GCSE
Mathematics

Paper 2 Higher Tier

Mark scheme

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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

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.

M	Method marks are awarded for a correct method which could lead to a correct answer.
A	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	Marks awarded independent of method.
ft	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
SC	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
M dep	A method mark dependent on a previous method mark being awarded.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
oe	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
[a, b]	Accept values between a and b inclusive.
[a, b)	Accept values $a \leq$ value $< b$
3.14 …	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
Use of brackets	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	$\frac{31}{8}$	B1	
	Additional Guidance		
2	250%	B1	
	Additional Guidance		
3	$\left(\frac{1}{3}, \frac{1}{9}\right)$	B1	
	Additional Guidance		
4	kg/m^3	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
5	**Alternative method 1**		
	$12x - 8$	M1	May be seen in a grid
	their $12x - 2x = -5$ + their 8 or $10x = 3$ or their $-8 + 5 = 2x$ – their $12x$ or $-3 = -10x$	M1	Collecting two terms in x and two constant terms correctly oe eg $10x - 3 = 0$
	0.3 or $\frac{3}{10}$	A1ft	ft M1M0 or M0M1 with exactly one error
	Alternative method 2		
	$\frac{x}{2} - \frac{5}{4}$	M1	
	$3x$ – their $\frac{x}{2}$ = their $-\frac{5}{4}$ + 2 or $\frac{5}{2}x = \frac{3}{4}$ or -2 + their $\frac{5}{4}$ = their $\frac{x}{2} - 3x$ or $-\frac{3}{4} = -\frac{5}{2}x$	M1	Collecting two terms in x and two constant terms correctly oe eg $\frac{5}{2}x - \frac{3}{4} = 0$
	0.3 or $\frac{3}{10}$	A1ft	ft M1M0 or M0M1 with exactly one error

Additional Guidance is on the next page

	Additional Guidance	
5	$12x - 2 = 2x - 5$ $10x = -3$ $x = -0.3$	M0 M1 A1ft
	$12x - 8 = 2x - 5$ $10x = -5$ $x = \frac{-5}{10}$	M1 M0 A1ft
	$12x - 8 = 2x - 5$ $14x = 3$ $x = \frac{3}{14}$	M1 M0 A1ft
	$12x - 8 = 2x - 5$ $14x = -13$ $x = -\frac{13}{14}$ (two errors)	M1 M0 A0ft
	$12x - 8 = 8x - 20$	M1M0A0
	Any ft answer must be exact or rounded or truncated to at least 2 dp	
	The last two marks can be implied without the collection of terms seen eg $12x - 6 = 2x - 5$ and answer 0.1	M0M1A1ft
	Collecting terms before the bracket has been expanded	Zero

Question	Answer	Mark	Comments
6(a)	Correct product using a point on the curve or correct division using a point on the curve	B1	eg 2 × 12 (= 24) or 3 × 8 (= 24) or 5 × 4.8 (= 24) or 6 × 4 (= 24) or 10 × 2.4 (= 24) or 24 ÷ 2 = 12 or 24 ÷ 6 = 4
	Additional Guidance		
	1 × 24 (= 24)		B0
	12 + 12 (= 24)		B0
	3 × 4 × 2 = 24		B0
	For multiplication, 24 does not have to be shown		
	Ignore any units seen		
	Ignore any lines on the graph		
	8 × 3 = 24 and 12 + 12 = 24 (choice)		B0
	area 6 and length 4 and volume 24		B0

Question	Answer	Mark	Comments
6(b)	**Alternative method 1**		
	Reading from 5 on the graph to give [4.7, 4.9]	M1	
	$\frac{1}{2} \times 6 \times h$ = [4.7, 4.9] or [4.7, 4.9] ÷ ($\frac{1}{2} \times 6$)	M1dep	oe
	[1.56, 1.64]	A1	
	Alternative method 2		
	24 ÷ 5 or 4.8 or $\frac{1}{2} \times 6 \times h$ or $\frac{1}{2} \times 6 \times h \times 5$	M1	oe
	$\frac{1}{2} \times 6 \times h = 24 \div 5$ or $24 \div 5 \div (\frac{1}{2} \times 6)$ or $\frac{1}{2} \times 6 \times h \times 5 = 24$ or $15h = 24$ or $24 \div (\frac{1}{2} \times 6 \times 5)$ or $24 \div 15$	M1dep	oe
	1.6	A1	
	Additional Guidance		

Question	Answer	Mark	Comments
7	Enlargement	B1	
	Scale factor (×) $\frac{1}{3}$	B1	
	Centre (5, 1)	B1	
	Additional Guidance		
	Enlarge (×) $\frac{1}{3}$ (5, 1)		B1B1B1
	Reduction or makes bigger or unenlargement or increase or negative enlargement		1st B0
	Any other transformation mentioned or implied such as reflection, rotation or translation loses the mark for enlargement eg enlarged and moved up 4 or enlarged and $\begin{pmatrix} -2 \\ 2 \end{pmatrix}$		1st B0
	Do not accept ÷ 3 for scale factor		2nd B0
8	[0, 5] × 20 + [5, 10] × 48 + [10, 15] × 30 + [15, 20] × 22 or 1170	M1	Must add 4 products
	their 1170 ÷ 120	M1dep	
	9.75 or $\frac{39}{4}$ or $9\frac{3}{4}$	A1	
	Additional Guidance		
	1170 ÷ 120 or 9.75 with $5 < x \leqslant 10$ on answer line		M2A0
	Do not allow M1 for working in the table if a different method is used in working lines		

Question	Answer	Mark	Comments
9	$\tan x = \frac{3}{7}$ or $\tan^{-1}\frac{3}{7}$ or $\sin x = \frac{3(\sin 90)}{\sqrt{3^2+7^2}}$ or $\sin x = \frac{3(\sin 90)}{\sqrt{58}}$ or $\cos x = \frac{7}{\sqrt{3^2+7^2}}$ or $\cos x = \frac{7}{\sqrt{58}}$ or $90 - \tan^{-1}\frac{7}{3}$ or 90 – [66.7, 66.81] or 90 – 67	M1	oe eg $\cos x = \frac{7^2+\left(\sqrt{7^2+3^2}\right)^2-3^2}{2\times\sqrt{3^2+7^2}\times 7}$ Any letter
	[23, 23.3]	A1	
	Additional Guidance		
	$\tan = \frac{3}{7}$ or $\tan\frac{3}{7}$ or $\tan^{-1} = \frac{3}{7}$ (unless recovered)		M0
	Answer [23, 23.3] (possibly coming from scale drawing)		M1A1
	If using sine rule must rearrange to $\sin x =$ for M1		
	If using cosine rule must rearrange to $\cos x =$ for M1		
	Allow [0.42, 0.43] for $\frac{3}{7}$		
	Allow 2.33… for $\frac{7}{3}$		
	Allow [7.6, 7.62] for $\sqrt{3^2+7^2}$		

Question	Answer	Mark	Comments
10	3 6 9 … or 23 + 12 or $1.5n^2$…	M1	
	35	A1	
	Additional Guidance		
	Answer line blank with 35 as next term in sequence		M1A1
	Answer line has attempt at term to term rule or *n*th term but 35 seen		M1A0
	35 seen on dotted line in sequence but a different answer given eg 50		M1A0
11	$\frac{x^2}{2x^2+1}$	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
12	64 000 000 ÷ 95 000 or 673.(…) or 674 or $\frac{12\ 800}{19}$ or 82 000 000 ÷ 140 000 or 585.(…) or 586 or $\frac{4100}{7}$	M1	oe population ÷ area Accept a pair of consistent divisions eg 64 ÷ 95 or 0.673… or 0.674 and 82 ÷ 140 or 0.585… or 0.586
	673.(…) or 674 or 670 and 585.(…) or 586 or 590 or $\frac{89\ 600}{133}$ and $\frac{77\ 900}{133}$	A1	Correct comparable values from consistent divisions eg 0.674 and 0.586 Accept 700 with division seen for UK Accept 600 with division seen for Germany
	Comparable values and correct conclusion	A1ft	eg 673 and 585 and greater for UK 0.673 and 0.585 and greater for UK ft M1A0 and comparable values Ignore further work
	Additional Guidance		
	Comparable values means both must be in the same form eg fractions with common denominators		
	64 000 000 ÷ 95 000 = 67.4 82 000 000 ÷ 140 000 = 5857 Germany is higher	M1 A0 A1ft	
	Ignore subtraction of results		
	673 and 585 and UK has more people per square mile	M1A1A1ft	
	673 and 585 and Germany has more space for their population	M1A1A1ft	
	673 and 585 and UK's population is less spread out	M1A1A1ft	
	673 and 585 and UK is more than Germany	M1A1A1ft	
	673 and 585 and UK is 78 more than Germany (ignore further work)	M1A1A1ft	

Additional Guidance continues on the next page

12 cont	673 and 585 and the difference is 88	M1A1A0ft
	673 and 585 and UK population is bigger	M1A1A0ft
	673 and 586 and UK	M1A1A0ft
	673 and 585 and Germany has more space	M1A1A0ft
	673 > 585 (unless links to countries in working)	M1A1A0ft
	$\frac{12\ 800}{19}$ and $\frac{4100}{7}$ and UK is greater (fractions not comparable)	M1A0A0ft

Question	Answer	Mark	Comments
13	$\left(-\frac{1}{3}, -1\right)$	B1	
	Additional Guidance		

14(a)	$\frac{3}{4} \times \frac{3}{4} \times 15$ or $\frac{3}{4} \times 15$ or 11.25 and $\frac{3}{4}$ × their 11.25	M1	oe
	8.4(375) or 8.44 or 8.438 or $\frac{135}{16}$ or $8\frac{7}{16}$	A1	
	Additional Guidance		
	8.43 or 8.437		M1A1
	8.4 seen, answer 8		M1A1
	$\frac{3}{4}$ of 11.25 (unless correctly evaluated)		M0
	$\frac{3}{4}$ × 8.4375, answer 6.328 (further work)		M1A0
	11.25 + 8.4375, answer 19.6875 (further work)		M1A0

Question	Answer	Mark	Comments
14(b)	**Alternative method 1**		
	Ticks second box and [7.425, 7.5375] or Ticks second box and correctly evaluates $\frac{2}{3}$ × their 11.25	B2ft	ft correct box ticked for comparing with their answer to (a) B1ft [7.425, 7.5375] with no or incorrect decision or Correctly evaluates $\frac{2}{3}$ × their 11.25 with no or incorrect decision
	Alternative method 2		
	Ticks second box and valid comparison	B2	eg $\frac{8}{12}$ and $\frac{9}{12}$ 0.66… or 0.67 and 0.75 66.(...)% or 67% and 75% $\frac{9}{16}$ and $\frac{8}{16}$ clear diagrams showing $\frac{2}{3}$ and $\frac{3}{4}$ B1 Ticks second box and incomplete comparison eg $\frac{8}{12}$ and $\frac{3}{4}$ two thirds is less than three quarters $\frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$ and $\frac{3}{4} \times \frac{2}{3} = \frac{6}{12}$ or Valid comparison (that would score B2) with no or incorrect decision

Additional Guidance is on the next page

	Additional Guidance	
	In Alt 1 only follow through their answer to (a) for the comparison, the working for $\frac{2}{3}$ × their 11.25 must be correct	
	(a) answer 6.5 (b) Ticks first box and 7.5 seen	B2ft
	Accept 0.66… or 0.67 for $\frac{2}{3}$	
	Using 0.6 for $\frac{2}{3}$	B0

Question	Answer	Mark	Comments
15	**Alternative method 1**		
	1.015	M1	oe eg 101.5% or $1 + \frac{1.5}{100}$ Implied by 6090
	6000×1.015^n for any positive integer $n > 1$	M1dep	oe Implied by 6181.(…)
	11	A1	If showing trials for 10 and/or 11 years, must have $6000 \times 1.015^{10} = 6963.(\ldots)$ and/or $6000 \times 1.015^{11} = 7067.(\ldots)$ or 7068 If showing totals from year on year for 10 and/or 11 years, must have (Y10) [6963.21, 6963.30] and/or (Y11) [7067.65, 7067.75]
	Alternative method 2		
	1.015	M1	oe eg 101.5% or $1 + \frac{1.5}{100}$ Implied by 6090
	Evaluates 1.015^n for any positive integer $n > 1$ and 7000 ÷ 6000 or 1.166… or 1.167 or 1.17	M1dep	
	11	A1	If showing trials for $n = 10$ and/or 11 must have $1.015^{10} = [1.160, 1.161]$ and/or $1.015^{11} = [1.177, 1.178]$

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	Additional Guidance	
15	Values for working year on year Y1 6000 × 1.015 = 6090 Y2 6090 × 1.015 = 6181.35 Y3 6181.35 × 1.015 = [6274.07, 6274.08] Y4 [6274.07, 6274.08] × 1.015 = [6368.18, 6368.20] Y5 [6368.18, 6368.20] × 1.015 = [6463.70, 6463.73] Y6 [6463.70, 6463.73] × 1.015 = [6560.65, 6560.69] Y7 [6560.65, 6560.69] × 1.015 = [6659.05, 6659.11] Y8 [6659.05, 6659.11] × 1.015 = [6758.93, 6759.00] Y9 [6758.93, 6759.00] × 1.015 = [6860.31, 6860.39] Y10 [6860.31, 6860.39] × 1.015 = [6963.21, 6963.30] Y11 [6963.21, 6963.30] × 1.015 = [7067.65, 7067.75]	
	Answer 11 with no working	M2A1
	1000 ÷ 90 = 11.1 Answer 11	Zero

Question	Answer	Mark	Comments

16(a)	$3y(3y^2 - 2)$ or $-3y(2 - 3y^2)$	B2	B1 $3(3y^3 - 2y)$ or $y(9y^2 - 6)$ or $-3(2y - 3y^3)$ or $-y(6 - 9y^2)$
	Additional Guidance		
	$3y(3y^2 - 2)$ or $-3y(2 - 3y^2)$ followed by incorrect further work eg $3y(3y^2 - 2) = 3y^2(3y - 2)$		B1
	$3y(3y^2 - 2) = 3y(\sqrt{3}\,y + 2)(\sqrt{3}\,y - 2)$		B2
	$3y(3y^2 - 2) = 9y^3 - 6y$ (checking)		B2
	$3y \times (3y^2 - 2)$		B2
	$3 \times (3y^3 - 2y)$		B1
	$y3(3y^2 - 2)$		B1

16(b)	$(3x - 1)(x - 7)$ or $(1 - 3x)(7 - x)$	B2	B1 $(3x + a)(x + b)$ where $ab = 7$ or $a + 3b = -22$ or $(a - 3x)(b - x)$ where $ab = 7$ or $a + 3b = 22$
	Additional Guidance		
	$(3x + 1)(x + 7)$		B1
	$(3x - 1)(x - 7)$		B1
	$(3x - 4)(x - 6)$		B1
	$(7 - 3x)(1 - x)$		B1
	$(10 - 3x)(4 - x)$		B1
	$(3x - 1) \times (x - 7)$		B2
	Ignore any 'solutions' seen eg $(3x - 1)(x - 7)$ in working with $\frac{1}{3}$ and 7 on answer line		B2

Question	Answer	Mark	Comments
17	**Alternative method 1**		
	sin 72 = $\frac{h}{12}$ or 12 sin 72 or cos (90 – 72) = $\frac{h}{12}$ or 12 cos (90 – 72) or $\frac{h}{\sin 72} = \frac{12}{\sin 90}$ or 11.4…	M1	oe Any letter
	16 × their 11.4…	M1dep	
	[182.4, 182.603] or 183	A1	
	Alternative method 2		
	$h^2 + (12 \cos 72)^2 = 12^2$ or $h^2 + (12 \sin (90 – 72))^2 = 12^2$ or $\sqrt{12^2 - (12 \cos 72)^2}$ or $\sqrt{12^2 - (12 \sin (90 - 72))^2}$ or 11.4…	M1	oe Any letter
	16 × their 11.4…	M1dep	
	[182.4, 182.603] or 183	A1	
	Alternative method 3		
	0.5 × 16 × 12 × sin 72 or 91.3…	M1	oe eg 0.5 × 16 × 12 × sin 108
	2 × their 91.3…	M1dep	
	[182.4, 182.603] or 183	A1	
	Additional Guidance		
	2 × 16 × 12 × sin 72		M1M0A0
	sin = $\frac{h}{12}$ or sin θ = $\frac{h}{12}$ (unless recovered)		M0

Question	Answer	Mark	Comments
18(a)	A ∩ B'	B1	
	Additional Guidance		

18(b)	(A U B)'	B1	
	Additional Guidance		

19	**Alternative method 1**		
	$5w \times w$ or $5w^2$ or 1620 ÷ 5 or 324 or trials a value of w for $5w^2$	M1	oe Any letter eg 5 × 12 × 12 or 50 × 10
	$\sqrt{\frac{1620}{5}}$ or $\sqrt{324}$	M1dep	
	18	A1	A0 if –18 also given
	Alternative method 2		
	$l \times \frac{l}{5}$ or $\frac{l^2}{5}$ or 1620 × 5 or 8100 or trials a value of l for $\frac{l^2}{5}$	M1	oe Any letter eg $\frac{60 \times 60}{5}$ or 80 × 16
	$\sqrt{1620 \times 5}$ or $\sqrt{8100}$ or 90	M1dep	
	18	A1	A0 if –18 also given
	Additional Guidance		
	Answer 18		M2A1
	18 in working with 90 on answer line		M2A0
	Trials for $5w^2$ or $\frac{l^2}{5}$ without answer 18		M1M0A0

Question	Answer	Mark	Comments
20	**Alternative method 1**		
	$h = kv^2$ or $5 = k \times 10^2$ or $5 \div 10^2$ or $5 : 10^2$	M1	oe
	$(k =) \frac{1}{20}$ or $(k =) 0.05$ or $h = \frac{1}{20}v^2$ or $h = 0.05v^2$	A1	oe Correct value for k or correct equation in h and v
	their $\frac{1}{20} \times 24^2$	M1dep	oe $\frac{1}{20} \times 24^2$ implies M1A1M1
	28.8	A1ft	ft their k and M1A0M1
	Alternative method 2		
	$kh = v^2$ or $k \times 5 = 10^2$ or $10^2 \div 5$ or $10^2 : 5$	M1	oe
	$(k =) 20$ or $20h = v^2$	A1	oe Correct value for k or correct equation or correct equation in h and v
	$24^2 \div$ their 20	M1dep	oe $24^2 \div 20$ implies M1A1M1
	28.8	A1ft	ft their k and M1A0M1

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Question	Answer	Mark	Comments
20	**Alternative method 3**		
	$\left(\frac{24}{10}\right)^2$ or $\frac{576}{100}$ or $24^2 : 10^2$	M1	oe
	$\frac{h}{5} = \left(\frac{24}{10}\right)^2$	A1	oe Correct equation in h
	5 × their $\left(\frac{24}{10}\right)^2$	M1dep	oe $5 \times \left(\frac{24}{10}\right)^2$ implies M1A1M1
	28.8	A1ft	ft their $\left(\frac{24}{10}\right)^2$ and M1A0M1
	Alternative method 4		
	$\left(\frac{10}{24}\right)^2$ or $\frac{100}{576}$ or $10^2 : 24^2$	M1	oe
	$\frac{5}{h} = \left(\frac{10}{24}\right)^2$	A1	oe Correct equation in h
	5 ÷ their $\left(\frac{10}{24}\right)^2$	M1dep	oe $5 \div \left(\frac{10}{24}\right)^2$ implies M1A1M1
	28.8	A1ft	ft their $\left(\frac{24}{10}\right)^2$ and M1A0M1
	Additional Guidance		
	h α v^2 with no further valid working		Zero
	$h = kv$ or $h = kv^3$ or $h = \frac{k}{v^2}$ etc not recovered		Zero
	Up to first two marks can be awarded for correct working even if not subsequently used		
	Allow use of other letters		

Question	Answer	Mark	Comments
21(a)	Draws $y = 3x$ and (x =) [–0.1, 0.1] and (x =) [1.4, 1.6]	B2	B1 Draws $y = 3x$ or states $y = 3x$ $\pm\frac{1}{2}$ square tolerance for drawing graph Graph must be seen for x values from 0 to 1.5
	Additional Guidance		
	Ignore any y values seen		
	Solutions from a non-graphical method		B0
	Ignore other lines drawn on grid		

Question	Answer	Mark	Comments
21(b)	Full evaluation of method and answer	B2	eg1 Cannot divide by x as it could be zero eg2 Should have factorised and then he would have also found that $x = 0$ eg3 Should have used the formula and then he would have also found that $x = 0$ eg4 Should have used a graphical method then he would have also found that $x = 0$ eg5 Should have completed the square then he would have also found that $x = 0$ B1 Partial evaluation eg1 $x = 0$ has been omitted eg2 Should have factorised eg3 Should have used the formula eg4 Should have drawn a graph eg5 Only found one solution eg6 Cannot divide by zero
	Additional Guidance		
	For B2 there needs to be an evaluation of the method and an indication that $x = 0$ has been omitted from the answer		
	$x(2x + 5) = 0$ $x = 0$ and $x = –2.5$	B2	
	Should be two solutions	B1	
	What about $x = 0$	B1	
	The answer is wrong	B0	
	Ignore non-contradictory further work		

Question	Answer	Mark	Comments
22	**Alternative method 1**		
	$(\frac{1}{2}\ \times)\ \pi \times 25 \times 25$ or 625π or 312.5π or [1962.5, 1964] or [981, 982] or $\pi \times 12 \times 12$ or 144π or [452, 452.45]	M1	oe Area of circle or semicircle radius 25 or area of circle radius 12
	$\frac{150}{360}$ or $\frac{5}{12}$ or 0.41(6…) or 0.417 or 0.42 or $\frac{360}{150}$ or $\frac{12}{5}$ or 2.4	M1	May be seen in two steps eg × 150 ÷ 360
	their $\frac{150}{360} \times \pi \times 12 \times 12$ or $\pi \times 12 \times 12 \div$ their $\frac{360}{150}$ or 60π or [188.4, 188.52]	M1dep	oe dep on M2 Area of sector
	$\frac{\text{their [188.4, 188.52]}}{\text{their [981, 982]}}$ (× 100) or [0.19, 0.1922] or [19, 19.22]	M1dep	oe dep on M3 their [981, 982] must be the area of semicircle radius 25
	[19, 19.22] and No or [0.19, 0.1922] and 0.2 and No	A1	

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Question	Answer	Mark	Comments
22	**Alternative method 2**		
	$(\frac{1}{2}\times)\ \pi \times 25 \times 25$ or 625π or 312.5π or [1962.5, 1964] or [981, 982] or $\pi \times 12 \times 12$ or 144π or [452, 452.45]	M1	oe Area of circle or semicircle radius 25 or area of circle radius 12
	$\frac{150}{360}$ or $\frac{5}{12}$ or 0.41(6…) or 0.417 or 0.42 or $\frac{360}{150}$ or $\frac{12}{5}$ or 2.4	M1	May be seen in two steps eg × 150 ÷ 360
	their $\frac{150}{360} \times \pi \times 12 \times 12$ or $\pi \times 12 \times 12 \div$ their $\frac{360}{150}$ or 60π or [188.4, 188.52]	M1dep	oe dep on M2 Area of sector
	their [188.4, 188.52] × 5 or [942, 942.6]	M1dep	oe dep on M3
	[942, 942.6] and [981, 982] and No	A1	oe eg 300π and 312.5π and No

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Additional Guidance is on the next page

Question	Answer	Mark	Comments
22	**Alternative method 3**		
	$(\frac{1}{2}\ \times) \pi \times 25 \times 25$ or 625π or 312.5π or [1962.5, 1964] or [981, 982] or $\pi \times 12 \times 12$ or 144π or [452, 452.45]	M1	oe Area of circle or semicircle radius 25 or area of circle radius 12
	0.2 × their [981, 982] or 62.5π or [196.2, 196.4]	M1dep	oe dep on 1st M1 their [981, 982] must be the area of semicircle radius 25
	$\frac{150}{360}$ or $\frac{5}{12}$ or 0.41(6…) or 0.417 or 0.42 or $\frac{360}{150}$ or $\frac{12}{5}$ or 2.4	M1	May be seen in two steps eg × 150 ÷ 360
	their $\frac{150}{360} \times \pi \times 12 \times 12$ or $\pi \times 12 \times 12 \div$ their $\frac{360}{150}$ or 60π or [188.4, 188.52]	M1dep	oe dep on 1st M1 and 3rd M1 Area of sector
	[188.4, 188.52] and [196.2, 196.4] and No	A1	oe eg 60π and 62.5π and No
	Additional Guidance		
	Alt 3 20% of [981, 982] does not score 2nd M1 unless evaluated correctly		

Question	Answer	Mark	Comments
23(a)	**Alternative method 1**		
	30 ÷ 20 or 1.5	M1	May be implied by correct labelling on vertical axis
	12 ÷ 15 or 0.8	M1	
	Draws block for $65 \leqslant x < 80$ with height 8 small squares	A1	Mark intention
	Alternative method 2		
	12 ÷ (30 ÷ 6) or 12 ÷ 5 or 2.4	M1	
	their 2.4 ÷ 1.5 or 1.6	M1dep	
	Draws block for $65 \leqslant x < 80$ with height 8 small squares	A1	Mark intention
	Alternative method 3		
	12 ÷ (30 ÷ 150) or 12 ÷ 0.2 or 60	M1	
	their 60 ÷ 7.5 or 8	M1dep	
	Draws block for $65 \leqslant x < 80$ with height 8 small squares	A1	Mark intention
	Alternative method 4		
	1.5 × (30 ÷ 6) or 1.5 × 5 or 7.5	M1	
	12 ÷ their 7.5 or 1.6	M1dep	
	Draws block for $65 \leqslant x < 80$ with height 8 small squares	A1	Mark intention
	Additional Guidance		
	Draws block for $65 \leqslant x < 80$ with height 8 small squares		3 marks

Question	Answer	Mark	Comments
23(b)	10 × 4.5 or 9 × 30 ÷ 6 or 225 ÷ (30 ÷ 6) or 45 or 10 × 3.6 or 7.2 × (30 ÷ 6) or 180 ÷ (30 ÷ 6) or 36 or 25 × 2 or 10 × (30 ÷ 6) or 250 ÷ (30 ÷ 6) or 50 or 34.6 × 30 ÷ 6 or 865 ÷ (30 ÷ 6)	M1	oe May be seen on histogram
	173	A1	
	Additional Guidance		

Question	Answer	Mark	Comments
24	**Alternative method 1**		
	0.5 × 8 × 9 or 36 or (27 – 8) × 9 or 19 × 9 or 171	M1	May be seen on graph
	0.5 × 8 × 9 + (27 – 8) × 9 or 207	M1dep	M2 0.5 × (27 + 19) × 9
	207 and Yes	A1	
	Alternative method 2		
	0.5 × 8 × 9 or 36	M1	May be seen on graph
	$\frac{200 - \text{their } 36}{9}$ or $\frac{164}{9}$ or 18.2…	M1dep	
	26.2… and Yes or 18.2… and 19 and Yes	A1	
	Alternative method 3		
	0.5 × 8 × 9 or 36	M1	May be seen on graph
	$\frac{200 - \text{their } 36}{27 - 8}$ or $\frac{164}{19}$ or 8.6…	M1dep	
	8.6… and Yes	A1	
	Alternative method 4		
	0.5 × 8 × 9 or 36	M1	May be seen on graph
	Attempt at total distance for Beth for $26.\dot{2} \leqslant$ total time < 27	M1dep	eg (time 26.5s) 0.5 × 8 × 9 + (26.5 – 8) × 9
	Correct total distance for Beth for $26.\dot{2} \leqslant$ total time < 27 and Yes	A1	eg (time 26.5s) 202.5 and Yes
	Additional Guidance		

Question	Answer	Mark	Comments
25	342.5 or 347.5	B1	Allow $347.4\dot{9}$ for 347.5
	6.35 or 6.45 or 2.55 or 2.65	B1	Allow $6.44\dot{9}$ for 6.45 Allow $2.64\dot{9}$ for 2.65
	their 6.35 × their 2.55 or 16.1925	M1	Must use their lower bounds for lengths their 6.35 must be [6.3, 6.4) their 2.55 must be [2.5, 2.6)
	their 347.5 ÷ their 16.1925	M1dep	Must use their upper bound for force their 347.5 bound must be (345, 350]
	21.46	A1	Must come from 347.5 ÷ (6.35 × 2.55) or $347.4\dot{9}$ ÷ (6.35 × 2.55)
	Additional Guidance		
	347.49 ÷ (6.35 × 2.55) = 21.46		B0B1M1M1A0
	21.4… or 21.5 does not score any marks if no working is seen		

Question	Answer	Mark	Comments
26	**Alternative method 1** Shows that *CB* (or *BC*) is equal and parallel to *DE* (or *ED*)		
	$(\vec{CB} =) -(\mathbf{b} - 2\mathbf{a}) - 2\mathbf{b} - \mathbf{a}$ or $(\vec{BC} =) \mathbf{b} - 2\mathbf{a} + 2\mathbf{b} + \mathbf{a}$	M1	oe method
	$(\vec{CB} =) \mathbf{a} - 3\mathbf{b}$ or $(\vec{BC} =) 3\mathbf{b} - \mathbf{a}$	A1	Must see correct method for $\vec{CB}$ or $\vec{BC}$
	CB is equal and parallel to *DE*	A1	Must see a correct vector for first A1 and have a statement oe eg *CB* is equal and parallel to *ED*
	Alternative method 2 Shows that *BE* (or *EB*) is equal and parallel to *CD* (or *DC*)		
	$(\vec{BE} =) \mathbf{a} + 2\mathbf{b}$ or $(\vec{CD} =) -(\mathbf{b} - 2\mathbf{a}) - (\mathbf{a} - 3\mathbf{b})$ or $(\vec{EB} =) -\mathbf{a} - 2\mathbf{b}$ or $(\vec{DC} =) (\mathbf{a} - 3\mathbf{b}) + (\mathbf{b} - 2\mathbf{a})$	M1	oe method
	$(\vec{BE} =) \mathbf{a} + 2\mathbf{b}$ and $(\vec{CD} =) \mathbf{a} + 2\mathbf{b}$ or $(\vec{EB} =) -\mathbf{a} - 2\mathbf{b}$ and $(\vec{DC} =) -\mathbf{a} - 2\mathbf{b}$	A1	Must see correct method for $\vec{CD}$ or $\vec{DC}$ oe eg $(\vec{BE} =) \mathbf{a} + 2\mathbf{b}$ and $(\vec{DC} =) -\mathbf{a} - 2\mathbf{b}$
	BE is equal and parallel to *CD*	A1	Must see two correct vectors for first A1 and have a statement oe eg *BE* is equal and parallel to *DC*

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Question	Answer	Mark	Comments
26	**Alternative method 3** Shows that two pairs of opposite sides are parallel		
	$(\vec{CB} =)$ $-(\mathbf{b} - 2\mathbf{a}) - 2\mathbf{b} - \mathbf{a}$ or $(\vec{BC} =)$ $\mathbf{b} - 2\mathbf{a} + 2\mathbf{b} + \mathbf{a}$ or $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ or $(\vec{CD} =)$ $-(\mathbf{b} - 2\mathbf{a}) - (\mathbf{a} - 3\mathbf{b})$ or $(\vec{EB} =)$ $-\mathbf{a} - 2\mathbf{b}$ or $(\vec{DC} =)$ $(\mathbf{a} - 3\mathbf{b}) + (\mathbf{b} - 2\mathbf{a})$	M1	oe method
	$(\vec{CB} =)$ $\mathbf{a} - 3\mathbf{b}$ or $(\vec{BC} =)$ $3\mathbf{b} - \mathbf{a}$ or $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{CD} =)$ $\mathbf{a} + 2\mathbf{b}$ or $(\vec{EB} =)$ $-\mathbf{a} - 2\mathbf{b}$ and $(\vec{DC} =)$ $-\mathbf{a} - 2\mathbf{b}$	A1	Must see correct method for $\vec{CB}$ or $\vec{BC}$ or $\vec{CD}$ or $\vec{DC}$ oe eg $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{DC} =)$ $-\mathbf{a} - 2\mathbf{b}$
	$(\vec{CB} =)$ $\mathbf{a} - 3\mathbf{b}$ and $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{CD} =)$ $\mathbf{a} + 2\mathbf{b}$ and *CB* is parallel to *DE* and *BE* is parallel to *CD*	A1	Must see three correct vectors and have two statements oe eg $(\vec{BC} =)$ $3\mathbf{b} - \mathbf{a}$ and $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{DC} =)$ $-\mathbf{a} - 2\mathbf{b}$ and *BC* is parallel to *DE* and *BE* is parallel to *DC*

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Additional Guidance is on the next page

Question	Answer	Mark	Comments
26	**Alternative method 4** Shows that two pairs of opposite sides are equal		
	$(\vec{CB} =)$ $-(\mathbf{b} - 2\mathbf{a}) - 2\mathbf{b} - \mathbf{a}$ or $(\vec{BC} =)$ $\mathbf{b} - 2\mathbf{a} + 2\mathbf{b} + \mathbf{a}$ or $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ or $(\vec{CD} =)$ $-(\mathbf{b} - 2\mathbf{a}) - (\mathbf{a} - 3\mathbf{b})$ or $(\vec{EB} =)$ $-\mathbf{a} - 2\mathbf{b}$ or $(\vec{DC} =)$ $(\mathbf{a} - 3\mathbf{b}) + (\mathbf{b} - 2\mathbf{a})$	M1	oe
	$(\vec{CB} =)$ $\mathbf{a} - 3\mathbf{b}$ or $(\vec{BC} =)$ $3\mathbf{b} - \mathbf{a}$ or $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{CD} =)$ $\mathbf{a} + 2\mathbf{b}$ or $(\vec{EB} =)$ $-\mathbf{a} - 2\mathbf{b}$ and $(\vec{DC} =)$ $-\mathbf{a} - 2\mathbf{b}$	A1	Must see correct method for $\vec{CB}$ or $\vec{BC}$ or $\vec{CD}$ or $\vec{DC}$ oe eg $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{DC} =)$ $-\mathbf{a} - 2\mathbf{b}$
	$(\vec{CB} =)$ $\mathbf{a} - 3\mathbf{b}$ and $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{CD} =)$ $\mathbf{a} + 2\mathbf{b}$ and *CB* is equal to *DE* and *BE* is equal to *CD*	A1	Must see three correct vectors and have two statements oe eg $(\vec{BC} =)$ $3\mathbf{b} - \mathbf{a}$ and $(\vec{BE} =)$ $\mathbf{a} + 2\mathbf{b}$ and $(\vec{DC} =)$ $-\mathbf{a} - 2\mathbf{b}$ and *BC* is equal to *DE* and *BE* is equal to *DC*
	Additional Guidance		
	Choose the method that gives most marks		
	Ignore incorrect vectors if not contradictory		
	For parallel allow in the same direction or in the opposite direction		
	For equal to allow = or the same as		
	Condone incorrect notation if unambiguous eg *CB* = –(b – 2a) – 2b – a		M1

Question	Answer	Mark	Comments
27	**Alternative method 1**		
	$x(x + 2)$ or $x^2 + 2x$ or $2x \times 4$ or $8x$ or $4(x + 2)$ or $4x + 8$	M1	
	$x(x + 2)$ or $x^2 + 2x$ and $2x \times 4$ or $8x$ and $4(x + 2)$ or $4x + 8$	M1dep	oe eg $\frac{x(x+2) - 2x \times 4}{4(x+2)}$
	$x(x + 2) - 2x \times 4 = 4(x + 2)$	M1dep	oe equation with fractions eliminated dep on M2
	$x^2 - 10x - 8$ (= 0)	A1	oe 3-term quadratic equation with terms collected
	$\frac{--10 \pm \sqrt{(-10)^2 - 4 \times 1 \times -8}}{2 \times 1}$ or $\frac{10 \pm \sqrt{100 + 32}}{2}$ or $\frac{10 \pm \sqrt{132}}{2}$ or $5 \pm \sqrt{5^2 + 8}$ or $5 \pm \sqrt{33}$ or [10.744, 10.745] and [–0.745, –0.744]	M1	oe Correct for their 3-term quadratic Allow correct factorisation of their 3-term quadratic
	10.74 and –0.74 with $x^2 - 10x - 8$ (= 0) oe seen	A1	Must both be to 2 decimal places

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Question	Answer	Mark	Comments
27	**Alternative method 2** (from $\frac{x}{4} = 1 + \frac{2x}{x+2}$)		
	$x(x + 2)$ or $x^2 + 2x$ or $(x + 2) + 2x$ or $3x + 2$ or $12x + 8$	M1	
	$\frac{x(x+2)}{4}$ or $\frac{x^2+2x}{4}$ and $\frac{x+2+2x}{x+2}$ or $\frac{3x+2}{x+2}$	M1dep	
	$x(x + 2) = 4(x + 2 + 2x)$ or $x(x + 2) = 4(3x + 2)$	M1dep	oe equation with fractions eliminated dep on M2
	$x^2 – 10x – 8 (= 0)$	A1	oe 3-term quadratic equation with terms collected
	$\frac{--10 \pm \sqrt{(-10)^2 - 4 \times 1 \times -8}}{2 \times 1}$ or $\frac{10 \pm \sqrt{100 + 32}}{2}$ or $\frac{10 \pm \sqrt{132}}{2}$ or $5 \pm \sqrt{5^2 + 8}$ or $5 \pm \sqrt{33}$ or [10.744, 10.745] and [–0.745, –0.744]	M1	oe Correct for their 3-term quadratic Allow correct factorisation of their 3-term quadratic
	10.74 and –0.74 with $x^2 – 10x – 8 (= 0)$ oe seen	A1	Must both be to 2 decimal places

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Question	Answer	Mark	Comments
27	**Alternative method 3** (from $\frac{x}{4} - 1 = \frac{2x}{x+2}$)		
	$\frac{x-4}{4}$	M1	
	$(x-4)(x+2)$ or $x^2 - 4x + 2x - 8$ or $x^2 - 2x - 8$ and $2x \times 4$ or $8x$	M1dep	
	$(x-4)(x+2) = 2x \times 4$ or $x^2 - 4x + 2x - 8 = 8x$	M1dep	oe equation with fractions eliminated dep on M2
	$x^2 - 10x - 8 (= 0)$	A1	oe 3-term quadratic equation with terms collected
	$\frac{--10 \pm \sqrt{(-10)^2 - 4 \times 1 \times -8}}{2 \times 1}$ or $\frac{10 \pm \sqrt{100+32}}{2}$ or $\frac{10 \pm \sqrt{132}}{2}$ or $5 \pm \sqrt{5^2 + 8}$ or $5 \pm \sqrt{33}$ or [10.744, 10.745] and [–0.745, –0.744]	M1	oe Correct for their 3-term quadratic Allow correct factorisation of their 3-term quadratic
	10.74 and –0.74 with $x^2 - 10x - 8 (= 0)$ oe seen	A1	Must both be to 2 decimal places
	Additional Guidance		
	10.74 and –0.74 from T & I or with no working		6 marks
	10.74 or –0.74 from T & I or with no working		Zero
	In quadratic formula, do not allow -10^2 for $(-10)^2$ unless recovered		