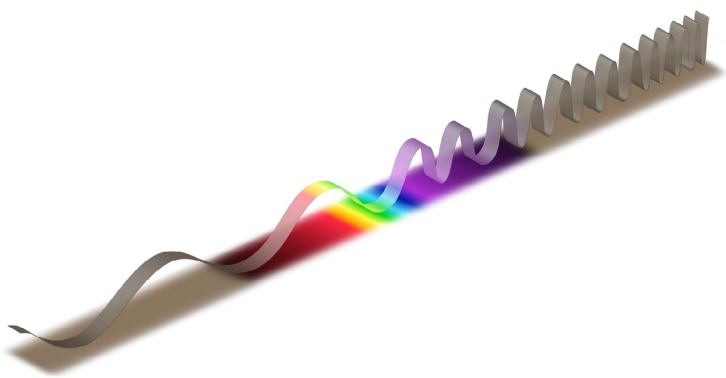
Cambridge Assessment International Education

Example Candidate Responses – Paper 3

Cambridge IGCSE™ / IGCSE (9-1)

Physics 0625 / 0972

For examination from 2021



Cambridge Pathway

Contents

Introduction....5
Question 1....7
Example Candidate Response – high....7
Example Candidate Response – middle....9
Example Candidate Response – low....11
Question 2....13
Example Candidate Response – high....13
Example Candidate Response – middle....14
Example Candidate Response – low....15
Question 3....16
Example Candidate Response – high....16
Example Candidate Response – middle....17
Example Candidate Response – low....18
Question 4....20
Example Candidate Response – high....20
Example Candidate Response – middle....21
Example Candidate Response – low....22
Question 5....23
Example Candidate Response – high....23
Example Candidate Response – middle....24
Example Candidate Response – low....25
Question 6....27
Example Candidate Response – high....27
Example Candidate Response – middle....28
Example Candidate Response – low....29
Question 7....30
Example Candidate Response – high....30
Example Candidate Response – middle....31
Example Candidate Response – low....32
Question 8....34
Example Candidate Response – high....34
Example Candidate Response – middle....35
Example Candidate Response – low....36
Question 9....38
Example Candidate Response – high....38
Example Candidate Response – middle....39
Example Candidate Response – low....40

Question 10 42
Example Candidate Response – high 42
Example Candidate Response – middle 44
Example Candidate Response – low 46
Question 11 48
Example Candidate Response – high 48
Example Candidate Response – middle 49
Example Candidate Response – low 50
Question 12 51
Example Candidate Response – high 51
Example Candidate Response – middle 52
Example Candidate Response – low 53

Introduction

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

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

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

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

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

0625 June 2021 Question Paper 31

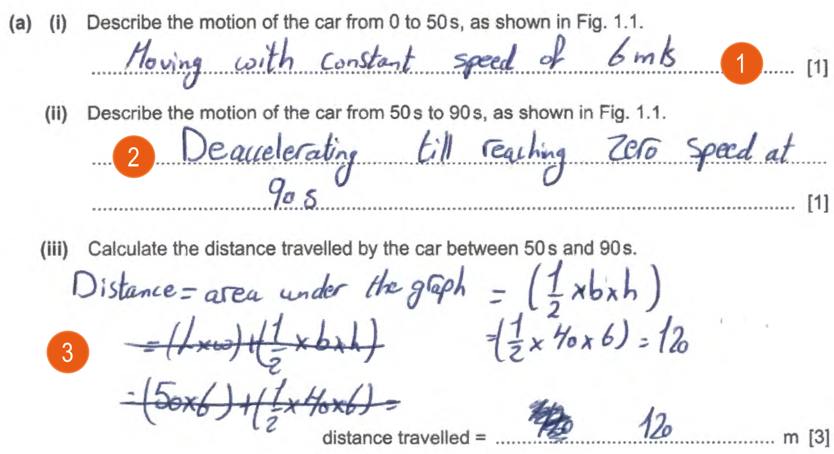
0625 June 2021 Mark Scheme 31

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

www.cambridgeinternational.org/support

How to use this booklet

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

Example Candidate Response – high	Examiner comments
 (a) (i) Describe the motion of the car from 0 to 50 s, as shown in Fig. 1.1. Moving with constant speed of 6 m/s (1) [1] (ii) Describe the motion of the car from 50 s to 90 s, as shown in Fig. 1.1. (2) Deaccelerating till reaching zero speed at 90 s [1] (iii) Calculate the distance travelled by the car between 50 s and 90 s. Distance = area under the graph = $(\frac{1}{2} \times b \times h)$ (3) ~~= (l × w) + (½ × b × h)~~ = (½ × 40 × 6) = 120 ~~= (50 × 6) + (½ × 40 × 6) =~~ distance travelled = 120 m [3]	(1) Mark for (a)(i) = 1 out of 1 (2) The candidate uses the word ‘deaccelerating’ but should use the correct term, i.e. decelerating. Mark for (a)(ii) = 1 out of 1 (3) The candidate gives a correct statement linking distance travelled and area under the graph line. Incorrect working is clearly crossed out and will be ignored by the examiner. Mark for (a)(iii) = 3 out of 3

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

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

How the candidate could have improved their answer

- **(a)(ii)** The candidate used the word ‘deaccelerating’ but should have used the correct term, i.e. decelerating. Examiners were instructed to accept deaccelerating. If unsure of the correct technical term, candidates are advised to give a full description. In this question, a suitable description was: the speed decreased from 6 m/s at 50 s to 0 m/s at 90 s.
- **(a)(iii)** To avoid a common mistake giving the crossed out incorrect answer, the candidate should have written a clearer statement about the area to be calculated, i.e. dis… 90 s.
- **(b)(ii)** The candidate’s line was acceptable as a horizon… practice drawing horizontal or vertical lines on graphs. T…

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

Common mistakes candidates made in this question

- **(a)(i)** A common error was for candidates to simply state ‘constant’ or ‘constant motion’; these both fell short of the required understanding of speed.
- **(b)(ii)** Common errors included drawing a line as a continuation of the 6m/s line or one that was too short or at the wrong speed. Some candidates ignored the instruction to draw the line on the existing axes of Fig. 1.1 and wasted time drawing their own axes. Candidates should be enc…
- (… graph fo…

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

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

Question 1

Example Candidate Response – high

1 Fig. 1.1 shows a speed–time graph for a car.

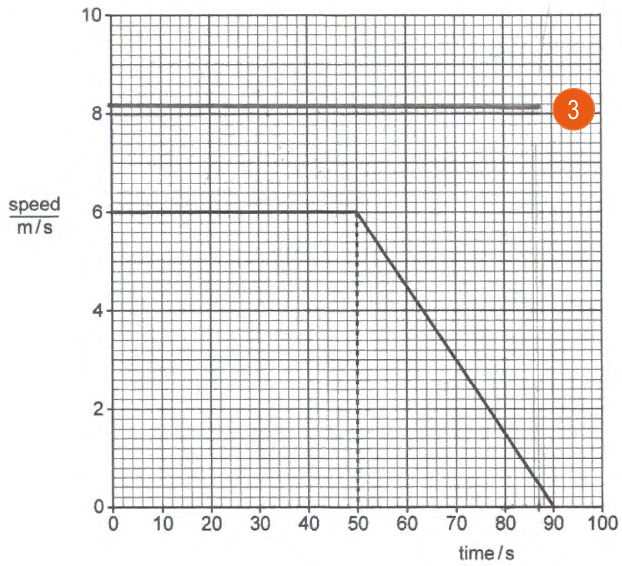


Fig. 1.1

(a) **(i)** Describe the motion of the car from 0 to 50 s, as shown in Fig. 1.1.

Moving with constant speed of 6 m/s [1]

(ii) Describe the motion of the car from 50 s to 90 s, as shown in Fig. 1.1.

1 Deaccelerating till reaching zero speed at 90 s [1]

(iii) Calculate the distance travelled by the car between 50 s and 90 s.

Distance = area under the graph = $(\frac{1}{2} \times b \times h)$

2 ~~$= (l \times w) + (\frac{1}{2} \times b \times h)$~~ $= (\frac{1}{2} \times 40 \times 6) = 120$

~~$= (50 \times 6) + (\frac{1}{2} \times 40 \times 6) =$~~

distance travelled = 120 m [3]

(b) A motorcycle travels at a constant speed.

(i) The motorcycle travels 710 m in 87 s.

Calculate the speed of the motorcycle and show that it is close to 8 m/s.

Speed = $\frac{\text{distance}}{\text{Time}} = \frac{710}{87} = 8.1609$ m/s

$\simeq 8$ m/s

[3]

(ii) The motorcycle in part **(b)(i)** travels at a constant speed for 87 s.

On Fig. 1.1, draw the speed–time graph for the motorcycle. [2]

[Total: 10]

Examiner comments

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

1 The candidate uses the word 'deaccelerating' but should use the correct term, i.e. decelerating.
Mark for (a)(ii) = 1 out of 1

2 The candidate gives a correct statement linking distance travelled and area under the graph line. Incorrect working is clearly crossed out and will be ignored by the examiner.
Mark for (a)(iii) = 3 out of 3

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

3 The candidate's line has a slight negative gradient. However, it is acceptable as a horizontal line as it is the within the tolerance given to examiners.
Mark for (b)(ii) = 2 out of 2

Total mark awarded = 10 out of 10

How the candidate could have improved their answer

- **(a)(ii)** The candidate used the word ‘deaccelerating’ but should have used the correct term, i.e. decelerating. Examiners were instructed to accept ‘deaccelerating’. If unsure of the correct technical term, candidates are advised to give a full description. In this question, a suitable description was: the speed decreased from 6 m/s at 50 s to 0 m/s at 90 s.
- **(a)(iii)** The candidate should have written a clearer statement about the area to be calculated, i.e. distance travelled = area below graph between 50 s and 90 s.
- **(b)(ii)** The candidate’s line was acceptable as a horizontal line, but it clearly slopes downward. Candidates should practice drawing horizontal or vertical lines on graphs. This is often done when taking a reading from a graph.

Example Candidate Response – middle	Examiner comments

1 Fig. 1.1 shows a speed–time graph for a car.

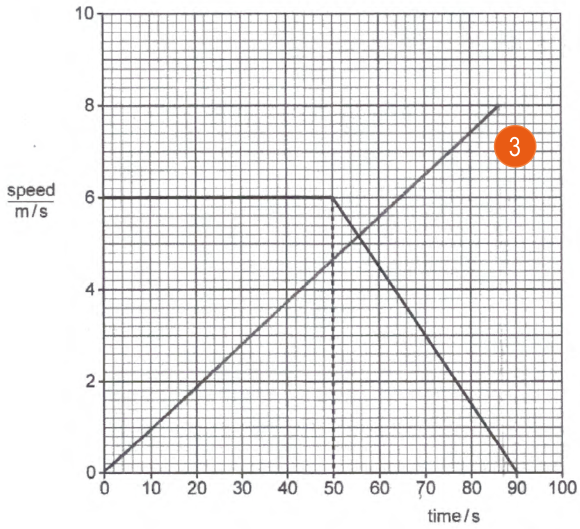


Fig. 1.1

(a) (i) Describe the motion of the car from 0 to 50 s, as shown in Fig. 1.1.

Constant speed [1]

(ii) Describe the motion of the car from 50 s to 90 s, as shown in Fig. 1.1.

1 The car starts to decelerate. [1]

(iii) Calculate the distance travelled by the car between 50 s and 90 s.

Distance = Speed x Time

Speed = 6 m/s

Time = 40 s

2

distance travelled = 240 m [3]

6 x 40 = 240m

(b) A motorcycle travels at a constant speed.

(i) The motorcycle travels 710 m in 87 s.

Calculate the speed of the motorcycle and show that it is close to 8 m/s.

Speed = Distance / Time

710m / 87s = 8.16

Distance = 710m

Time = 87s

8.16 = 8 m/s [3]

(ii) The motorcycle in part (b)(i) travels at a constant speed for 87 s.

On Fig. 1.1, draw the speed–time graph for the motorcycle. [2]

[Total: 10]

Examiner comments

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

1 The candidate correctly states that the car starts to decelerate.
Mark for (a)(ii) = 1 out of 1

2 The candidate uses the wrong method for calculating speed. A compensatory mark is awarded for the candidate giving an answer of 240 m.
Mark for (a)(iii)= 1 out of 3

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

3 The candidate draws a speed-time graph for a motorcycle moving with constant acceleration instead of constant speed, so is incorrect.
Mark for (b)(ii) = 0 out of 2

**Total mark awarded =
6 out of 10**

How the candidate could have improved their answer

- **(a)(ii)** The candidate has stated that 'the car starts to decelerate'. As the graph is a continuous straight line with negative gradient from 50 s to 90 s, the candidate should have stated that the car has constant/steady deceleration.
- **(a)(iii)** The candidate has used the wrong method for calculating speed. This question required candidates to calculate the speed by determining the area under the graph line between 50 s and 90 s, i.e. the area of the triangle which gives a distance 120 m. A compensatory mark was awarded for candidates giving an answer of 240 m.
- **(b)(ii)** The candidate has drawn a speed-time graph for a motorcycle moving with constant acceleration instead of constant speed. Candidates should be encouraged to practise drawing speed-time graphs for different types of motion.

Example Candidate Response – low

1 Fig. 1.1 shows a speed–time graph for a car.

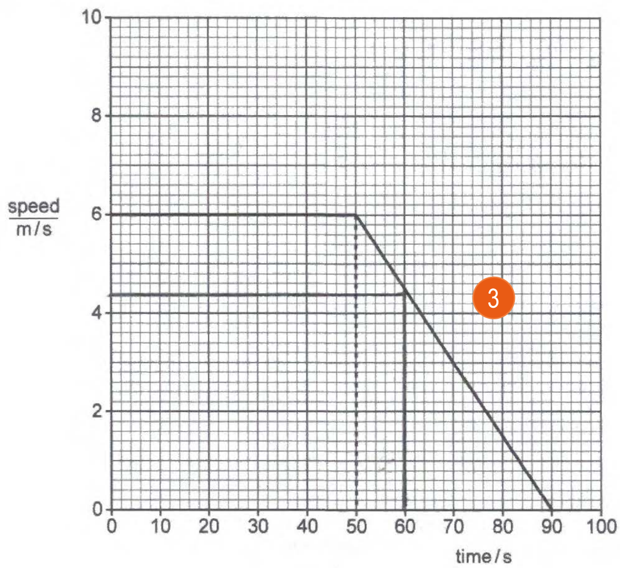


Fig. 1.1

(a) (i) Describe the motion of the car from 0 to 50 s, as shown in Fig. 1.1.

Constant speed. [1]

(ii) Describe the motion of the car from 50 s to 90 s, as shown in Fig. 1.1.

The car is moving in constant deceleration. [1]

(iii) Calculate the distance travelled by the car between 50 s and 90 s.

$d = \frac{s}{t} = \frac{6}{40} = 0.15$ (1)

distance travelled = 0.15 m [3]

(b) A motorcycle travels at a constant speed.

(i) The motorcycle travels 710 m in 87 s.

Calculate the speed of the motorcycle and show that it is close to 8 m/s.

710m ÷ 1000 = 0.71 km

$S = d \times t = 0.71 \times 87 = 61.77$ m/s (2)

[3]

(ii) The motorcycle in part **(b)(i)** travels at a constant speed for 87 s.

On Fig. 1.1, draw the speed–time graph for the motorcycle. [2]

[Total: 10]

Examiner comments

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

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

1 The candidate uses the wrong method for calculating distance.
Mark for (a)(iii) = 0 out of 3

2 The candidate writes down an incorrect equation for calculating speed.
Mark for (b)(i) = 0 out of 3

3 The candidate draws a horizontal line graph on Fig. 1.1 and so the first mark is awarded.
Mark for (b)(ii) = 1 out of 2

Total mark awarded = 3 out of 10

How the candidate could have improved their answer

- **(a)(iii)** This question required candidates to calculate the distance by determining the area under the graph line between 50 s and 90 s, i.e. the area of the triangle which is 120 m. The candidate has used an incorrect rearrangement of the equation, speed = distance ÷ time.
- **(b)(i)** The correct equation was speed = distance ÷ time. Candidates should be encouraged to practise writing out the standard equations used in the specification.
- **(b)(ii)** The line was at the wrong speed, and it does not reach a time of 87 s. The correct speed was 8 m/s.

Common mistakes candidates made in this question

- **(a)(i)** A common error was for candidates to simply state 'constant' or 'constant motion'; these both fell short of the required understanding of speed.
- **(b)(ii)** Common errors included drawing a line as a continuation of the 6 m/s line or one that was too short or at the wrong speed. Some candidates ignored the instruction to draw the line on the existing axes of Fig. 1.1 and wasted time drawing their own axes. Candidates should be encouraged to follow instructions in the questions.
- **(b)(ii)** A relatively common error was drawing a graph for a motorcycle with constant acceleration.

Question 2

Example Candidate Response – high	Examiner comments

2 A liquid-in-glass thermometer contains mercury.

(a) The mass of the mercury in the thermometer is 12 g.

(i) Calculate the weight of the mercury.

weight = mass x g   12 g = 12/1000 = 0.012 kg
= ~~12 x 10~~
= ~~120~~
0.012 x 10 = 0.12

weight of mercury = ~~120~~ 0.12 N [3]

(ii) The 12 g of mercury has a volume of $0.88\,cm^3$.

Calculate the density of mercury.

density = mass / Volume = 12 / 0.88 = 13.6

density of mercury = 13.6 g/cm^3 [3]

(b) The mercury in the thermometer expands when its temperature rises.

(i) State what happens to the mass of the mercury when its temperature rises.
Tick (✓) **one** box.

mass decreases	
mass stays the same	✓
mass increases	

[1]

(ii) State what happens to the density of the mercury when its temperature rises.
Tick (✓) **one** box.

density decreases	✓
density stays the same	
density increases	

[1]

[Total: 8]

Examiner comments

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

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

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

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

Total mark awarded = 8 out of 8

How the candidate could have improved their answer

- **(a)(i)** The candidate has made a good attempt at crossing out incorrect working and the marker has ignored the crossed-out work. Candidates should be advised to draw two horizontal straight lines through any work they do not wish to be marked.
- **(a)(ii)** To avoid the final answer being read as 136, candidates should always write decimal points in the centre of the space where it is intended and not level with the base of the digits.

Example Candidate Response – middle

2 A liquid-in-glass thermometer contains mercury.

(a) The mass of the mercury in the thermometer is 12 g.

(i) Calculate the weight of the mercury.

W = m x g

W = 12 x 10

W = 120 N

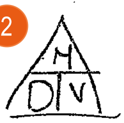
1

weight of mercury = ...120.................... N [3]

(ii) The 12 g of mercury has a volume of $0.88\,cm^3$.

Calculate the density of mercury.

2



Density = Mass / Volume

Volume = $0.88cm^3$

Mass = 12g

D = 12g / 0.88 = 13.6 g/cm³

density of mercury = ...13.6.................... g/cm^3 [3]

(b) The mercury in the thermometer expands when its temperature rises.

(i) State what happens to the mass of the mercury when its temperature rises.
Tick (✓) **one** box.

mass decreases	
mass stays the same	✓
mass increases	

[1]

(ii) State what happens to the density of the mercury when its temperature rises.
Tick (✓) **one** box.

density decreases	
density stays the same	✓
density increases	

3

[1]

[Total: 8]

Examiner comments

1 The candidate gives the correct relationship between mass and weight. The candidate needs to appreciate that the mass in g needs converting to kg.
Mark for (a)(i) = 2 out of 3

2 This is a well set out response with the candidate using a 'triangle' to recall different arrangements of the equation. The candidate writes down the correct form of the equation, selects the values from the question, then substitutes and evaluates correctly.
Mark for (a)(ii) = 3 out of 3

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

3 The candidate follows a very useful technique by underlining key words in the stem of the question. They need to link the expansion of the mercury to a decrease in its density.
Mark for (b)(ii) = 0 out of 1

Total mark awarded = 6 out of 8

How the candidate could have improved their answer

- **(a)(i)** Candidates should be encouraged to include the correct unit for physical quantities when they practise writing out standard equations, e.g. weight in N = mass in kg x gravitational field strength (g) in N/kg.
- **(b)(ii)** A useful technique is to use up and down arrows to show what happens to related quantities when one is constant and another changes. In this instance, mass is constant and the volume increases. This means the density must decrease, i.e. D ↓ = M ÷ V↑.

Example Candidate Response – low	Examiner comments
2 A liquid-in-glass thermometer contains mercury. **(a)** The mass of the mercury in the thermometer is 12 g. **(i)** Calculate the weight of the mercury. 1 12×10 weight of mercury = ...120...... N [3]	1 There is no explanation as to what the candidate is evaluating. Examiners were advised to accept 12 x 10 as an attempt to multiply mass by gravitational field strength, i.e. m x g. Mark for (a)(i) = 2 out of 3
(ii) The 12 g of mercury has a volume of 0.88 cm^3. Calculate the density of mercury. m x v = 12 x 0.88 = 10.52 2 density of mercury = ...10.52...... g/cm^3 [3]	2 The candidate uses an incorrect form of the equation density = mass ÷ volume. Mark for (a)(ii) = 0 out of 3
(b) The mercury in the thermometer expands when its temperature rises. **(i)** State what happens to the mass of the mercury when its temperature rises. Tick (✓) **one** box. mass decreases [ ] mass stays the same [✓] mass increases [ ] [1]	Mark for (b)(i) = 1 out of 1
(ii) State what happens to the density of the mercury when its temperature rises. Tick (✓) **one** box. density decreases [ ] density stays the same [ ] density increases [✓] [1] [Total: 8]	Mark for (b)(ii) = 0 out of 1 **Total mark awarded = 3 out of 8**

How the candidate could have improved their answer

- **(a)(i)** Candidates should be encouraged to write out the equation they are going to use in the arrangement best suited to answer the equation, then select the values to be used from the question and write down their substitution into the equation. The evaluation should be performed and written down on the paper.
- **(a)(ii)** The candidate has written down an incorrect equation for calculating speed. The correct equation is density = mass ÷ volume. Candidates should be encouraged to practise writing out the standard equations used in the specification.

Common mistakes candidates made in this question

- **(a)** The most common error in this question involved not converting the mass to kilograms, which led to an answer of 120 N. A less common error was to divide the mass by g rather than multiply by it.
- **(a)(ii)** Weaker candidates inverted the equation and so divided the volume by the mass, or simply multiplied the two values.
- **(b)(ii)** The most common error was to indicate that density increases rather than decreases.

Question 3

Example Candidate Response – high	Examiner comments

3 A plank balances horizontally on a log of wood, which acts as a pivot.

(a) A girl sits on one end of the plank, and her brother pushes down on the other end to make the plank balance horizontally. Fig. 3.1 shows the arrangement.

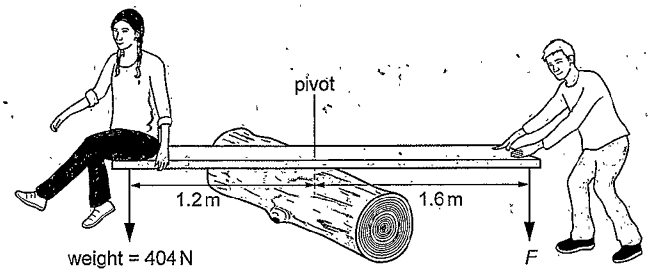


Fig. 3.1 (not to scale)

Calculate the moment of the girl's weight about the pivot and show that it is close to 480 N m.

Moment = distance from pivot × force
= 1.2 × 404 = 484.8 Nm
484.8 is close to 480

1

[3]

(b) The plank balances horizontally when the boy pushes down with a force *F* at a distance of 1.6 m from the pivot.

Calculate the size of force *F*.

Clockwise moment = anticlockwise moment

2

484.8 = 1.6F

F = 484.8 / 1.6 =

force *F* = ...303.......... N [3]

[Total: 6]

Examiner comments

1 The candidate gives a clear expression for calculating the moment of the girl's weight about the pivot. The evaluation is correct and there is a clear statement that the moment is close to 480 Nm.
Mark for (a) = 3 out of 3

2 The candidate gives a clear expression for the principle of moments. There is a clear substitution of the correct values, and the evaluation is correct.
Mark for (b) = 3 out of 3

Total mark awarded = 6 out of 6

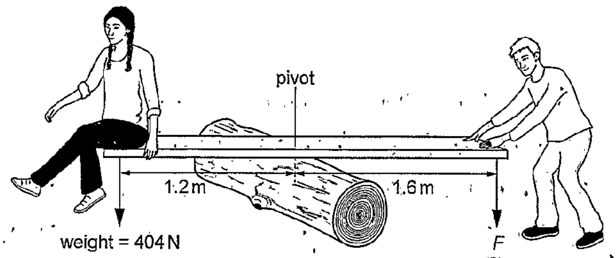
How the candidate could have improved their answer

Answers to both **(a)** and **(b)** are well set out and correctly evaluated. These could be used as exemplars for other students.

Example Candidate Response – middle

3 A plank balances horizontally on a log of wood, which acts as a pivot.

(a) A girl sits on one end of the plank, and her brother pushes down on the other end to make the plank balance horizontally. Fig. 3.1 shows the arrangement.



538.66 N

Fig. 3.1 (not to scale)

Calculate the moment of the girl's weight about the pivot and show that it is close to 480 N m.

moment = force × ⊥ distance

= 404 × 1.2 = 484.8 Nm

– within experimental accuracy. 484.8 – 480 = 4.8 → difference

[3]

(b) The plank balances horizontally when the boy pushes down with a force *F* at a distance of 1.6 m from the pivot.

Calculate the size of force *F*.

1.2 → 404
1.6 → x

= (404 × 1.6) / 1.2 = 538.6666…7

force *F* = 538.66 N [3]

[Total: 6]

Examiner comments

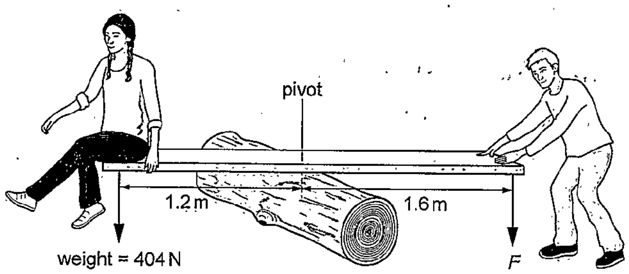
1 The candidate gives a clear expression for calculating the moment of the girl's weight about the pivot. The evaluation is correct and there is a clear statement that the moment is close to 480 Nm, i.e. difference is 4.8 Nm.
Mark for (a) = 3 out of 3

2 The candidate does not use a correct expression of the principle of moments for a beam in equilibrium. There is an incorrect attempt at using cross-multiplication.
Mark for (b) = 0 out of 3

Total mark awarded = 3 out of 6

How the candidate could have improved their answer

(b) The candidate needed to appreciate that the balancing of the beam involves using the principle of moments. A common form of this principle is the sum of clockwise moments = sum of anti-clockwise moments. Candidates should be given opportunities to use this relationship in practical situations, or using computer-generated models of beams. This would involve candidates practising writing out, and using, the principle of moments.

Example Candidate Response – low	Examiner comments
3 A plank balances horizontally on a log of wood, which acts as a pivot.	
(a) A girl sits on one end of the plank, and her brother pushes down on the other end to make the plank balance horizontally. Fig. 3.1 shows the arrangement.  **Fig. 3.1** (not to scale)	
Calculate the moment of the girl's weight about the pivot and show that it is close to 480 N m. 1 $\frac{1.2 \times 1.6}{404}$ = 475 Nm [3]	1 The candidate does not write down a correct expression for the moment of the girl's weight about the pivot in either words, symbols or numbers. Mark for (a) = 0 out of 3
(b) The plank balances horizontally when the boy pushes down with a force *F* at a distance of 1.6 m from the pivot. Calculate the size of force *F*. 2 force *F* = 404 N N [3] [Total: 6]	2 The candidate does not use a correct expression for the principle of moments. The candidate simply states that force F is the same as the weight of the girl. Mark for (b) = 0 out of 3 **Total mark awarded = 0 out of 6**

How the candidate could have improved their answer

- **(a)** The candidate needed to write down a correct expression for the moment of the girl's weight about the pivot, then substitute correct values and evaluate.
- **(b)** The candidate needed to appreciate that the balancing of the beam involves using the principle of moments. A common form of this principle is the sum of clockwise moments = sum of anti-clockwise moments. Candidates should be given opportunities to use this relationship in practical situations, or using computer-generated models of beams, which involve candidates practising writing out and using the principle of moments.

Common mistakes candidates made in this question

- **(a)** The most common errors were to multiply 404 by 1.6 or 404 x (1.2 + 1.6) or to divide the force by distance. These errors were almost always made by candidates that did not write down a correct expression in words for the moment of the girl's weight about the pivot.
- **(b)** The most common error was to either divide 404 by 1.6 or to multiply 404 by 1.6. Some candidates attempted a form of cross multiplication that invariably led to multiplying 404 by 1.6 and then dividing by 1.2 to give an answer of 540 N from rounding 538.67 N.

Question 4

Example Candidate Response – high	Examiner comments
4 A country needs to build new power stations to provide electricity for homes and industry. One type of power station is a coal-fired power station. **(a)** Describe how the energy stored in the coal is used in a coal-fired power station to generate electrical energy. (1) Coal is burned to release thermal energy, this thermal energy heats the boiler turning water inside to steam, the steam turns turbines, turbines drive generator which generate electricity. [4]	(1) The candidate gives a clear account of all the main stages in a coal-fired power station to generate electricity. Mark for (a) = 4 out of 4
(b) Some people in the country argue against building a new coal-fired power station. They say that the power station is expensive and not very efficient. Explain the meaning of *not very efficient*. (2) most of the ~~en~~ ~~thee~~ chemical energy of coal and thermal energy produced are wasted to the environment as thermal energy and little energy are used to generate electricity. [1]	(2) The candidate gives a valid explanation of the phrase 'not very efficient'. Mark for (b) = 1 out of 1
(c) Apart from cost and efficiency, give **two** other reasons for **not** building a coal-fired power station. (3) 1. It can cause air pollution 2. It is a non renewable source of energy [2] [Total: 7]	(3) The candidate gives two acceptable reasons for not building a coal-fired power station. Mark for (c) = 2 out of 2 **Total mark awarded = 7 out of 7**

How the candidate could have improved their answer

- **(a)** This was a very comprehensive description of the generation of electricity in a coal-fired power station. Candidates should note that the only difference between many forms of electricity generation is in the mechanism used to make the turbines rotate.
- **(b)** There is a danger that an examiner could not follow the numerous insertions and deletions made by the candidate. Candidates should be encouraged to add extra material in the space below or after a question. They must, however, have written something to the effect of 'continued in space below question' to the left of the original answer space.
- **(c)** Air pollution was an acceptable answer, but the candidate should give more detail, e.g. air pollution in the form of acidic gases such as sulphur dioxide or carbon dioxide emissions causing global warming.

Example Candidate Response – middle	Examiner comments
4 A country needs to build new power stations to provide electricity for homes and industry. One type of power station is a coal-fired power station. **(a)** Describe how the energy stored in the coal is used in a coal-fired power station to generate electrical energy. (1) Coal is burned to produce ~~#~~ smoke, this smoke ~~turns it drives the turns~~ turns the turbine and the turbine drives the generator to produce electricity [4] **(b)** Some people in the country argue against building a new coal-fired power station. They say that the power station is expensive and not very efficient. Explain the meaning of *not very efficient*. (2) does not produce alot ~~electrit~~ of electricity [1] **(c)** Apart from cost and efficiency, give **two** other reasons for **not** building a coal-fired power station. (3) 1. ~~(non ex envirnto envitomentaly friendly)~~ causes pollution 2. ~~takes up alot of space~~ non-renewable [2] [Total: 7]	(1) Although the references to smoke are incorrect, the candidate identifies three correct stages in the generation of electricity in a coal-fired power station. Mark for (a) = 3 out of 4 (2) The candidate's explanation is insufficient. It needs to be developed. Mark for (b) = 0 out of 1 (3) The answer 'causes pollution' is too vague and so insufficient. 'Pollution caused by the release of greenhouse gases which contribute to global warming' is one way to develop this answer. Mark for (c) = 1 out of 2 **Total mark awarded = 4 out of 7**

How the candidate could have improved their answer

- **(a)** The candidate needed to link the burning of coal to the heating of water in a boiler to produce steam. The steam (at high pressure) is then used to turn the turbine blades.
- **(b)** The candidate needed to link the small useful output power to the idea that most of the input energy is wasted/ lost as heat energy to the surroundings.
- **(c)** The candidate needed to give specific examples of pollution caused by burning coal, e.g. burning coal releases sulphur dioxide / nitrogen oxide(s) into the atmosphere.

Example Candidate Response – low	Examiner comments
4 A country needs to build new power stations to provide electricity for homes and industry. One type of power station is a coal-fired power station. **(a)** Describe how the energy stored in the coal is used in a coal-fired power station to generate electrical energy. 1 Coal stores in electrical energy to generate electrical energy. The coil mostly gives out electricity to generate electrical energy. .... [4]	1 The candidate is mostly paraphrasing the statements in the question. Mark for (a) = 0 out of 4
(b) Some people in the country argue against building a new coal-fired power station. They say that the power station is expensive and not very efficient. Explain the meaning of *not very efficient*. 2 efficient means not very available also not the best. [1]	2 The candidate is incorrectly linking availability to efficiency. Mark for (b) =0 out of 1
(c) Apart from cost and efficiency, give **two** other reasons for **not** building a coal-fired power station. 3 1. It can burn the station 2. It has so much electricity [2] [Total: 7]	3 Neither of the statements is a valid/acceptable reason for not building a coal-fired power station. Mark for (c) = 0 out of 2 **Total mark awarded = 0 out of 7**

How the candidate could have improved their answer

- **(a)** The candidate needed to link the burning of coal to the heating of water in a boiler to produce steam. The steam (at high pressure) is then used to turn the turbine blades and then the rotating turbine turns a generator.
- **(b)** The candidate needed to link the small useful output power to the idea that most of the input energy is wasted/ lost as heat energy to the surroundings.
- **(c)** The candidate needed to give specific examples of pollution caused by burning coal, e.g. burning coal releases carbon dioxide / greenhouse gases that contribute to global warming.

Common mistakes candidates made in this question

- **(a)** Common errors made by some candidates included:
  - missing out one or two stages or compressing separate stages into one process.
  - that the coal is burnt and the gases/smoke from burning were used to drive the turbine.
  - that it was the turbine turning that generated electricity.
- **(b)** A common error was to only give a partial explanation. Candidates usually missed out the need for the fact that much of the input energy is wasted. Other common misconceptions included ‘not very efficient means it does not work very well’ or ‘not very efficient means it is not renewable’.
- **(c)** The most common errors involved responses that fell short of the necessary understanding that was required. These responses included candidates simply stating ‘pollution’ or ‘harms the environment’ or ‘not eco-friendly’.

Question 5

Example Candidate Response – high

5 (a) A man starts pulling his suitcase across the floor.

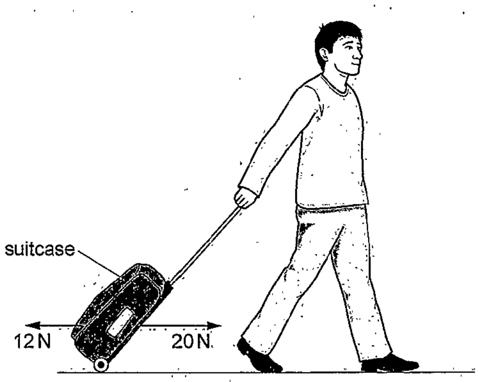


Fig. 5.1 (not to scale)

(i) Fig. 5.1 shows the horizontal forces acting on the suitcase.

Calculate the resultant horizontal force on the suitcase.

1

20 − 12 = 8

size of force = ...8........ N

direction ....right to the........ [2]

(ii) After a short time, the suitcase is moving at a constant speed.

Suggest values for the sizes of the two horizontal forces on the suitcase when it is moving at a constant speed.

pulling force = ...~~15~~ 20........ (N)

friction force = ...~~15~~ 20........ (N) [1]

(b) The total downward force of the suitcase on the ground is 150 N. The suitcase has two wheels. Each wheel has an area of 0.60 cm^2 touching the ground.

Calculate the pressure of the suitcase on the ground.

2

Pressure = $\frac{\text{force}}{\text{area}}$ = $\frac{150}{(0.6 \times 2)}$ = 125

pressure on the ground = ...125........ N/cm^2 [4]

[Total: 7]

Examiner comments

1 The candidate includes working to show how the magnitude of the resultant force is calculated. Even if not requested it is good practice to show all working in calculations.
Mark for (a)(i) = 2 out of 2

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

2 A well set out response. The candidate clearly shows that the area in contact with the ground is 2 x 0.6 square centimetres as there are two wheels in contact with the ground.
Mark for (b) = 4 out of 4

Total mark awarded = 7 out of 7

How the candidate could have improved their answer

(a)(ii) The candidate could have stated that, when moving at constant speed, the horizontal forces are equal in size, but in opposite directions.

Example Candidate Response – middle	Examiner comments
5 **(a)** A man starts pulling his suitcase across the floor.	

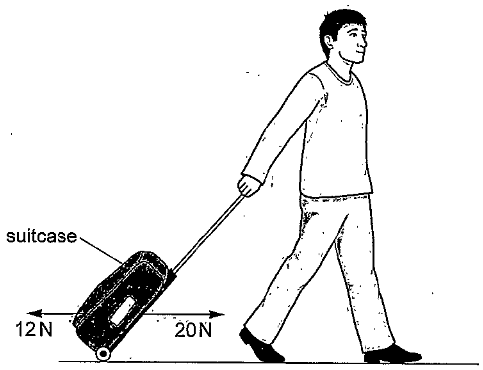


Fig. 5.1 (not to scale)

(i) Fig. 5.1 shows the horizontal forces acting on the suitcase.

Calculate the resultant horizontal force on the suitcase.

size of force = ...8 N...... N

direction ......right......

[2]

(ii) After a short time, the suitcase is moving at a constant speed.

Suggest values for the sizes of the two horizontal forces on the suitcase when it is moving at a constant speed.

pulling force = ...20...... (N)

friction force = ...10...... (N) ① [1]

Mark for (a)(i) = 2 out of 2

① The candidate does not give two forces with the same value.
Mark for (a)(ii) = 0 out of 1

(b) The total downward force of the suitcase on the ground is 150 N. The suitcase has two wheels. Each wheel has an area of 0.60 cm^2 touching the ground.

Calculate the pressure of the suitcase on the ground.

$P = \frac{F}{A}$ ②

$\frac{150}{0.60}$

pressure on the ground = ...250...... N/cm^2 [4]

[Total: 7]

② The candidate needs to appreciate that the suitcase has two wheels in contact with the ground.
Mark for (b) = 3 out of 4

Total mark awarded = 5 out of 7

How the candidate could have improved their answer

- **(a)(ii)** It is always helpful to write down the principle or equation used to answer a given item. In this question, the candidate could have stated that, when moving at constant speed, the horizontal forces are equal in size but in opposite directions or are balanced.
- **(b)** A useful technique is to underline the key pieces of information / physical quantities given in a question. In this instance, the candidate would underline the force, the area and the statement that the suitcase has two wheels.

Example Candidate Response – low

5 (a) A man starts pulling his suitcase across the floor.

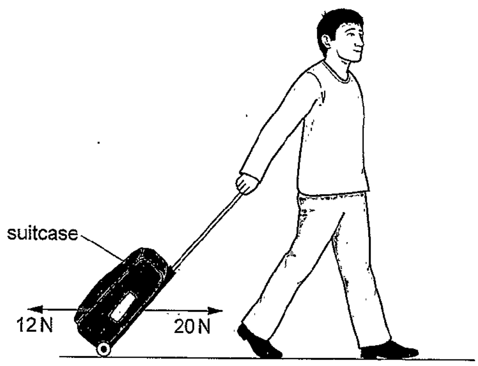


Fig. 5.1 (not to scale)

(i) Fig. 5.1 shows the horizontal forces acting on the suitcase.

Calculate the resultant horizontal force on the suitcase.

1

size of force = 32 N

direction Forward

[2]

(ii) After a short time, the suitcase is moving at a constant speed.

Suggest values for the sizes of the two horizontal forces on the suitcase when it is moving at a constant speed.

pulling force = 20 (N)

friction force = 20 (N) [1]

(b) The total downward force of the suitcase on the ground is 150 N. The suitcase has two wheels. Each wheel has an area of 0.60 cm^2 touching the ground.

Calculate the pressure of the suitcase on the ground.

2

P = W × D

150 × 0.60

= 90

pressure on the ground = 90 N/cm^2 [4]

[Total: 7]

Examiner comments

1 The candidate adds the forces instead of subtracting them. The candidate needs to appreciate that the direction arrows are in opposite directions.
Mark for (a)(i) = 1 out of 2

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

2 The candidate uses an incorrect arrangement of the equation P = F ÷ A. If the correct area had been used, this mark could still be awarded.
Mark for (b) = 0 out of 4

Total mark awarded = 2 out of 7

How the candidate could have improved their answer

- **(a)(i)** Candidates should practise adding and subtracting forces acting along the same line to calculate the resultant of two or more forces acting in the same direction or at 180° to each other.
- **(b)** Candidates should practise writing out standard equations used in the specification. Another useful technique is to use a triangle to give the different arrangements for an equation involving three quantities.

Common mistakes candidates made in this question

- **(a)(i)** Common errors for the force included giving 32 from adding the two forces or 240 from multiplying the two forces, and a very small number stated 'East' without indicating on the diagram which direction they thought was East.
- **(a)(ii)** A common error was to put two zeroes.
- **(b)** A common error was to forget that the suitcase had two wheels and so these candidates gave 250 N/cm^2 as the answer. Weaker candidates multiplied the force by the area.

Question 6

Example Candidate Response – high

6 Fig. 6.1 shows a smoke cell. The smoke cell contains air molecules and smoke particles.
A student views the motion of the smoke particles in the smoke cell by using a microscope.

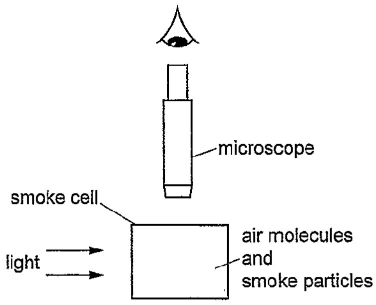


Fig. 6.1

Fig. 6.2 shows the path of one of the smoke particles.

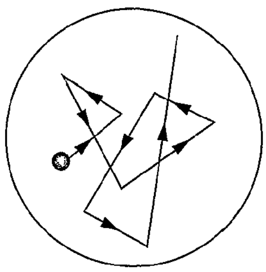


Fig. 6.2

(a) State the term used for the motion of the smoke particle.

Brownian motion [1]

(b) Explain the motion of the smoke particle in Fig. 6.2.

1 Smoke particles which are large, heavy and Slow are being hit with air molecules which are Small, light and fast randomly from all directions, Causing the Smoke particles to move in zig zag pathway called brownian motion. [3]

[Total: 4]

Examiner comments

Mark for (a) = 1 out of 1

1 The candidate gives a very clear and comprehensive explanation. Candidates are advised, as in this example, to carry on writing the answer lines in the space below if they need more room for their response. If there is another question interposed, they must indicate that the answer continues at the bottom of the page or on the next page, so the examiner is alerted.

Mark for (b) = 3 out of 3

Total mark awarded = 4 out of 4

How the candidate could have improved their answer

- **(a)** The candidate could also include the idea that Brownian motion is a form of random motion.
- **(b)** Rather than describe the path of the smoke particle as zig-zag, the candidate should use the correct term of random motion.

Example Candidate Response – middle

6 Fig. 6.1 shows a smoke cell. The smoke cell contains air molecules and smoke particles.
A student views the motion of the smoke particles in the smoke cell by using a microscope.

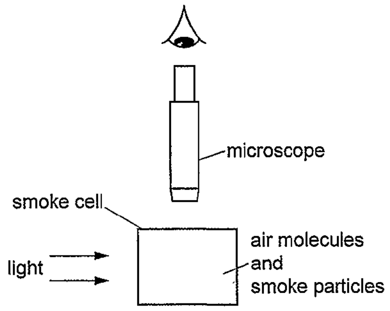


Fig. 6.1

Fig. 6.2 shows the path of one of the smoke particles.

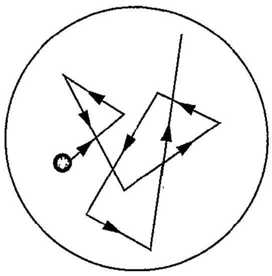


Fig. 6.2

(a) State the term used for the motion of the smoke particle.

~~moves freely~~ Collision (1) [1]

(b) Explain the motion of the smoke particle in Fig. 6.2.

Smoke particle collide with air molecules and moves fast and freely (2)

[3]

[Total: 4]

Examiner comments

(1) The candidate does not give a correct term for the motion of the smoke particle.
Mark for (a) = 0 out of 1

(2) The candidate gives a partially correct explanation for the motion of the smoke particle, by stating that the air molecules collide with the smoke particle.
Mark for (b) = 2 out of 3

Total mark awarded = 2 out of 4

How the candidate could have improved their answer

- **(a)** The candidate needed to state that the motion of the smoke particle is Brownian motion, a form of random motion.
- **(b)** The candidate needed to state that the collisions with air molecules are the cause of the changes in direction of the smoke particle.

Example Candidate Response – low

6 Fig. 6.1 shows a smoke cell. The smoke cell contains air molecules and smoke particles.
A student views the motion of the smoke particles in the smoke cell by using a microscope.

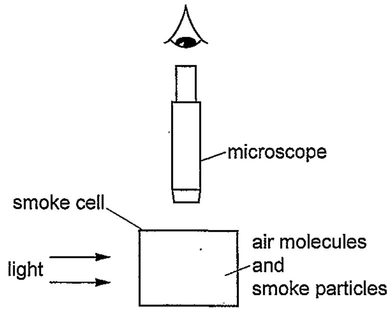


Fig. 6.1

Fig. 6.2 shows the path of one of the smoke particles.

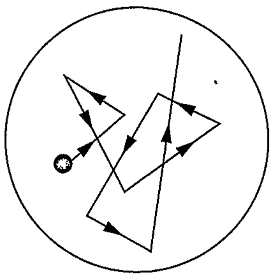


Fig. 6.2

(a) State the term used for the motion of the smoke particle.

(1) gas motion [1]

(b) Explain the motion of the smoke particle in Fig. 6.2.

They move in all direction and have no fixed shape of fixed volume (2) because particles have plenty of spaces between each other [3]

[Total: 4]

Examiner comments

1 The candidate does not give a correct term for the motion of the smoke particle.
Mark for (a) = 0 out of 1

2 The candidate is not answering the question. The candidate is giving a description of the movement and arrangement of particles in a gas.
Mark for (b) = 0 out of 3

Total mark awarded = 0 out of 4

How the candidate could have improved their answer

- **(a)** The candidate needed to state that the motion of the smoke particle is Brownian motion, a form of random motion.
- **(b)** The candidate needed to state that the random changes in direction of the smoke particle are caused by collisions with fast, randomly moving air molecules.

Common mistakes candidates made in this question

- **(a)** The most common error was to state that the term used was diffusion. Unfortunately, many of these candidates then attempted to explain diffusion of gas particles in **(b)**.
- **(b)** A common error was to try and explain that the motion was a result of pollen grains colliding with other pollen grains or even the walls of the container.

Question 7

Example Candidate Response – high

7 A narrow beam of white light enters a glass prism and splits into the colours of the visible spectrum, as shown in Fig. 7.1.

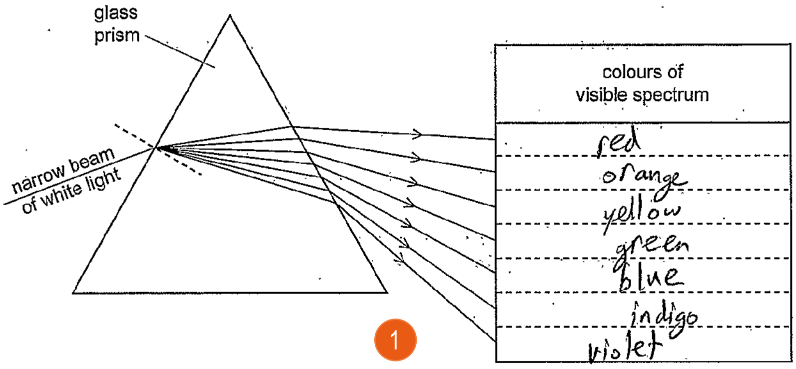


Fig. 7.1

(a) The rays leaving the prism represent the seven main colours of the visible spectrum.

Complete the labelling on Fig. 7.1 by writing the colours of the visible spectrum in the table. [2]

(b) State the term used to describe:

(i) the bending of the light as it enters the prism

refraction [1]

(ii) the different amounts of bending that produce the spectrum.

~~dispersion~~ dispersion [1]

(c) A student incorrectly writes some sentences about electromagnetic waves. His teacher circles a mistake in each sentence.

In the table, write a suitable correction for each mistake. The first one has been done for you.

student's sentences	correction
the speed of light is (faster than) radio waves in a vacuum	the same as
(X-rays) are used in television remote controllers	Infra-red waves
(radio waves) have the highest frequencies in the electromagnetic spectrum	Gamma rays

[2]

[Total: 6]

Examiner comments

1 The candidate gives six or more colours in the correct order. This response scores both marks.

Mark for (a) = 2 out of 2

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

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

Mark for (c) = 2 out of 2

Total mark awarded = 6 out of 6

How the candidate could have improved their answer

This candidate has been well prepared for questions about the production of a visible spectrum and the uses of the electromagnetic spectrum.

Example Candidate Response – middle

7 A narrow beam of white light enters a glass prism and splits into the colours of the visible spectrum, as shown in Fig. 7.1.

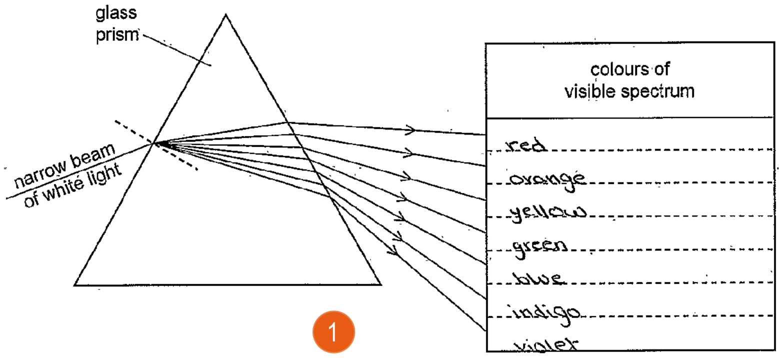


Fig. 7.1

(a) The rays leaving the prism represent the seven main colours of the visible spectrum.

Complete the labelling on Fig. 7.1 by writing the colours of the visible spectrum in the table. [2]

(b) State the term used to describe:

(i) the bending of the light as it enters the prism (2)

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

(ii) the different amounts of bending that produce the spectrum.

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

(c) A student incorrectly writes some sentences about electromagnetic waves. His teacher circles a mistake in each sentence.

In the table, write a suitable correction for each mistake. The first one has been done for you.

student's sentences	correction
the speed of light is (faster than) radio waves in a vacuum	the same as
(X-rays) are used in television remote controllers	ultra-violet rays.
(radio waves) have the highest frequencies in the electromagnetic spectrum	micro wave

[2]

(3)

[Total: 6]

Examiner comments

(1) The candidate gives six or more colours in the correct order. This response scores both marks.
Mark for (a) = 2 out of 2

(2) The candidate gives the same response to parts (i) and (ii). Candidates should be warned that it is very rare that the same answer will be correct for two different parts of a question. They should re-read the question to check their response if this happens.
Mark for (b)(i) = 0 out of 1

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

(3) The candidate gives incorrect parts of the electromagnetic spectrum and so is not awarded any marks.
Mark for (c) = 0 out of 2

Total mark awarded = 3 out of 6

How the candidate could have improved their answer

- **(b)(i)** Candidates need to be able to describe the change in direction of a ray of light as it travels from one material into another with a different optical density and state that this effect is known as refraction.
- **(c)** Candidates should be encouraged to practise writing down the common uses of parts of the electromagnetic spectrum as listed in the specification. Candidates often use an acronym or mnemonic to assist in recalling the order of the different parts of the electromagnetic spectrum. They should be encouraged to make up their own mnemonic as an aide memoire.

Example Candidate Response – low

7 A narrow beam of white light enters a glass prism and splits into the colours of the visible spectrum, as shown in Fig. 7.1.

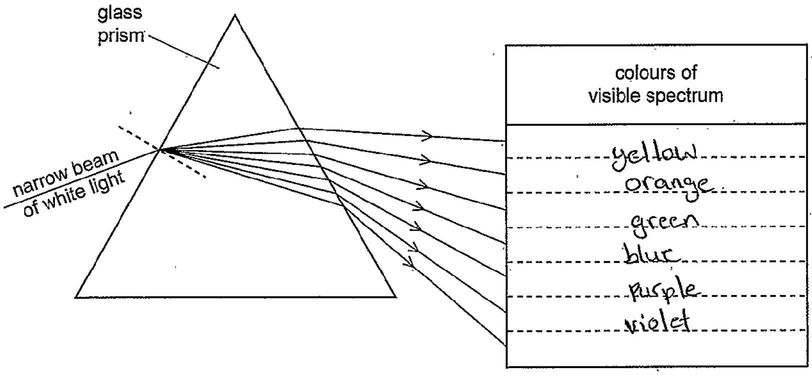


Fig. 7.1

(a) The rays leaving the prism represent the seven main colours of the visible spectrum.

Complete the labelling on Fig. 7.1 by writing the colours of the visible spectrum in the table. [2]

(b) State the term used to describe:

(i) the bending of the light as it enters the prism

Spectrum [1]

(ii) the different amounts of bending that produce the spectrum.

glass prism [1]

(c) A student incorrectly writes some sentences about electromagnetic waves. His teacher circles a mistake in each sentence.

In the table, write a suitable correction for each mistake. The first one has been done for you.

student's sentences	correction
the speed of light is (faster than) radio waves in a vacuum	the same as
(X-rays) are used in television remote controllers	
(radio waves) have the highest frequencies in the electromagnetic spectrum	radio amplitude

[2]

[Total: 6]

Examiner comments

1 The candidate only gives five colours, and the order is incorrect.
Mark for (a) = 0 out of 2

2 The candidate just repeats words from the question. This invariably leads to an incorrect answer.
Mark for (b)(i) = 0 out of 1

Mark for (b)(ii) = 0 out of 1

3 The candidate does not attempt one part and gives the shortest frequency in the second box. Candidates should be warned that if radio (waves) was the correct answer, the addition of 'amplitude' in the box risks being taken as a second incorrect response, and this means the mark cannot be awarded.
Mark for (c) = 0 out of 2

Total mark awarded = 0 out of 6

How the candidate could have improved their answer

- **(a)** Candidates often find an aide memoire a useful technique in remembering the order of lists. It is not uncommon to see ROYGBIV written near questions about colours in the visible spectrum. Candidates should be encouraged to use blank spaces on the paper to write out such aide memoires if it helps in framing an answer to a question.
- **(c)** Candidates should be encouraged to attempt all items in a paper. No mark could be awarded for a 'no response' but writing the name of another part of the electromagnetic spectrum could be correct.

Common mistakes candidates made in this question

- **(a)** Common errors included giving white, black, pink and even magenta in their list of colours. Other candidates gave both purple and violet and so did not give the six correct colours that were needed to score the M mark. The majority of candidates put the colours in the correct order, but a small minority reversed the order, and a few gave the colours in no particular order.
- **(b)(i)**, **(ii)** A common error was to give refraction and dispersion in the reverse order. This scored one mark. Other errors included giving reflection or rarefaction for refraction. A higher number of candidates gave diffraction, spreading, spectrum or just 'colours' for dispersion.
- **(c)** The majority of candidates knew that infrared waves were used in tv remote controllers but those who did not seemed to choose microwaves or ultraviolet; these being the most common errors. Responses for the highest frequency in the electromagnetic spectrum were often parts near the middle of the electromagnetic spectrum.

Question 8

Example Candidate Response – high	Examiner comments

8 (a) A loudspeaker is producing a sound.

Choose words from the box to complete the sentences about sound.

amplitude	frequency	speed	wavelength

1 **(i)** To increase the loudness of the sound, increase the ....amplitude.... of the sound wave. [1]

(ii) To increase the pitch of the sound, increase the ....~~fre~~ frequency.... of the sound wave. [1]

(b) Two students determine the speed of sound in air. The students stand together, 80 m from a large brick wall as shown in Fig. 8.1.

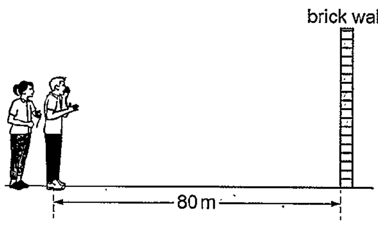


Fig. 8.1 (not to scale)

One student shouts and as he shouts the other student starts a stop-watch. She stops the stop-watch when she hears the echo of the shout. The reading on the stop-watch is 0.56 s.

(i) State the **total** distance the sound travels during the 0.56 s. 2

distance = ...160.... m [1]

(ii) Calculate the speed of sound in air using the measurements given in part **(b)**.

3

0.56 ÷ 2 = 0.28 / Speed = Distance / Time

80 / 0.28 = 285.714 = 286

speed of sound = ...286.... m/s [3]

(iii) The students' value for the speed of sound is **not** accurate.

Suggest **two** ways of improving the students' experiment.

4

1. ....Increasing the distance between them and the wall).

2. ....Repeating the experiment and finding an average.

[2]

[Total: 8]

Examiner comments

1 The candidate chooses the correct quantity for each sentence.
Mark for (a)(i) = 1 out of 1

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

2 The candidate correctly doubles the distance from the students to the wall.
Mark for (b)(i) = 1 out of 1

3 This is not a very common approach of halving the time, but the candidate uses correct values and evaluates to give a correct answer.
Mark for (b)(ii) = 3 out of 3

4 The candidate correctly decides to continue both answers on the next line, rather than attempting to squeeze the words onto the end of the line.
Mark for (b)(iii) = 2 out of 2

Total mark awarded = 8 out of 8

How the candidate could have improved their answer

- **(b)(ii)** The candidate would have had less chance of an error if they had used the 160 m calculated in **7(b)(i)**, together with the time of 0.56 s given in the question.
- **(b)(iii)** The candidate could have been more precise by stating what is to be averaged, e.g. the results / times from the two (or more) experiments.

Example Candidate Response – middle

8 (a) A loudspeaker is producing a sound.

Choose words from the box to complete the sentences about sound.

amplitude	frequency	speed	wavelength

1 (i) To increase the loudness of the sound, increase the ......Frequency...... of the sound wave. [1]

(ii) To increase the pitch of the sound, increase the ......amplitude...... of the sound wave. [1] 2

(b) Two students determine the speed of sound in air.
The students stand together, 80 m from a large brick wall as shown in Fig. 8.1.

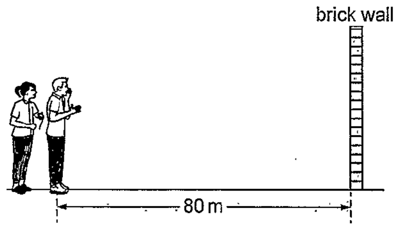


Fig. 8.1 (not to scale)

One student shouts and as he shouts the other student starts a stop-watch. She stops the stop-watch when she hears the echo of the shout.
The reading on the stop-watch is 0.56 s.

(i) State the **total** distance the sound travels during the 0.56 s. 3

distance = ...160...... m [1]

(ii) Calculate the speed of sound in air using the measurements given in part **(b)**.

4 Speed = Distance / Time = 160 / 0.56 = 285.7

speed of sound = ...285.7...... m/s [3]

(iii) The students' value for the speed of sound is **not** accurate.

Suggest **two** ways of improving the students' experiment.

5
1. ......Repeat and take average in order to reduce error......
2. ......Try to decrease the reaction time......

[2]

Examiner comments

1 The candidate chooses incorrect quantities for (a)(i) and (a)(ii).
Mark for (a)(i) = 0 out of 1

2 Mark for (a)(ii) = 0 out of 1

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

4 A well set out response where the candidate uses the distance from (b)(i) and the time in the question stem.
Mark for (b)(ii) = 3 out of 3

5 The candidate's first suggestion is correct, but it is impossible to ensure that reaction time decreases.
Mark for (b)(iii) = 1 out of 2

Total mark awarded = 5 out of 8

How the candidate could have improved their answer

- **(a)(i), (a)(ii)** The candidate has confused the quantities needed to increase loudness and pitch of a sound.
- **(b)(iii)** The candidate needed to take their second idea a bit further and think of ways of reducing the effect of reaction time on the measurement. For example, by increasing the distance the sound needed to travel.

Example Candidate Response – low

8 (a) A loudspeaker is producing a sound.

Choose words from the box to complete the sentences about sound.

amplitude	frequency	speed	wavelength

(i) To increase the loudness of the sound, increase the ...wave length... of the sound wave. [1]

(ii) To increase the pitch of the sound, increase the ...frequency... of the sound wave. [1]

1

(b) Two students determine the speed of sound in air.
The students stand together, 80 m from a large brick wall as shown in Fig. 8.1.

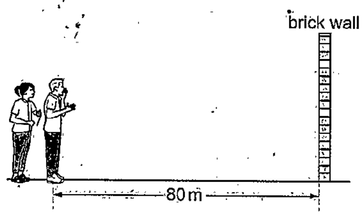


Fig. 8.1 (not to scale)

One student shouts and as he shouts the other student starts a stop-watch. She stops the stop-watch when she hears the echo of the shout.
The reading on the stop-watch is 0.56 s.

(i) State the <u>total distance</u> the sound travels during the 0.56 s.

$D = \frac{S}{T} = \frac{142.9}{0.56} = 255.2$ $S = \frac{D}{T} = \frac{80}{0.56} = \frac{80}{0.56} = 142.9$

distance = ...255.2... m [1]

2

(ii) Calculate the speed of sound in air using the measurements given in part **(b)**.

$S = \frac{D}{T} = \frac{80}{0.56} = 142.9$

3

speed of sound = ...142.9... m/s [3]

(iii) The students' value for the speed of sound is **not** accurate.

Suggest **two** ways of improving the students' experiment.

4

1. ...Divide the reading on the Stop watch by 2.

2. ...RePeat the test at least 2 more times.

[2]

[Total: 8]

Examiner comments

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

1 The candidate gives the correct quantity in (a)(ii) to increase the pitch of the sound.
Mark for (a)(ii) = 1 out of 1

2 The candidate is using the wrong approach to find the distance.
Mark for (b)(i) = 0 out of 1

3 The candidate uses the correct equation but substitutes the wrong distance.
Mark for (b)(ii) = 2 out of 3

4 The candidate gives two incorrect suggestions.
Mark for (b)(iii) = 0 out of 2

Total mark awarded = 3 out of 8

How the candidate could have improved their answer

- **(a)(i)** The candidate needed to link the increase in loudness to an increase in amplitude. The amplitude of a wave is a measure of the energy contained in the wave.
- **(b)(i)** The candidate should have doubled the distance given on Fig. 8.1 to find the total distance travelled by the wave, i.e. to the wall and back to the students.
- **(b)(ii)** The candidate has substituted 80 m instead of 160 m into the correct equation. Candidates who made this mistake and gave an answer of 143 m (from 142.9 m) were awarded 2 out of 3 marks.
- **(b)(iii)** If the candidate had combined the two suggestions to state ‘repeat the experiment, added the two results and divided by two’ this would have scored 1 mark.

Common mistakes candidates made in this question

- **(a)(i)** The most common errors were frequency and wavelength.
- **(a)(ii)** The most common errors were amplitude and wavelength.
- **(b)(i)** The most common error was 80, but a few attempted to calculate the speed here and gave their answer as the distance.
- **(b)(ii)** The most common error was the incorrect use of 80 m as the distance, sometimes as an error carried forward from an incorrect distance in **(i)**. A very small number multiplied a distance by 0.56 to reveal a fundamental misunderstanding.
- **(b)(iii)** A common mistake was not stating the essential need to average the repeated results. Other candidates incorrectly suggested decreasing the distance of the students from the wall.

Question 9

Example Candidate Response – high

9 (a) The box lists four materials.

aluminium	iron	plastic	wood

Use words from the box to answer parts **(i)** and **(ii)**.
Each word may be used once, more than once or not at all.

(i) State **all** materials that are electrical insulators.

Plastic, wood [1]

(ii) State **one** example of a magnetic material.

iron [1]

(b) Fig. 9.1 shows two magnets, P and Q, which are repelling each other.

1

Fig. 9.1

On magnet P, the N pole is labelled N.

On Fig. 9.1, label the other pole on magnet P and **both** poles on magnet Q. [1]

(c) One advantage that electromagnets have, compared with permanent magnets, is that their strength can easily be altered.

State **one** other advantage of an electromagnet compared with a permanent magnet.

Can be turned on and off [1]

(d) A student wants to make the strongest electromagnet possible.

Indicate which properties produce the **strongest** electromagnet.

Tick (✓) **one** box in each list.

number of turns in the coil		**material in the core**		**size of current in the coil**	
200 turns	✓	air		20 mA	
100 turns		iron	✓	0.5 A	
50 turns		plastic		3.0 A	✓

2

[3]

Examiner comments

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

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

1 The candidate underlines the word repelling in the question as a reminder that the same poles are on either side of the gap.
Mark for (b)(i) = 1 out of 1

Mark for (c) = 1 out of 1

2 The candidate clearly indicates the correct properties in each column.
Mark for (d) = 3 out of 3

Total mark awarded = 7 out of 7

How the candidate could have improved their answer

- This candidate has been well prepared to answer questions on permanent magnets and properties of electromagnets.
- **(c)** The candidate should be more precise and state that it is the electromagnet that can be turned on or off by switching on or off the current in the coil of the electromagnet.

Example Candidate Response – middle

9 (a) The box lists four materials.

aluminium	iron	plastic	wood

Use words from the box to answer parts **(i)** and **(ii)**.
Each word may be used once, more than once or not at all.

(i) State **all** materials that are electrical insulators.

1 aluminium and iron [1]

(ii) State **one** example of a magnetic material.

iron [1]

(b) Fig. 9.1 shows two magnets, P and Q, which are repelling each other.

2

Fig. 9.1

On magnet P, the N pole is labelled N.

On Fig. 9.1, label the other pole on magnet P and **both** poles on magnet Q. [1]

(c) One advantage that electromagnets have, compared with permanent magnets, is that their strength can easily be altered.

State **one** other advantage of an electromagnet compared with a permanent magnet.

~~CGA~~ cheaper 3 [1]

(d) A student wants to make the strongest electromagnet possible.

Indicate which properties produce the **strongest** electromagnet.

Tick (✓) **one** box in each list.

number of turns in the coil		**material in the core**		**size of current in the coil**	
200 turns	✓	air		20 mA	✓
100 turns		iron	✓	0.5A	
50 turns	~~✓~~ (crossed out)	plastic		3.0A	

4

[3]

Examiner comments

1 Plastic and wood are the electrical insulators.
Mark for (a)(i) = 0 out of 1

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

2 The candidate gives an incorrect response.
Mark for (b) = 1 out of 1

3 The candidate gives an incorrect response.
Mark for (c) = 0 out of 1

4 The candidate indicates clearly that it is the top box that they wish to be marked. It is good practice for candidates to attempt to change responses in tables or on limited space answer lines. They can then be aware of strategies to use should the need arise on an examination paper.
Mark for (d) = 2 out of 3

Total mark awarded = 4 out of 7

How the candidate could have improved their answer

- **(a)(i)** The candidate has confused electrical conductors and electrical insulators. The candidate should be stating plastic and wood.
- **(c)** The candidate should state that by switching on or off the current in the coil of the electromagnet, it is easy to quickly magnetise or demagnetise the electromagnet.
- **(d)** The candidate should have chosen 3.0 A in the final column. The candidate has mistakenly thought that 20 mA is larger than 3.0 A.

Example Candidate Response – low

9 (a) The box lists four materials.

aluminium	iron	plastic	wood

Use words from the box to answer parts **(i)** and **(ii)**.
Each word may be used once, more than once or not at all.

(i) State **all** materials that are electrical insulators.

plastic wood iron [1]

(ii) State **one** example of a magnetic material.

1 ~~Plast~~ aluminum [1]

(b) Fig. 9.1 shows two magnets, P and Q, which are repelling each other.

Fig. 9.1

On magnet P, the N pole is labelled N.

On Fig. 9.1, label the other pole on magnet P and **both** poles on magnet Q. [1]

(c) One advantage that electromagnets have, compared with permanent magnets, is that their strength can easily be altered.

State **one** other advantage of an electromagnet compared with a permanent magnet.

2 [crossed out] has many uses [1]

(d) A student wants to make the strongest electromagnet possible.

Indicate which properties produce the **strongest** electromagnet.

Tick (✓) **one** box in each list.

number of turns in the coil		**material in the core**		**size of current in the coil**	
200 turns		air		20 mA	✓
100 turns		iron	✓	0.5A	
50 turns	✓	plastic		3.0A	

3

[3]

Examiner comments

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

1 The candidate incorrectly identifies aluminium as a magnetic material.
Mark for (a)(ii) = 0 out of 1

Mark for (b) = 1 out of 1

2 The candidate gives an incorrect advantage of electromagnets compared with permanent magnets.
Mark for (c) = 0 out of 1

3 The candidate's responses in the first and third columns are incorrect.
Mark for (d) = 1 out of 3

Total mark awarded = 2 out of 7

How the candidate could have improved their answer

- **(a)(i)** The candidate has added iron to the list of two insulators and so their answer is incorrect.
- **(a)(ii)** The candidate should state that iron is the magnetic material.
- **(c)** The candidate should state that by switching on or off the current in the coil of the electromagnet it is easy to quickly magnetise or demagnetise the electromagnet.
- **(d)** The responses selected in columns one and three would make the weakest electromagnet. The candidate should have selected the highest number of turns in column one and the greatest current in column three.

Common mistakes candidates made in this question

- **(a)(i)** The most common errors were giving only one of plastic or wood or adding aluminium and/or iron.
- **(a)(ii)** The most common error was to choose aluminium.
- **(b)** An error seen a number of times was for candidates to reverse the poles on the right-hand magnet.
- **(c)** A common error was to paraphrase the stem and to state that the strength of the electromagnet could be increased.
- **(d)** The most common error was to choose 20 mA instead of 3.0 A in the third column.

Question 10

Example Candidate Response – high

10 (a) Fig. 10.1 shows a lamp and a resistor connected in a circuit.

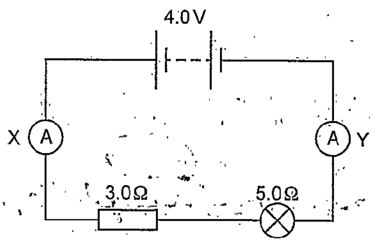


Fig. 10.1

(i) Determine the combined resistance of the 3.0 Ω resistor and the 5.0 Ω lamp.

3+5=8.0

combined resistance = ...8.0........ Ω [1]

(ii) The reading on ammeter X is 0.50 A.

1

State the reading on ammeter Y.

reading on ammeter Y = ...0.50........ A [1]

(b) In another circuit, the 3.0 Ω resistor and the 5.0 Ω lamp are connected in parallel, as shown in Fig. 10.2.

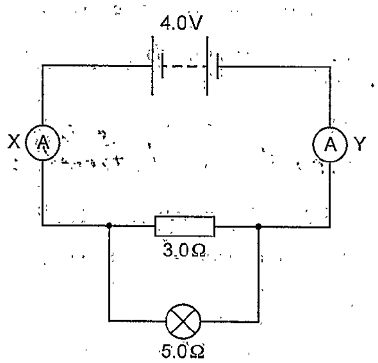


Fig. 10.2

The lamp and resistor have changed from a series to a parallel combination.

State and explain the effect of this change on the current in ammeter X.

2

the reading on the both ammeters will be higher because the total resistance is less than before $\frac{15}{8}$; The total resistance is 1.875 and using the equation $I = \frac{V}{R}$ $\frac{4}{1.875} = 2.13$ this current is greater than 0.50A [3]

(c) The current in a different lamp is 0.40 A when the potential difference (p.d.) across the lamp is 6.0 V.

Calculate the resistance of the lamp.

3

V=IR Resistance = $\frac{\text{voltage}}{\text{current}}$ $\frac{6}{0.4} = 15$

resistance of lamp = ...15.0........ Ω [3]

[Total: 8]

Examiner comments

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

1 The candidate shows the working for calculating the combined resistance of the two resistors in series. This is good practice in case of any ambiguity in reading the final answer.
Mark for (a)(ii) = 1 out of 1

2 This detailed answer is awarded full marks.
Mark for (b) = 3 out of 3

2 A well set out response giving a correct arrangement of the equation, substitution of values from the question and a correct evaluation.
Mark for (c) = 3 out of 3

Total mark awarded = 8 out of 8

How the candidate could have improved their answer

- This candidate has been well prepared to answer questions on resistance and electric circuits.
- **(b)** The candidate could have improved their answer by including the unit for resistance, i.e. 1.875 ohms and for current, i.e. 2.13 A. They could also have added that the combined resistance of resistors in parallel is less than the smallest of the resistors in the parallel combination, i.e. less than 3 ohms.

Example Candidate Response – middle

10 **(a)** Fig. 10.1 shows a lamp and a resistor connected in a circuit.

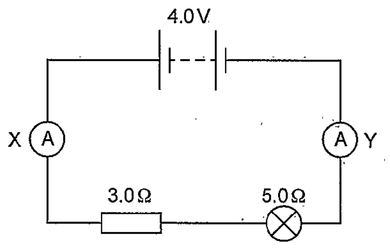


Fig. 10.1

(i) Determine the combined resistance of the 3.0 Ω resistor and the 5.0 Ω lamp.

combined resistance = ...8.......... Ω [1]

(ii) The reading on ammeter X is 0.50 A.

1 State the reading on ammeter Y.

reading on ammeter Y = ...0.50.......... A [1]

(b) In another circuit, the 3.0 Ω resistor and the 5.0 Ω lamp are connected in parallel, as shown in Fig. 10.2.

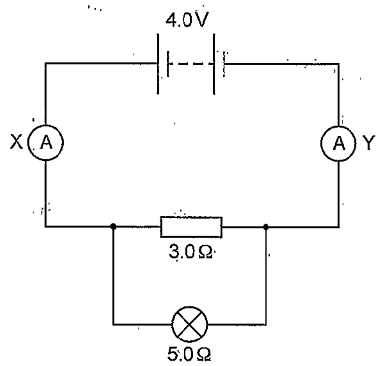


Fig. 10.2

The lamp and resistor have changed from a series to a parallel combination.

State and explain the effect of this change on the current in ammeter X.

2 The reading on ammeter X stays the same as before, it is still a series circuit ~~so current stays the same~~ and it is placed in the same place as before. [3]

(c) The current in a different lamp is 0.40 A when the potential difference (p.d.) across the lamp is 6.0 V.

Calculate the resistance of the lamp.

3 $V = IR$

$R = V/I \quad \frac{6.0}{0.40} = 15$

resistance of lamp = ...15.......... Ω [3]

[Total: 8]

Examiner comments

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

1 The candidate gives correct answers to (a)(i) and (a)(ii). It is good practice to write the decimal point in the centre of the gap between digits. In (a)(ii), the decimal is too low and would be impossible to discern if a bit lower and on the answer line dots.
Mark for (a)(ii) = 1 out of 1

2 This response with the candidate contradicting the question is not awarded any marks.
Mark for (b) = 0 out of 3

3 A well set out response. Use of correct symbols is just as valid as writing the equation in words.
Mark for (c) = 3 out of 3

Total mark awarded = 5 out of 8

How the candidate could have improved their answer

- **(b)** The candidate needed to note that the question states the lamp and resistor are now in a parallel combination. Candidates should practice underlining/highlighting key words, phrases and quantities in the question. These are then more readily visible when composing a response to the item.
- The candidate needed to state that the combined resistance of resistor and lamp in parallel is less than the smaller resistance of the two components in the parallel combination, i.e. less than a 3 ohm resistor. This means that the current in ammeter X must be much greater than when the components were connected in series.

Example Candidate Response – low

10 **(a)** Fig. 10.1 shows a lamp and a resistor connected in a circuit.

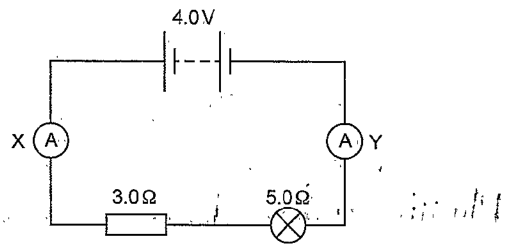


Fig. 10.1

(i) Determine the combined resistance of the 3.0Ω resistor and the 5.0Ω lamp. (1)

combined resistance = ...2.......... Ω [1]

(ii) The reading on ammeter X is 0.50A.

State the reading on ammeter Y.

reading on ammeter Y = ...0.50.......... A [1] (2)

(b) In another circuit, the 3.0Ω resistor and the 5.0Ω lamp are connected in parallel, as shown in Fig. 10.2.

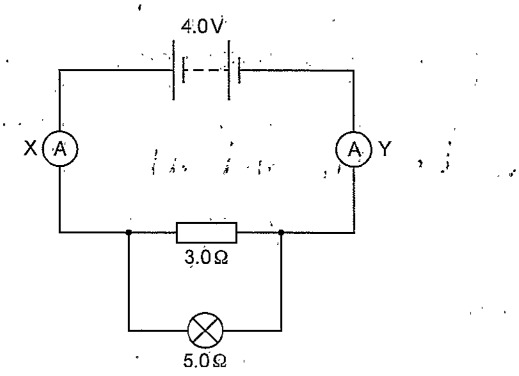


Fig. 10.2

The lamp and resistor have changed from a series to a parallel combination.

State and explain the effect of this change on the current in ammeter X.

(3) Have less resistance than the series
longer wire

.... [3]

(c) The current in a different lamp is 0.40A when the potential difference (p.d.) across the lamp is 6.0V.

Calculate the resistance of the lamp.

(4)

resistance of lamp = ...4.......... Ω [3]

[Total: 8]

Examiner comments

1 The answer to (a)(i) is incorrect. The candidate subtracts the two resistance values instead of adding them.
Mark for (a)(i) = 0 out of 1

2 The answer to (a)(ii) is correct.
Mark for (a)(ii) = 1 out of 1

3 The candidate is awarded one mark for stating that the resistance of the components in parallel is less than that of the same components in series.
Mark for (b) = 1 out of 3

4 The candidate gives an incorrect value for the resistance of the lamp.
Mark for (c) = 0 out of 3

Total mark awarded =
2 out of 8

How the candidate could have improved their answer

- **(b)** The candidate needed to link the decrease in the resistance to an increase in the current. To gain the third mark, the candidate needed to state that the combined resistance of resistor and lamp in parallel is less than the smaller resistance of the two components in the parallel combination, i.e. less than a 3 ohm resistor.
- **(c)** The candidate should have written down all the working when determining the answer to a calculation. Candidates should be encouraged to write down the equation they are using to solve a given problem, then to substitute values from the question and evaluate.

Common mistakes candidates made in this question

- **(a)** The vast majority of candidates correctly evaluated the combined resistance in **(i)** and slightly fewer evaluated the current in ammeter Y in **(ii)**. An error repeatedly seen in **(a)(i)** was to multiply the two values of resistance to give 15 Ω. In **(a)(ii)**, a number of candidates divided the battery voltage of 4.0 V by the resistance of the lamp, i.e. 5 Ω to give 0.8 A.
- **(b)** A minority of candidates stated both that the resistance decreases and the current increases. The most common error was to just give one of these changes. Others stated things like resistance rises so current increases.
- Another common misconception of parallel circuits was to state that the current was shared between the components and so the current would decrease.
- **(c)** A common error among weaker candidates was inverting the equation and so dividing the current by the voltage or simply multiplying the two values to give an answer of 2.4 Ω.

Question 11

Example Candidate Response – high

11 A student uses a coil and a magnet on a spring to generate an electromotive force (e.m.f.) that varies. He suspends the magnet above a coil as shown in Fig. 11.1.

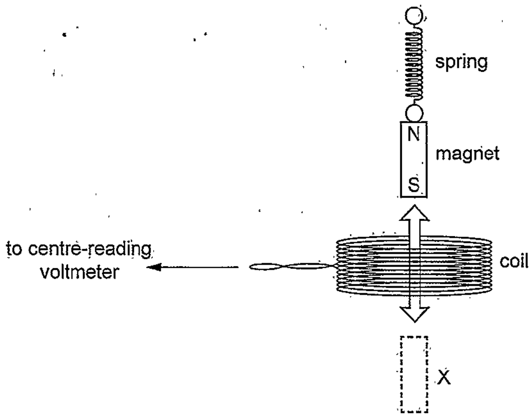


Fig. 11.1

(a) The student pulls the magnet through the coil to X and then releases it. The magnet moves up and down through the coil.

State the type of voltage induced in the coil. Tick (✓) **one** box.

1

alternating	✓
digital	
direct	

[1]

(b) State **two** ways of increasing the voltage induced in the coil.

2

1. increase the number of turns in the coil
2. use a stronger magnet

[2]

[Total: 3]

Examiner comments

1 The candidate clearly indicates the correct box.
Mark for (a) = 1 out of 1

2 Both of the candidate's suggestions are clearly stated and correct.
Mark for (b) = 2 out of 2

Total mark awarded = 3 out of 3

How the candidate could have improved their answer

- Electromagnetic induction is one the most difficult concepts on the core theory specification. The candidate has done well to achieve full marks on this question.

Example Candidate Response – middle

11 A student uses a coil and a magnet on a spring to generate an electromotive force (e.m.f.) that varies. He suspends the magnet above a coil as shown in Fig. 11.1.

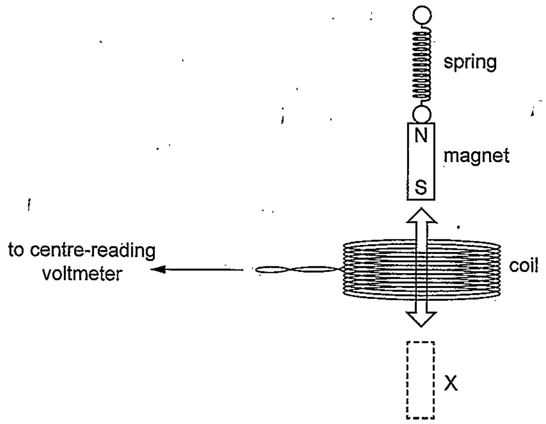


Fig. 11.1

(a) The student pulls the magnet through the coil to X and then releases it. The magnet moves up and down through the coil.

State the type of voltage induced in the coil. Tick (✓) **one** box.

(1) alternating ☐

digital ☐

direct ☑

[1]

(b) State **two** ways of increasing the voltage induced in the coil.

1. more number of coil turns ✓

(2) 2. Add another magnet

[2]

[Total: 3]

Examiner comments

(1) The candidate indicates an incorrect option.
Mark for (a) = 0 out of 1

(2) The candidate's second suggestion is insufficient and is not awarded a mark.
Mark for (b) = 1 out of 2

Total mark awarded = 1 out of 3

How the candidate could have improved their answer

- **(a)** The candidate should have linked the up and down motion of the magnet through the coil to the production of an e.m.f. that reverses polarity with each change in direction, i.e. an alternating e.m.f.
- **(b)** In the second option, the candidate needed to be more precise about increasing the strength of the magnet. Candidates should be reminded that vague statements such as 'adding another magnet' or 'use a bigger magnet' are insufficient and will not be awarded a mark.

Example Candidate Response – low

11 A student uses a coil and a magnet on a spring to generate an electromotive force (e.m.f.) that varies. He suspends the magnet above a coil as shown in Fig. 11.1.

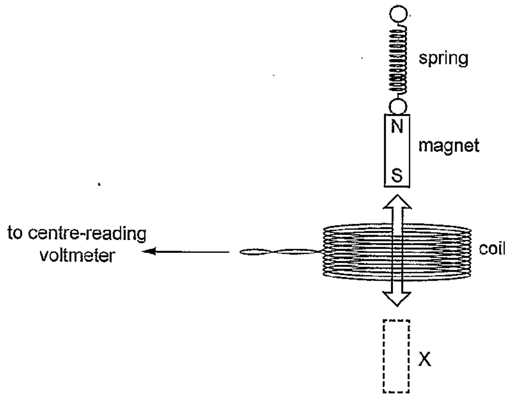


Fig. 11.1

(a) The student pulls the magnet through the coil to X and then releases it. The magnet moves up and down through the coil.

State the type of voltage induced in the coil. Tick (✓) **one** box.

①

- alternating ☐
- digital ☑
- direct ☐

[1]

(b) State **two** ways of increasing the voltage induced in the coil.

②

1. increase the space between the ~~magne~~ magnet and the coil
2. increase the current

[2]

[Total: 3]

Examiner comments

① The candidate indicates an incorrect option.
Mark for (a) = 0 out of 1

② Neither of the candidate's suggestions is correct.
Mark for (b) = 0 out of 2

Total mark awarded = 0 out of 3

How the candidate could have improved their answer

- **(a)** The candidate should have linked the up and down motion of the magnet through the coil to the production of an e.m.f. that reverses polarity with each change in direction, i.e. an alternating e.m.f.
- **(b)** The candidate should have given suggestions such as: increase the strength of the magnet or increase the speed of magnet through the coil or increase the number of turns of wire in the coil.

Common mistakes candidates made in this question

- **(a)** The most common error was to select 'direct' current. However, the majority of candidates selected the correct option.
- **(b)** The most common wrong answer was to think there was a current in the coil which should be increased. Other incorrect suggestions were to make the spring longer, or to put an iron core in the coil.

Question 12

Example Candidate Response – high	Examiner comments

12 (a) Table 12.1 describes four nuclides.

Table 12.1

name of nuclide	plutonium-238	thorium-234	uranium-235	uranium-238
nuclide notation	$^{238}_{94}Pu$	$^{234}_{90}Th$	$^{235}_{92}U$	$^{238}_{92}U$

(i) State which **two** nuclides have the same number of protons.

uranium – 235 and uranium – 238 (1) [1]

(ii) State which **two** nuclides have the same number of nucleons.

plutonium – 238 and uranium – 238 [1]

(iii) State which **one** of the four nuclides has the most electrons orbiting when it is in a neutral atom.

plutonium – 238 [1]

(b) Thorium-234 has a half-life of 24 days. A sample of radioactive material contains 40 mg of thorium-234.

Calculate the mass of thorium-234 remaining after 72 days.

$\frac{72}{24} = 3$ half lives

$\frac{40}{2} = 20 \rightarrow 24$

$\frac{20}{2} = 10 \rightarrow 48$

$\frac{10}{2} = 5 \rightarrow 72$

(2)

mass of thorium-234 remaining = 5 mg [3]

[Total: 6]

Examiner comments

(1) The candidate gives correct responses to all parts in (a). Note that in many instances the dash between the element name and the nucleon number has been obscured by the answer line.
Mark for (a)(i) = 1 out of 1

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

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

(2) The candidate clearly determines that 72 days represents 3 half-lives of thorium-234 and then calculates the mass of thorium-234 remaining after 3 half-lives.
Mark for (b) = 3 out of 3

Total mark awarded = 6 out of 6

How the candidate could have improved their answer

- **(a)** Although not critical in this instance, the candidate should not write the dash between element name and nucleon number in the dots of the answer line.
- **(b)** The candidate has put an arrow linking the mass remaining and the number of days that have elapsed. This could be misconstrued as a different mass and so taken as a contradiction by an examiner. The candidate should have written, for the working, something like: after 24 days mass remaining = 40/2 = 20 mg, after 48 days mass remaining = 20/2 = 10 mg, after 72 days mass remaining = 10/2 = 5 mg.

Example Candidate Response – middle

12 (a) Table 12.1 describes four nuclides.

Table 12.1

name of nuclide	plutonium-238	thorium-234	uranium-235	uranium-238
nuclide notation	$^{238}_{94}Pu$	$^{234}_{90}Th$	$^{235}_{92}U$	$^{238}_{92}U$

(i) State which **two** nuclides have the same number of protons.

1 uranium-235 and uranium-238 [1]

(ii) State which **two** nuclides have the same number of nucleons.

Plutonium-238 and uranium-238 [1]

(iii) State which **one** of the four nuclides has the most electrons orbiting when it is in a neutral atom.

plutonium-238 [1]

(b) Thorium-234 has a half-life of 24 days. A sample of radioactive material contains 40 mg of thorium-234.

Calculate the mass of thorium-234 remaining after 72 days.

72 ÷ 24 = 3 half life 2

mass of thorium-234 remaining = 13.33 mg [3]

[Total: 6]

40 ÷ 3

Examiner comments

1 The candidate gives correct responses to all three parts of (a). Note that the dashes between element name and nucleon number are very clear.

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

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

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

2 The candidate correctly determines the half-life of thorium-234 but fails to make use of this information.

Mark for (b) = 1 out of 3

Total mark awarded = 4 out of 6

How the candidate could have improved their answer

- **(a)** The candidate has demonstrated a good understanding of nuclide notation and atomic structure.
- **(b)** The candidate has correctly determined the half-life of thorium-234. The candidate needed to show how the mass of thorium-234 halves for each of the 3 half-lives to give a mass of 5 mg remaining after 72 days.

Example Candidate Response – low

12 **(a)** Table 12.1 describes four nuclides.

Table 12.1

name of nuclide	plutonium-238	thorium-234	uranium-235	uranium-238
nuclide notation	${}^{238}_{94}\mathrm{Pu}$	${}^{234}_{90}\mathrm{Th}$	${}^{235}_{92}\mathrm{U}$	${}^{238}_{92}\mathrm{U}$

(i) State which **two** nuclides have the same number of protons.

Uranium-235, Uranium-238 [1]

(ii) State which **two** nuclides have the same number of nucleons.

plutonium-238, uranium-238 [1]

(iii) State which **one** of the four nuclides has the most electrons orbiting when it is in a neutral atom.

thorium-234 $\left({}^{234}_{90}\mathrm{Th}\right)$ **1** [1]

(b) Thorium-234 has a half-life of 24 days. A sample of radioactive material contains 40 mg of thorium-234.

Calculate the mass of thorium-234 remaining after 72 days.

2

$$\frac{40\,\text{mg}}{24\text{days} - 72\text{days}} = \frac{5}{6}$$

mass of thorium-234 remaining = 0.83 mg [3]

[Total: 6]

Examiner comments

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

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

1 The candidate gives an incorrect response to (a)(iii).
Mark for (a)(iii) = 0 out of 1

2 The candidate does not produce any rewardable material.
Mark for (b) = 0 out of 3

Total mark awarded = 2 out of 6

How the candidate could have improved their answer

- **(a)(iii)** The candidate needed to link the nuclide with the highest proton number i.e. Plutonium-234 as being the nuclide with the highest number of electrons.
- **(b)** This calculation involving half-lives is difficult because there are two separate stages. For the first stage, the candidate needed to select the information required to calculate the number of half-lives of thorium-234 that elapse in 72 days, i.e. 3 half-lives. The candidate then needed to halve the original mass 3 times to give 5 mg of thorium-234 remaining after 72 days.

Common mistakes candidates made in this question

- **(a)(i)** The most common error was to state Pu – 238 and U – 238 as a result of confusing nucleon number and proton number.
- **(a)(ii)** A common error was to give plutonium – 238 and thorium – 234, displaying confusion between nucleons and neutrons.
- **(a)(iii)** The most common error was to state U – 238.
- **(b)** The most common errors were to multiply 40 by 3 or divide 40 by 3. A few considered only 2 half-lives to get the answer 10 mg.

Cambridge Assessment International Education
The Triangle Building, Shaftesbury Road, Cambridge, CB2 8EA, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org   www.cambridgeinternational.org