



# Cambridge O Level Mathematics (Syllabus D) 4024

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## Introduction

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The main aim of this booklet is to exemplify standards for those teaching Cambridge O Level Mathematics (Syllabus D) 4024, and to show how different candidates' performance relate to the subjects curriculum and assessment objectives.

In this booklet candidate responses have been chosen from the June 2022 exam 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. 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.

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.

**4024 June 2022 Question Paper 22**

**4024 June 2022 Mark Scheme 22**

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

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

[www.cambridgeinternational.org/support](http://www.cambridgeinternational.org/support)



## How to use this booklet

This booklet goes through the paper one question at a time. 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 1	Examiner comments
<p>1 (a) In 2021, the cost of posting a letter was 84 cents.</p> <p>(i) A company posts 1950 letters.</p> <p>Find the cost, in dollars, to post these letters.</p> <p><math>1 = 84</math> <math>x = 163800</math></p> <p><math>1950 = x</math></p> <p>\$ 163800 [1]</p> <p>(ii) In 2022, the cost of posting a letter is 96 cents.</p> <p>Calculate the percentage increase in the cost of posting a letter.</p> <p>96 100</p> <p>2 .....% [2]</p>	<p>1 The candidate finds the cost to post these letters in cents and not in dollars, a common error amongst candidates. They should be encouraged to read the whole question in order to access all the available marks.</p> <p>2</p>

**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.

## Question 1

### Example Candidate Response 1

### Examiner comments

- 1 (a) In 2021, the cost of posting a letter was 84 cents.

- (i) A company posts 1950 letters.

Find the cost, in dollars, to post these letters.

$$= 84 \times 1950$$

$$= \frac{163800}{100}$$

$$= \$1638$$

\$.....1638..... [1]

- (ii) In 2022, the cost of posting a letter is 96 cents.

Calculate the percentage increase in the cost of posting a letter.

$$= \frac{12}{84} \times 100$$

$$= 14.2\%$$

.....14.2.....% [2]

- (b)

Cost of posting a letter is 96 cents

15% discount when monthly postage is more than \$1000.

Company A posts 1200 letters in one month. \$1152

Company B posts fewer letters than Company A in the same month.

Company A and Company B each pay the same amount to post their letters that month.

Find the number of letters Company B posts in that month.

$$= \frac{15}{100} \times 1152$$

$$= 172.8$$

$$= 1152 - 172.8$$

$$\text{Company A} = \$979.2$$

$$\text{Company B paid} = \frac{97920}{96}$$

$$\text{Company B posted} = 1020 \text{ letters}$$

.....1020..... [3]

1 The correct method for M1 is seen to calculate the percentage increase, however, it was common to see candidates truncating their answer rather than correctly rounding it to 3 significant figures.

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

Mark for (a)(i) = 1 out of 2

Mark for (b) = 3 out of 3

Example Candidate Response 1, continued	Examiner comments
<p>(c) In 2022, the cost of posting a parcel with a mass of 1 kg or less is <u>\$4.60</u>. The cost increases by <u>\$1.10</u> for each additional 0.5 kg.</p> <p>Find the cost of posting a parcel with a mass of 3.5 kg.</p> <p><del><math>= 3 \times \\$4.60 + \\$1.10</math></del></p> <p><math>= 14.9</math></p> <p style="text-align: right;">\$ ..... 14.9 ..... [2]</p> <p>(d) The cost of posting parcels increases by <u>7.2%</u>. After the increase, the cost of posting a parcel is \$13.40.</p> <p>Calculate the original cost of posting this parcel.</p> <p><math>= \frac{7.2}{100} \times 13.40</math></p> <p><math>= \\$0.964</math></p> <p><math>= 13.40 - 0.964</math></p> <p><math>= \\$12.436</math></p> <p style="text-align: right;">\$ ..... 12.436 ..... [2]</p>	<p><b>3</b> This candidate demonstrates a common misunderstanding of how the cost of posting a parcel is calculated. They calculate the cost as \$4.60 per whole kilogram and \$1.10 for the extra 0.5 kg. Careful reading of the given information is required to use this information correctly for parcels with a mass of more than 1 kg.</p> <p>Mark for (c) = 0 out of 2</p> <p><b>4</b> An answer of \$12.43 to \$12.44 was common. It comes from a misunderstanding of the 7.2% increase and calculating the original cost of posting this parcel as 92.8% of \$13.40. The 7.2% increase relates to the original cost which is unknown and so \$13.40 is 107.2% of the original cost.</p> <p>Mark for (d) = 0 out of 2</p> <p><b>Total mark awarded = 5 out of 10</b></p>

## Example Candidate Response 2

## Examiner comments

- 1 (a) In 2021, the cost of posting a letter was 84 cents.

- (i) A company posts 1950 letters.

Find the cost, in dollars, to post these letters.

$$\begin{array}{l} 1 = 84 \\ 1950 = x \\ x = 163800 \end{array} \quad \text{①}$$

\$ 163800 [1]

- (ii) In 2022, the cost of posting a letter is 96 cents.

Calculate the percentage increase in the cost of posting a letter.

$$= \frac{96}{84} \times 100 = 114.28 \quad \text{②}$$

114.28 % [2]

- (b)

Cost of posting a letter is 96 cents  
15% discount when monthly postage is more than \$1000

Company A posts 1200 letters in one month.

Company B posts fewer letters than Company A in the same month.

Company A and Company B each pay the same amount to post their letters that month.

Find the number of letters Company B posts in that month.

$$\begin{array}{l} 1200 \times 96 = 115200 \\ 115200 = \frac{15}{100} \times 115200 \\ = 17280 \\ 115200 - 17280 = 97920 \end{array} \quad \text{③}$$

1190 [3]

① The candidate finds the cost to post these letters in cents and not in dollars, a common error amongst candidates. They should be encouraged to read the whole question in order to access all the available marks.

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

② The method for finding 96 as a percentage of 84 is seen, however this candidate makes a common error of not subtracting 100 to progress further to find the percentage increase, so they are only awarded M1.

Mark for (a)(i) = 1 out of 2

③ The candidate finds the cost in cents for Company A to post the letters with the discount of 15 % for the first method mark. Frequently, candidates did not show a method for their final answer, in this case a method to reach the answer of 1190.

Mark for (b) = 1 out of 3

## Example Candidate Response 2, continued

## Examiner comments

- (c) In 2022, the cost of posting a parcel with a mass of 1 kg or less is \$4.60. The cost increases by \$1.10 for each additional 0.5 kg.

Find the cost of posting a parcel with a mass of 3.5 kg.

$$\begin{array}{l}
 1.5 \text{ kg} = \$4.60 \\
 3.5 \text{ kg} = x \\
 1.5n = 19.95 \\
 x = \frac{3.88}{1.68} \\
 \text{Cost} = 13.3
 \end{array}
 \quad
 \begin{array}{l}
 n = 2.5 \\
 n = 19.95 \\
 n = 13.3
 \end{array}
 \quad
 \text{[2]}$$

- (d) The cost of posting parcels increases by 7.2%. After the increase, the cost of posting a parcel is \$13.40.

Calculate the original cost of posting this parcel.

$$\begin{array}{l}
 = \frac{7.2}{100} \times 13.40 \\
 = 0.96 \\
 = 13.40 - 0.96 \\
 = 12.44
 \end{array}
 \quad
 \text{[2]}$$

4 No relevant work is seen for the cost of the additional 2.5 kg which is required to then calculate the cost of posting the parcel.

Mark for (c) = 0 out of 2

5 A common misunderstanding on this question was to decrease \$13.40 by 7.2%, rather than appreciate that \$13.40 is equal to 107.2% of the original cost. If a question asks for the original cost, then no marks are available if the percentage is multiplied by the given cost.

Mark for (d) = 0 out of 2

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

## Question 2

Example Candidate Response 1	Examiner comments
<p>2 (a) <math>A = 3p + q</math></p> <p>Find <math>q</math> when <math>A = 23</math> and <math>p = 5</math>.</p> <p><math>A = 3p + q</math>      <math>8 = q</math></p> <p><math>23 = 3(5) + q</math></p> <p><math>23 = 15 + q</math></p> <p><math>23 - 15 = q</math></p> <p><math>q = 8</math> ..... [2]</p> <p>(b) Expand and simplify <math>2(2x+5) + 3(x-6)</math>.</p> <p><math>2(2x+5) + 3(x-6)</math></p> <p><math>= 4x + 10 + 3x - 18</math></p> <p><math>= 7x - 8</math></p> <p>..... <math>7x - 8</math> ..... [2]</p> <p>(c) Solve <math>5y + 3 = 1</math>.</p> <p><math>5y + 3 = 1</math></p> <p><math>5y = -3</math></p> <p><math>y = \frac{-3}{5}</math></p> <p>..... <math>y = \frac{-3}{5}</math> ..... [2]</p> <p>(d) Factorise <math>12r^2 - 8rs</math>.</p> <p><math>12r^2 - 8rs</math></p> <p><math>4r(6r - 4s)</math></p> <p>..... <math>4r(6r - 4s)</math> ..... [2]</p> <p>(e) Rearrange <math>a = 3b</math> to make <math>b</math> the subject.</p> <p><math>a = 3b</math></p> <p><math>\frac{a}{3} = b</math></p> <p>..... <math>\frac{a}{3}</math> ..... [1]</p>	<p>Mark for (a) = 2 out of 2</p> <p>Mark for (b) = 2 out of 2</p> <p>1 The candidate understands the need to subtract 3 from both sides of the equation, however the 1 on the right-hand side of the equation disappears.</p> <p>Mark for (c) = 0 out of 2</p> <p>2 A partial factorisation of this expression, particularly the one given by this candidate, is common. The candidate is awarded B1. To access all the marks on questions of this form, a completely factorised expression is required, in this case with the factor <math>4r</math> outside the bracket.</p> <p>Mark for (d) = 1 out of 2</p> <p>3 In the working, this candidate demonstrates understanding of how to rearrange the equation to make <math>b</math> the subject. This final answer on the answer line was common. All the marks for a rearrangement are only available if an equation is given for the final answer and not an expression.</p> <p>Mark for (e) = 0 out of 1</p> <p><b>Total mark awarded = 5 out of 9</b></p>

## Example Candidate Response 2

## Examiner comments

- 2 (a)
- $A = 3p + q$

Find  $q$  when  $A = 23$  and  $p = 5$ .

$$23 = 3(5) + q$$

$$23 = 15 + q$$

$$q = 23 - 15$$

- (b) Expand and simplify
- $2(2x+5) + 3(x-6)$
- .

$$2(2x+5) + 3(x-6)$$

$$4x + 10 + 3x - 18$$

$$4x + 3x + 10 - 18$$

$$7x - 8$$

- (c) Solve
- $5y + 3 = 1$
- .

$$5y + 3 = 1$$

$$5y = 1 - 3$$

$$5y = -2$$

$$y = \frac{-2}{5}$$

$$y = -0.4$$

- (d) Factorise
- $12r^2 - 8rs$
- .

$$12r^2 - 8rs$$

$$4r(3r - 2s)$$

- (e) Rearrange
- $a = 3b$
- to make
- $b$
- the subject.

$$b = 3a$$

$$q = 15 - 23$$

$$q = -8$$

$$q = -8 \dots\dots\dots [2]$$

$$7x + 10 + 18$$

$$7x + 28$$

$$x = \frac{28}{7}$$

$$x = 4$$

$$\dots\dots\dots [2]$$

$$y = 0.8 \dots\dots\dots [2]$$

$$12r^2 - 8rs$$

$$4r(3r - 2s)$$

$$4r(3r - 2s)$$

$$\dots\dots\dots [2]$$

$$b = 3a$$

$$\dots\dots\dots [1]$$

1 A correct substitution into the equation of the values of  $A$  and  $p$  is shown. Having arrived at the equation  $23 = 15 + q$ , many candidates have difficulty solving this. Some arrived at the answer  $q = -8$ , like this candidate, with another common wrong answer being

$$q = \frac{23}{15}.$$

Mark for (a) = 1 out of 2

2 A common misconception on this question was knowing what is required by the demand 'Expand and simplify'. Having expanded and then attempted to simplify, many, like this candidate, think further work was required and attempted a solution usually by setting the expression equal to zero. M1 is awarded for correct expansion of brackets.

Mark for (b) = 1 out of 2

3 Errors are frequently seen in the first step of the solution of this equation, with the most common errors being either  $5y = 1 + 3$  or  $5y = -1 + 3$ .

Mark for (c) = 0 out of 2

Mark for (d) = 2 out of 2

4 A common misconception for this rearrangement is to think that  $b$  would become the subject if the equation is multiplied by 3. Consideration needs to be given to the present operation (in this case multiplication) and then the reverse operation (in this case division) is needed when 'undoing' an operation.

Mark for (e) = 0 out of 1

**Total mark awarded =  
4 out of 9**

## Question 3

### Example Candidate Response 1

### Examiner comments

- 3 A 5-sided spinner is numbered 1, 2, 3, 4 and 5.  
The table shows the results from spinning the spinner 200 times.

Number	Frequency
1	51
2	19
3	28
4	35
5	67

- (a) A pie chart is drawn to show this information.

Calculate the angle of the sector representing the number 4.

$$\frac{360}{200} \times 35 = 63^\circ$$

.....  $63^\circ$  ..... [2]

- (b) Use the results to estimate the probability that the spinner lands on 3.

$$\frac{28}{200} = \frac{7}{50}$$

.....  $\frac{7}{50}$  ..... [1]

- (c) Use the results to estimate the probability that the spinner lands on a number that is a factor of 30.

2, 3, and 5

$$\frac{19}{200} + \frac{28}{200} + \frac{67}{200} = \frac{57}{100}$$

.....  $\frac{57}{100}$  ..... [2]

- (d) The spinner is spun 3000 times.

Estimate the number of times it lands on an even number.

$$\frac{19}{200} + \frac{35}{200} = \frac{27}{100}$$

$$\frac{27}{100} \times 15 = \frac{81}{20} \quad \frac{405}{1500} = \frac{27}{100}$$

$$\frac{3000}{200} = 15$$

.....  $\frac{27}{100}$  ..... [2]

Mark for (a) = 2 out of 2

Mark for (b) = 1 out of 1

**1** A common error when selecting the factors of 30 was not to include the factor 1. This candidate uses the information for the factors 2, 3 and 5 correctly giving an answer  $\frac{7}{50}$  which is awarded SC1.

Mark for (c) = 1 out of 2

**2** The probability of the spinner landing on an even number was frequently seen on the answer line. Some candidates make no further progress having obtained this probability, while others, like this candidate, attempt to use the 3000, but do so incorrectly.

Mark for (d) = 1 out of 2

**Total mark awarded =  
5 out of 7**



## Example Candidate Response 2

## Examiner comments

- 3 A 5-sided spinner is numbered 1, 2, 3, 4 and 5.  
The table shows the results from spinning the spinner 200 times.

Number	Frequency
1	51
2	19
3	28
4	35
5	67

- (a) A pie chart is drawn to show this information.

Calculate the angle of the sector representing the number 4.

$$\frac{35}{200} \times 100 = 17.5$$

17.5 ..... [2]

- (b) Use the results to estimate the probability that the spinner lands on 3.

$$\frac{28}{200} = \frac{7}{50} = \frac{1}{5}$$

$\frac{1}{5}$  ..... [1]

- (c) Use the results to estimate the probability that the spinner lands on a number that is a factor of 30.

$$\frac{4}{5}$$

$\frac{4}{5}$  ..... [2]

- (d) The spinner is spun 3000 times.

Estimate the number of times it lands on an even number.

$$\frac{3000}{200} = 15$$

$$15 \left( \frac{2}{5} \right) = 1200$$

1200 ..... [2]

1 This candidate uses the table correctly to find the fraction of the pie chart that represents the number 4. A common error is to find the percentage of the pie chart rather than the angle of the sector as required. B1 is awarded for an answer 17.5[%].

Mark for (a) = 1 out of 2

2 This candidate correctly estimates the probability that the spinner lands on a 3, however this work is then replaced. A common misconception is to assume that the spinner is equally likely to land on each number, ignoring the information in the right-hand column of the table, resulting in a probability of  $\frac{1}{5}$ .

Mark for (b) = 0 out of 1

3 The common misconception of the previous part appears to be carried over to this part with an answer of  $\frac{4}{5}$ , as 4 of the 5 numbers are factors of 30. No indication is seen in this part of 1, 2, 3 and 5 being factors of 30.

Mark for (c) = 0 out of 2

4 A continuation of the misconception is seen again in this part with  $\frac{2}{5}$  being the required probability. This probability is used to estimate the number of times out of the 3000 spins the spinner lands on an even number. Throughout the last three parts of the question a fair spinner is assumed rather than using the information given in the table.

Mark for (d) = 0 out of 2

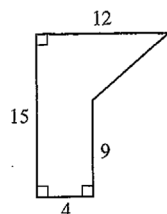
**Total mark awarded =**  
**1 out of 7**

## Question 4

### Example Candidate Response 1

### Examiner comments

(a)

NOT TO  
SCALE

The diagram shows a pentagon.  
All the lengths are in centimetres.

(i) Calculate the area of the pentagon.

$$= \frac{1}{2}(12)(15) + \frac{1}{2}(4)(9)$$

$$= 90 + 18$$

$$= 108$$

1

108 ..... cm<sup>2</sup> [2]

(ii) Find the perimeter of the pentagon.

$$H^2 = 15^2 + 12^2$$

$$= \sqrt{369}$$

$$= 19.2$$

$$= \frac{19.2}{2} = 9.6$$

$$= 12 + 15 + 4 + 9 + 9.6 = 49.6$$

2

49.6 ..... cm [3]

(b) [Volume of a sphere =  $\frac{4}{3}\pi r^3$ ]A sphere has a volume of 2572 cm<sup>3</sup>.

Find the radius of the sphere.

3

$$2572 = \frac{4}{3}\pi r^3$$

$$r^3 = \frac{2572 \times 3}{4\pi}$$

$$= \sqrt[3]{614}$$

$$= 8.49$$

8.5 ..... cm [3]

1 A misunderstanding of how to split the pentagon into shapes where each area can be calculated is shown by this candidate. It was common for candidates to work out the area of a triangle with a base of 12 and height of 15, assuming that this triangle was contained inside the pentagon.

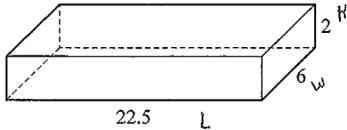
Mark for (a)(i) = 0 out of 2

2 This candidate realises that Pythagoras is needed to calculate the missing length of the perimeter. However, they continue with the previous common misunderstanding and assume this length is part of the 12 by 15 triangle. The length found is added to the four given lengths. The candidate is awarded M1 for  $12 + 15 + 4 + 9 +$  their  $h$  after their attempt at Pythagoras' to find  $h$ .

Mark for (a)(ii) = 1 out of 3

3 The candidate's most accurate answer (8.49 in this case) needs to be in the required range for full marks.

Mark for (b) = 3 out of 3

Example Candidate Response 1, continued	Examiner comments
<p>(c)</p>  <p>A cuboid has dimensions 2 cm by 6 cm by 22.5 cm.</p> <p>(i) Calculate the surface area of the cuboid.</p> <p>S.A = <del>1/2(LW + WH + LH)</del> <math>2(LW + WH + LH)</math></p> <p><math>= 2((22.5)(6) + (6)(2) + (22.5)(2))</math></p> <p><math>= 384</math></p> <p>..... 384 ..... cm<sup>2</sup> [3]</p> <p>(ii) A cube of edge x cm has the same surface area as the cuboid.</p> <p>Form an equation in x and solve it to find the length of the edge of the cube. Show your working.</p> <p><math>L^3 = 384</math></p> <p><math>= \sqrt[3]{384}</math></p> <p><math>= 7.26</math></p> <p>..... 7.26 ..... cm [3]</p>	<p>Mark for (c)(i) = 3 out of 3</p> <p>4 A common error seen was to write an equation equating the volume of the cube to the surface area of the cuboid. Consideration of the dimensions of each side of the equation indicates that the cube of <math>l</math> is a volume and not a surface area.</p> <p>Mark for (c)(ii) = 0 out of 3</p> <p><b>Total mark awarded = 7 out of 14</b></p>

## Example Candidate Response 2

## Examiner comments

4 (a)

$$bc^2 = 9^2 + 4^2$$

$$bc^2 = 97$$

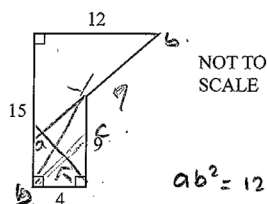
$$bc = \sqrt{97}$$

$$bc = 9.8$$

$$= 19.2 = 9.8$$

$$= 10$$

The diagram shows a pentagon.  
All the lengths are in centimetres.



$$ab^2 = 12^2 + 15^2$$

$$ab^2 = 369$$

$$ab = \sqrt{369}$$

$$ab = 19.2$$

(i) Calculate the area of the pentagon.

$$15 \times 4 \times 9 \times 12$$

=

$$64.80 \dots \text{cm}^2 \quad [2]$$

(ii) Find the perimeter of the pentagon.

$$= 15 + 9 + 4 + 12 + 10$$

$$= 50$$

$$50 \dots \text{cm} \quad [3]$$

(b) [Volume of a sphere =  $\frac{4}{3}\pi r^3$ ]

A sphere has a volume of  $2572 \text{ cm}^3$ .

Find the radius of the sphere.

$$\frac{4}{3} \pi r^3 = 2572$$

$$r^3 = \frac{2572 \times 3}{4\pi}$$

$$r = 85.83$$

$$4 \quad 3(\pi r^3) = 2572 \times 3$$

$$3\pi r^3 = 7716$$

$$r^3 = \frac{7716}{3\pi}$$

$$85.83 \dots \text{cm} \quad [3]$$

1 Multiplying all the given dimensions was a common misconception as to how to calculate the area of this pentagon. Consideration of the dimensions indicates a wrong formula ( $\text{cm} \times \text{cm} \times \text{cm} \times \text{cm} = \text{cm}^4$ ).

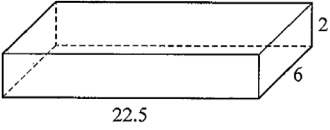
Mark for (a)(i) = 0 out of 2

2 This candidate arrives at the correct perimeter for the pentagon. However this perimeter must not come from wrong working (nfw on the mark scheme). The working seen next to the shape shows that the unknown length of 10 is a rounded value coming from Pythagoras, subtracting the hypotenuse of a 9 by 4 triangle from the hypotenuse of a 15 by 12 triangle. This is an incorrect method for calculating the unknown length. The candidate is awarded M1 for  $12 + 15 + 4 + 9 + \text{their } h$  after attempt at Pythagoras' to find  $h$ .

Mark for (a)(ii) = 1 out of 3

3 A correct equation is written by the candidate which earns M1. Mistakes are then made in solving this equation, firstly replacing the 4 by a 3. A common error was getting as far as a value for the cube of  $r$ , as seen by this candidate, and then not obtaining the correct cube root even if the cube root sign was seen. Frequently the calculator was used to find the square root.

Mark for (b) = 1 out of 3

Example Candidate Response 2, continued	Examiner comments
<p>(c)</p>  <p>A cuboid has dimensions 2 cm by 6 cm by 22.5 cm.</p> <p>(i) Calculate the surface area of the cuboid.</p> <p>Area = <math>22.5 \times 6 \times 2</math>.</p> <p>Area = <u>270 cm<sup>2</sup></u>.</p> <p style="text-align: right;">..... 270 ..... cm<sup>2</sup> [3]</p> <p>(ii) A cube of edge <math>x</math> cm has the same surface area as the cuboid.</p> <p>Form an equation in <math>x</math> and solve it to find the length of the edge of the cube.</p> <p>Show your working.</p> <p><math>x^3 = 270</math></p> <p><math>x = \sqrt[3]{270}</math></p> <p><math>x = 4.92</math></p> <p style="text-align: right;">..... 49.2 ..... cm [3]</p>	<p><b>4</b> The volume of the cuboid is calculated, a common error.</p> <p>Mark for (c)(i) = 0 out of 3</p> <p><b>5</b> This candidate continues the previous error by writing an equation equating the volume of the cube to the volume of the cuboid.</p> <p>Mark for (c)(ii) = 0 out of 3</p> <p><b>Total mark awarded = 2 out of 14</b></p>

## Question 5

### Example Candidate Response 1

### Examiner comments

- 5 (a) A group of students each complete a puzzle.  
The table shows the time,  $t$  seconds, each student took to complete the puzzle.

Time ( $t$ seconds)	$80 < t \leq 120$	$120 < t \leq 140$	$140 < t \leq 150$	$150 < t \leq 240$
Frequency	13	26	27	24
$f \cdot x$	520	520	270	2160

- (i) Find the number of students who took 2 minutes 20 seconds or less to complete the puzzle.

$$\begin{aligned} \frac{1}{2} \times 60 &= 30 \\ 13 + 26 &= 39 \end{aligned}$$

120 + 20 = 140 s

..... 39 ..... [1]

- (ii) Calculate an estimate of the mean time taken, in seconds, to complete the puzzle.

$$\begin{aligned} 40 \times 13 &= 520 & f &= 13 + 26 + 27 + 24 \\ 20 \times 26 &= 520 & f &= 90 \\ 10 \times 27 &= 270 \\ 90 \times 24 &= 2160 \\ \hline &3770 \\ \hline \Sigma fx &= 3770 \\ &90 \\ \hline &= 38.5 \text{ s} \end{aligned}$$

3770

..... 38.5 s ..... s [3]

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

1 Instead of calculating the midpoint of the intervals, the candidate calculates the class width of the intervals and attempts to use these to calculate the estimate of the mean. This is a very common error.

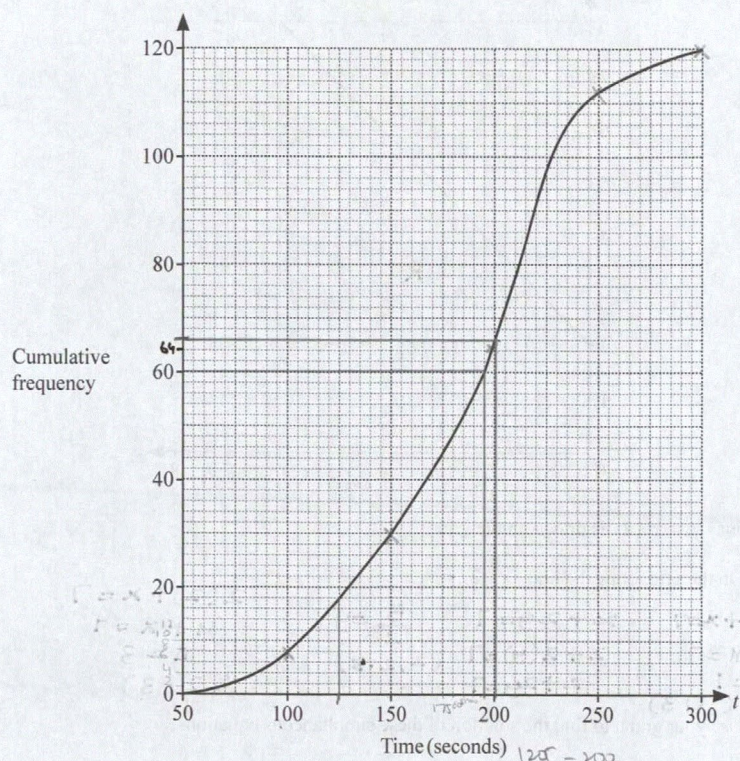
Mark for (a)(ii) = 0 out of 3



## Example Candidate Response 1, continued

## Examiner comments

- (b) A group of adults also completed this puzzle.  
A cumulative frequency diagram for their times is shown.



- (i) Use the cumulative frequency diagram to complete the frequency table.

Time ( $t$ seconds)	$50 < t \leq 100$	$100 < t \leq 150$	$150 < t \leq 200$	$200 < t \leq 250$	$250 < t \leq 300$
Frequency	8	30	64	114	120

[2]

- (ii) Use the cumulative frequency diagram to find an estimate of the median.

.....195..... s [1]

- (iii) 55% of the adults took between 125 seconds and  $k$  seconds to complete the puzzle.

Use the cumulative frequency diagram to find the value of  $k$ .

$$\frac{55 \times 120}{100} = 66 \text{ adults}$$

$k = \dots\dots\dots 200 \dots\dots\dots$  [3]

2 Candidates frequently completed the table by writing the cumulative frequencies. The difference between the way intervals are written in the first row of a cumulative frequency table compared to a frequency table should be noted.

Mark for (b)(i) = 0 out of 2

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

3 The candidate finds the value of  $k$  if 55% of the adults took between 50 seconds and  $k$  seconds. It was extremely common for the answer to be 200. The candidate is awarded M1 for the method of finding 55% of 120.

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

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

## Example Candidate Response 2

## Examiner comments

- 5 (a) A group of students each complete a puzzle.  
The table shows the time,  $t$  seconds, each student took to complete the puzzle.

	100	130	145	195
Time ( $t$ seconds)	$80 < t \leq 120$	$120 < t \leq 140$	$140 < t \leq 150$	$150 < t \leq 240$
Frequency	13	26	27	24

$\frac{26+13}{90} = \frac{39}{90}$

- (i) Find the number of students who took 2 minutes 20 seconds or less to complete the puzzle.

$$\frac{26+13}{90} = \frac{39}{90} \quad 1$$

- (ii) Calculate an estimate of the mean time taken, in seconds, to complete the puzzle.

$$\frac{100 + 130 + 145 + 195}{4} = \frac{570}{4} = 142.5$$

$$\frac{13}{30} \dots \dots \dots [1]$$

$$\frac{142.5}{3.56} \dots \dots \dots \text{ s } [3]$$

1 Reading the requirements of the question is essential for candidates to access the marks. A common error on this question was to give a probability rather than a number of students.

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

2 A common misconception when calculating the estimated mean is to sum the midpoints and divide by the number of intervals. By doing this candidates do not take into consideration the number of students in each interval.

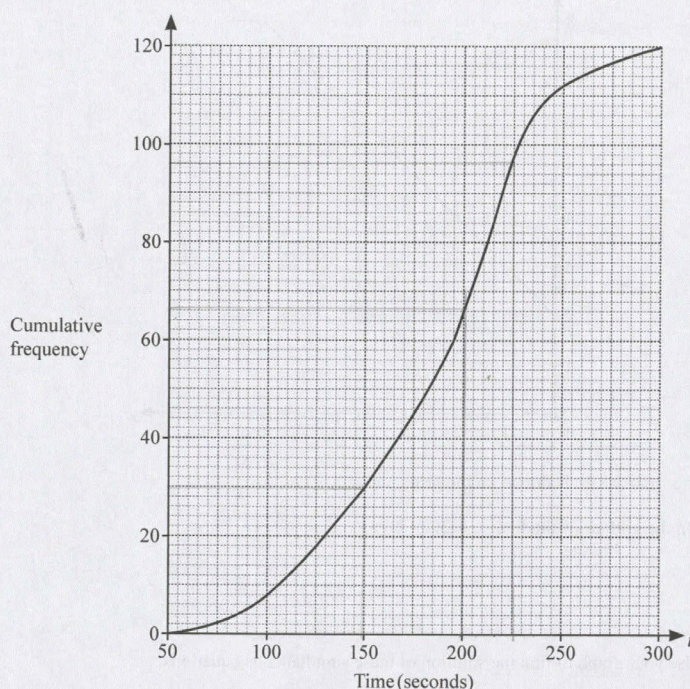
Mark for (a)(ii) = 1 out of 3



## Example Candidate Response 2, continued

## Examiner comments

- (b) A group of adults also completed this puzzle.  
A cumulative frequency diagram for their times is shown.



- (i) Use the cumulative frequency diagram to complete the frequency table.

Time ( $t$ seconds)	$50 < t \leq 100$	$100 < t \leq 150$	$150 < t \leq 200$	$200 < t \leq 250$	$250 < t \leq 300$
Frequency	8	22	42	70	50

3

- (ii) Use the cumulative frequency diagram to find an estimate of the median.

$$\frac{192}{2} = 96^{\text{th}} \text{ element} \quad \dots\dots\dots 225 \dots\dots\dots \text{ s [1]}$$

4

- (iii) 55% of the adults took between 125 seconds and  $k$  seconds to complete the puzzle.

Use the cumulative frequency diagram to find the value of  $k$ .

$$\begin{aligned} & \frac{55 \times 120}{100} \\ & = 66^{\text{th}} \text{ element} \\ & = 200 \text{ seconds} \end{aligned}$$

5

$$k = \dots\dots\dots 200 \dots\dots\dots \text{ s [3]}$$

3 The candidate correctly finds the frequency of 22. It is unclear how the remaining three frequencies have been calculated.

Mark for (b)(i) = 0 out of 2

4 The candidate uses their frequency values in the table in attempting to find an estimate of the median. Using the direction given in the demand was required, in this case using the cumulative frequency diagram.

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

5 This candidate correctly calculates 55% of 120 and then uses the graph to find the time with a cumulative frequency of 66. This was the most common mistake on this part of the question, with many not taking into account the information given about 55% of the adults taking between 125 seconds and  $k$  seconds. The candidate is awarded M1 for the correct method to find 55% of 120.

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

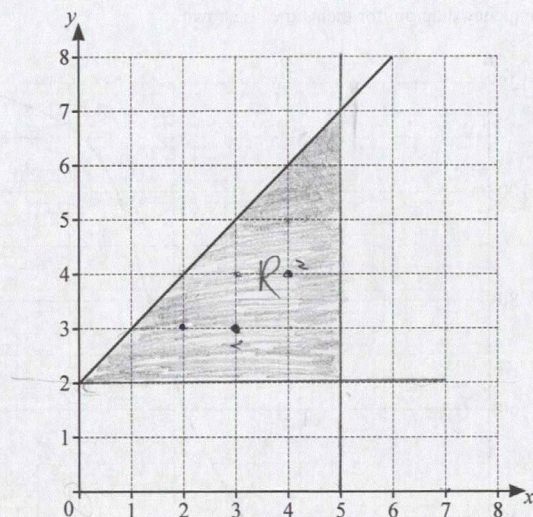
**Total mark awarded =  
2 out of 10**

## Question 6

### Example Candidate Response 1

### Examiner comments

6



The line  $y = x + 2$  is drawn on the grid.

(a) On the grid, draw the line  $x + 2y = 7$ .

[2]

(b) Use your graph to find the solution of these simultaneous equations.

$$\begin{aligned} y &= x + 2 \\ x + 2y &= 7 \end{aligned}$$

$x = 0$   
 $y = 2$  [1]

1 A common wrong line drawn instead of the required line is the one this candidate draws,  $y = 2$ .

Mark for (a) = 0 out of 2

2 Understanding of the graphical solution of simultaneous equations is demonstrated by this candidate, giving the value of  $x$  and the value of  $y$  where their line intersects the given line.

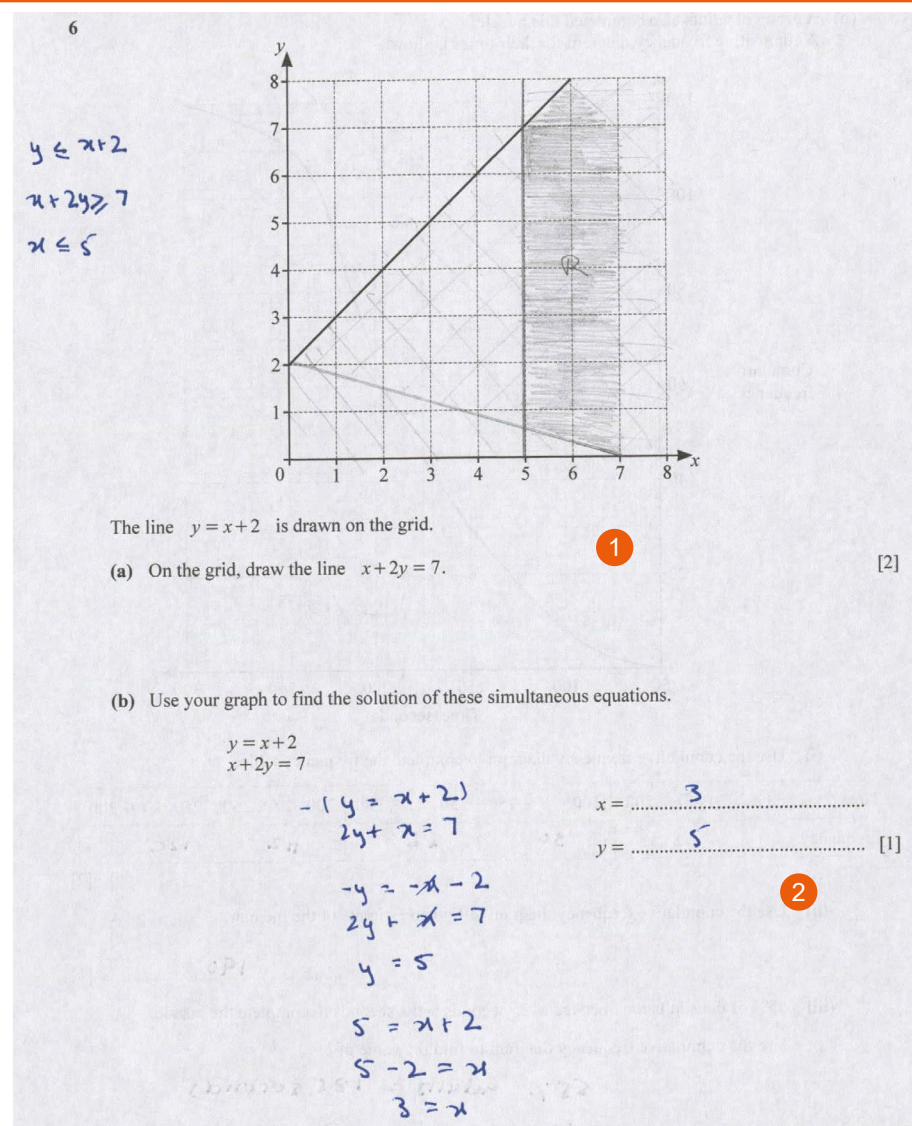
Mark for (b) = 1 out of 1

Example Candidate Response 1, continued	Examiner comments
<p>(c) The region R is defined by these three inequalities.</p> $y \leq x+2 \quad x+2y \geq 7 \quad x \leq 5$ <p>(i) Shade and label region R. <span style="float: right;">3 [2]</span></p> <p>(ii) The point Z is in region R. The x-coordinate and the y-coordinate of point Z are both integers. Point Z does <b>not</b> lie on the boundary of region R.</p> <p>(a) Find the number of possible positions of point Z. <span style="float: right;">4</span></p> <p style="text-align: right;">(3,3) (4,3) (4,4) [1]</p> <p>(b) The y-coordinate of point Z is one more than its x-coordinate. Write down all the possible coordinates for point Z.</p> <p style="text-align: right;">(2,3) (3,4) (4,5) [2]</p>	<p><b>3</b> Following through from the previous error, the candidate is able to identify the region R by shading the correct side of each line.</p> <p>Mark for (c)(i) = 2 out of 2</p> <p><b>4</b> This candidate makes a common error of giving some of the coordinates of the possible positions of Z rather than finding the number of possible positions of Z. Careful reading of the question to 'Find the number of ...', indicates that one number is needed as the answer.</p> <p>Mark for (c)(ii)(a) = 0 out of 1</p> <p>Mark for (c)(ii)(b) = 2 out of 2</p> <p><b>Total mark awarded = 5 out of 8</b></p>



## Example Candidate Response 2

## Examiner comments



1 A common error candidates made when drawing this line was to join (0, 2) to (7, 0). The point (7, 0) is a point on the line, but (0, 2) is not. Making use of the working space provided to calculate at least three points on the line should be encouraged.

Mark for (a) = 0 out of 2

2 Not using the method of solution stated in the question was frequently seen with many candidates using an algebraic method, often leading to errors. A follow through mark for  $x = 0, y = 2$  is available for this candidate if they realised that the point where their line crosses the given line is the graphical solution for simultaneous equations.

Mark for (b) = 0 out of 1

## Example Candidate Response 2, continued

## Examiner comments

(c) The region R is defined by these three inequalities.

$$y \leq x+2 \quad x+2y \geq 7 \quad x \leq 5$$

(i) Shade and label region R.

3

(ii) The point Z is in region R.  
The x-coordinate and the y-coordinate of point Z are both integers.  
Point Z does **not** lie on the boundary of region R.

(a) Find the number of possible positions of point Z.

$$y = x + 2 \quad x = 5$$

$$4 = 4 + 2 \quad 4 < 5$$

$$4 < 6$$

$$x + 2y = 7$$

$$6 + 2(4) = 7$$

$$6 + 8 = 7$$

$$14 > 7$$

$$(6, 2) \quad [1]$$

(b) The y-coordinate of point Z is one more than its x-coordinate.

Write down all the possible coordinates for point Z.

$$y = 1, 2, 3, 4, 5, 6, 7 \quad [2]$$

$$x = 6$$

5

3 This candidate demonstrates a good understanding of the first two inequalities. The line  $x = 5$  is drawn, but the shading is the wrong side of the line for that given inequality. The candidate is awarded B1 for  $x = 5$  drawn.

Mark for (c)(i) = 1 out of 2

4 This candidate gives the coordinates of a possible position of Z in their region. The question asks for the number of possible positions and not the coordinates.

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

5 Candidates frequently gave a list of numbers in answer to this question rather than a list of coordinates which the question asks for.

Mark for (c)(ii)(b) = 0 out of 2

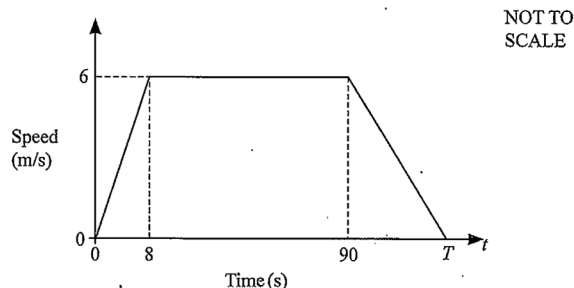
**Total mark awarded =**  
**1 out of 8**

## Question 7

### Example Candidate Response 1

### Examiner comments

7 (a)



The diagram shows the speed–time graph for a cyclist's journey.

- (i) Calculate the acceleration of the cyclist during the first 8 seconds.

$$\text{Acceleration} = \frac{\text{final speed} - \text{initial speed}}{\text{Time Taken}}$$

$$= \frac{6-0}{8} = \frac{3}{4} = 0.75 \text{ m/s}^2 \quad 0.75 \text{ m/s}^2 \quad [1]$$

- (ii) Describe the motion of the cyclist between  $t = 8$  and  $t = 90$ .

It is constant.

- (iii) The total distance travelled by the cyclist during the journey is 558 m.

Find the value of  $T$ .

$$\begin{aligned} \text{A of trapezium} &= \frac{1}{2} \times h \times (\text{sum of parallel sides}) \\ &= \frac{1}{2} \times 6 \times (558 + 98) \\ &= 1968 \end{aligned}$$

$$T = \frac{558}{6}$$

$$T = \frac{558}{6} = 93 \text{ m/s}$$

$$T = 93 \text{ m/s} \quad [3]$$

- (iv) Convert 6 m/s into km/h.

$$\begin{aligned} 1 \text{ min} &= 60 \text{ min} \\ 1 \text{ m} &= 1000 \text{ km} \\ 1 \text{ s} &= 60 \text{ seconds} \end{aligned}$$

$$= 6 \times 60 \times 1000$$

$$= \frac{360000}{1000} = 360 \text{ km/h}$$

$$360 \text{ km/h} \quad [2]$$

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

1 It was common for candidates just to refer to the motion as being constant. In describing the motion it is necessary for candidates to make reference to the speed being constant or the acceleration being zero.

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

2 A common misconception was to assume that the value of  $T$  could be found by dividing the total distance by the maximum speed, resulting in the common answer of 93. Appreciation of distance being the area under a speed-time graph is needed for the candidates to access any marks.

Mark for (a)(iii) = 0 out of 3

3 The candidate finds the speed in metres per minute. Conversion to kilometres per minute is required for a method mark.

Mark for (a)(iv) = 0 out of 2

## Example Candidate Response 1, continued

## Examiner comments

- (b) A car travels 352 km, correct to the nearest kilometre.  
The time taken to travel this distance is 4.2 hours, correct to the nearest 0.1 hour.

Calculate the upper bound for the average speed of the car.

~~352.5 km (upper bound for distance)~~

⊕

$$1 \div 2 = 0.5$$

$$\text{Upper bound for Distance} \\ = 352 + 0.5 = 352.5 \text{ km}$$

$$0.1 \div 2 = 0.05$$

$$\text{Upper bound for time} \\ = 4.2 + 0.05 = 4.25 \text{ hrs}$$

$$\text{Avg speed} = \frac{\text{Distance}}{\text{Time}}$$

$$= \frac{352.5}{4.25}$$

$$= 82.941 \text{ km/h}$$

$$82.941 \text{ km/h [3]}$$

4

4 The candidate demonstrates understanding of both a distance written to the nearest kilometre and a time to the nearest 0.1 hours and is awarded B1 for 352.5 seen. The common error when finding the upper bound for the average speed is to use the upper bound for both the distance and the time. When the calculation is a division, the upper bound is found by dividing an upper bound by a lower bound. Here M1 is awarded for the division with their bounds.

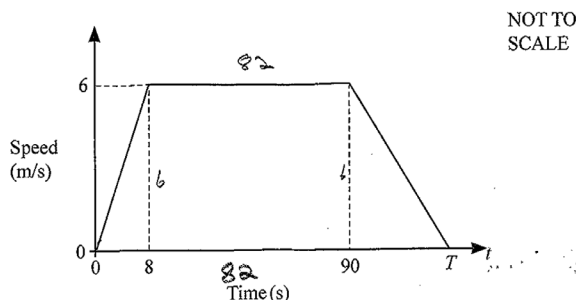
Mark for (b) = 2 out of 3

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

## Example Candidate Response 2

## Examiner comments

(a)



The diagram shows the speed-time graph for a cyclist's journey.

(i) Calculate the acceleration of the cyclist during the first 8 seconds.

$$a = \frac{6-0}{8-0} = 0.75 \quad \dots\dots\dots 0.75 \text{ m/s}^2 \quad [1]$$

(ii) Describe the motion of the cyclist between  $t = 8$  and  $t = 90$ .

constant 1 [1]

(iii) The total distance travelled by the cyclist during the journey is 558 m.

Find the value of  $T$ .

$$558 = (8 \times 6) + (82 \times 6) + \frac{1}{2} \times (90 - T) \times 6$$

$$558 = 48 + 492 + 270 - 3T$$

$$558 - 810 = -3T$$

$$\frac{-252}{-3} = T$$

$$T = 84 \quad \dots\dots\dots [3]$$

(iv) Convert 6 m/s into km/h.

$$\frac{6000}{3600} = 1.66$$

$$\dots\dots\dots 1.6 \text{ km/h} \quad [2]$$

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

**1** The candidate needs to refer to the speed being constant to give an adequate description on the motion. This was a common description candidates gave.

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

**2** This candidate makes some attempt to relate the distance to the area under the speed-time graph. The area of the middle rectangle is correct and is awarded M1. Two mistakes are seen: the first area being taken as a rectangle and the base of the last triangle written as  $90 - T$ . The latter was a common error usually resulting in an answer of 76.

Mark for (a)(iii) = 1 out of 3

**3** The candidate makes the common error of multiplying by 1000 and dividing by 3600, instead of dividing by 1000 and multiplying by 3600.

Mark for (a)(iv) = 0 out of 2



## Example Candidate Response 2, continued

## Examiner comments

- (b) A car travels 352 km, correct to the nearest kilometre.  
The time taken to travel this distance is 4.2 hours, correct to the nearest 0.1 hour.

Calculate the upper bound for the average speed of the car.

$$[352 + 0.5] \div [4.2 + 0.05]$$

$$(352.5) \div (4.25)$$

\* upper bound of distance = 352.5  
upper bound of time = 4.25

$$\text{Average speed} = \frac{352.5}{4.25}$$

$$\text{Average speed} = 82.94$$

$$\text{upper bound of average speed} = 82.94$$

4

4 The candidate gives the correct upper bound for the distance and is awarded B1. However, although they know the formula to calculate the average speed, they are unable to deal correctly with the given accuracy of the time.

Mark for (b) = 1 out of 3

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

## Question 8

### Example Candidate Response 1

### Examiner comments

- 8 (a) The matrix  $A$  satisfies the following equation.

$$\begin{pmatrix} 2 & 3 \\ 5 & 2 \end{pmatrix} - 3A = \begin{pmatrix} 5 & 3 \\ -4 & -1 \end{pmatrix}$$

Find  $A$ .

$$\begin{pmatrix} 2 & 3 \\ 5 & 2 \end{pmatrix} - \begin{pmatrix} 5 & 3 \\ -4 & -1 \end{pmatrix} = 3A$$

$$\frac{\begin{pmatrix} 3 & 0 \\ 9 & 3 \end{pmatrix}}{3} = A$$

$$A = \begin{pmatrix} 1 & 0 \\ 3 & 1 \end{pmatrix} \quad [2]$$

**1** This candidate shows the correct method to find the matrix  $A$ . An arithmetic mistake is made with one of the elements, which was a common error, usually with one of the elements in the first column. B1 is awarded for 3 correct elements in the final answer.

Mark for (a) = 1 out of 2

(b)  $B = \begin{pmatrix} 2 & -2 \\ 4 & p \end{pmatrix}$

The determinant of  $B$  is 2.

Find the value of  $p$  and hence write down  $B^{-1}$ .

$$2p - (-2 \times 4)$$

$$2 = 2p + 8$$

$$\begin{aligned} -6 &= 2p \\ \frac{-6}{2} &= p \\ p &= -3 \end{aligned}$$

$$B^{-1} = \frac{1}{2} \begin{pmatrix} 2 & -2 \\ 4 & -3 \end{pmatrix} \quad [3]$$

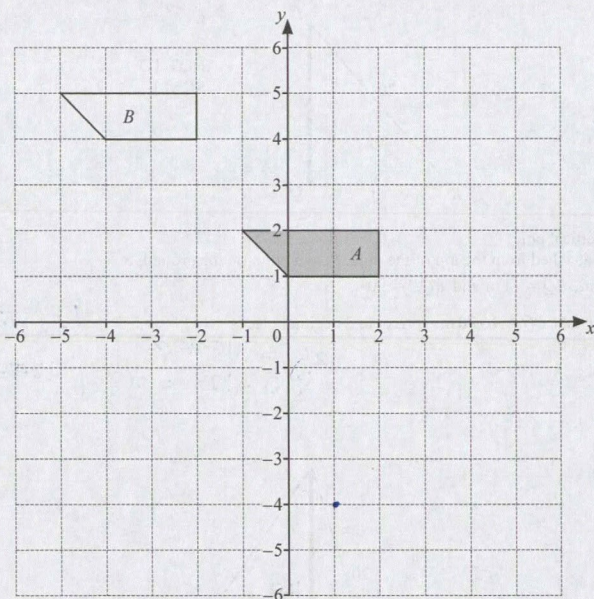
**2** The given determinant is used correctly to find the value of  $p$ . When finding the inverse of matrix  $B$ , this candidate uses the determinant correctly, however does not find the adjoint of matrix  $B$ . B2 is awarded for  $p = -3$ .

Mark for (b) = 2 out of 3

## Example Candidate Response 1, continued

## Examiner comments

(c)



The diagram shows shape  $A$  and shape  $B$ .

- (i) Describe fully the **single** transformation that maps shape  $A$  onto shape  $B$ .

*Translation*

[2]

- (ii) The transformation represented by the matrix  $\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$  maps shape  $A$  onto shape  $C$ .

Draw and label shape  $C$ .

[2]

$$\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix} \begin{pmatrix} -1 \\ 2 \end{pmatrix} = \begin{pmatrix} 2 \\ -4 \end{pmatrix}$$

$$\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix} \begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 0 \\ -2 \end{pmatrix}$$

3 It was common for candidates to know that the required transformation is a translation. Many, like this candidate, did not give the required vector or gave an incorrect vector.

Mark for (c)(i) = 1 out of 2

4 This candidate uses the matrix correctly to find (and not replace) two of the coordinates of shape  $C$ . To access any marks at least one more point is required.

Mark for (c)(ii) = 0 out of 2

**Total mark awarded =  
4 out of 9**

## Example Candidate Response 2

## Examiner comments

- 8 (a) The matrix  $A$  satisfies the following equation.

$$\begin{pmatrix} 2 & 3 \\ 5 & 2 \end{pmatrix} - 3A = \begin{pmatrix} 5 & 3 \\ -4 & -1 \end{pmatrix}$$

Find  $A$ .

$$\begin{aligned} \begin{pmatrix} 2 & 3 \\ 5 & 2 \end{pmatrix} - 3A &= \begin{pmatrix} 5 & 3 \\ -4 & -1 \end{pmatrix} \\ -3A &= \begin{pmatrix} 5 & 3 \\ -4 & -1 \end{pmatrix} - \begin{pmatrix} 2 & 3 \\ 5 & 2 \end{pmatrix} \\ -3A &= \begin{pmatrix} 5-2 & 3-3 \\ -4-5 & -1-2 \end{pmatrix} \\ -3A &= \begin{pmatrix} 3 & 0 \\ -9 & -3 \end{pmatrix} \\ A &= \begin{pmatrix} 3/-3 & 0/-3 \\ -9/-3 & -3/-3 \end{pmatrix} \Rightarrow \begin{pmatrix} -1 & 0 \\ 3 & 1 \end{pmatrix} \quad A = \begin{pmatrix} -1 & 0 \\ -3 & 1 \end{pmatrix} \quad [2] \end{aligned}$$

(b)  $B = \begin{pmatrix} 2 & -2 \\ 4 & p \end{pmatrix}$

The determinant of  $B$  is 2.

Find the value of  $p$  and hence write down  $B^{-1}$ .

$$\begin{aligned} \frac{1}{2} \begin{pmatrix} p & 2 \\ -4 & 2 \end{pmatrix} \quad \text{determinant} = ad - bc \\ 2p - 8 = 2 \\ 2p = 2 + 8 \\ p = \frac{10}{2} \\ p = 5 \end{aligned}$$

$$\begin{pmatrix} p/2 & 1 \\ -2 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 5/2 & 1 \\ -2 & 1 \end{pmatrix}$$

$$B^{-1} = \begin{pmatrix} 5/2 & 1 \\ -2 & 1 \end{pmatrix} \quad [3]$$

1 The correct method is seen for finding matrix  $A$ . It was common for an error to be made with one of the elements, in this case when dividing by  $-3$ . B1 is awarded for 3 correct elements in the final answer.

Mark for (a) = 1 out of 2

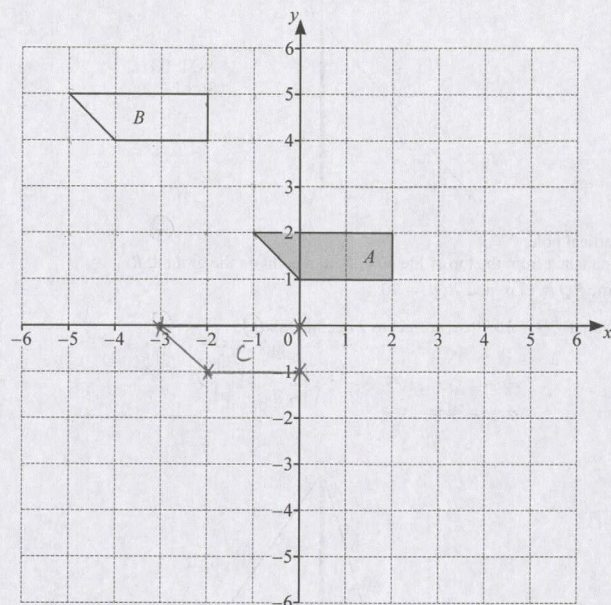
2 A common error when trying to find the matrix was to write the determinant of  $B$  as  $2p - 8$ , leading to  $p = 5$ . This candidate is able to follow through their mistake correctly, using the determinant and their adjoint matrix and is awarded B1.

Mark for (b) = 1 out of 3

## Example Candidate Response 2, continued

## Examiner comments

(c)



The diagram shows shape *A* and shape *B*.

- (i) Describe fully the **single** transformation that maps shape *A* onto shape *B*.

Translation <sup>translation</sup> from factor  $\begin{pmatrix} -4 \\ 3 \end{pmatrix}$  [2]

- (ii) The transformation represented by the matrix  $\begin{pmatrix} -2 & 0 \\ 0 & -2 \end{pmatrix}$  maps shape *A* onto shape *C*.

Draw and label shape *C*.

3 [2]

3 It was common to see candidates drawing shape *C* the same size as shape *A*. This candidate, like many, assumes the given matrix represents a translation 2 to the left and 2 down.

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

Mark for (c)(ii) = 0 out of 2

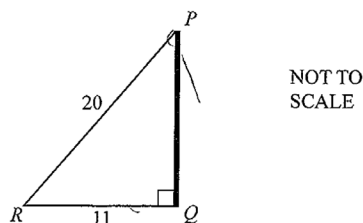
**Total mark awarded =  
4 out of 9**

## Question 9

### Example Candidate Response 1

### Examiner comments

9



$PQ$  is a vertical pole.

A rope is attached from the top of the pole,  $P$ , to a point on the ground,  $R$ .  
 $PR = 20$  m,  $RQ = 11$  m and  $\angle RQP = 90^\circ$ .

(a) Show that  $PQ = 16.70$  m, correct to 2 decimal places.

by pythagoras theorem

$$H^2 = b^2 + c^2$$

$$20^2 = 11^2 + x^2$$

(b)

$$20^2 = 11^2 + x^2$$

$$20^2 - 11^2 =$$

$$279$$

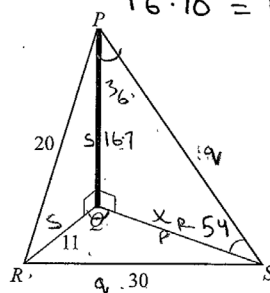
1

$$20^2 - 11^2 = x^2$$

$$\sqrt{279} = x$$

[2]

$$16.70 = PQ$$



$$a^2 = b^2 + c^2 - 2bc \cos A$$

SAS SSS

ASA SSA

A second rope is attached from  $P$  to a point  $S$ .

$\angle QPS = 90^\circ$  and  $RS = 30$  m.

The angle of elevation of  $P$  from  $S$  is  $36^\circ$ .

Calculate  $\angle RQS$ .  $\angle PSQ = 180 - 90 - 36 = 54$

first find  $QS$  through sine rule

$QS$ :

$$\frac{P}{\sin(36)} = \frac{16.7}{\sin(54)}$$

$$P \sin(54) = 9.8$$

$$P = \frac{9.8}{\sin(54)}$$

$$PQS = 12.11$$

$$\frac{P}{\sin(36)} = \frac{16.7}{\sin(54)}$$

2

$$QS = 12.11$$

now through cosine rule find  $\angle RQS$

$$\cos(\theta) = \frac{S^2 + R^2 - Q^2}{2SR}$$

$$295$$

$$-2.3$$

$$\cos Q = \frac{11^2 + 12.11^2 - 30^2}{2(11)(12.11)}$$

$$= -2.3$$

$$\angle RQS = \dots \dots \dots -2.3 \dots \dots \dots [5]$$

1 The correct method for calculating  $PQ$  is shown in the working. The candidate makes the extremely common error of not writing the value of  $PQ$  to at least 3 decimal places. To access full marks when being required to show a value to a given accuracy, candidates need to show a value to greater accuracy than that given in the demand.

Mark for (a) = 1 out of 2

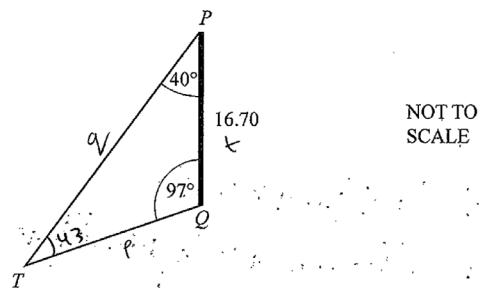
2 The candidate incorrectly places the angle of elevation in triangle  $PQS$  resulting in  $QS = 12.11$ . This value was frequently seen for  $QS$ , either from the given error or from a misapplication of the tangent formula, with the angle of elevation correctly placed. Their value of  $QS$  is then applied correctly into the explicit form of the cosine rule for  $\cos Q$ . The candidate is awarded M2 for the correct use of cosine rule with their  $QS$ .

Mark for (b) = 2 out of 5

## Example Candidate Response 1, continued

## Examiner comments

(c)



A third rope is attached from  $P$  to a point  $T$ .  
 $\angle TPQ = 40^\circ$  and  $\angle PQT = 97^\circ$ .

Calculate  $PT$ .

- sine rule

$$\frac{q}{\sin(97)} = \frac{16.7}{\sin(43)} \quad \left| \quad \begin{array}{l} q = 24.3 \\ PT = 24.3 \end{array} \right.$$

$$\begin{aligned} \angle PTQ &= 180 - (97 + 40) \\ &= 43 \end{aligned}$$

$$q \sin(43) = 16.6$$

$$q = \frac{16.6}{\sin(43)}$$

$$PT = 24.3 \text{ m [4]}$$

Mark for (c) = 4 out of 4

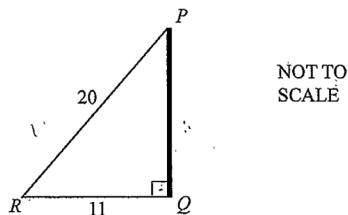
Total mark awarded =  
7 out of 11



## Example Candidate Response 2

## Examiner comments

9



$PQ$  is a vertical pole.

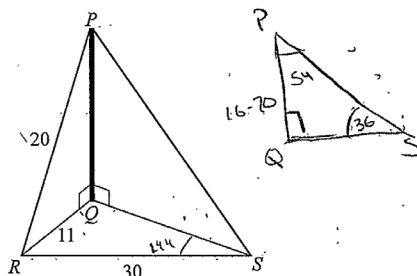
A rope is attached from the top of the pole,  $P$ , to a point on the ground,  $R$ .

$PR = 20$  m,  $RQ = 11$  m and  $\angle PQR = 90^\circ$ .

(a) Show that  $PQ = 16.70$  m, correct to 2 decimal places.

$$\begin{aligned} 20^2 &= 11^2 + a^2 \\ 400 &= 121 + a^2 \\ 400 - 121 &= a^2 \\ 279 &= a^2 \\ \sqrt{279} &= a \\ 16.7032 &= a \end{aligned} \quad \begin{array}{l} = 16.70 \\ [2] \end{array}$$

(b)



A second rope is attached from  $P$  to a point  $S$ .

$\angle PQR = 90^\circ$  and  $RS = 30$  m.

The angle of elevation of  $P$  from  $S$  is  $36^\circ$ .

Calculate  $\angle RQS$ .

$$\begin{aligned} \frac{\sin Q}{30} &= \frac{\sin 144}{11} \\ 11 \sin Q &= 30 \sin 144 \\ &= 17.6335 \\ \sin Q &= 1.6030 \\ \text{which is } > 1 \end{aligned}$$

$\angle RQS = \dots\dots\dots$  [5]

Mark for (a) = 2 out of 2

1 The candidate makes a wrong assumption that angle  $QSR$  can be calculated by subtracting  $36$  (the angle of elevation) from  $180$ .

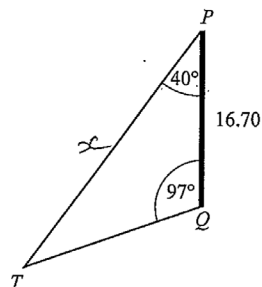
Mark for (b) = 0 out of 5



## Example Candidate Response 2, continued

## Examiner comments

(c)

NOT TO  
SCALEA third rope is attached from  $P$  to a point  $T$ . $\angle TPQ = 40^\circ$  and  $\angle PQT = 97^\circ$ .Calculate  $PT$ .

$$\frac{\sin 97}{x} = \frac{\sin 40}{16.70}$$

$$16.70 \sin 97 = x \sin 40$$

$$16.5755 = x (0.6427)$$

$$\frac{16.5755}{0.6427} = x$$

$$25.790 = x$$

$$PT = 25.790 \text{ m [4]}$$

2

2 The candidate assumes that the given values can be used in the sine rule to calculate  $PT$ , either by assuming the triangle is isosceles or by misapplying the sine rule. This was a common error made by the candidates, failing to realise that angle  $PTQ$  could be calculated by considering the angle sum of a triangle.

Mark for (c) = 0 out of 4

Total mark awarded =  
2 out of 11

## Question 10

### Example Candidate Response 1

### Examiner comments

10  $D$  is the point  $(4, 6)$  and  $E$  is the point  $(e, e)$ .

(a) The length of  $DE$  is  $\sqrt{20}$ .

Form an equation in  $e$  and solve it to find the possible coordinates of  $E$ .  
Show your working.

$$DE = \sqrt{(4-e)^2 + (6-e)^2}$$

$$\sqrt{20} = \sqrt{(4-e)^2 + (6-e)^2}$$

$$20 = 16 - 4e + e^2 + 36 - 6e + e^2$$

$$2e^2 - 20e + 52 = 20$$

$$2e^2 - 20e + 32 = 0$$

$$2(e^2 - 10e + 16) = 0$$

$$e^2 - 8e - 2e + 16 = 0$$

$$e(e-8) - 2(e-8) = 0$$

$$(e-2)(e-8) = 0$$

$$e-2=0 \quad e-8=0$$

$$e=2 \quad \text{or} \quad e=8$$

(.....2....., .....8.....) or (.....8....., .....2.....) [5]

1 This candidate starts again from the second line and correctly works out the values of  $e$ . Frequently candidates did not give coordinates of the form  $(e, e)$  for the final answer, instead using one of each value in the coordinates, as seen in these answers.

Mark for (a) = 4 out of 5

## Example Candidate Response 1, continued

## Examiner comments

- (b)
- $F$
- is the point
- $(-f, 5f)$
- .
- $(4, 6)$

The gradient of the perpendicular bisector of  $DF$  is  $\frac{3}{2}$ .

- (i) Find the value of
- $f$
- .

$$\frac{6-5f}{4-(-f)} = \frac{3}{2}$$

$$12-10f = 12+3f$$

$$0 = 13f$$

$$f = 0$$

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

checking

$$m = \frac{y_2 - y_1}{x_2 - x_1}$$

$$= \frac{6-0}{4-0}$$

$$= \frac{6}{4} = \frac{3}{2}$$

2

2 This candidate finds a correct algebraic expression for the gradient of  $DF$  to earn M1. This is then equated to the gradient of the perpendicular of  $DF$ , which was a common error.

Mark for (b)(i) = 1 out of 4

$$f = \dots\dots\dots 0 \dots\dots\dots [4]$$

- (ii) The equation of the perpendicular bisector of
- $DF$
- is
- $2y = 3x + k$
- .

Find the value of  $k$ .

$$2(6) = 3(4) + k$$

$$12 = 12 + k$$

$$k = 12 - 12$$

$$= 0$$

putting coordinates of D.

3

3 When attempting to find the value of  $k$ , this candidate makes a common error of using the coordinates of  $D$  in the equation rather than the coordinates of the midpoint of  $DF$ .

Mark for (b)(ii) = 0 out of 3

$$k = \dots\dots\dots 0 \dots\dots\dots [3]$$

Total mark awarded =  
5 out of 12

## Example Candidate Response 2

## Examiner comments

10  $D$  is the point  $(4, 6)$  and  $E$  is the point  $(e, e)$ .

(a) The length of  $DE$  is  $\sqrt{20}$ .

Form an equation in  $e$  and solve it to find the possible coordinates of  $E$ .  
Show your working.

1

$$\sqrt{20}^2 = (e-4)^2 + (e-6)^2$$

$$20^2 = e^2 + 16 + e^2 + 36$$

$$400 = 52 + 2e^2$$

$$400 - 52 = 2e^2$$

$$\frac{348}{2} = e^2$$

$$\sqrt{174} = e$$

$$13.19 = e$$

$$\text{with } 13 = e$$

$$= 20^2 = (13-4)^2 + (e-6)^2$$

$$20^2 = 81 + e^2 + 36$$

$$20^2 = 117 + e^2$$

$$400 - 117 = e^2$$

$$283 = e^2$$

$$\sqrt{283} = e$$

$$16.8 = e$$

$$\text{or } 17 = e$$

$$(17, 17)$$

$$(\dots, \dots, 13) \text{ or } (\dots, \dots, 13.19)$$

1 The correct algebraic expression is seen for the square of  $DE$ . A common error when expanding  $(e - 4)^2$  was to write  $e^2 + 16$ . This candidate also incorrectly equates this to 400 instead of 20.

Mark for (a) = 1 out of 5

## Example Candidate Response 2, continued

## Examiner comments

(b)  $F$  is the point  $(-f, 5f)$ .

The gradient of the perpendicular bisector of  $DF$  is  $\frac{3}{2}$ .

(i) Find the value of  $f$ .

$$m_1 \times m_2 = -1$$

$$m_1 \times \frac{3}{2} = -1$$

$$m_1 = -\frac{2}{3}$$

2

Gradient  $\therefore$

$$\frac{-2}{3} \neq \frac{5f}{-f}$$

$$-2(-f) = 3(5f)$$

$$2f = 15f$$

$$f = \frac{15}{2}$$

$$f = \dots\dots\dots 7.5 \dots\dots\dots [4]$$

(ii) The equation of the perpendicular bisector of  $DF$  is  $2y = 3x + k$ .

Find the value of  $k$ .

$$7.5(5) = 3(-7.5) + k$$

$$37.5 = -22.5 + k$$

$$37.5 + 22.5 = k$$

$$60 = k$$

3

$$k = \dots\dots\dots 60 \dots\dots\dots [3]$$

2 The candidate calculates the correct gradient of  $DF$  to earn B1. They then make a common error giving the algebraic expression for the gradient of  $DF$  as  $5f/(-f)$ , coming from use of the coordinates of  $F$  and no use of the coordinates of  $D$ .

Mark for (b)(i) = 1 out of 4

3 The candidate makes the common error of attempting to find the value of  $k$  when the perpendicular line is through  $F$ . They also make a further error, missing the 2 on the left-hand side of the equation. Use of the midpoint of  $DF$  is required for the perpendicular bisector.

Mark for (b)(ii) = 0 out of 3

**Total mark awarded =**  
**2 out of 12**

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