

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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# GCSE MATHEMATICS

# H

Higher Tier

Paper 3 Calculator

Tuesday 13 June 2017

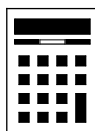
Morning

Time allowed: 1 hour 30 minutes

## Materials

For this paper you must have:

- a calculator
- mathematical instruments.



## Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

## Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.

## Advice

- In all calculations, show clearly how you work out your answer.

For Examiner's Use

Pages	Mark
2–3	
4–5	
6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24–25	
26	
<b>TOTAL</b>	



J U N 1 7 8 3 0 0 3 H 0 1

Answer **all** questions in the spaces provided

**1**  $\mathbf{a} = \begin{pmatrix} -4 \\ -1 \end{pmatrix}$  and  $\mathbf{b} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$

Circle the vector  $2\mathbf{a} + \mathbf{b}$

[1 mark]

$$\begin{pmatrix} -5 \\ -3 \end{pmatrix}$$

$$\begin{pmatrix} -11 \\ -3 \end{pmatrix}$$

$$\begin{pmatrix} -5 \\ -1 \end{pmatrix}$$

$$\begin{pmatrix} -11 \\ -1 \end{pmatrix}$$

**2** Which of these values of  $n$  makes  $2.7 \times 10^n$  a cube number?

Circle your answer.

[1 mark]

0

1

2

3

**3** Rearrange  $2x = \frac{y}{w}$  to make  $w$  the subject.

Circle your answer.

[1 mark]

$$w = \frac{2y}{x}$$

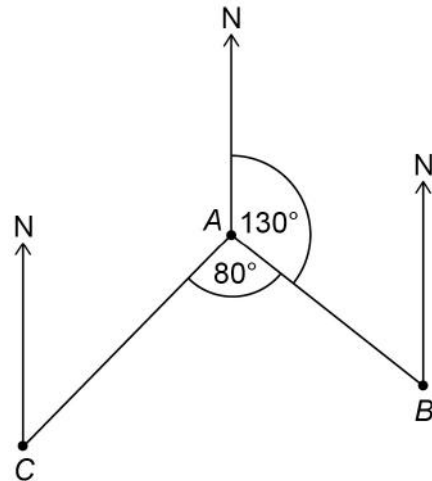
$$w = \frac{2x}{y}$$

$$w = \frac{y}{2x}$$

$$w = \frac{x}{2y}$$



4

Not drawn  
accurately

Work out the bearing of C from A.

Circle your answer.

[1 mark]

030°

130°

150°

210°

Turn over for the next question

Turn over ►



- 5** A coin lands on Tails 200 times.  
The relative frequency of Tails is 0.4  
Work out the number of times the coin was thrown.

**[2 marks]**

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Answer \_\_\_\_\_

- 6** How are the whole number solutions to A and B different?

A            Solve     $3 \leq 3x < 18$

B            Solve     $3 < 3x \leq 18$

**[2 marks]**

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**7 (a)** The length of a pipe is 6 metres to the nearest metre.

Complete the error interval for the length of the pipe.

**[2 marks]**

Answer \_\_\_\_\_ m  $\leq$  length < \_\_\_\_\_ m

**7 (b)** The length of a different pipe is 4 metres to the nearest metre.

Olly says,

“The total length of the two pipes is 11 metres to the nearest metre.”

Give an example to show that he could be correct.

**[2 marks]**

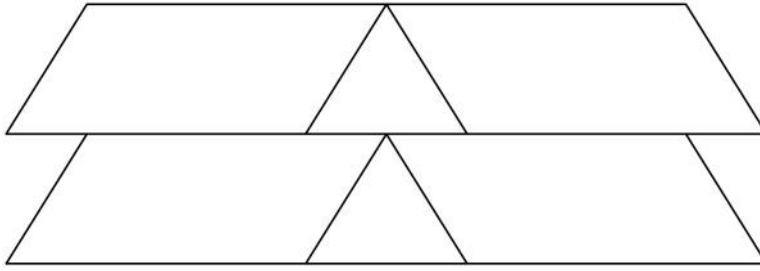
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**Turn over for the next question**



- 8** This shape is made from two triangles and four congruent parallelograms.



Not drawn  
accurately

For each statement, tick the correct box.

- 8 (a)** The triangles are equilateral.

[1 mark]

☐

Must be true

☐

Could be true

☐

Must be false

- 8 (b)** The triangles are congruent.

[1 mark]

☐

Must be true

☐

Could be true

☐

Must be false



- 9** There are 720 boys and 700 girls in a school.

The probability that a boy chosen at random studies French is  $\frac{2}{3}$

The probability that a girl chosen at random studies French is  $\frac{3}{5}$

- 9 (a)** Work out the number of students in the school who study French.

**[3 marks]**

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Answer \_\_\_\_\_

- 9 (b)** Work out the probability that a student chosen at random from the whole school does **not** study French.

**[2 marks]**

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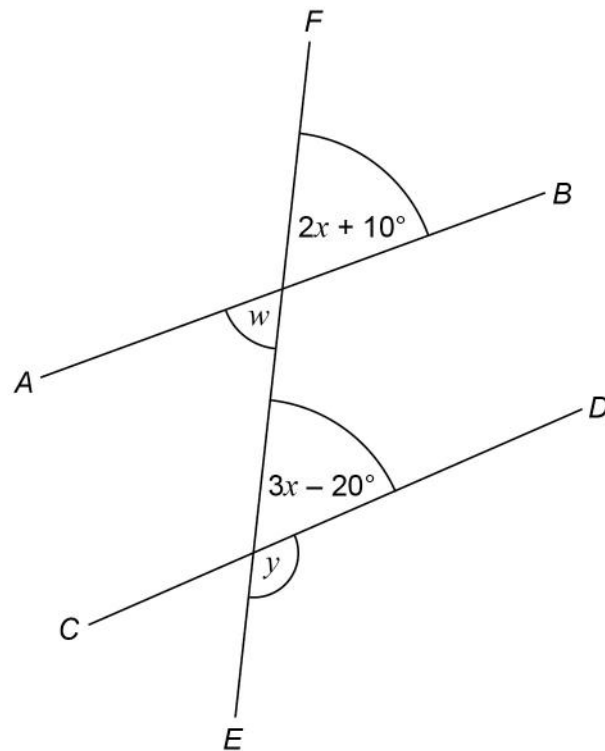
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Answer \_\_\_\_\_

**Turn over for the next question**



- 10**  $AB$ ,  $CD$  and  $EF$  are straight lines.



Not drawn  
accurately

- 10 (a)** Ava assumes that  $AB$  and  $CD$  are parallel.

What answer should she get for the size of angle  $y$ ?

**[4 marks]**

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Answer \_\_\_\_\_ degrees





**10 (b)**

In fact,

 $AB$  and  $CD$  are **not** parallelangle  $w$  is  $60^\circ$ What effect does this have on the size of angle  $y$ ?

Tick a box.

☐ $y$  is bigger☐ $y$  is the same☐ $y$  is smaller

Show working to support your answer.

**[3 marks]**

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**Turn over for the next question****Turn over ►**

- 11** Purple paint is made by mixing red paint and blue paint in the ratio 5 : 2  
Yan has 30 litres of red paint and 9 litres of blue paint.

What is the **maximum** amount of purple paint he can make?

**[3 marks]**

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Answer \_\_\_\_\_ litres

- 12**  $(ar^b)^4 = 16r^{20}$  where  $a$  and  $b$  are positive integers.

Work out  $a$  and  $b$

**[2 marks]**

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$a =$  \_\_\_\_\_  $b =$  \_\_\_\_\_



13

In a class of 28 students

the mean height of the 12 boys is 1.58 metres

the mean height of all 28 students is 1.52 metres.

Work out the mean height of the girls.

**[4 marks]**


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Answer \_\_\_\_\_ metres

14

 $xy = c$  where  $c$  is a constant.

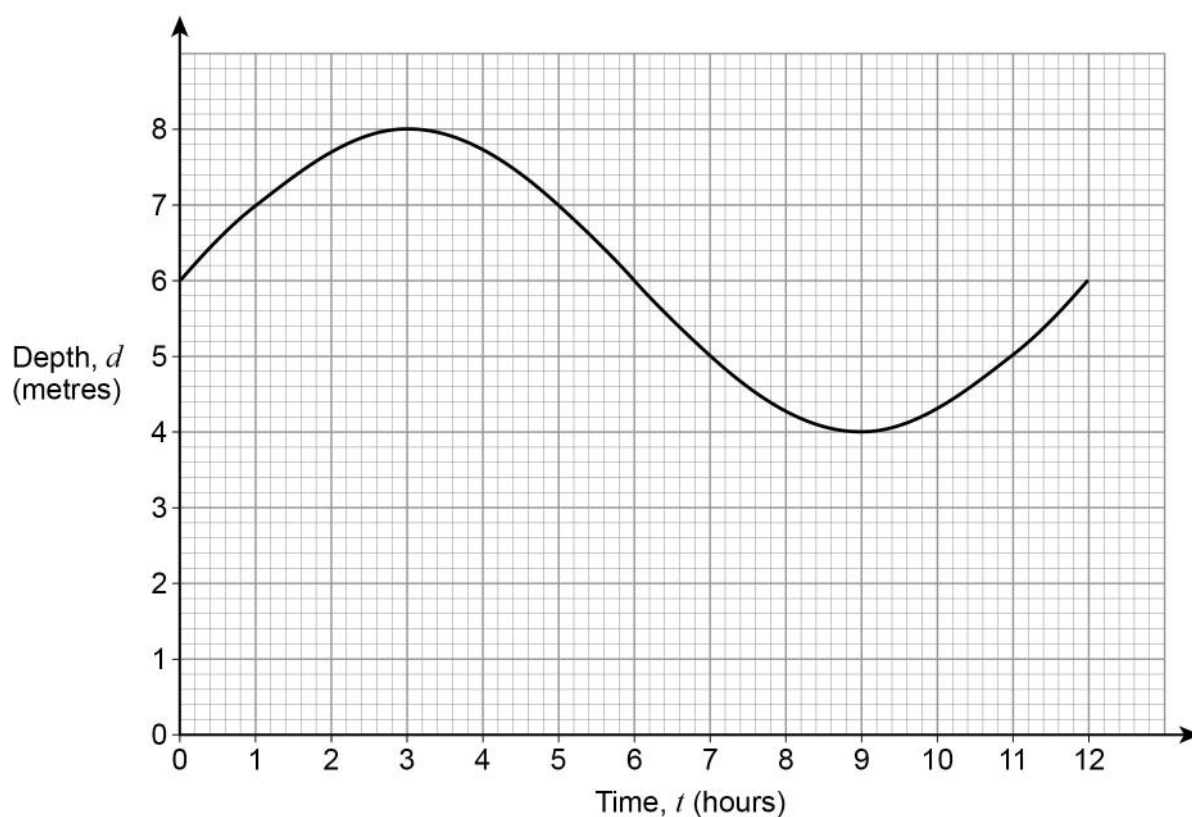
Circle the correct statement.

**[1 mark]** $y$  is directly proportional to  $x$  $y$  is directly proportional to  $\frac{1}{x}$  $y$  is inversely proportional to  $\frac{1}{x}$  $x$  is directly proportional to  $y$ **Turn over for the next question**

- 15** The graph shows the depth of water in a harbour for 12 hours.

$d$  is the depth of water in a harbour in metres

$t$  is the number of hours after 9 am



- 15 (a)** For how many of the 12 hours is the depth more than 5 metres?

[1 mark]

Answer \_\_\_\_\_

- 15 (b)** By how much does the depth change between 12 noon and 4 pm?

[1 mark]

Answer \_\_\_\_\_ metres



**16**

The value of a new car is £18 000

The value of the car decreases by

25% in the first year

12% in each of the next 4 years.

Work out the value of the car after 5 years.

**[3 marks]**

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Answer £ \_\_\_\_\_

**Turn over for the next question**



Liam drives his car.

He then drives at an average speed of 70 miles per hour for 1 hour 36 minutes.

He finds this information about his car.

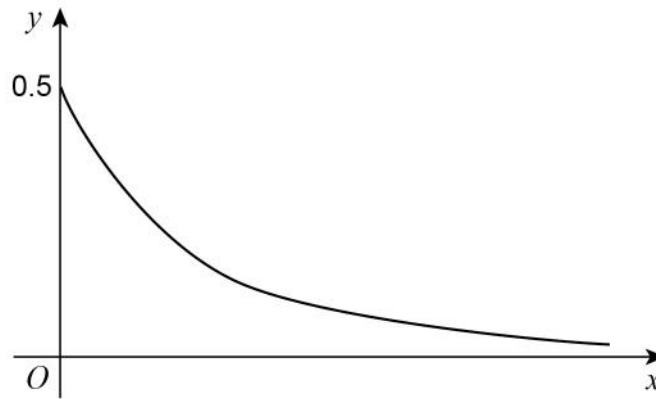
Average speed	Miles travelled per gallon
65 miles per hour or less	50
More than 65 miles per hour	40

Use the information to show that his car uses less than 3 gallons of petrol for the drive.

**[5 marks]**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 18 Nick sketches the graph of  $y = 0.5^x$  for  $x \geq 0$



Make **one** criticism of his sketch.

[1 mark]

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Turn over for the next question

Turn over ►

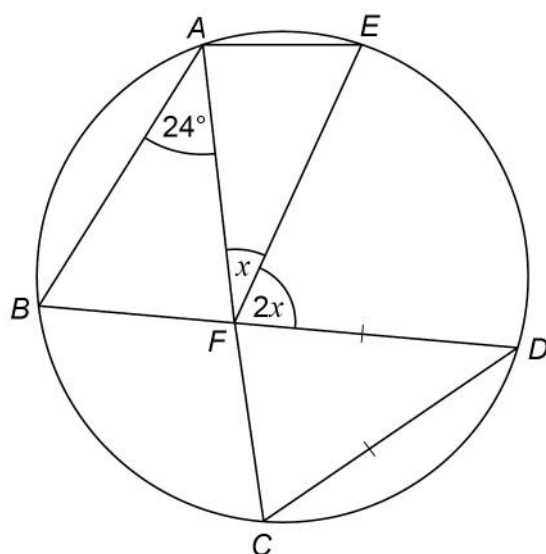


19

$A, B, C, D$  and  $E$  are points on a circle.

$BFD$  and  $AFC$  are straight lines.

$DC = DF$



Not drawn  
accurately

Work out the size of angle  $x$ .

You **must** show your working which may be on the diagram.

[4 marks]

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Answer \_\_\_\_\_ degrees





20

This sign shows when a lift is safe to use.

Total mass of people must be 450 kg or less

Ben and some other people are in the lift.

Their total mass is 525 kg to the nearest 5 kg

Ben gets out.

He has a mass of 78 kg to the nearest kg

Is the lift now safe to use?

You **must** show your working.

[4 marks]

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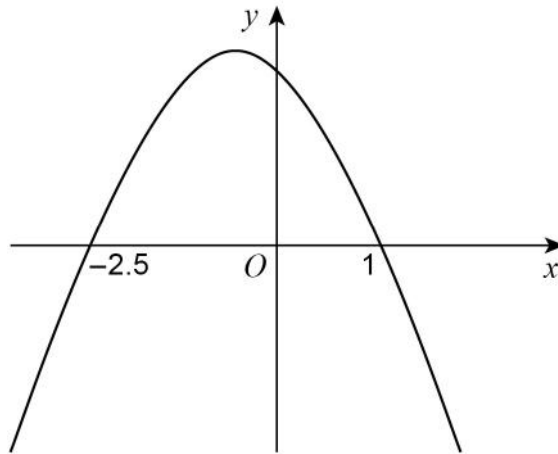
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Answer \_\_\_\_\_

Turn over for the next question



- 21** Here is a sketch of  $y = f(x)$  where  $f(x)$  is a quadratic function.  
The graph intersects the  $x$ -axis where  $x = -2.5$  and  $x = 1$



Not drawn  
accurately

Circle the solution of  $f(x) > 0$

**[1 mark]**

$x < -2.5$  or  $x > 1$

$x > -2.5$  or  $x > 1$

$-2.5 < x < 1$

$x > -2.5$  or  $x < 1$



**22**Work out an expression for the  $n$ th term of the quadratic sequence

2      17      40      71      ....

Give your answer in the form  $an^2 + bn + c$  where  $a$ ,  $b$  and  $c$  are constants.**[3 marks]**

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Answer \_\_\_\_\_

**Turn over for the next question****Turn over ►**

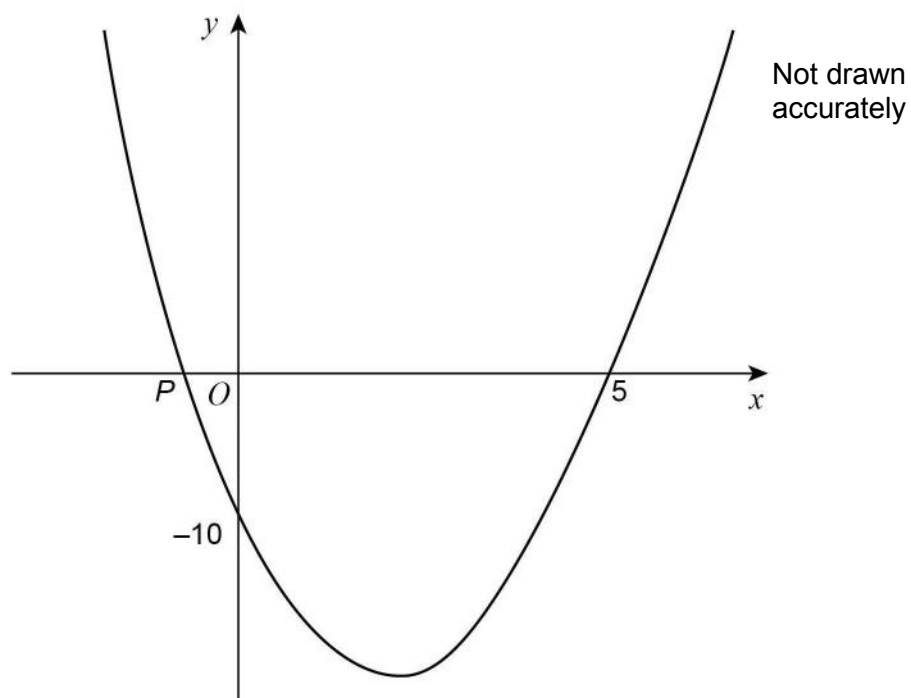
23

Here is a sketch of  $y = x^2 + bx + c$

The curve intersects

the  $x$ -axis at  $(5, 0)$  and point  $P$

the  $y$ -axis at  $(0, -10)$



Work out the  $x$ -coordinate of the turning point of the graph.

[4 marks]

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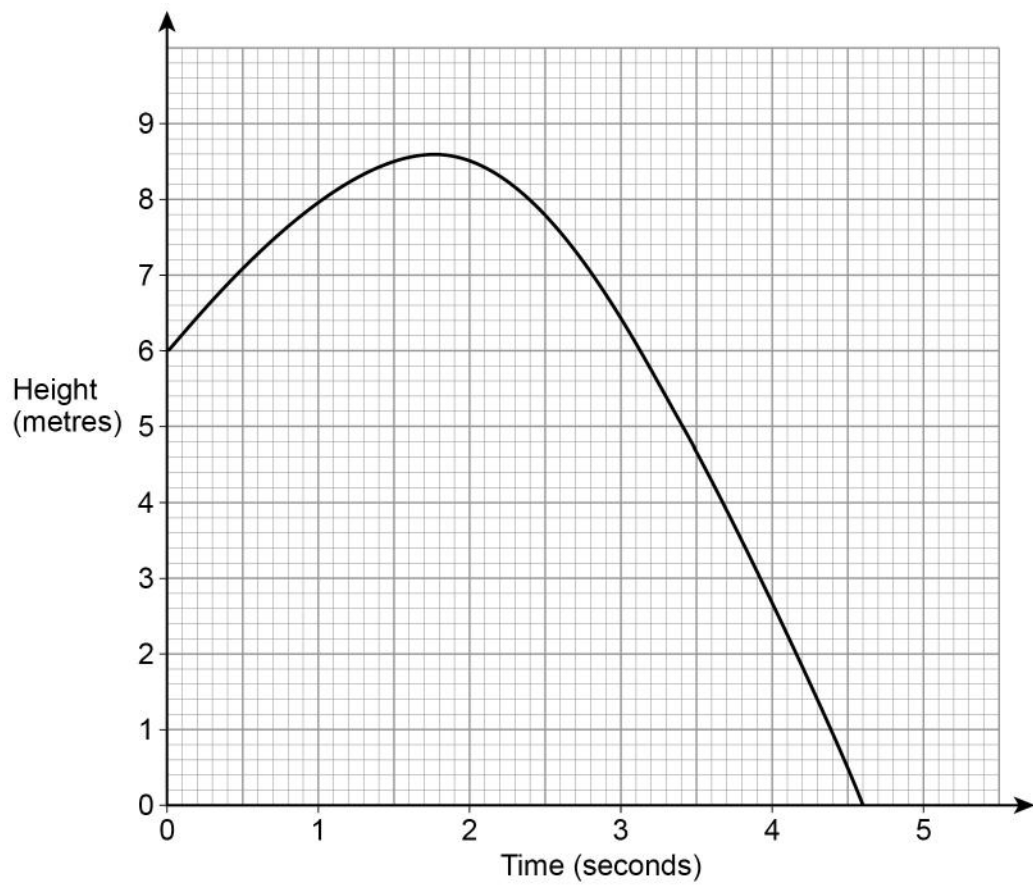
Answer \_\_\_\_\_



24

A ball is thrown from a point 6 metres above the ground.

The graph shows the height of the ball above the ground, in metres.



Estimate the speed of the ball, in m/s, after 1 second.

You **must** show your working.

[2 marks]

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Answer \_\_\_\_\_ m/s

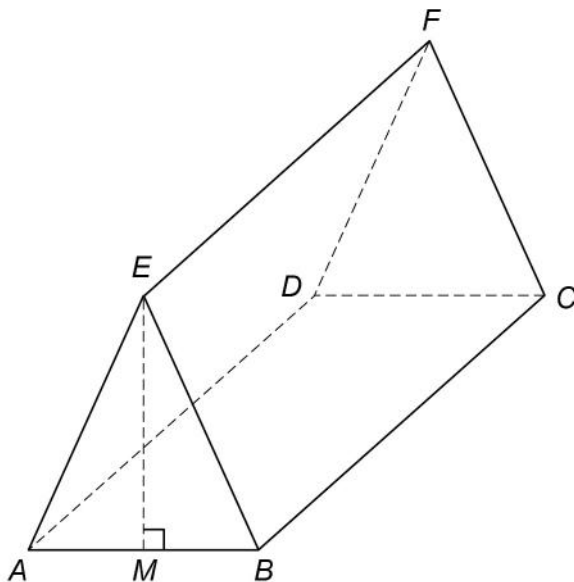


**25** Rectangle  $ABCD$  is the horizontal base of a triangular prism  $ABCDEF$ .

$$AE = BE$$

$E$  is vertically above  $M$ , the midpoint of  $AB$ .

$$AB = 16 \text{ cm} \quad AE = 17 \text{ cm} \quad BC = 30 \text{ cm}$$



**25 (a)** Show that  $EM = 15 \text{ cm}$

**[2 marks]**

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**[4 marks]**

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Answer degrees

**Turn over for the next question**

6

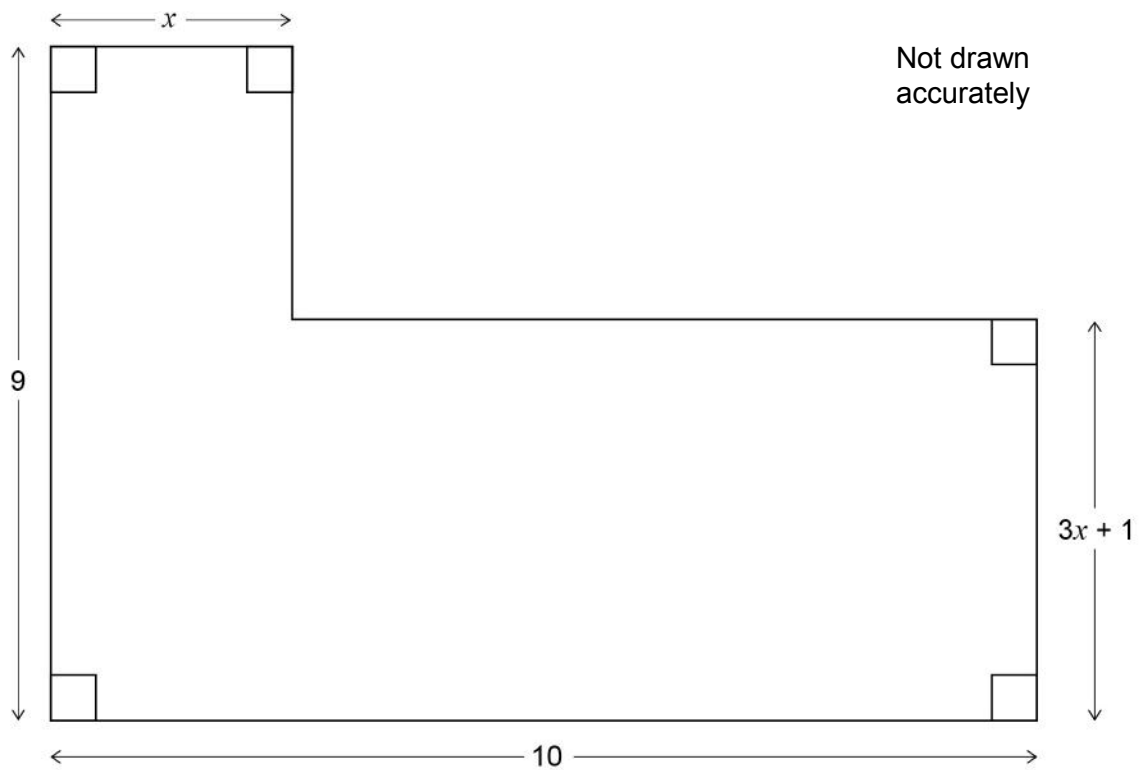
**Turn over ►**



26

Here is an L-shape.

All dimensions are in centimetres.





Work out the value of  $x$ .

[illegible]

Answer

6

**Turn over ►**



27 Prove that  $x^2 + x + 1$  is always positive.

[3 marks]

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END OF QUESTIONS



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**There are no questions printed on this page**

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# GCSE Mathematics

Paper 3 Higher Tier

Mark scheme

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8300  
June 2017

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Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

**Glossary for Mark Schemes**

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

<b>M</b>	Method marks are awarded for a correct method which could lead to a correct answer.
<b>A</b>	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
<b>B</b>	Marks awarded independent of method.
<b>ft</b>	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
<b>SC</b>	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
<b>M dep</b>	A method mark dependent on a previous method mark being awarded.
<b>B dep</b>	A mark that can only be awarded if a previous independent mark has been awarded.
<b>oe</b>	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
<b>[a, b]</b>	Accept values between a and b inclusive.
<b>[a, b)</b>	Accept values $a \leq \text{value} < b$
<b>3.14...</b>	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
<b>Use of brackets</b>	It is not necessary to see the bracketed work to award the marks.

Examiners should consistently apply the following principles

**Diagrams**

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

**Responses which appear to come from incorrect methods**

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

**Questions which ask students to show working**

Instructions on marking will be given but usually marks are not awarded to students who show no working.

**Questions which do not ask students to show working**

As a general principle, a correct response is awarded full marks.

**Misread or miscopy**

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

**Further work**

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

**Choice**

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

**Work not replaced**

Erased or crossed out work that is still legible should be marked.

**Work replaced**

Erased or crossed out work that has been replaced is not awarded marks.

**Premature approximation**

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

**Continental notation**

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.



Question	Answer	Mark	Comments
1	$\begin{pmatrix} -5 \\ -3 \end{pmatrix}$	B1	
	Additional Guidance		
2	1	B1	
	Additional Guidance		
3	$w = \frac{y}{2x}$	B1	
	Additional Guidance		
4	210°	B1	
	Additional Guidance		

5	200 ÷ 0.4 or 200 ÷ 40 × 100 or 200 = 0.4 × <i>n</i>	M1	oe (Heads =) 300 200 : 300
	500	A1	
	<b>Additional Guidance</b>		
	Build up method must be complete  eg 200 = 40%, 100 = 20%, 500 (= 100%) 200 = 40%, 100 = 20%, 400 = 80%, 100 + 400 200 = 40%, 100 = 20%, 400 = 80%		M1A1 M1A0 M0A0
	0.4 : 0.6 = 200 : 300		M1A0
	100 = 20%, 300 = 60%		M1A0
	200 ÷ 0.4 = 500, 500 + 200 = 700 incorrect method		M0A0

Question	Answer	Mark	Comments
6	<b>Alternative method 1</b>		
	A includes 1 or B does not include 1	B1	oe Correct statement about 1 without contradiction
	A does not include 6 or B includes 6	B1	oe Correct statement about 6 without contradiction
	<b>Alternative method 2</b>		
	$1 \leq x < 6$ or $1 < x \leq 6$  or $1 \leq x$ and $1 < x$ or $x < 6$ and $x \leq 6$  or A is 1, 2, 3, 4, 5 or B is 2, 3, 4, 5, 6	M1	oe eg $x \geq 1$ and $x < 6$ for 1 <sup>st</sup> statement  A includes 3 and B includes 18  A is 3, ... 17 and B is 4, ... 18
	A is 1, 2, 3, 4, 5 and B is 2, 3, 4, 5, 6	A1	oe eg A = 1 to 5 and B = 2 to 6
	<b>Additional Guidance</b>		
	For 2 marks, must have clearly indicated both sets of integer solutions	M1A1	
	For 2 marks, must have clearly indicated both differences	B1B1	
	A could be 1 but not 6, B could be 6 but not 1	B1B1	
	A is $x = 1$ and B is $x = 6$	B1B1	
	A: 3, 6, 9, 12, 15 and B: 6, 9, 12, 15, 18	M1A0	
	Comment that inequality signs are switched with no other working	B0B0	
	'1 and 6 don't appear in both' – need to be correctly linked to A and B	B0B0	

Question	Answer	Mark	Comments
7(a)	5.5 in the correct position	B1	oe
	6.5 in the correct position	B1	oe
	<b>Additional Guidance</b>		
	5.50 or $5\frac{1}{2}$ or $\frac{11}{2}$		B1
	6.50 or $6\frac{1}{2}$ or $\frac{13}{2}$		B1
7(b)	One correctly evaluated trial using (6, 6.5] + (4, 4.5) or (6, 6.5) + (4, 4.5]  or <b>two</b> values in the ranges given that work if correctly evaluated	M1	eg $6.3 + 4.1 = 10.4$  eg 6.4, 4.2
	One correctly evaluated trial using (6, 6.5) + (4, 4.5) with an answer that rounds to 11	A1	eg $6.4 + 4.2 = 10.6$  Ignore fw
	<b>Additional Guidance</b>		
	$6.4 + 4.4 = 10.8 (= 11)$ do not need to show 11		M1A1
	$6.4999 + 4.4999 = 10.9998$		M1A1
	$6.5 + 4.4 = 10.9$		M1A0
	$4.5 + 6.2 = 10.7$		M1A0
	$6 + 4 = 10$		M0
	$6.5 + 4.5 = 11$		M0
	$6.\dot{4}9 + 4.\dot{4}9 = 11$		M0
8(a)	Could be true	B1	
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
8(b)	Must be true	B1	
	<b>Additional Guidance</b>		
9(a)	$\frac{2}{3} \times 720$ or $\frac{3}{5} \times 700$	M1	oe Accept use of 0.66... or 0.67
	480 or 420	A1	
	900	A1	Ignore fw
	<b>Additional Guidance</b>		
	900 with no working		M1A1A1
	900 out of 1420 or $\frac{900}{1420}$ (ignore fw)		M1A1A1
	$\frac{480}{720}$ (480 boys out of 720) or $\frac{420}{1420}$ (420 girls out of 1420 students)		M1A1A0

Question	Answer	Mark	Comments
9(b)	<b>Alternative method 1</b>		
	720 + 700 or 1420 or 720 + 700 – their 900 or 520	M1	oe
	$\frac{520}{1420}$ or $\frac{26}{71}$	A1ft	oe fraction, decimal or percentage 0.36(6...) or 0.37 36.(6...) % or 37% ft their part (a) Ignore fw
	<b>Alternative method 2</b>		
	720 + 700 or 1420 or $\frac{1}{3} \times 720$ or 240 or $\frac{2}{5} \times 700$ or 280 or 240 + 280 or 520	M1	oe
	$\frac{520}{1420}$ or $\frac{26}{71}$	A1	oe fraction, decimal or percentage 0.36(6...) or 0.37 36.(6...) % or 37% Ignore fw
	<b>Alternative method 3</b>		
	720 + 700 or 1420 or $\frac{900}{1420}$ or $\frac{45}{71}$ or $\frac{\text{their } 900}{1420}$	M1	oe fraction, decimal or percentage 0.63... or 0.63 63.(...) % or 63%
	$\frac{520}{1420}$ or $\frac{26}{71}$	A1ft	oe fraction, decimal or percentage 0.36(6...) or 0.37 36.(6...) % or 37% ft their part (a) Ignore fw

Additional guidance is on the next page

Question	Answer	Mark	Comments
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9(b) cont	<b>Additional Guidance</b>		
	$\frac{520}{1420}$ followed by incorrect simplification of fraction		M1A1

10(a)	$2x + 10 = 3x - 20$	M1	oe $180 - (2x + 10) + 3x - 20 = 180$
	$3x - 2x = 20 + 10$ or $x = 30$	M1dep	oe
	$2 \times \text{their } 30 + 10$ or $3 \times \text{their } 30 - 20$ or 70	M1dep	oe
	110	A1	
	<b>Additional Guidance</b>		
	$x = 30, y = 180 - 3(30) + 20 = 110$		M1M1M1A1
	$x = 30, y = 180 - 3(30) - 20 = 110$ recovered missing bracket		M1M1M1A1
	$x = 30, y = 180 - 3(30) - 20 = 70$ not recovered		M1M1M0A0
	$2x + 10 = 3x - 20$ $3x - 2x = 20 + 10$ $x = 10$ $2 \times 10 + 10 (= 30)$		M1M1M1A0
	$2x + 10 = 3x - 20$ $x = 10$ $2 \times 10 + 10 (= 30)$		M1M0M0A0
	$y + 2x + 10 = 3x - 20 + y$		M1M0M0A0
	$w = 3x - 20$ seen or on diagram		M0M0M0A0
	$w = 2x + 10$ seen or on diagram		M0M0M0A0

Question	Answer	Mark	Comments
10(b)	$2x + 10 = 60$ or $2x = 60 - 10$ or $2x = 50$ or $x = 25$	M1	
	$3 \times \text{their } 25 - 20 \text{ or } 55$ or $180 - 55 \text{ or } 125$	M1dep	oe
	$(y =) 125 \text{ and bigger}$ or $(y \text{ is}) 15 \text{ bigger}$	A1ft	oe ft their (a)
	<b>Additional Guidance</b>		
	Note: A complete logical explanation of the effect of lines not being parallel eg $w$ is smaller so $2x + 10$ is smaller so $x$ is smaller so $3x - 20$ is smaller so $y$ is bigger		M1M1A1
	$2 \times 25 + 10 = 60$		M1M0A0
	$y$ is bigger ticked but no valid working		M0M0A0



Question	Answer	Mark	Comments
11	<b>Alternative method 1</b>		
	Any correct scaling of the ratio 5 : 2 eg 10 (:) 4 or 20 (:) 8 or 25 (:) 10	M1	oe
	22.5 (:) 9 or 22.5 (red) or 30 (:) 12 or 12 (blue)	M1dep	oe
	31.5 or $31\frac{1}{2}$ or $\frac{63}{2}$	A1	
	<b>Alternative method 2</b>		
	9 ÷ 2 or 4.5 or 30 ÷ 5 or 6	M1	oe 2 ÷ 9 or 0.22... 5 ÷ 30 or 0.16... or 0.17
	5 × their 4.5 or 22.5 or 7 × their 4.5 or 2 × their 6 or 12 or 7 × their 6 or 42	M1dep	oe
	31.5 or $31\frac{1}{2}$ or $\frac{63}{2}$	A1	
	<b>Alternative method 3</b>		
	$\frac{2}{7}$ × purple = blue $\frac{5}{7}$ × purple = red	M1	oe $\frac{2}{7}$ × purple = 9 $\frac{5}{7}$ × purple = 30
	$9 \times \frac{7}{2}$ or $30 \times \frac{7}{5}$ or 42	M1dep	oe
	31.5 or $31\frac{1}{2}$ or $\frac{63}{2}$	A1	

Additional guidance is on the next page

Question	Answer	Mark	Comments
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11 cont	<b>Additional Guidance</b>		
	$28 + 3.5 = 31.5$		M1M1A1
	$28 + 3.5$		M1M1A0
	31.5, answer 31		M1M1A1
	$31.5 + 42 = 73.5$		M1M1A0
	10 4		M1M0A0
	10, 4		M1M0A0
	$10 + 4$		M1M0A0
	'He has 2.5 times more red than blue'		M1M0A0
	$2.5 : 1$		M1M0A0
	2.5		M0M0A0
	28 on its own		M0M0A0

12	$a = 2$	B1	May be embedded
	$b = 5$	B1	May be embedded
	<b>Additional Guidance</b>		
	$(2r^5)^4$		B1B1
	$(r^5)^4$		B1
	$2^4 = 16$ on its own is not enough		B0
	$a = 5$ and $b = 2$		B0B0

Question	Answer	Mark	Comments
13	<b>Alternative method 1</b>		
	$12 \times 1.58$ or 18.96 or $28 \times 1.52$ or 42.56	M1	
	$28 \times 1.52 - 12 \times 1.58$ or their 42.56 – their 18.96 or 23.6	M1dep	oe
	their $23.6 \div (28 - 12)$ or their $23.6 \div 16$	M1dep	oe dep on M1 M1
	1.475 or 1.48	A1	
	<b>Alternative method 2</b>		
	$16x + 12 \times 1.58$ or $16x + 18.96$ or $28 \times 1.52$ or 42.56	M1	
	(16x =) their 42.56 – their 18.96 or (16x =) 23.6	M1dep	oe
	their $23.6 \div (28 - 12)$ or their $23.6 \div 16$	M1dep	oe dep on M1 M1
	1.475 or 1.48	A1	
	<b>Additional Guidance</b>		
	$23.6 \div 16 = 1.475 = 1.5$	M1M1M1A1	
	$23.6 \div 16 = 1.5$	M1M1M1A0	
	$23.6 \div (28 - 12)$ $23.6 \div 14$	M1M1M1A0	
	$23.6 \div 14$	M1M1M0A0	
	Beware use of 0.06 eg $1.58 - 1.52 = 0.06$	M0	

Question	Answer	Mark	Comments
14	y is directly proportional to $\frac{1}{x}$	B1	
	Additional Guidance		
15(a)	8	B1	
	Additional Guidance		
15(b)	3	B1	Accept –3
	Additional Guidance		

Question	Answer	Mark	Comments
16	<b>Alternative method 1</b>		
	$\frac{25}{100} \times 18\,000$ or 4500 and $18\,000 - \text{their } 4500$  or $18\,000 \times (1 - 0.25)$ or $18\,000 \times 0.75$ or 13 500 or 0.88	M1	oe
	their $13\,500 \times (1 - 0.12)^4$ or their $13\,500 \times 0.88^4$  their $13\,500 \times (1 - 0.12)^3$ or their $13\,500 \times 0.88^3$ or 9199.87 or 9199.88 or 9199.90 or 9200	M1dep	oe Complete method for at least 4 years
	8095.88 or 8095.89 or 8095.90 or 8096 or 8096.00 or 8100 or 8100.00	A1	Correct money notation
	<b>Alternative method 2</b>		
	$\frac{25}{100} \times 18\,000$ or 4500 and $18\,000 - \text{their } 4500$ or 13 500 or 0.88	M1	oe
	13 500, 11 880, 10 454.(...) 9199.(...)	M1dep	oe Complete method for at least 4 years
	8095.88 or 8095.89 or 8095.90 or 8096 or 8096.00 or 8100 or 8100.00	A1	Correct money notation

Additional guidance is on the next page

16 cont	Additional Guidance	
	Condone eg £8095.88p	M1M1A1
	8095.887...	M1M1A0
	Note the values for successive calculations are 13 500, 11880, 10454.4, 9199.87(2), 8095.88(736)  The values for successive savings are 4500, 1620, 1425.6, 1254.52(8), 1103.98	
	For method marks allow rounding or truncating of their totals or savings	

Question	Answer	Mark	Comments
17	<b>Alternative method 1</b>		
	1 mile per minute or 60 miles per hour or 0.15 (hours) or 1.6 (hours) or $1\frac{36}{60}$ (hours)	B1	
	$9 \div 50$ or 0.18	M1	oe
	$70 \times 1\frac{36}{60}$ or $70 \times 1.6$ or 112	M1	oe
	their $112 \div 40$ or 2.8	M1dep	dep on 2nd M1
	2.98 or 2.8 and $(3 - 0.18 = )$ 2.82 or 0.18 and $(3 - 2.8 = )$ 0.2	A1	Ignore fw
	<b>Alternative method 2</b>		
	1 mile per minute or 60 miles per hour or 0.15 (hours) or 1.6 (hours) or $1\frac{36}{60}$ (hours)	B1	
	$9 \div 50$ or 0.18	M1	oe
	$70 \times 1\frac{36}{60}$ or 112 or $70 \times 1.6$ or 112	M1	
	$40 \times (3 - \text{their } 0.18)$ or 112.8	M1dep	dep on 1st M1
	112.8 and 112	A1	Ignore fw

Alternative method 3 and additional guidance is on the next page

<b>17 cont</b>	<b>Alternative method 3</b>		
	1 mile per minute or 60 miles per hour or 0.15 (hours) or 1.6 (hours) or $1\frac{36}{60}$ (hours)	B1	
	$9 \div 50$ or 0.18	M1	oe
	$70 \div 40$ or 1.75	M1	
	$70 \div 40 \times 1.6$ or 2.8 or their $1.75 \times 1.6$	M1dep	oe eg $1.75 + 0.875 + 0.175$ dep on 2nd M1
	2.98 or 2.8 and $(3 - 0.18 = ) 2.82$ or 0.18 and $(3 - 2.8 = ) 0.2$	A1	Ignore fw
	<b>Additional Guidance</b>		
	Key facts are :  First stage: Distance travelled 9 miles (given) Time taken 9 minutes (given) or 0.15 hours Average speed 60 mph Miles per gallon 50 mpg (given), Amount of petrol $9 \div 50 = 0.18$ gallons  Second stage: Distance travelled $70 \times 1.6 = 112$ miles Time taken 1 hour 36 minutes (given) or 1.6 hours Average speed 70 mph (given) Miles per gallon 40 mpg (given), Amount of petrol $112 \div 40 = 2.8$ gallons		
	An incorrect conversion of 1 hour 36 minutes to 1.36 can score: eg $70 \times 1.36 = 95.2$ , $95.2 \div 40 = 2.38$ $70 \times 1.36 = 95.2$ , $95.2 \div 40 = 2.38$ , $0.18 + 2.38 = 2.56$		B0M0M1M1A0 B1M1M1M1A0
	$2.98 = 3$ (further work)		B1M1M1M1A1
	$9 \div 50$		B1M1



Question	Answer	Mark	Comments
18	Valid criticism	B1	eg $(y = ) 0.5$ should be $(y =) 1$ $y = 0.5$ should be when $x = 1$ When $x = 0$ $y = 1$ 0.5 is incorrect Crosses $y$ axis in wrong place Graph should start at 1 $0.5^0 = 1$
	<b>Additional Guidance</b>		
	Do not accept statements which are contradictory		
	He does not have a scale on the $x$ axis		B0
	It does not pass through zero		B0
	The line should meet the $x$ axis		B0

Question	Answer	Mark	Comments
19	<b>Alternative method 1</b>		
	$BDC = 24$	B1	May be on the diagram
	$DFC = \frac{180 - 24}{2}$ or $DCF = \frac{180 - 24}{2}$ or $\frac{156}{2}$ or 78	B1dep	May be on the diagram Finding a base angle in triangle $CDF$
	$(3x =) 180 - \text{their } 78$ or $(3x =) 24 + \text{their } 78$ or $(3x =) 102$	M1	oe May be on the diagram
	34	A1	May be on the diagram
	<b>Alternative method 2</b>		
	$BDC = 24$	B1	May be on the diagram
	$DFC = 180 - 3x$	M1	May be on the diagram
	$2(180 - 3x) + 24 = 180$ or $360 - 6x + 24 = 180$  or $3x + 78 = 180$ or $(3x =) 102$	M1dep	oe
	34	A1	May be on the diagram
	<b>Additional Guidance</b>		
	If angles in the same segment are not used ie all the working is using triangle $ABF$ then award maximum of 2 marks		
	If triangle $ABF$ is assumed to be isosceles and there is no evidence of angle $BDC = 24$ being used then award maximum of 2 marks		
	If triangle $ABF$ is used as isosceles and correctly justified then all marks are available eg 'triangle $ABF$ is similar to triangle $CDF$ '		
	Answer of 34 does not imply full marks		

Additional guidance continues on the next page

<b>19</b> <b>cont</b>	Answer of 34 with no working	B0B0M1A1
	‘their 78’ must come from an attempt to calculate $\frac{180 - 24}{2}$	
	Angles must be clearly identified eg $D = 24$ 24 (unless shown on diagram)	B1 B0

<b>20</b>	522.5 or 527.5	B1	oe Accept 527.499(999...)
	77.5 or 78.5	B1	oe Accept 78.499(999...)
	527.5 – 77.5	M1	their max total – their min Ben their max total must be (525, 530] their min Ben must be [77, 78) Accept 527.4 $\dot{9}$ or 527.499(999...) for 527.5
	450 and Yes with correct working seen	A1	Accept [449.999, 450]
	<b>Additional Guidance</b>		
	525 – 78 = 447 and yes		B0B0M0A0
	525 = 520 to 530 78 = 77.5 to 78.5 520 – 78.5 = 441.5 520 – 77.5 = 442.5 530 – 78.5 = 451.5 530 – 77.5 = 452.5 Answer No		B0 B1    M1 A0

<b>21</b>	$-2.5 < x < 1$	B1	
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
22	<b>Alternative method 1</b>		
	Second differences 8	M1	Implied by $4n^2$
	Any three values from -2 1 4 7	M1dep	
	$4n^2 + 3n - 5$	A1	oe Allow $a = 4$ $b = 3$ $c = -5$
	<b>Alternative method 2</b>		
	Any 3 of $a + b + c = 2$ $4a + 2b + c = 17$ $9a + 3b + c = 40$ $16a + 4b + c = 71$	M1	Using $an^2 + bn + c$
	Any 2 equations in 2 unknowns eg $3a + b = 15$ $5a + b = 23$ $7a + b = 31$ $8a + 2b = 38$ $12a + 2b = 54$ $15a + 3b = 69$	M1dep	Correctly eliminates the same letter using two different pairs of equations
	$4n^2 + 3n - 5$	A1	oe Allow $a = 4$ $b = 3$ $c = -5$

**Alternative method 3 and additional guidance is on the next page**

<b>22 cont</b>	<b>Alternative method 3</b>		
	Second differences 8 $a = 4$ or $c = 2 - 7$ or $-5$	M1	Using $an^2 + bn + c$
	$3a + b = 17 - 2$ and substitutes their $a$	M1dep	oe eg $b = 3$ May also see $a + b + c = 2$ used to work out $c$
	$4n^2 + 3n - 5$	A1	oe Allow $a = 4$ $b = 3$ $c = -5$
	<b>Additional Guidance</b>		
	Sequence $(-5)$ 2    17    40    71 1 <sup>st</sup> differences are $(7)$ 15    23    31 2 <sup>nd</sup> differences are            8    8    8		

Question	Answer	Mark	Comments
23	$0 = 5^2 + 5b + c$ or $-10 = 0^2 + b(0) + c$ or $c = -10$	M1	oe
	$b = -3$ or $x^2 - 3x + c$ or $(y =) x^2 - 3x - 10$	M1dep	oe $(x - 5)(x + k)$ and $-5k = -10$
	$(x - 5)(x + 2)$ or $\frac{-3 \pm \sqrt{(-3)^2 - 4 \times 1 \times -10}}{2 \times 1}$ or $\frac{3 \pm \sqrt{49}}{2}$ or $(x - \frac{3}{2})^2 + \dots$ or $2x - 3 = 0$ or $x$ -coordinate of $P = -2$ or two symmetrical coordinates	M1dep	oe Correctly factorises the 3-term quadratic expression or correctly substitutes into quadratic formula for the 3-term quadratic dep on M1 M1  eg (1, -12) and (2, -12)
	$1\frac{1}{2}$ or $\frac{3}{2}$ with no incorrect working	A1	oe Accept (1.5, -12.25)
	<b>Additional Guidance</b>		
24	Draws a tangent at 1 second	M1	
	Their gradient at 1 second	A1ft	Must see a tangent on the graph ft their tangent $\pm 0.2$ tolerance on vertical reading $\pm 0.1$ tolerance on horizontal reading
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
25(a)	<b>Alternative method 1</b>		
	$17^2 - (16 \div 2)^2$ or $17^2 - 8^2$ or $289 - 64$	M1	Correct use of Pythagoras' theorem eg $8^2 + 15^2 = 17^2$ or $64 + 225 = 289$
	$\sqrt{17^2 - (16 \div 2)^2} (= 15)$ or $\sqrt{17^2 - 8^2} (= 15)$ or $\sqrt{289 - 64} (= 15)$	A1	Correct use of Pythagoras' theorem using a square root
	<b>Alternative method 2</b>		
	$\sin E = \frac{8}{17}$ or $\cos A = \frac{8}{17}$ or $E = 28.(\dots)$ or $A = 61.9(\dots)$ or 62 and $\cos 28.(\dots) = \frac{EM}{17}$ or $\tan 28.(\dots) = \frac{8}{EM}$ or $\sin 61.9(\dots) = \frac{EM}{17}$ or $\tan 61.9(\dots) = \frac{EM}{8}$	M1	
	$17 \cos 28.(\dots)$ or $8 \div \tan 28.(\dots)$ or $17 \sin 61.9(\dots)$ or $8 \tan 61.9(\dots)$	A1	
	<b>Additional Guidance</b>		
	8, 15, 17 on their own		M0A0
	$EM^2 = 289 - 64 = 225$ , $EM = 15$		M1A0

Question	Answer	Mark	Comments
25(b)	<b>Alternative method 1</b>		
	$30^2 + (16 \div 2)^2$ or $30^2 + 8^2$ or 964	M1	oe
	$\sqrt{\text{their } 964}$ or $2\sqrt{241}$ or [31, 31.1]	M1dep	oe CM
	$\tan x = \frac{15}{\text{their } [31, 31.1]}$	M1dep	oe eg $90 - \tan^{-1} \frac{\text{their } [31, 31.1]}{15}$ dep on M1 M1
	[25.7, 26]	A1	
	<b>Alternative method 2</b>		
	$30^2 + 17^2$ or 1189	M1	oe
	$\sqrt{\text{their } 1189}$ or [34.4, 34.5]	M1dep	oe CE
	$\sin x = \frac{15}{\text{their } [34.4, 34.5]}$	M1dep	oe eg $90 - \cos^{-1} \frac{15}{\text{their } [34.4, 34.5]}$ or $\frac{\sin x}{15} = \frac{\sin 90}{\text{their } [34.4, 34.5]}$ dep on M1 M1
	[25.7, 26]	A1	



25(b) cont	<b>Alternative method 3</b>		
	$30^2 + (16 \div 2)^2$ or 964 or $30^2 + 17^2$ or 1189	M1	oe
	$\sqrt{\text{their } 964}$ or $2\sqrt{241}$ or [31, 31.1] or $\sqrt{\text{their } 1189}$ or [34.4, 34.5]	M1dep	oe <i>CM</i> <i>CE</i>
	$\cos x = \frac{\text{their } [31, 31.1]}{\text{their } [34.4, 34.5]}$	M1dep	oe eg $90 - \sin^{-1} \frac{\text{their } [31, 31.1]}{\text{their } [34.4, 34.5]}$ dep on M1 M1
	[25.7, 26]	A1	
	<b>Alternative method 4</b>		
	$17^2 - (16 \div 2)^2$ or 225 or $30^2 + (16 \div 2)^2$ or 964 or $30^2 + 17^2$ or 1189	M1	oe $EM^2$ $CM^2$ $CE^2$
	$\cos x = \frac{\text{their } 964 + \text{their } 1189 - \text{their } 225}{2 \times \sqrt{\text{their } 964} \times \sqrt{\text{their } 1189}}$	M1dep	oe
	$\cos^{-1} \frac{\text{their } 964 + \text{their } 1189 - \text{their } 225}{2 \times \sqrt{\text{their } 964} \times \sqrt{\text{their } 1189}}$	M1dep	oe dep on M1 M1
	[25.7, 26]	A1	
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
26	$10(3x + 1)$ or $9x$ or $x(9 - 3x - 1)$ or $x(8 - 3x)$ or $(10 - x)(3x + 1)$ or $x(3x + 1)$ or $(10 - x)(9 - 3x - 1)$	M1	oe One correct area expression in $x$ May be implied
	$10(3x + 1) + x(9 - 3x - 1)$ or $9x + (10 - x)(3x + 1)$ or $(10 - x)(3x + 1) + x(9 - 3x - 1)$ + $x(3x + 1)$ or $10 \times 9 - (10 - x)(9 - 3x - 1)$	M1dep	oe Fully correct unsimplified expression for area
	$30x + 10 + 9x - 3x^2 - x$ or $9x + 30x + 10 - 3x^2 - x$ or $30x + 10 - 3x^2 - x + 9x - 3x^2 - x$ + $3x^2 + x$ or $90 - 90 + 30x + 10 + 9x - 3x^2 - x$ or $38x + 10 - 3x^2$	M1dep	oe dep on M1 M1 Full expansion All brackets removed
	$3x^2 - 38x + 55 (= 0)$	A1	oe 3-term equation
	$(3x - 5)(x - 11)$ $\frac{-(-38) \pm \sqrt{(-38)^2 - 4 \times 3 \times 55}}{2 \times 3}$ or $\frac{38 \pm \sqrt{1444 - 660}}{6}$ or $\frac{38 \pm \sqrt{784}}{6}$	M1	oe their 3-term quadratic factorised correctly or correct substitution in formula for their 3-term quadratic equation
	$\frac{5}{3}$ or $1\frac{2}{3}$ or 1.66(6...) or 1.67	A1	oe $x = 11$ included is A0
	<b>Additional Guidance</b>		
	$3x^2 = 38x - 55$		M1M1M1A1

Question	Answer	Mark	Comments
27	<b>Alternative method 1 – completing the square</b>		
	$(x + \frac{1}{2})^2 + \dots$	M1	
	$(x + \frac{1}{2})^2 - (\frac{1}{2})^2 + 1$ or $(x + \frac{1}{2})^2 - \frac{1}{4} + 1$ or $(x + \frac{1}{2})^2 + \frac{3}{4}$	A1	oe
	$(x + \frac{1}{2})^2 \geq 0$ and $\frac{3}{4} > 0$ and always positive	A1	oe
	<b>Alternative method 2 – real roots</b>		
	$\frac{-1 \pm \sqrt{1^2 - 4 \times 1 \times 1}}{2 \times 1}$ or a correct sketch showing a quadratic curve with turning point above the $x$ -axis	M1	oe
	States no values on $x$ -axis	A1	oe
	States no values on $x$ -axis and (minimum value =) $\frac{3}{4}$	A1	oe
	<b>Alternative method 3 – Calculus</b>		
	$2x + 1 = 0$	M1	
	$x = -\frac{1}{2}$	A1	
	(minimum value =) $\frac{3}{4}$	A1	

<b>27 cont</b>	<b>Alternative method 4 – Explanation method</b>		
	<p>If <math>x \geq 0</math>,  <math>x^2 \geq 0</math> and <math>x \geq 0</math> (<math>1 &gt; 0</math>)  so <math>x^2 + x + 1 &gt; 0</math></p> <p>and</p> <p>If <math>-1 &lt; x &lt; 0</math>  <math>x^2 &gt; 0</math> and <math>x + 1 &gt; 0</math>  so <math>x^2 + x + 1 &gt; 0</math></p> <p>and</p> <p>If <math>x \leq -1</math>  <math>x^2 &gt; x</math> and <math>x^2 + x &gt; 0</math>  so <math>x^2 + x + 1 &gt; 0</math></p>	B3	<p>Accept <math>x &gt; 0</math> for <math>x \geq 0</math></p> <p>B2 for two correct statements  B1 for one correct statement</p>
	<b>Additional Guidance</b>		
	Calculating pairs of coordinates alone		M0A0A0