GCSE
Mathematics

Paper 3 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	$\begin{pmatrix}-5\\-3\end{pmatrix}$	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 × n	M1	oe (Heads =) 300 200 : 300
	500	A1	
	Additional Guidance		
	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	**Alternative method 1**		
	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
	Alternative method 2		
	$1 \leq x < 6$ 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 1st 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
	Additional Guidance		
	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
	Additional Guidance		
	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 **two** 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
	Additional Guidance		
	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
	$6.4\dot{9} + 4.4\dot{9} = 11$		M0
8(a)	Could be true	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
8(b)	Must be true	B1	
	Additional Guidance		

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
	Additional Guidance		
	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)	**Alternative method 1**		
	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
	Alternative method 2		
	720 + 700 or 1420 or $\frac{1}{3}$ × 720 or 240 or $\frac{2}{5}$ × 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
	Alternative method 3		
	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

9(b) cont	**Additional Guidance**	
	$\frac{520}{1420}$ 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 × their 30 + 10 or 3 × their 30 – 20 or 70	M1dep	oe
	110	A1	
	Additional Guidance		
	$x = 30$, $y = 180 - 3(30) + 20 = 110$		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 × 10 + 10 (= 30)		M1M1M1A0
	$2x + 10 = 3x - 20$ $x = 10$ 2 × 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 × their 25 – 20 or 55 or 180 – 55 or 125	M1dep	oe
	(y =) 125 and bigger or (y is) 15 bigger	A1ft	oe ft their (a)
	Additional Guidance		
	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 × 25 + 10 = 60		M1M0A0
	y is bigger ticked but no valid working		M0M0A0

Question	Answer	Mark	Comments
11	**Alternative method 1**		
	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	
	Alternative method 2		
	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	
	Alternative method 3		
	$\frac{2}{7}$ × 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

11 cont	**Additional Guidance**	
	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
	Additional Guidance		
	$(2r^5)^4$		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	**Alternative method 1**		
	12 × 1.58 or 18.96 or 28 × 1.52 or 42.56	M1	
	28 × 1.52 – 12 × 1.58 or their 42.56 – their 18.96 or 23.6	M1dep	oe
	their 23.6 ÷ (28 – 12) or their 23.6 ÷ 16	M1dep	oe dep on M1 M1
	1.475 or 1.48	A1	
	Alternative method 2		
	16x + 12 × 1.58 or 16x + 18.96 or 28 × 1.52 or 42.56	M1	
	(16x =) their 42.56 – their 18.96 or (16x =) 23.6	M1dep	oe
	their 23.6 ÷ (28 – 12) or their 23.6 ÷ 16	M1dep	oe dep on M1 M1
	1.475 or 1.48	A1	
	Additional Guidance		
	23.6 ÷ 16 = 1.475 = 1.5		M1M1M1A1
	23.6 ÷ 16 = 1.5		M1M1M1A0
	23.6 ÷ (28 – 12) 23.6 ÷ 14		M1M1M1A0
	23.6 ÷ 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	**Alternative method 1**		
	$\frac{25}{100}$ × 18 000 or 4500 and 18 000 – their 4500 or 18 000 × (1 – 0.25) or 18 000 × 0.75 or 13 500 or 0.88	M1	oe
	their 13 500 × $(1 - 0.12)^4$ or their 13 500 × 0.88^4 their 13 500 × $(1 - 0.12)^3$ or their 13 500 × 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
	Alternative method 2		
	$\frac{25}{100}$ × 18 000 or 4500 and 18 000 – 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

	Additional Guidance	
16 cont	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	**Alternative method 1**		
	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 70×1.6 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
	Alternative method 2		
	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 70×1.6 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

	Alternative method 3		
	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 ÷ 50 or 0.18	M1	oe
	70 ÷ 40 or 1.75	M1	
	70 ÷ 40 × 1.6 or 2.8 or their 1.75 × 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
	Additional Guidance		
17 cont	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 ÷ 50 = 0.18 gallons Second stage: Distance travelled 70 × 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 ÷ 40 = 2.8 gallons		
	An incorrect conversion of 1 hour 36 minutes to 1.36 can score: eg 70 × 1.36 = 95.2, 95.2 ÷ 40 = 2.38 70 × 1.36 = 95.2, 95.2 ÷ 40 = 2.38, 0.18 + 2.38 = 2.56		B0M0M1M1A0 B1M1M1M1A0
	2.98 = 3 (further work)		B1M1M1M1A1
	9 ÷ 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 $0.5^0 = 1$
	Additional Guidance		
	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	**Alternative method 1**		
	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*
	(3*x* =) 180 – their 78 or (3*x* =) 24 + their 78 or (3*x* =) 102	M1	oe May be on the diagram
	34	A1	May be on the diagram
	Alternative method 2		
	BDC = 24	B1	May be on the diagram
	DFC = 180 – 3*x*	M1	May be on the diagram
	2(180 – 3*x*) + 24 = 180 or 360 – 6*x* + 24 = 180 or 3*x* + 78 = 180 or (3*x* =) 102	M1dep	oe
	34	A1	May be on the diagram
	Additional Guidance		
	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

19 cont	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

20	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]
	Additional Guidance		
	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

21	$-2.5 < x < 1$	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
22	**Alternative method 1**		
	Second differences 8	M1	Implied by $4n^2$
	Any three values from –2 1 4 7	M1dep	
	$4n^2 + 3n - 5$	A1	oe Allow $a = 4$ $b = 3$ $c = -5$
	Alternative method 2		
	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

22 cont	**Alternative method 3**		
	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 $a = 4$ $b = 3$ $c = -5$
	Additional Guidance		
	Sequence (–5) 2 17 40 71 1st differences are (7) 15 23 31 2nd 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 $(x - \frac{3}{2})^2 + ...$ 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)
	Additional Guidance		

Question		Mark	Comments
24	Draws a tangent at 1 second	M1	
	Their gradient at 1 second	A1ft	Must see a tangent on the graph ft their tangent ±0.2 tolerance on vertical reading ±0.1 tolerance on horizontal reading
	Additional Guidance		

Question	Answer	Mark	Comments
25(a)	**Alternative method 1**		
	$17^2 - (16 \div 2)^2$ 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
	Alternative method 2		
	$\sin E = \frac{8}{17}$ or $\cos A = \frac{8}{17}$ or $E = 28.(\ldots)$ or $A = 61.9(\ldots)$ or 62 and $\cos 28.(\ldots) = \frac{EM}{17}$ or $\tan 28.(\ldots) = \frac{8}{EM}$ or $\sin 61.9(\ldots) = \frac{EM}{17}$ or $\tan 61.9(\ldots) = \frac{EM}{8}$	M1	
	$17 \cos 28.(\ldots)$ or $8 \div \tan 28.(\ldots)$ or $17 \sin 61.9(\ldots)$ or $8 \tan 61.9(\ldots)$	A1	
	Additional Guidance		
	8, 15, 17 on their own		M0A0
	$EM^2 = 289 - 64 = 225$, $EM = 15$		M1A0

Question	Answer	Mark	Comments
25(b)	**Alternative method 1**		
	$30^2 + (16 \div 2)^2$ 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	
	Alternative method 2		
	$30^2 + 17^2$ 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	**Alternative method 3**		
	$30^2 + (16 \div 2)^2$ 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 *CM* *CE*
	$\cos x = \frac{\text{their [31, 31.1]}}{\text{their [34.4, 34.5]}}$	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	
	Alternative method 4		
	$17^2 - (16 \div 2)^2$ 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	
	Additional Guidance		

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
	Additional Guidance		
	$3x^2 = 38x – 55$		M1M1M1A1

Question	Answer	Mark	Comments
27	**Alternative method 1** – completing the square		
	$(x+\frac{1}{2})^2 + ...$	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
	Alternative method 2 – real roots		
	$\frac{-1 \pm \sqrt{1^2 - 4 \times 1 \times 1}}{2 \times 1}$ 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
	Alternative method 3 – Calculus		
	$2x + 1 = 0$	M1	
	$x = -\frac{1}{2}$	A1	
	(minimum value =) $\frac{3}{4}$	A1	

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