$x + y$ =75–85 cm two *f* values the same to within ± 1 cm both *f* values to 2 or 3 significant figures, consistent	[1] [1] [1]
	(h)	Correct statement for results (expect Yes) Idea of within (or beyond) experimental accuracy	[1] [1]
	(i)	One from: Use of darkened room How to avoid parallax when taking readings Movement of lens back and forth to obtain clearest image Mark lens holder to show position of centre of lens Metre rule clamped or on bench Object, lens and screen all perpendicular to bench Object and lens same height above bench	[1]

Example candidate response – grade A

4 In this experiment, you will determine the focal length of a lens.

Carry out the following instructions referring to Fig. 4.1.

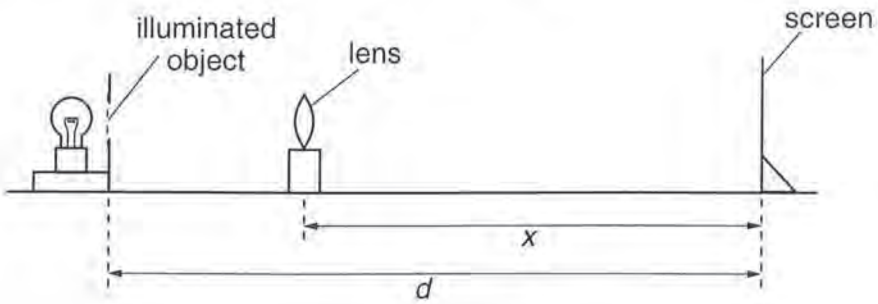


Fig. 4.1

(a) Place the screen at a distance $d = 0.800\,\text{m}$ from the illuminated object.

(b) Place the lens between the object and the screen and close to the object. Move the lens towards the screen until an **enlarged** image is formed on the screen. Adjust the position of the lens until the image is as clearly focused as possible.

(c) Measure and record the distance x between the centre of the lens and the screen.

$x =$ ~~[illegible]~~ 17.5cm [1] ✓

(d) Without moving the illuminated object or the screen, move the lens towards the screen until a clearly focused **diminished** image is formed on the screen. ✓

(e) Measure and record the distance y between the centre of the lens and the screen.

$y =$ 62cm [2] ✓

(f) Calculate the focal length f of the lens using the equation $f = \dfrac{xy}{d}$.

$$\frac{17.5 \times 62}{80}$$

✗

$f =$ 13.5 6 [1]

(g) Turn the lens through an angle of 180° so that the other side of the lens faces the screen. Repeat steps **(a)** to **(f)**.

x = 17.5 cm

y = 62 cm

f = 13.5

[3]

(h) A student suggests that the two values of the focal length f should be the same. State whether or not your results support this suggestion. Justify your answer by reference to the results.

statement The focal length are the same

justification when I turned the lens through 180° and repeated the experiment the values were still the same

[2]

(i) Briefly describe a precaution that you took in this experiment in order to obtain a reliable result.

I made sure that the lens was very clean and there was no stain on it for accurate results. [1]

[Total: 10]

Examiner comment – grade A

(c)–(e) The candidate records the x and y values correctly with the appropriate unit.

(f) There is an error in the calculation.

(g) The x and y values are within the tolerance allowed and the two focal length values are the same to within ± 1 cm. Both focal length values are recorded to three significant figures with the correct unit.

(h) The candidate makes a correct statement and gives an appropriate justification.

(i) The candidate does not suggest a relevant precaution.

Mark awarded = 8 out of 10

Example candidate response – grade C

4 In this experiment, you will determine the focal length of a lens.

Carry out the following instructions referring to Fig. 4.1.

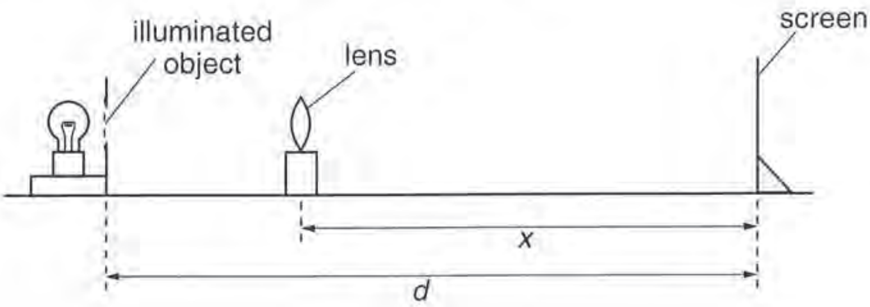


Fig. 4.1

(a) Place the screen at a distance $d = 0.800\,m$ from the illuminated object.

(b) Place the lens between the object and the screen and close to the object. Move the lens towards the screen until an **enlarged** image is formed on the screen. Adjust the position of the lens until the image is as clearly focused as possible.

(c) Measure and record the distance x between the centre of the lens and the screen.

x = ~~58 cm~~ 22cm [1]

(d) Without moving the illuminated object or the screen, move the lens towards the screen until a clearly focused **diminished** image is formed on the screen.

(e) Measure and record the distance y between the centre of the lens and the screen.

y = 10 cm [2]

(f) Calculate the focal length f of the lens using the equation $f = \frac{xy}{d}$.

$\frac{10 \times 22}{0.800} = 2.75$

f = 2.75cm [1]

(g) Turn the lens through an angle of 180° so that the other side of the lens faces the screen. Repeat steps **(a)** to **(f)**.

For Examiner's Use

x = ~~58.2 cm~~ ~~88~~ 22 cm

y = 10 cm

~~58~~ ~~58.2 × 10~~

10 × 22 / ~~60~~ ~~200~~ 80

f = ~~2.75 cm~~ 2.75 cm

[3]

(h) A student suggests that the two values of the focal length f should be the same. State whether or not your results support this suggestion. Justify your answer by reference to the results.

statement both answer are 2.75 cm

justification they are the same, because they all are the same lenget

[2]

(i) Briefly describe a precaution that you took in this experiment in order to obtain a reliable result.

the ~~ten~~ lens distance to the Screen

[1]

[Total: 10]

Examiner comment – grade C

(c)–(e) The candidate records a value of x that is within the tolerance allowed but the y value is unrealistic. The units are correct.

(f) The calculation of f is correct.

(g) The x and y values are unrealistic but the two f values are the same and given to three significant figures with the appropriate unit.

(h) The candidate makes a correct statement and gives an appropriate justification.

(i) The candidate does not suggest a relevant precaution.

Mark awarded = 7 out of 10

Example candidate response – grade E

4 In this experiment, you will determine the focal length of a lens.

Carry out the following instructions referring to Fig. 4.1.

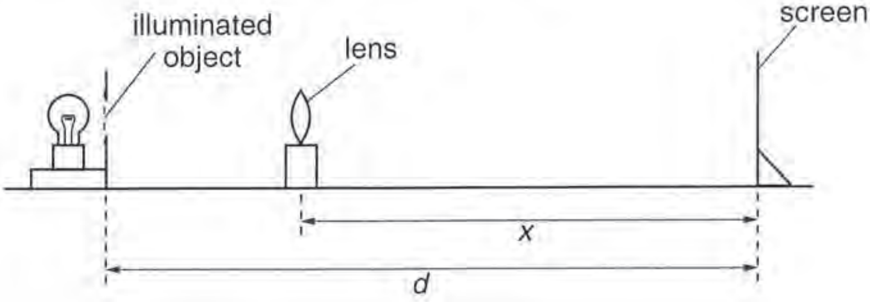


Fig. 4.1

(a) Place the screen at a distance $d = 0.800\,\text{m}$ from the illuminated object.

(b) Place the lens between the object and the screen and close to the object. Move the lens towards the screen until an **enlarged** image is formed on the screen. Adjust the position of the lens until the image is as clearly focused as possible.

(c) Measure and record the distance x between the centre of the lens and the screen.

$x =$ 47 cm [1]

(d) Without moving the illuminated object or the screen, move the lens towards the screen until a clearly focused **diminished** image is formed on the screen.

(e) Measure and record the distance y between the centre of the lens and the screen.

$y =$ 27 cm [2]

(f) Calculate the focal length f of the lens using the equation $f = \frac{xy}{d}$.

(47× 27) ÷ 80 = 15.86

$f =$ 15.86 cm [1]

(g) Turn the lens through an angle of 180° so that the other side of the lens faces the screen. Repeat steps **(a)** to **(f)**.

For Examiner's Use

$x =$ 54 cm

$y =$ 27.5 cm

(54 × 27.5) ÷ 80 = 18.56

$f =$ 18.56 cm

[3]

(h) A student suggests that the two values of the focal length f should be the same. State whether or not your results support this suggestion. Justify your answer by reference to the results.

statement My result does not support this

justification The images became clear at different distances.

[2]

(i) Briefly describe a precaution that you took in this experiment in order to obtain a reliable result.

Exact readings to get more exact answers.

[1]

[Total: 10]

Examiner comment – grade E

(c)–(e) The candidate's x and y values are unrealistic, but the unit is correct.

(f) The calculation of f is correct.

(g) Here, the x and y values are within the tolerance allowed but the two f values are not the same to within ± 1 cm. Both f values are given to too many significant figures.

(h) The candidate's statement matches the results but the justification given is not worthy of a mark.

(i) The candidate is unable to make a suitable suggestion.

Mark awarded = 4 out of 10

Paper 6 – Alternative to Practical

Paper 6 is a written paper designed to test candidates' familiarity with laboratory practical procedure. The purpose of this component is to test appropriate skills in assessment objective C (Experimental skills and investigations). Candidate are not be required to use knowledge outside the Core curriculum.

Question 1

Mark scheme

1 **(a)** graph:

axes:	the right way round, labelled *x* and *y* with unit cm	[1]
scale:	both 10 small squares = 2 cm	
	(either or both 20 small squares = 5 cm also acceptable)	[1]
plots:	all correct to ½ small square	[1]
line:	well-judged, best-fit, straight, thin, continuous line	[1]

(b) correct triangle method using at least ½ candidate's line, with method clearly indicated on graph [1]
G = 0.94 – 1.00, no ecf [1]

(c) 1.0/(candidate's G) calculation correct, 2 or 3 significant figures and unit N [1]

(d) **(i)** (where rule) balances on pivot o.w.t.t.e. [1]

(ii) take readings from 49.7 OR
adjust rule by adding weight until it balances at 50.0 cm mark [1]

[Total: 9]

Example candidate response – grade A

1 An IGCSE student is determining the weight of a metre rule.

Fig. 1.1 shows the apparatus.

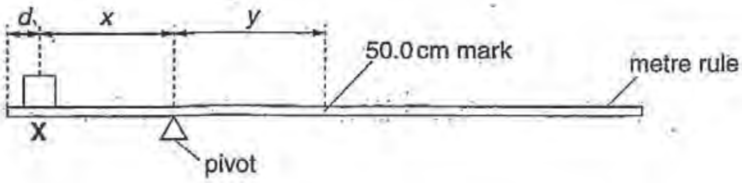


Fig. 1.1

X is a 1.0 N load.

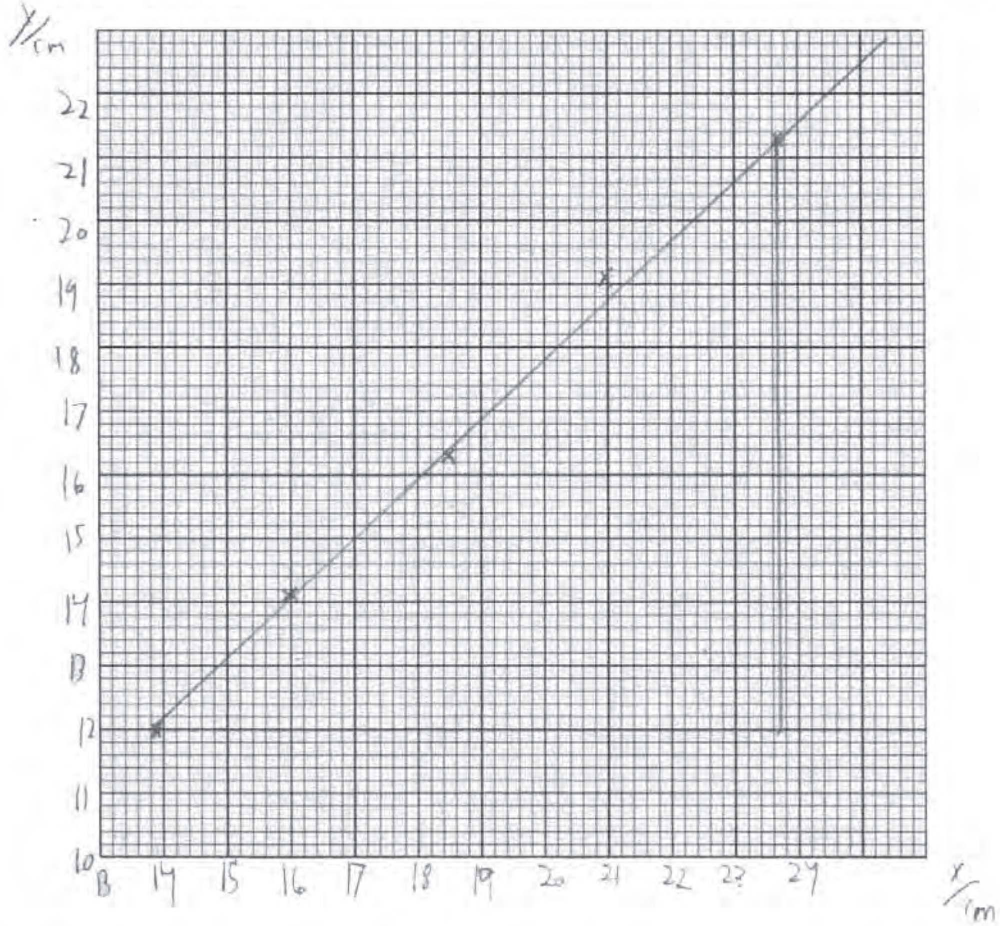
The student places the load **X** on the rule so that its centre is at d = 5.0 cm from the zero end of the rule, as shown in Fig.1.1. He adjusts the position of the rule so that it is as near as possible to being balanced, with the 50.0 cm mark to the right of the pivot.

He measures and records the distance x from the centre of the load **X** to the pivot, and the distance y from the pivot to the 50.0 cm mark on the rule. He repeats the procedure using d values of 10.0 cm, 15.0 cm, 20.0 cm and 25.0 cm. The readings of d, x and y are shown in Table 1.1.

Table 1.1

d/cm	x/cm	y/cm
5.0	23.7	21.3
10.0	21.0	19.1
15.0	18.5	16.3
20.0	16.0	14.1
25.0	13.9	12.0

(a) Plot the graph of y/cm (y-axis) against x/cm (x-axis). You do not need to include the origin (0,0) on your graph.



[4]

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

$$\frac{y_2 - y_1}{x_2 - x_1} = \frac{21.3 - 12}{23.7 - 13.9} = 0.95$$

G = 0.95 [2]

(c) Calculate the weight W of the metre rule using the equation $W = \frac{L}{G}$, where L = 1.0 N.

$$\frac{1}{0.95} =$$

W = 1.05 N [1]

(d) The calculation of *W* is based on the assumption that the centre of mass of the rule is at the 50.0 cm mark.

(i) Describe briefly how you would determine the position of the centre of mass of the rule.

Move the pivot under the rule untill the rule balances at its center of mass.

(ii) Describe how you would modify the experiment if the centre of mass was at the 49.7 cm mark.

Adjust the position of load x to neutralize the small difference in center of mass. [2]

[Total: 9]

Examiner comment – grade A

(a) The candidate correctly labels both axes and chooses a sensible scale that uses the grid well. The advice given in the question 'You do not need to include the origin (0,0) on your graph' is taken.

The plots are accurate.

The candidate draws a straight line and, although a slightly better fit is possible, the line drawn is judged to be a best-fit line within the tolerance allowed.

(b) The candidate clearly shows the triangle method for determining the gradient and uses a large triangle. The result for the value of G is within the tolerance allowed.

(c) The candidate correctly calculates the value of W and expresses it to three significant figures with the correct unit, N.

(d) The candidate correctly explains how to find the position of the centre of mass, but loses the final mark. This mark could have been gained by describing how to add small pieces of modelling clay (or similar material) to one end of the rule, without loads, until it balances on the pivot at the 50.0 cm mark. Alternatively readings can be taken from the 49.7 cm mark.

Mark awarded = 8 out of 9

Example candidate response – grade C

1 An IGCSE student is determining the weight of a metre rule.

Fig. 1.1 shows the apparatus.

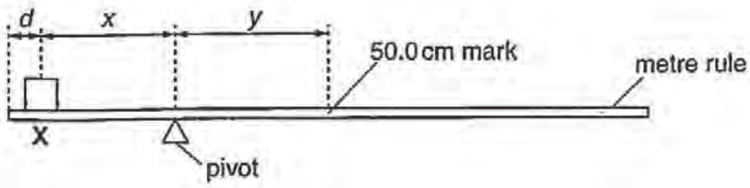


Fig. 1.1

X is a 1.0 N load.

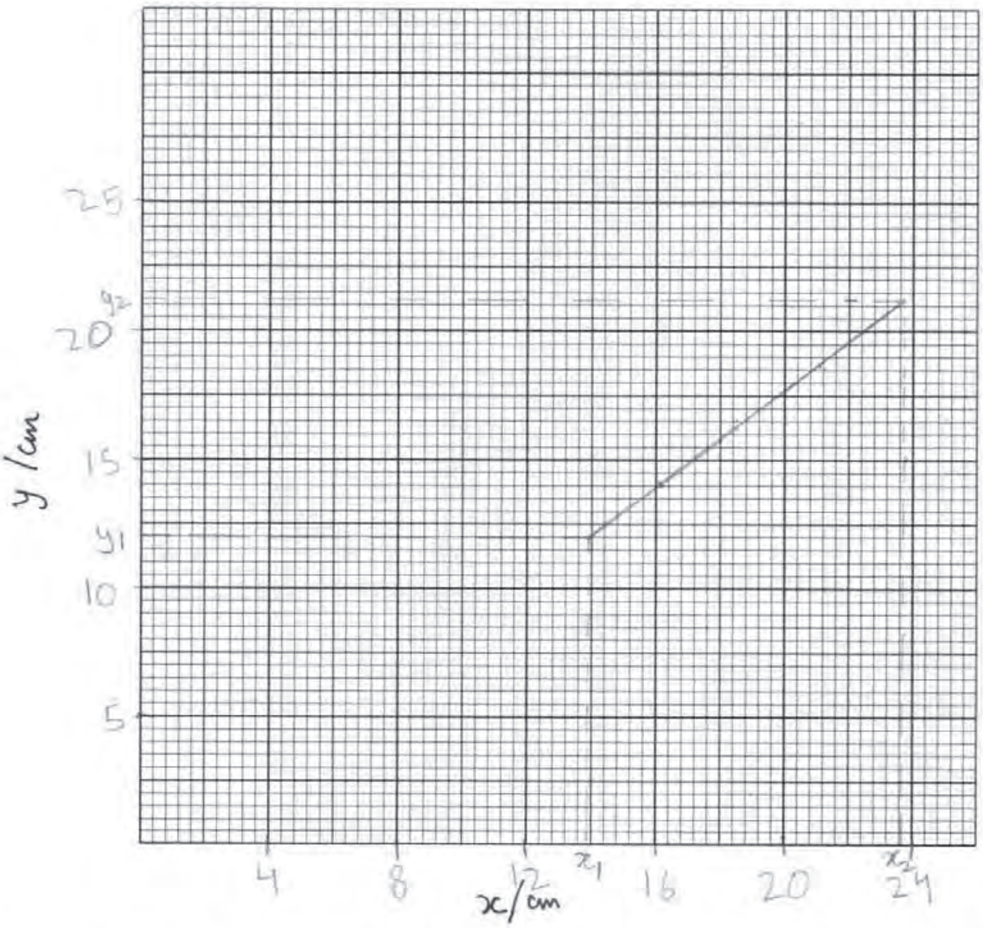
The student places the load **X** on the rule so that its centre is at $d = 5.0\,cm$ from the zero end of the rule, as shown in Fig.1.1. He adjusts the position of the rule so that it is as near as possible to being balanced, with the 50.0 cm mark to the right of the pivot.

He measures and records the distance x from the centre of the load **X** to the pivot, and the distance y from the pivot to the 50.0 cm mark on the rule. He repeats the procedure using d values of 10.0 cm, 15.0 cm, 20.0 cm and 25.0 cm. The readings of d, x and y are shown in Table 1.1.

Table 1.1

d/cm	x/cm	y/cm
5.0	23.7	21.3
10.0	21.0	19.1
15.0	18.5	16.3
20.0	16.0	14.1
25.0	13.9	12.0

(a) Plot the graph of y/cm (y-axis) against x/cm (x-axis). You do not need to include the origin (0,0) on your graph.



[4]

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

$\frac{y_2 - y_1}{x_2 - x_1}$ ~~21.3 – 23.7~~ $\frac{9.3}{9.8}$

$= 0.948$

$\frac{21.3 - 12.0}{23.7 - 13.9}$

$G =$ 0.95 [2]

(c) Calculate the weight W of the metre rule using the equation $W = \frac{L}{G}$, where L = 1.0 N.

$W = \frac{1}{0.95}$

$= 1.052\text{ N}$

$W =$ 1.05N [1]

(d) The calculation of *W* is based on the assumption that the centre of mass of the rule is at the 50.0 cm mark.

(i) Describe briefly how you would determine the position of the centre of mass of the rule.

Using a set square or a ruler and measuring it

(ii) Describe how you would modify the experiment if the centre of mass was at the 49.7 cm mark.

Pivot will be moved

The load X will also be moved [2]

[Total: 9]

Examiner comment – grade C

(a) The candidate does not take the advice given 'You do not need to include the origin (0,0) on your graph'. As a result the scale chosen is unsuitable with all the plots confined to a small part of the grid. The axes, however, are correctly labelled. The candidate makes two plotting errors, but draws a good best-fit line for the points plotted.

(b) The candidate shows the triangle method for determining the gradient and uses a large triangle. The result for the value of G is within the tolerance allowed.

(c) The candidate correctly calculates the value of W and expresses it to three significant figures with the correct unit, N.

(d) The candidate is unable to make suitable suggestions, perhaps indicating a lack of personal experience with this type of experiment.

Mark awarded = 5 out of 9

Example candidate response – grade E

1 An IGCSE student is determining the weight of a metre rule.

Fig. 1.1 shows the apparatus.

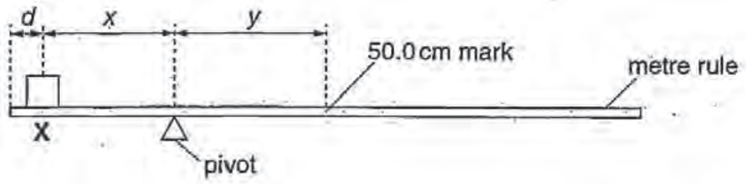


Fig. 1.1

X is a 1.0 N load.

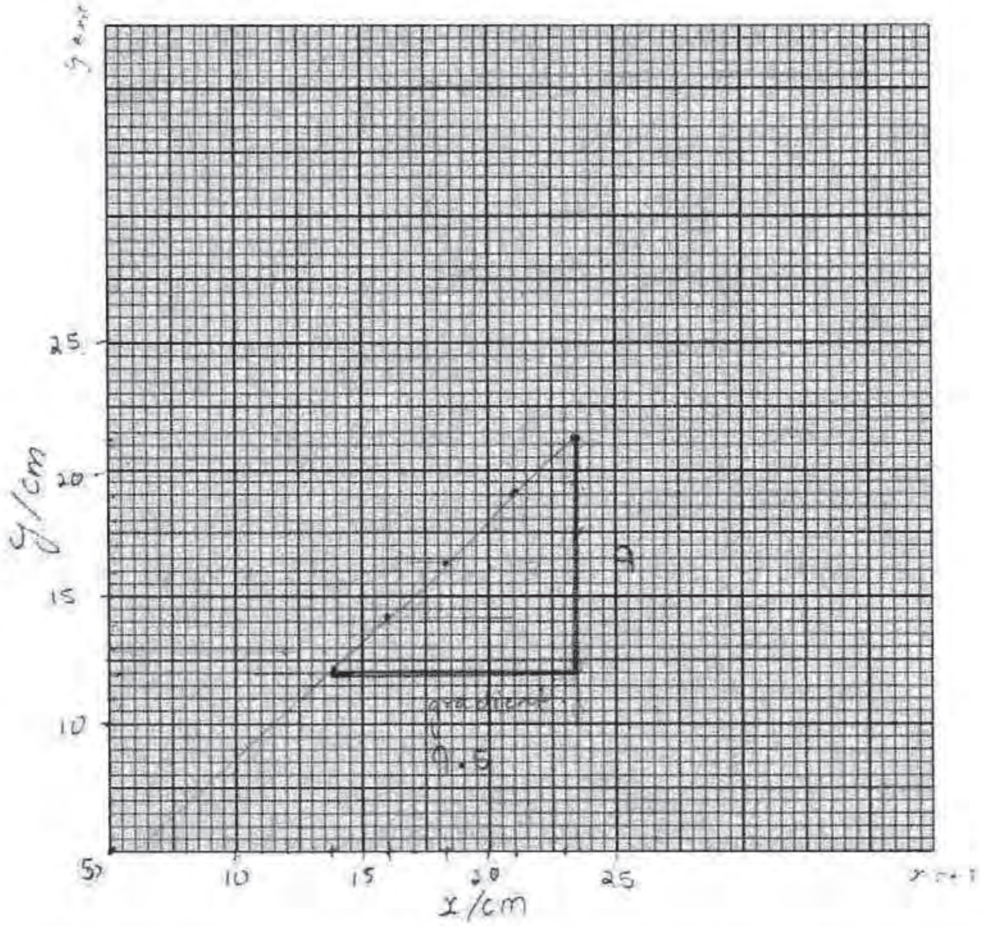
The student places the load **X** on the rule so that its centre is at d = 5.0 cm from the zero end of the rule, as shown in Fig.1.1. He adjusts the position of the rule so that it is as near as possible to being balanced, with the 50.0 cm mark to the right of the pivot.

He measures and records the distance x from the centre of the load **X** to the pivot, and the distance y from the pivot to the 50.0 cm mark on the rule. He repeats the procedure using d values of 10.0 cm, 15.0 cm, 20.0 cm and 25.0 cm. The readings of d, x and y are shown in Table 1.1.

Table 1.1

d/cm	x/cm	y/cm
5.0	23.7	21.3
10.0	21.0	19.1
15.0	18.5	16.3
20.0	16.0	14.1
25.0	13.9	12.0

(a) Plot the graph of y/cm (y-axis) against x/cm (x-axis). You do not need to include the origin (0,0) on your graph.



[4]

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

$$\frac{9}{9.5}$$

$G =$ ..... 0.95 ..... [2]

(c) Calculate the weight W of the metre rule using the equation $W = \frac{L}{G}$, where $L = 1.0\,\text{N}$.

$$W = \frac{1}{0.95}$$

$W =$ ..... 1.053 g ..... [1]

(d) The calculation of *W* is based on the assumption that the centre of mass of the rule is at the 50.0 cm mark.

(i) Describe briefly how you would determine the position of the centre of mass of the rule.

Carefully adjusting it where ~~it w~~ the weight on both sides seemeds to be equal.

(ii) Describe how you would modify the experiment if the centre of mass was at the 49.7 cm mark.

By moving the load x a few millimeters towards the edge of the rule [2]

[Total: 9]

Examiner comment – grade E

(a) The axes are correctly labelled. Although the scales chosen do not include the origin (0,0) the choice of scales is not suitable as all the plots are confined to a small part of the grid. Two of the points are incorrectly plotted. The line drawn is not straight.

(b) The candidate clearly shows the triangle method for determining the gradient and uses a large triangle. The result for the value of G is within the tolerance allowed.

(c) The calculation is correct but given to too many significant figures and with the wrong unit.

(d) The candidate is unable to make suitable suggestions, perhaps indicating a lack of personal experience with this type of experiment.

Mark awarded = 3 out of 9

Question 2

Mark scheme

2 **(a)** $\theta_c = 24$ [1]
°C [1]

(b) $\theta_{av} = 55$ (°C) ecf from **(a)** [1]

(c) any two from:
stirring
waiting for temperature (to stabilise)
view thermometer at right angles o.w.t.t.e. [2]

(d) heat loss (to surroundings) o.w.t.t.e. [1]

(e) one from:
lagging beakers o.w.t.t.e.
use of lid
swifter transfer of water [1]

(f) one from:
amount of stirring o.w.t.t.e.
hot water temperature
cold water temperature
room temperature o.w.t.t.e.
transfer time [1]

[Total: 8]

Example candidate response – grade A

2 The IGCSE class is investigating temperature changes when cold water and hot water are mixed.

(a) A student records the temperature θ_c of 100 cm^3 of cold water and the temperature θ_h of 100 cm^3 of hot water.

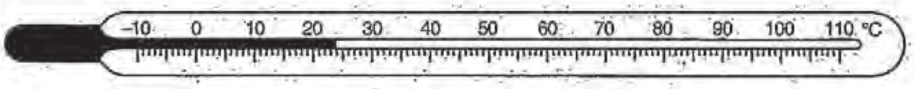


Fig. 2.1

Write down the temperature θ_c shown on the thermometer in Fig. 2.1.

θ_c = 24 °C [2]

(b) The hot water is at a temperature θ_h = 86 °C.

Calculate θ_{av}, the average of θ_c and θ_h.

$\theta_{AV} = \frac{\theta_c + \theta_h}{2}$ $\quad$ $\theta_{AV} = 55°C$

$\theta_{AV} = \frac{24°C + 86°C}{2}$

average θ_{av} = 55°C [1]

(c) The student adds 100 cm^3 of the hot water to the cold water. She records the temperature θ_m of the mixture of hot and cold water, θ_m = 48 °C.

State two precautions (other than repeating the experiment) that the student could take to ensure the reliability of her value of the temperature θ_m.

1. - To avoid measurement mistakes by taking the value at the same level of mark.

2. - When the hot water is measured, to pour it instantly to the cold water to avoid temperature loss. [2]

(d) Suggest a practical reason in this experiment for the temperature of the mixture θ_m being different from the average value θ_{av}, even when the student has taken the precautions you suggested in **(c)**.

-Because the hot water's temperature lowers in time, so by the time it is pour in the ~~hot~~ cold water, it doesn't have its initial temperature. [1]

(e) Suggest a modification to the experiment which should reduce the difference between θ_m and θ_{av}.

- To use a lid to cover the hot water to avoid the reducing of its temperature. [1]

(f) The student decides to repeat the experiment to check the readings. Suggest one possible variable that she should keep constant.

- The initial temperature of the hot and cold water. [1]

[Total: 8]

Examiner comment – grade A

(a) The candidate correctly reads the thermometer and includes the unit.

(b) The candidate correctly calculates the average.

(c) 1. The candidate may be thinking, correctly, of viewing the thermometer scale at a right angle to avoid a parallax error. However the wording is too vague to score the mark.

2. The candidate writes a sensible precaution related to the experiment, but it does not answer the question about reliability of the temperature value. A reference to waiting for the temperature to stabilise or stirring would have gained the mark.

(d) The correct answer here is 'heat loss to the surroundings'. In this case, the candidate misses the opportunity to write a concise answer and produces a long and complicated response which does not quite get to the point and leaves doubt as to whether the candidate understands the difference between heat and temperature.

(e) The candidate gives a sensible, straightforward suggestion of using a lid.

(f) The candidate suggests two variables to keep constant. Both are correct so the mark is scored.

Mark awarded = 6 out of 8

Example candidate response – grade C

2 The IGCSE class is investigating temperature changes when cold water and hot water are mixed.

(a) A student records the temperature θ_c of 100 cm^3 of cold water and the temperature θ_h of 100 cm^3 of hot water.

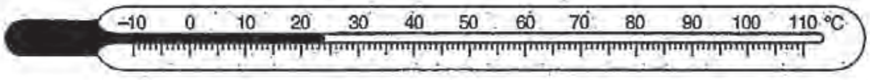


Fig. 2.1

Write down the temperature θ_c shown on the thermometer in Fig. 2.1.

θ_c = 20.4°C [2]

(b) The hot water is at a temperature θ_h = 86 °C.

Calculate θ_{av}, the average of θ_c and θ_h.

$$\frac{20.4 + 86}{2} = \frac{106.4}{2} = 53.2$$

average θ_{av} = 53.2°C. [1]

(c) The student adds 100 cm^3 of the hot water to the cold water. She records the temperature θ_m of the mixture of hot and cold water, θ_m = 48 °C.

State two precautions (other than repeating the experiment) that the student could take to ensure the reliability of her value of the temperature θ_m.

1. Taking accurate reading of every temperature drop
2. Keeping the volume of the water constant.

[2]

(d) Suggest a practical reason in this experiment for the temperature of the mixture θ_m being different from the average value θ_{av}, even when the student has taken the precautions you suggested in **(c)**.

This is because the temperature of the water is changing every second. [1]

(e) Suggest a modification to the experiment which should reduce the difference between θ_m and θ_{av}.

An ~~insulating~~ insulated container which can conserve heat should be used. [1]

(f) The student decides to repeat the experiment to check the readings. Suggest one possible variable that she should keep constant.

The variable that should be kept constant [1] is that of the starting temperature.

[Total: 8]

Examiner comment – grade C

(a) The candidate reads then thermometer wrongly, but uses the correct unit.

(b) The calculation is correct, taking into account the candidate's own answer for part **(a)**.

(c) The candidate's first suggestion is too vague to score a mark and the second suggestion is not relevant to this question.

(d) The candidate makes a vague statement and does not show understanding that heat is lost to the surroundings.

(e) The candidate makes a sensible suggestion.

(f) The candidate makes a sensible suggestion.

Mark awarded = 4 out of 8

Example candidate response – grade E

2 The IGCSE class is investigating temperature changes when cold water and hot water are mixed.

(a) A student records the temperature θ_c of 100 cm^3 of cold water and the temperature θ_h of 100 cm^3 of hot water.

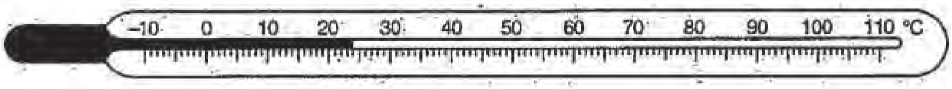


Fig. 2.1

Write down the temperature θ_c shown on the thermometer in Fig. 2.1.

θ_c = ...24 °C...... [2]

(b) The hot water is at a temperature θ_h = 86 °C.

Calculate θ_{av}, the average of θ_c and θ_h.

average θ_{av} = ...55 °C...... [1]

(c) The student adds 100 cm^3 of the hot water to the cold water. She records the temperature θ_m of the mixture of hot and cold water, θ_m = 48 °C.

State two precautions (other than repeating the experiment) that the student could take to ensure the reliability of her value of the temperature θ_m.

1. ......use insulator......

2. ......Put water slowly to avoid splashing...... [2]

(d) Suggest a practical reason in this experiment for the temperature of the mixture θ_m being different from the average value θ_{av}, even when the student has taken the precautions you suggested in (c).

......Due to......

...... [1]

(e) Suggest a modification to the experiment which should reduce the difference between θ_m and θ_{av}.

......repeat and take average......

...... [1]

(f) The student decides to repeat the experiment to check the readings. Suggest one possible variable that she should keep constant.

......amount of water (Volume)...... [1]

[Total: 8]

Examiner comment – grade E

(a) The candidate correctly reads the thermometer and includes the unit.

(b) The candidate correctly calculates the average.

(c) The candidate's suggestions are not relevant to the question.

(d) The candidate is unable to make a suggestion.

(e) The candidate's suggestion of repeated readings is not relevant here as it is not a modification to the experiment.

(f) The candidate's suggestion is not accepted because the question makes clear that the volume of the water is already a constant value.

Mark awarded = 3 out of 8

Question 3

Mark scheme

3 **(a)** **(i)** 0.27 (A) [1]

(ii) expect YES (ecf: no) [1]
expect close enough / within limits of experimental accuracy o.w.t.t.e.
ecf: beyond limits of experimental accuracy o.w.t.t.e. [1]

(b) vary/control current/voltage [1]

(c) **(i)** voltmeter symbol correct and correctly connected across all three resistors [1]

(ii) 2.2 (V) [1]

(iii) *R* correctly evaluated
ecf from **(ii)** [1]
2 or 3 significant figures and unit Ω [1]

[Total: 8]

Example candidate response – grade A

3 The IGCSE class is investigating the current in resistors in a circuit.

The circuit is shown in Fig. 3.1.

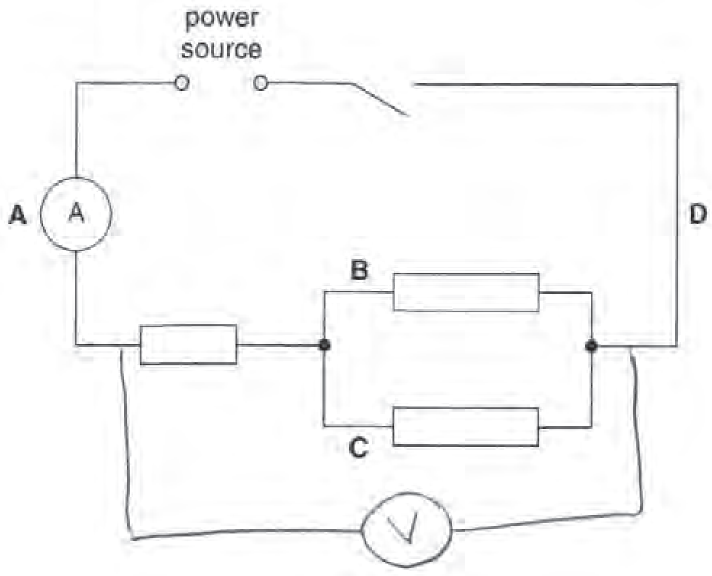


Fig. 3.1

(a) A student measures the current I_A at the position **A** shown by the ammeter, and then at positions **B** (I_B), **C** (I_C) and **D** (I_D).

The readings are:

$I_A = 0.28\,A$ $I_B = 0.13\,A$ $I_C = 0.14\,A$ $I_D = 0.27\,A$

Theory suggests that $I_A = I_B + I_C$ and $I_D = I_B + I_C$.

(i) Calculate $I_B + I_C$.

$I_B + I_C =$ 0.13 + 0.14 = 0.27 A

(ii) State whether the experimental results support the theory. Justify your statement by reference to the readings.

statement Yes, it justifys

justification $I_B + I_C$ is equal to 0.27A, which is almost equal to I_A (0.28A), the difference is within expermental accuracy.

[3]

(b) The student suggests repeating the experiment to confirm her conclusion. She connects a variable resistor (rheostat) in series with the switch. State the purpose of the variable resistor.

To control the resistance and the current in the circuit .... [1]

(c) The student connects a voltmeter and records the potential difference V across the combination of the three resistors.

(i) On Fig. 3.1, draw in the voltmeter connected as described, using the standard symbol for a voltmeter. [1]

(ii) Write down the voltmeter reading shown on Fig. 3.2.

Fig. 3.2

V = 2.2 V .... [1]

(iii) Calculate the resistance R of the combination of the three resistors using the equation $R = \frac{V}{I}$.

$$R = \frac{2.2}{0.27} = 8.14\ \Omega$$

R = 8.14 Ω .... [2]

[Total: 8]

Examiner comment – grade A

(a) **(i)** The candidate correctly calculates $I_B + I_C$.

(ii) The candidate states that the experimental results support the theory and justifies the statement well by pointing out that the difference in results (0.27 A and 0.28 A) is within the limits of experimental accuracy. The wording is sufficiently clear to show the candidate's understanding.

(b) The candidate knows that the purpose of the variable resistor is to control the current.

(c) **(i)** The candidate uses the standard symbol for a voltmeter and shows the voltmeter correctly connected.

(ii) The candidate reads the voltmeter correctly.

(iii) The candidate gives the answer with the correct unit and to three significant figures. However, a mark is lost as the answer is incorrectly rounded. (8.148 should be written as 8.15, to three significant figures.)

Mark awarded = 7 out of 8

Example candidate response – grade C

3 The IGCSE class is investigating the current in resistors in a circuit.

The circuit is shown in Fig. 3.1.

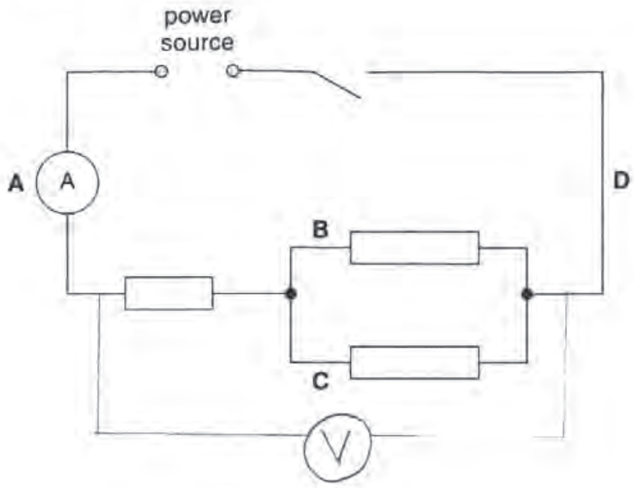


Fig. 3.1

(a) A student measures the current I_A at the position **A** shown by the ammeter, and then at positions **B** (I_B), **C** (I_C) and **D** (I_D).

The readings are:

$I_A = 0.28\,A$ $\quad$ $I_B = 0.13\,A$ $\quad$ $I_C = 0.14\,A$ $\quad$ $I_D = 0.27\,A$

Theory suggests that $I_A = I_B + I_C$ and $I_D = I_B + I_C$.

(i) Calculate $I_B + I_C$. 0.13 + 0.14 = 0.27

$I_B + I_C =$ 0.27

(ii) State whether the experimental results support the theory. Justify your statement by reference to the readings.

statement No it does not support

justification because from the calculations, the result got was that of current small than, the actual one recorded, calculated = 0.27 from readings = 0.28 [3]

Examiner comment – grade C

(a) **(i)** The candidate correctly calculates $I_B + I_C$.

(ii) The candidate does not realise that the difference in results (0.27 A and 0.28 A) is within the limits of experimental accuracy.

(b) The candidate knows that the purpose of the variable resistor is to control the current.

(c) **(i)** The candidate uses the standard symbol for a voltmeter and shows the voltmeter correctly connected.

(ii) The candidate reads the voltmeter correctly.

(iii) The candidate calculates the resistance using a wrong value for the current, but gives the answer to three significant figures with the correct unit, so scores one of the two available marks.

Mark awarded = 5 out of 8

Example candidate response – grade E

3 The IGCSE class is investigating the current in resistors in a circuit.

The circuit is shown in Fig. 3.1.

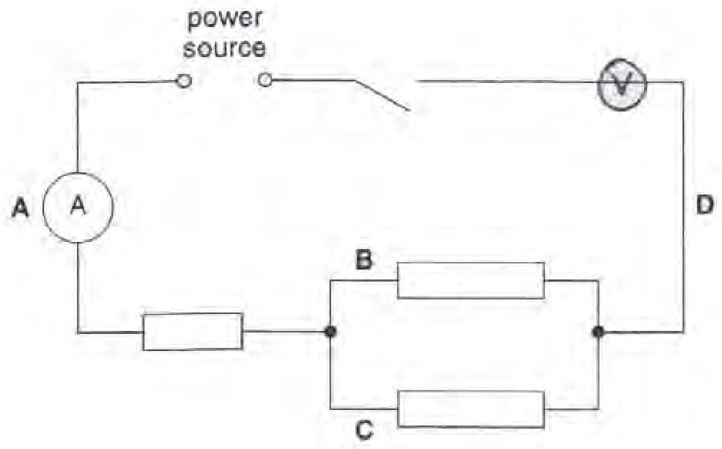


Fig. 3.1

(a) A student measures the current I_A at the position **A** shown by the ammeter, and then at positions **B** (I_B), **C** (I_C) and **D** (I_D).

The readings are:

$I_A = 0.28\,A$ $I_B = 0.13\,A$ $I_C = 0.14\,A$ $I_D = 0.27\,A$

Theory suggests that $I_A = I_B + I_C$ and $I_D = I_B + I_C$.

(i) Calculate $I_B + I_C$.

0.13+0.14=

$I_B + I_C =$ 0.27 A

(ii) State whether the experimental results support the theory. Justify your statement by reference to the readings.

statement It does not support the theory

justification Because there is a resistor before B, C, that takes electrons and reduce the intensity

[3]

(b) The student suggests repeating the experiment to confirm her conclusion. She connects a variable resistor (rheostat) in series with the switch. State the purpose of the variable resistor.

To control how ~~much~~ many electrons go through

.... [1]

(c) The student connects a voltmeter and records the potential difference V across the combination of the three resistors.

(i) On Fig. 3.1, draw in the voltmeter connected as described, using the standard symbol for a voltmeter. [1]

(ii) Write down the voltmeter reading shown on Fig. 3.2.

Fig. 3.2

$V =$ 2.2v [1]

(iii) Calculate the resistance R of the combination of the three resistors using the equation $R = \frac{V}{I}$.

$R = \frac{2.2}{0.27}$

$R =$ 8.15 [2]

[Total: 8]

Examiner comment – grade E

(a) **(i)** The candidate correctly calculates $I_B + I_C$.

(ii) The candidate does not realise that the difference in results (0.27 A and 0.28 A) is within the limits of experimental accuracy.

(b) The answer is too vague to convincingly show that the candidate understands that the variable resistor controls the current.

(c) **(i)** The voltmeter is not correctly placed.

(ii) The voltmeter reading is correct.

(iii) The resistance value is correctly calculated and given to three significant figures but the unit Ω is missing.

Mark awarded = 3 out of 8

Question 4

Mark scheme

4	(a)	(i)	normal at 90°, at centre of **MR** and crossing **MR**	[1]
		(ii)	**AB** is a continuous line from **B**, 8 cm long	[1]
			AB is at 40° to normal	[1]
	(b)	(i)	continuous, thin line that reaches normal and at least touches P_2 and P_3 dots	[1]
		(ii)	$r = 40 – 43(°)$ (no ecf)	[1]
	(c)		any two from: thickness of lines thickness of protractor o.w.t.t.e. / accuracy of reading protractor thickness of pins / pin holes accept thickness of mirror / glass in front of mirror	[2]
	(d)		ticks in boxes 1, 3, 5 (1 mark each) (if more than 3 ticks, –1 for each tick in a wrong box to minimum of 0)	[3]
				[Total: 10]

Example candidate response – grade A

4 An IGCSE student is investigating reflection of light in a plane mirror.

Fig. 4.1 shows the student's ray trace sheet.

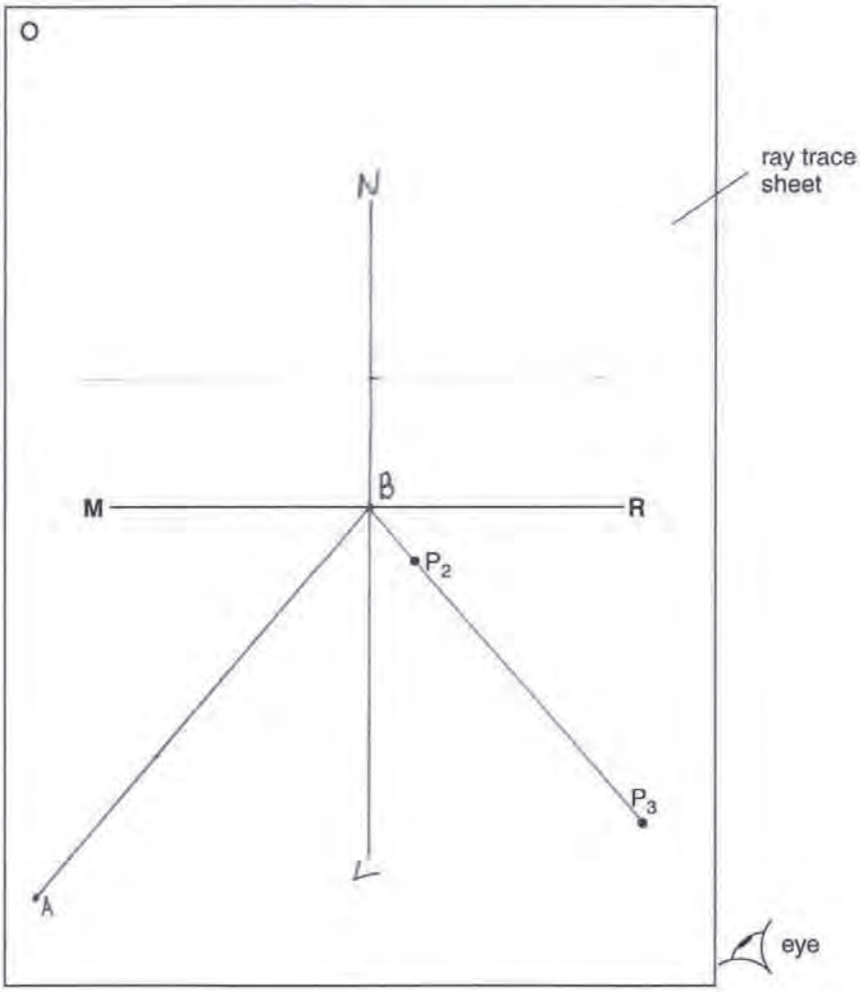


Fig. 4.1

(a) The line **MR** shows the position of a mirror.

(i) Draw a normal to this line that passes through its centre. Label the normal **NL**. Label the point at which **NL** crosses **MR** with the letter **B**.

[1]

(ii) Draw a line 8 cm long from **B** at an angle of incidence $i = 40°$ to the normal below **MR** and to the left of the normal. Label the end of this line **A**. Record the angle of incidence i in the first row of Table 4.1.

Table 4.1

i/°	r/°
40	40
34	33

[2]

(b) Fig. 4.2 shows the mirror which is made of polished metal and has a vertical line drawn on it.

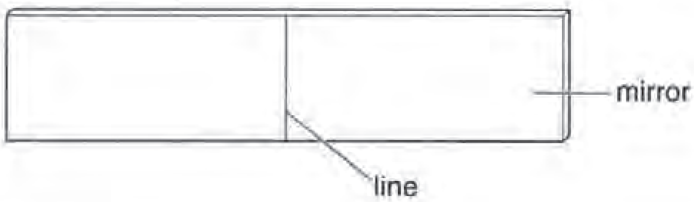


Fig. 4.2

The student places the mirror, with its reflecting face vertical, on **MR**. The lower end of the line on the mirror is at point **B**. He places a pin P_1 at **A**. He views the line on the mirror and the image of pin P_1 from the direction indicated by the eye in Fig. 4.1. He places two pins P_2 and P_3 some distance apart so that pins P_3, P_2, the image of P_1, and the line on the mirror all appear exactly one behind the other. The positions of P_2 and P_3 are shown.

(i) Draw the line joining the positions of P_2 and P_3. Continue the line until it meets the normal.

(ii) Measure, and record in the first row of Table 4.1, the angle of reflection r between the normal and the line passing through P_2 and P_3.

[2]

(c) The student draws a line parallel to **MR** and 2 cm above it. He places the mirror on this line and repeats the procedure without changing the position of pin P_1. His readings for i and r are shown in the table.

In spite of carrying out this experiment with reasonable care, it is possible that the values of the angle of reflection r will not be exactly the same as the values obtained from theory. Suggest two possible causes of this inaccuracy.

1. The thickness of the line is bigger or smaller or a different position of the eye view

2. The thickness of the pins or the mirror are affecting.

[2]

(d) The student was asked to list precautions that should be taken with this experiment in order to obtain readings that are as accurate as possible. Table 4.2 shows the suggestions.

Place a tick (✓) in the second column of the table next to each correctly suggested precaution.

Table 4.2

suggested precaution	
avoid parallax (line of sight) errors when taking readings with the protractor	✓
carry out the experiment in a darkened room	
draw the lines so that they are as thin as possible	✓
keep room temperature constant	
place pins P_2 and P_3 as far apart as possible	✓
use only two or three significant figures for the final answers	

[3]

[Total: 10]

Examiner comment – grade A

(a) (i) The candidate draws the normal correctly.

(ii) The line AB is a continuous, straight line of the specified length and at the correct angle of incidence.

(b) The line through P_2 and P_3 to the normal is drawn correctly and the value of the angle of incidence *r* is within the allowed tolerance.

(c) The candidate makes two sensible suggestions.

(d) The candidate successfully chooses the three suggested precautions.

Mark awarded = 10 out of 10

Example candidate response – grade C

4 An IGCSE student is investigating reflection of light in a plane mirror.

Fig. 4.1 shows the student's ray trace sheet.

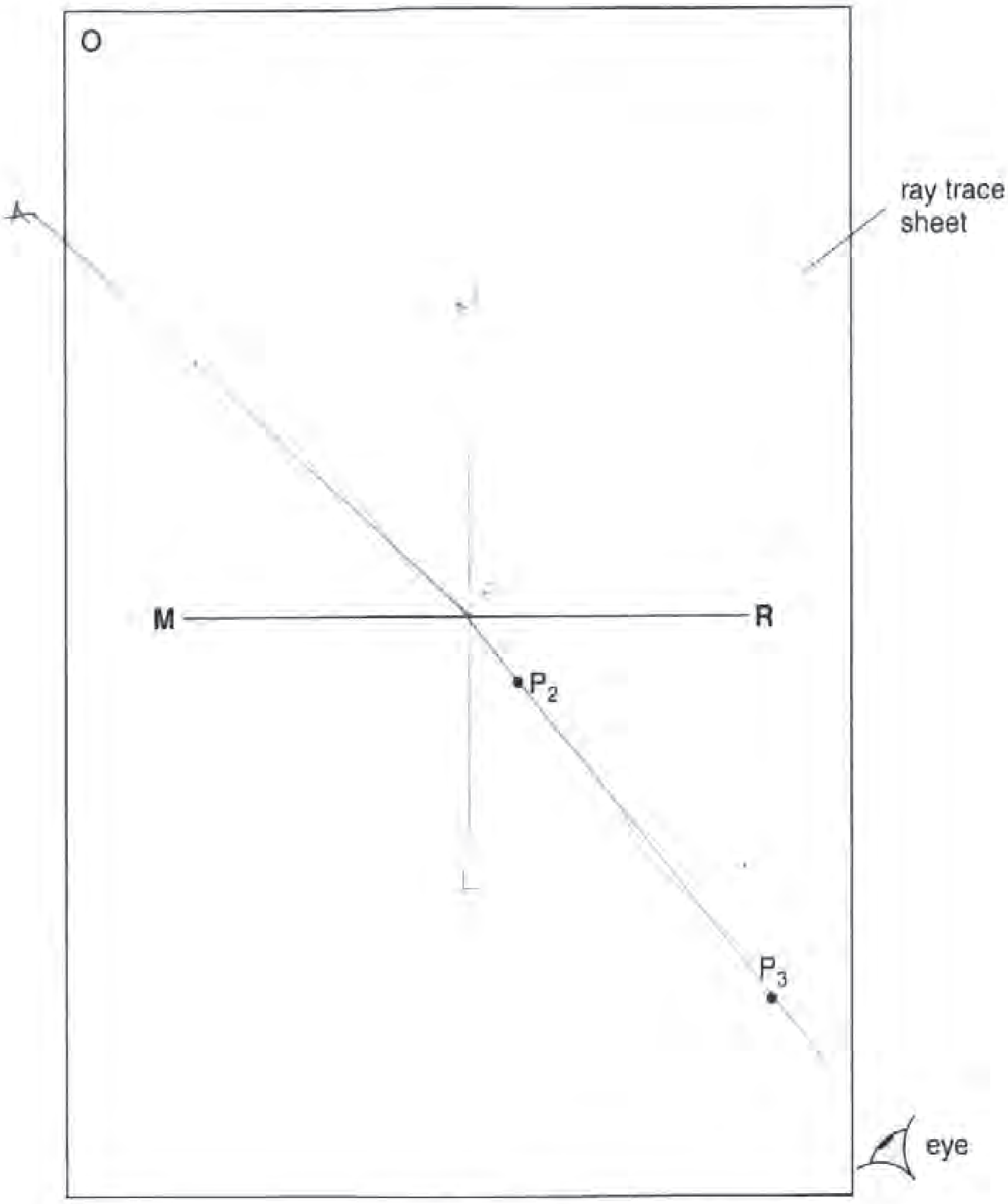


Fig. 4.1

(a) The line **MR** shows the position of a mirror.

(i) Draw a normal to this line that passes through its centre. Label the normal **NL**. Label the point at which **NL** crosses **MR** with the letter **B**.

[1]

(ii) Draw a line 8 cm long from **B** at an angle of incidence $i = 40°$ to the normal below **MR** and to the left of the normal. Label the end of this line **A**. Record the angle of incidence i in the first row of Table 4.1.

Table 4.1

i / °	r / °
40	49
34	33

[2]

(b) Fig. 4.2 shows the mirror which is made of polished metal and has a vertical line drawn on it.

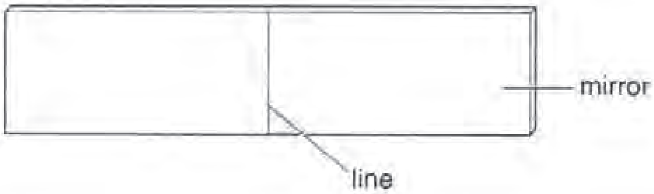


Fig. 4.2

The student places the mirror, with its reflecting face vertical, on **MR**. The lower end of the line on the mirror is at point **B**. He places a pin P_1 at **A**. He views the line on the mirror and the image of pin P_1 from the direction indicated by the eye in Fig. 4.1. He places two pins P_2 and P_3 some distance apart so that pins P_3, P_2, the image of P_1, and the line on the mirror all appear exactly one behind the other. The positions of P_2 and P_3 are shown.

(i) Draw the line joining the positions of P_2 and P_3. Continue the line until it meets the normal.

(ii) Measure, and record in the first row of Table 4.1, the angle of reflection r between the normal and the line passing through P_2 and P_3.

[2]

(c) The student draws a line parallel to **MR** and 2 cm above it. He places the mirror on this line and repeats the procedure without changing the position of pin P_1. His readings for i and r are shown in the table.

In spite of carrying out this experiment with reasonable care, it is possible that the values of the angle of reflection r will not be exactly the same as the values obtained from theory. Suggest two possible causes of this inaccuracy.

1. The pins were not matched with their bases which are more exact.

2. the encountered paralax error while taking readings from the protractor. [2]

(d) The student was asked to list precautions that should be taken with this experiment in order to obtain readings that are as accurate as possible. Table 4.2 shows the suggestions.

Place a tick (✓) in the second column of the table next to each correctly suggested precaution.

Table 4.2

suggested precaution	
avoid parallax (line of sight) errors when taking readings with the protractor	✓
carry out the experiment in a darkened room	
draw the lines so that they are as thin as possible	✓
keep room temperature constant	
place pins P_2 and P_3 as far apart as possible	
use only two or three significant figures for the final answers	✓

[3]

[Total: 10]

Examiner comment – grade C

(a) **(i)** The candidate draws the normal correctly.

(ii) The line AB is just acceptable as a straight line of the specified length but it is not at the correct angle of incidence.

(b) The line through P_2 and P_3 to the normal is drawn correctly but the value of the angle of incidence *r* is not within the allowed tolerance.

(c) The candidate does not make relevant suggestions.

(d) The candidate chooses two of the three suggested precautions. Sensible use of significant figures is not an experimental precaution.

Mark awarded = 5 out of 10

Example candidate response – grade C

4 An IGCSE student is investigating reflection of light in a plane mirror.

Fig. 4.1 shows the student's ray trace sheet.

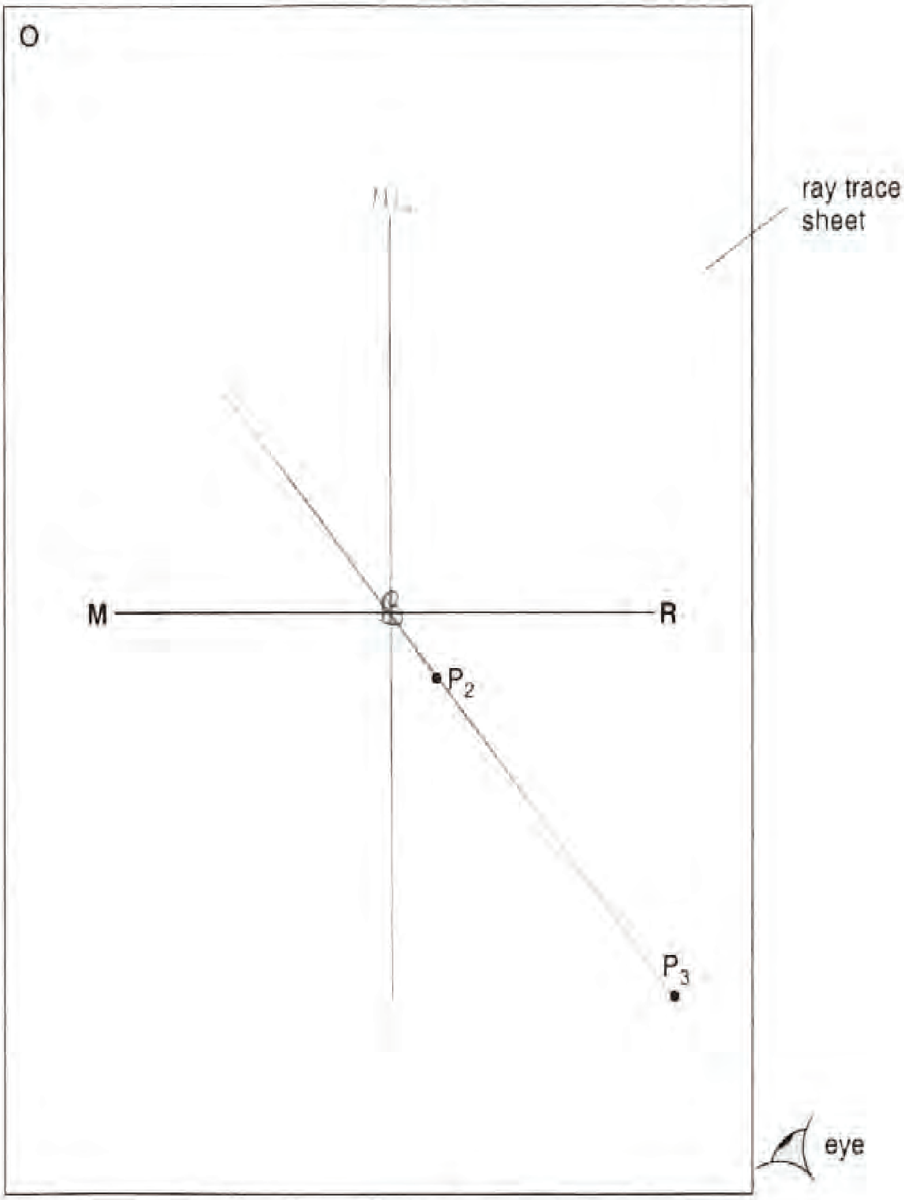


Fig. 4.1

(a) The line **MR** shows the position of a mirror.

(i) Draw a normal to this line that passes through its centre. Label the normal **NL**. Label the point at which **NL** crosses **MR** with the letter **B**.

[1]

(ii) Draw a line 8 cm long from **B** at an angle of incidence $i = 40°$ to the normal below **MR** and to the left of the normal. Label the end of this line **A**. Record the angle of incidence i in the first row of Table 4.1.

Table 4.1

i / °	r / °
34	33

[2]

(b) Fig. 4.2 shows the mirror which is made of polished metal and has a vertical line drawn on it.

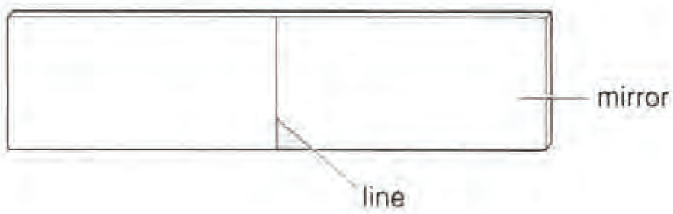


Fig. 4.2

The student places the mirror, with its reflecting face vertical, on **MR**. The lower end of the line on the mirror is at point **B**. He places a pin P_1 at **A**. He views the line on the mirror and the image of pin P_1 from the direction indicated by the eye in Fig. 4.1. He places two pins P_2 and P_3 some distance apart so that pins P_3, P_2, the image of P_1, and the line on the mirror all appear exactly one behind the other. The positions of P_2 and P_3 are shown.

(i) Draw the line joining the positions of P_2 and P_3. Continue the line until it meets the normal.

(ii) Measure, and record in the first row of Table 4.1, the angle of reflection r between the normal and the line passing through P_2 and P_3.

[2]

(c) The student draws a line parallel to **MR** and 2 cm above it. He places the mirror on this line and repeats the procedure without changing the position of pin P_1. His readings for i and r are shown in the table.

In spite of carrying out this experiment with reasonable care, it is possible that the values of the angle of reflection r will not be exactly the same as the values obtained from theory. Suggest two possible causes of this inaccuracy.

1. The normal might have changed

2. ~~The reflected ray might bend towards the normal~~

The pins might have been placed at different positions [2]

(d) The student was asked to list precautions that should be taken with this experiment in order to obtain readings that are as accurate as possible. Table 4.2 shows the suggestions.

Place a tick (✓) in the second column of the table next to each correctly suggested precaution.

Table 4.2

suggested precaution	
avoid parallax (line of sight) errors when taking readings with the protractor	✓
carry out the experiment in a darkened room	
draw the lines so that they are as thin as possible	✓
keep room temperature constant	
place pins P_2 and P_3 as far apart as possible	✓
use only two or three significant figures for the final answers	

[3]

[Total: 10]

Examiner comment – grade C

(a) **(i)** The candidate draws the normal correctly.

(ii) The candidate draws line AB in the wrong position and not of the required length.

(b) The line through P_2 and P_3 to the normal is drawn correctly but the value of the angle of incidence *r* is not given.

(c) The candidate does not make relevant suggestions.

(d) The candidate successfully chooses the three suggested precautions.

Mark awarded = 5 out of 10

No grade E examples are available.

Question 5

Mark scheme

5	**(a)**	200 m or more with unit	[1]
	(b)	tape measure, trundle wheel or gps device	[1]
	(c)	correct working seen	[1]
		345.67 (accept 345.66, 345, 346, 350)	[1]
	(d)	(No), <u>readings</u> (time or distance) too inaccurate	[1]
			[Total: 5]

Example candidate response – grade A

5 The IGCSE class is carrying out an experiment to determine the speed of sound in air.

Fig. 5.1 indicates the method used. The experiment is conducted outside the school building.

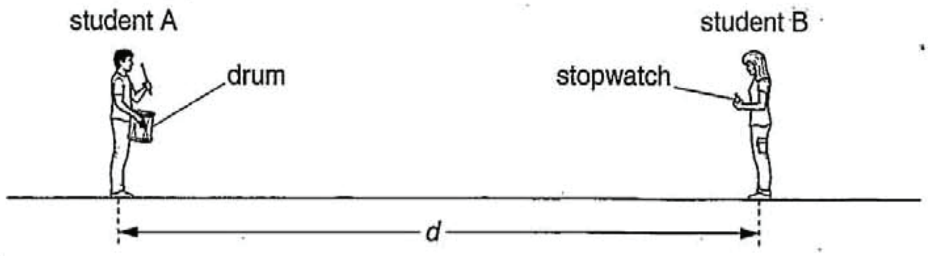


Fig. 5.1 (not to scale)

Student A strikes a drum once as loudly as possible. Student B stands some distance away from student A and starts a stopwatch when she sees the drum being hit. She stops the stopwatch when she hears the sound. She records the time interval *t* in Table 5.1. The experiment is repeated several times. She calculates the speed of sound *v* and enters the values in the table.

Table 5.1

t/s	*v*/(m/s)
0.87	344.83
0.92	326.09
0.84	357.14
0.83	361.45
0.86	338.84

(a) Suggest a suitable distance *d* for students to use when carrying out this experiment.

d = 200m [1]

(b) Suggest a suitable instrument for measuring the distance *d*.

~~A metre tape~~ An electronic tape measure [1]

(c) Calculate the average value v_{av} for the speed of sound from the results in the table. Show your working.

$$V_{av} = \frac{344,83 + 326,09 + 357,14 + 361,45 + 338,84}{5}$$

$$= \frac{1728,35}{5} = 345,67 \text{ m/s}$$

v_{av} = 345,67 m/s [2]

(d) The student has recorded the values for the speed of sound v to five significant figures. State whether this is a suitable number of significant figures for the speed of sound in air in this experiment. Give a reason for your answer.

statement It is ~~suitable~~ ~~suitable~~ not suitable

reason The result will only be approximate due to reaction time so fewer significant figures are more appropriate. [1]

[Total: 5]

Examiner comment – grade A

(a) The candidate suggests 200m, the minimum distance allowed to gain the mark.

(b) The candidate realises that a metre rule would be impractical for such a large distance and correctly suggests a tape measure.

(c) The candidate obtains the correct answer and shows the working clearly.

(d) The candidate realises that the student's reaction time will cause inaccuracy, so fewer significant figures are more appropriate.

Mark awarded = 5 out of 5

Example candidate response – grade C

5 The IGCSE class is carrying out an experiment to determine the speed of sound in air.

Fig. 5.1 indicates the method used. The experiment is conducted outside the school building.

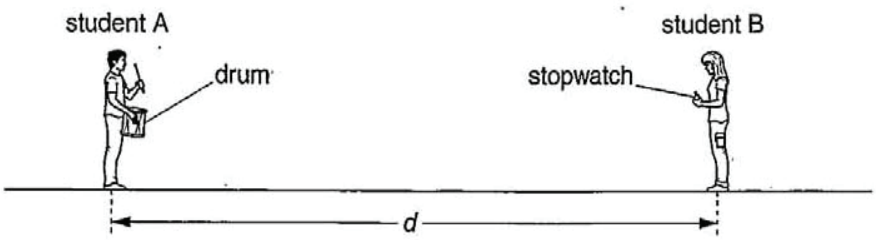


Fig. 5.1 (not to scale)

Student A strikes a drum once as loudly as possible. Student B stands some distance away from student A and starts a stopwatch when she sees the drum being hit. She stops the stopwatch when she hears the sound. She records the time interval *t* in Table 5.1. The experiment is repeated several times. She calculates the speed of sound *v* and enters the values in the table.

Table 5.1

t/s	v/(m/s)	d
0.87	344.83	396.4
0.92	326.09	354.3
0.84	357.14	425.2
0.83	361.45	435.5
0.86	338.84	394

(a) Suggest a suitable distance *d* for students to use when carrying out this experiment.

$d =$ 500m [1]

(b) Suggest a suitable instrument for measuring the distance *d*.

A metre [1]

(c) Calculate the average value v_{av} for the speed of sound from the results in the table. Show your working.

$$\frac{344.83 + 326.09 + 357.14 + 361.45 + 338.84 = 345.67}{5}$$

$v_{av} =$ 345.67 m/s [2]

(d) The student has recorded the values for the speed of sound *v* to five significant figures. State whether this is a suitable number of significant figures for the speed of sound in air in this experiment. Give a reason for your answer.

statement ....It is not..

reason ....because to measure speed of sound in air........

you need more accuracy...[1]

[Total: 5]

Examiner comment – grade C

(a) The candidate suggests a suitably large distance.

(b) The candidate states a unit, not an instrument.

(c) The candidate obtains the correct answer and shows the working clearly.

(d) The candidate does not realise that the student's reaction time will cause inaccuracy, so fewer significant figures are more appropriate.

Mark awarded = 3 out of 5

Example candidate response – grade E

5 The IGCSE class is carrying out an experiment to determine the speed of sound in air.

Fig. 5.1 indicates the method used. The experiment is conducted outside the school building.

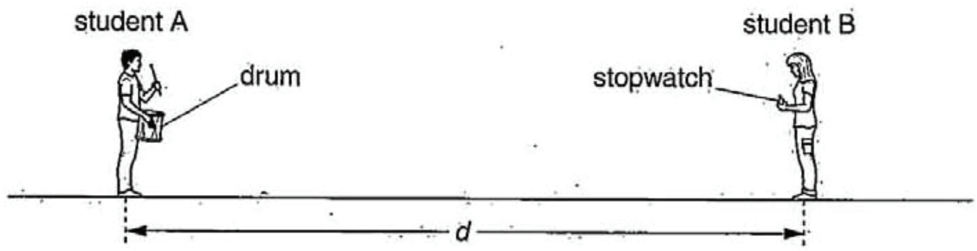


Fig. 5.1 (not to scale)

Student A strikes a drum once as loudly as possible. Student B stands some distance away from student A and starts a stopwatch when she sees the drum being hit. She stops the stopwatch when she hears the sound. She records the time interval *t* in Table 5.1. The experiment is repeated several times. She calculates the speed of sound *v* and enters the values in the table.

Table 5.1

t / s	*v* / (m/s)
0.87	344.83
0.92	326.09
0.84	357.14
0.83	361.45
0.86	338.84

(a) Suggest a suitable distance *d* for students to use when carrying out this experiment.

d = ~~1·683·5~~ 1·68 m [1]

(b) Suggest a suitable instrument for measuring the distance *d*.

A measuring tape. [1]

(c) Calculate the average value v_{av} for the speed of sound from the results in the table. Show your working.

Soln

$$\frac{344·83 · 326·09 + 357·14 + 361·45 + 338·84}{5}$$

v_{av} = 1·457 [2]

(d) The student has recorded the values for the speed of sound v to five significant figures. State whether this is a suitable number of significant figures for the speed of sound in air in this experiment. Give a reason for your answer.

statement ......No, it isn't...

reason ......this is because she didn't approximate them to the last possible approximation......[1]

[Total: 5]

Examiner comment – grade E

(a) The candidate suggests a very short distance which may indicate unfamiliarity with this experiment.

(b) The candidate correctly suggests a measuring tape. The mark is awarded for a correct answer in spite of the incorrect response to part **(a)**.

(c) The candidate shows the correct method of working, but performs the calculation incorrectly.

(d) The statement is correct, but no mark is awarded as a sensible reason is not given.

Mark awarded = 2 out of 5

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