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# GCSE Mathematics

Paper 2 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.

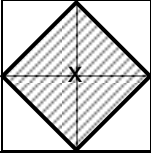
**Continental notation**

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	0.049	B1	
	<b>Additional Guidance</b>		
2	0.36 cm <sup>2</sup>	B1	
	<b>Additional Guidance</b>		
3	(5, 7)	B1	
	<b>Additional Guidance</b>		
4	98 – 8n	B1	
	<b>Additional Guidance</b>		

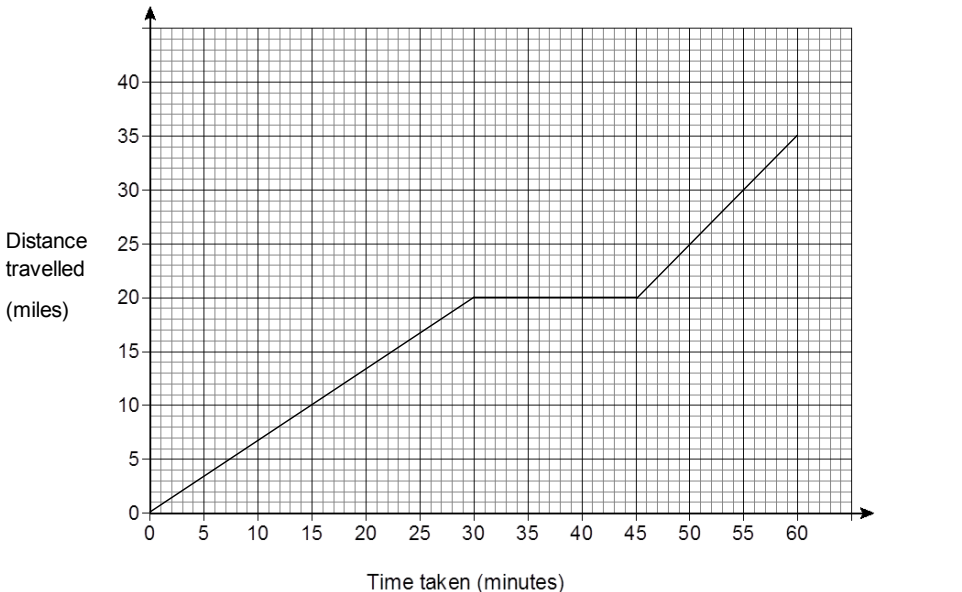
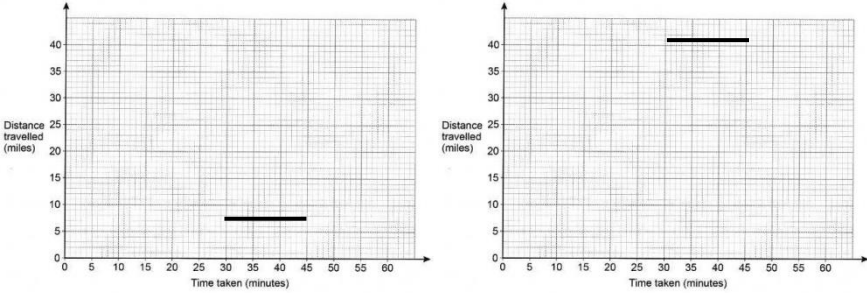
Question	Answer	Mark	Comments
5(a)	$\frac{1}{4}$ or 0.25 or 25%	B1	oe
	<b>Additional Guidance</b>		
	Ratio eg 1 : 4 or 1 : 3		B0
	$\frac{1}{4}$ seen and answer 1 : 4		B1
	Expressed only in words eg 1 out of 4		B0
	1 out of 4 and $\frac{1}{4}$		B1
	$\frac{1}{4}$ seen with change to incorrect decimal or incorrect percentage eg $\frac{1}{4}$ and answer 0.4		B1
Ignore chance words if $\frac{1}{4}$ seen eg $\frac{1}{4}$ and answer Likely		B1	

5(b)	(1 x) 10 (x) 10 (x) 5 or $\frac{10 \times 10 \times 10}{2}$ or $\frac{1000}{2}$	M1	oe
	500	A1	SC1 5 or 324 or 400 or 405
	<b>Additional Guidance</b>		
	10 + 10 + 5		M0A0
	SCs are for the answers from not including zero at least once ie $9 \times 9 \times 4$ or $10 \times 10 \times 4$ or $9 \times 9 \times 5$ or from a misread ie $1 \times 1 \times 1 \times 5$		

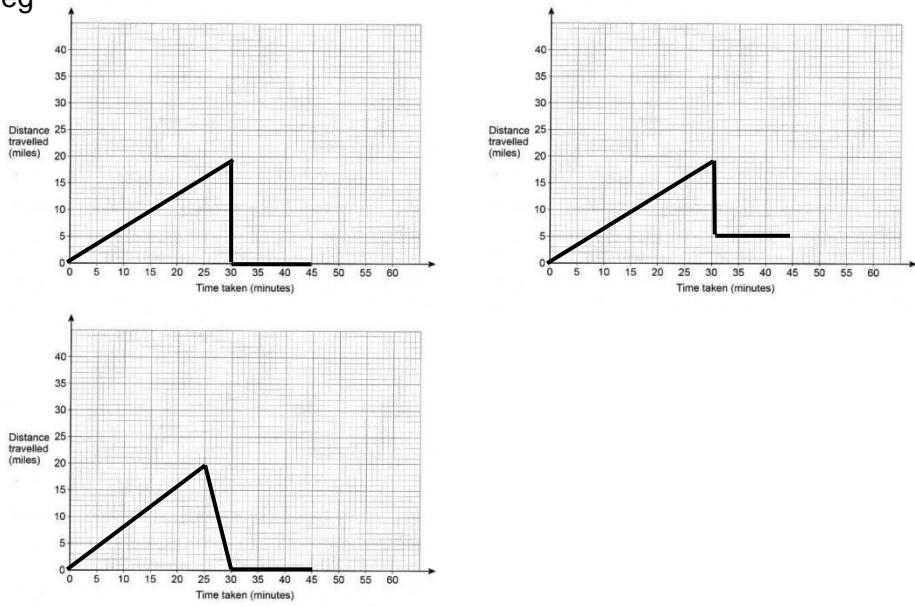
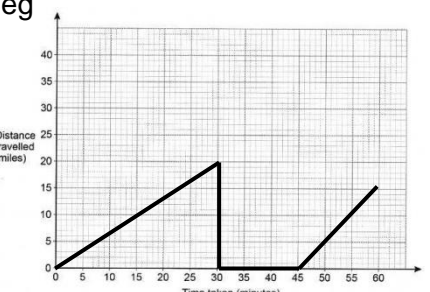
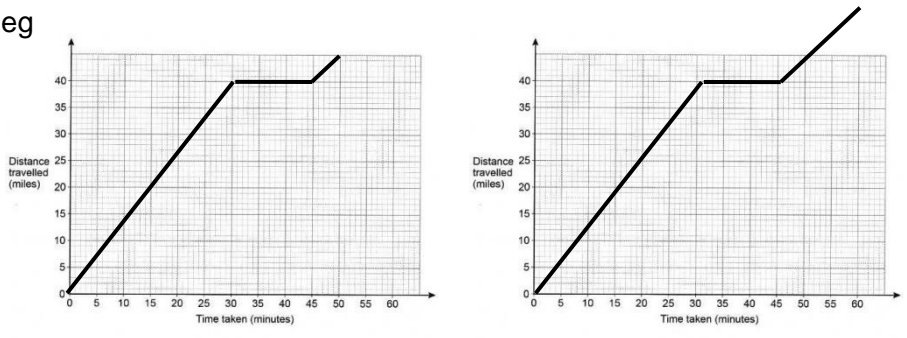
Question	Answer	Mark	Comments														
6(a)	<table border="1"> <tr> <td><math>x</math></td> <td>-2</td> <td>-1</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td><math>y</math></td> <td>4</td> <td>0</td> <td>-2</td> <td>-2</td> <td>0</td> <td>4</td> </tr> </table>	$x$	-2	-1	0	1	2	3	$y$	4	0	-2	-2	0	4	B2	B1 1 or 2 values correct
	$x$	-2	-1	0	1	2	3										
	$y$	4	0	-2	-2	0	4										
<b>Additional Guidance</b>																	
6(b)	5 or 6 points plotted correctly	M1	Correct or ft their table in (a) Tolerance of $\pm 1$ small square Points can be implied by graph passing through them														
	Correct smooth parabolic curve and $y$ -coordinate of minimum point in the range $-2.5 \leq y \leq -2.1$	A1	Tolerance of $\pm 1$ small square for the six <b>correct</b> points from the table No further tolerance for the minimum														
	<b>Additional Guidance</b>																
	Tolerance of $\pm 1$ small square means it is on the edges of or within the shaded area 																
	Ignore extra points plotted																
	If their table in (a) has points that are beyond the grid these points will not be able to be plotted correctly																
	Ignore any curve drawn for $x < -2$ or $x > 3$																
	Curve passing through all correct points within tolerance	M1A1															
Ruled straight lines	A0																

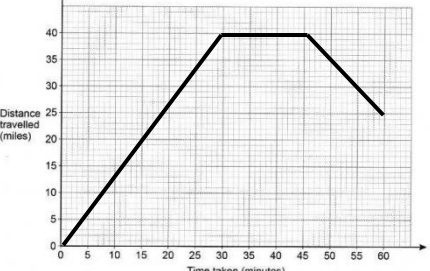
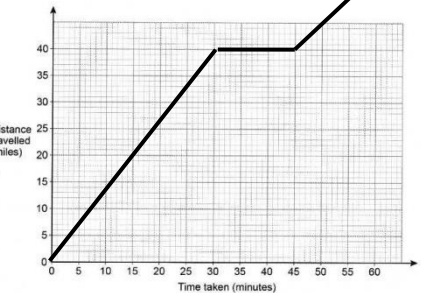
Question	Answer	Mark	Comments
6(c)	$\frac{1}{2}$ or 0.5	B1	Ignore any y-coordinate
	<b>Additional Guidance</b>		
	(-2.25, 0.5)		B0
	Ignore their graph drawn in (b) – there is no ft		
	Condone 0.5, -2.25		B1
7	$\sin 72 = \frac{x}{8}$ or $8 \times \sin 72$ or $\cos (90 - 72) = \frac{x}{8}$ or $8 \times \cos (90 - 72)$ or $\frac{x}{\sin 72} = \frac{8}{\sin 90}$ or $\frac{\sin 72}{x} = \frac{\sin 90}{8}$	M1	oe eg $8 \cos 72$ or 2.47... or 2.5 and $\sqrt{8^2 - (8\cos 72)^2}$
	[7.6, 7.61]	A1	
	<b>Additional Guidance</b>		
	If trigonometry and Pythagoras are used it must be a fully correct method that would lead to the correct value of $x$		
	Accept $\sin 72 \times 8$		M1
	Accept opp or o for $x$ eg $\sin 72 = \frac{\text{opp}}{8}$		M1
	$\sin = \frac{x}{8}$ or $\sin \theta = \frac{x}{8}$ (unless recovered)		M0
	Answer coming from scale drawing		M0A0
	Answer in range seen followed by 7 or 8		M1A1



Question	Answer	Mark	Comments
8(a)	Joins (0, 0) to (30, 20)	B1	Line does not need to be straight but must start and finish at correct points and not be decreasing Mark intention
	Horizontal <b>line</b> for 15 minutes from their (30, 20)	B1ft	Mark intention
	Line with gradient 1 or a curve from their (45, 20) <b>and</b> stops at 60 minutes or stops at top edge of grid or higher but not beyond 60 minutes	B1ft	A curve must not be decreasing and must start and finish at two points that could be joined by a line with gradient 1 Condone a horizontal or vertical line from 60 minutes Mark intention
<b>Additional Guidance</b>			
		B3	
	<p>Allow any horizontal line between 30 minutes and 45 minutes if first part of journey is blank</p> <p>eg</p> 	B0B1	

**Additional Guidance continues on the next page**

<b>Additional Guidance continued</b>		
<b>8(a)</b> <b>cont</b>	<p>Do not allow second mark if their first line is followed by a drop back towards the horizontal axis before she stops</p> <p>eg</p> 	B1B0  B0B0
	<p>If there are more than 3 lines or curves, assume the last part is the part where she completes her journey</p> <p>eg</p> 	B1B0B1ft
	<p>If their (45, 20) is too high to fit a line of gradient 1 ending at 60 minutes, allow the final line to stop at the top of the grid or higher, but not beyond 60 minutes</p> <p>eg</p> 	B0B1ftB1ft
<p>Points but no lines</p>	B0	
<p>Ignore any lines that could be working for part (a) or part (b)</p>		

Question	Answer	Mark	Comments	
<b>8(b)</b>	35	B1ft	Correct or ft total distance travelled for their graph at 60 minutes	
	<b>Additional Guidance</b>			
	35 from any or no graph	B1		
	If their graph extends beyond 60 minutes, read off at 60 minutes for ft			
	Follow through total distance travelled eg (a) 			B0ft B1ft
	(b) answer 25 (b) answer 55			
Ignores the stationary parts			B0	
Do not follow through a graph above the grid at 60 eg (a) 			B0ft	
(b) answer 55				

Question	Answer	Mark	Comments
9	<b>Alternative method 1</b>		
	40	B1	May be implied eg $\frac{2}{40}$
	$2 + x + 2x + 5 = \text{their } 40$ or $3x + 7 = \text{their } 40$ or $(\text{their } 40 - 2 - 5) \div 3$ or $33 \div 3$	M1	oe equation eg $3x + 5 = 38$ (scores B1M1) their 40 must be an integer
	$(x =) 11$	A1ft	ft B0M1 Does not have to be an integer Accept answer rounded or truncated to at least 2 sf
	$\frac{27}{40}$ or 0.675 or 67.5%	B1ft	Only ft evaluation of $\frac{2 \times \text{their integer } x + 5}{40}$ and $0 < \text{answer} < 1$ Denominator must be 40 (may subsequently be simplified)
	<b>Alternative method 2</b>		
	$\frac{2}{2+x+2x+5} = \frac{1}{20}$ or $\frac{x+2x+5}{2+x+2x+5} = \frac{19}{20}$	M2	oe equation
	$(x =) 11$	A1	
	$\frac{27}{40}$ or 0.675 or 67.5%	B1ft	Only ft evaluation of $\frac{2 \times \text{their integer } x + 5}{40}$ and $0 < \text{answer} < 1$ Denominator must be 40 (may subsequently be simplified)

Alternative methods 3, 4 and Additional Guidance continue on the next two pages

Question	Answer	Mark	Comments
<b>9 cont</b>	<b>Alternative method 3</b>		
	$3x \rightarrow 100\% - 5\% - 12.5\%$ or $3x \rightarrow 82.5\%$	M1	Using $2 \rightarrow 5\%$ and $5 \rightarrow 12.5\%$ oe
	$x \rightarrow 82.5\% \div 3$ or $x \rightarrow 27.5\%$	M1dep	oe
	$2x + 5 \rightarrow 2 \times 27.5\% + 12.5\%$	M1dep	oe
	$\frac{27}{40}$ or 0.675 or 67.5%	A1	
	<b>Alternative method 4</b>		
	$3x \rightarrow 1 - \frac{1}{20} - \frac{2.5}{20}$ or $3x \rightarrow \frac{16.5}{20}$	M1	Using $2 \rightarrow \frac{1}{20}$ and $5 \rightarrow \frac{2.5}{20}$ oe
	$x \rightarrow \frac{16.5}{20} \div 3$ or $x \rightarrow \frac{5.5}{20}$	M1dep	oe
	$2x + 5 \rightarrow 2 \times \frac{5.5}{20} + \frac{2.5}{20}$ or $2x + 5 \rightarrow \frac{13.5}{20}$	M1dep	oe
	$\frac{27}{40}$ or 0.675 or 67.5%	A1	

**Additional Guidance continues on the next page**

		<b>Additional Guidance</b>		
<b>9 cont</b>	(Alt 1) $x = 6$ (no working)    Answer $\frac{17}{40}$ (first B1 implied)	B1M0A0B1ft		
	(Alt 1) $2 + x + 2x + 5 = 20$ $x = \frac{13}{3}$ Answer $\frac{13.666}{20}$	B0M1 A1ftB0ft		
	Answer $\frac{13.5}{20}$	B1M1A1B0		
	11 by inspection or T & I scores the first 3 marks			
	Answer $\frac{2x+5}{40}$	B1M0A0B0		
	Answer $\frac{2x+5}{3x+7}$	Zero		
	Ratio eg 27 : 40			B1M1A1B0
	Expressed only in words eg 27 out of 40			B1M1A1B0
	27 out of 40 and $\frac{27}{40}$			B1M1A1B1
	$\frac{27}{40}$ seen with incorrect change of form or incorrect cancelling eg $\frac{27}{40}$ and answer 0.27			B1M1A1B1
	Ignore chance words if $\frac{27}{40}$ seen eg $\frac{27}{40}$ and answer Unlikely			B1M1A1B1

Question	Answer	Mark	Comments
<b>10</b>	<b>Alternative method 1</b>		
	360 – 110 or 250 or 360 – 110 – 110 or 140	M1	May be seen on diagram oe
	3360 ÷ their 140 or 24 or 2640 (men) or 6000 (women)	M1dep	their 140 must be from 360 – 110 – 110 oe
	8640	A1	SC2 4838 or 4839
	<b>Alternative method 2</b>		
	$100 - \frac{110}{360} \times 100$ or $100 - 30.5(\dots)$ or $100 - 30.6$ or $69.4(\dots\%)$ or $69.5(\%)$ or $100 - \frac{110}{360} \times 100 - \frac{110}{360} \times 100$ or $100 - 30.5(\dots) - 30.5(\dots)$ or $100 - 30.6 - 30.6$ or $38.8(\dots\%)$ or $38.9(\%)$	M1	May be seen on diagram oe
	3360 ÷ (their 69.4 – their 30.5) or 3360 ÷ their 38.8(...) or 86.4	M1dep	their 69.4 must be from $100 - \frac{110}{360} \times 100$ their 30.5 must be from $\frac{110}{360} \times 100$
	8640	A1	SC2 4838 or 4839

**Alternative method 3 and Additional Guidance continue on the next page**

<b>10 cont</b>	<b>Alternative method 3</b>		
	$\frac{250}{360}x - \frac{110}{360}x = 3360$ or $m = \frac{110}{360} \times (m + 3360 + m)$ or $w = \frac{250}{360} \times (w + w - 3360)$	M1	Sets up a correct equation to work out total ( $x$ ), men ( $m$ ) or women ( $w$ )  oe
	$x = 3360 \div \left( \frac{250 - 110}{360} \right)$ or $m = 336\,000 \div 140$ or 2640 or $w = 840\,000 \div 140$ or 6000	M1dep	oe
	8640	A1	SC2 4838 or 4839
	<b>Additional Guidance</b>		
	Condone 8639.9... → answer 8640		M2 A1
	2640 or 6000		M2
	4838 and 4839 come from 3360 women		SC2
<b>11</b>	$9.56 \times 3^{10}$ 9563 $9.56 \times 10^3$ or 564 508 (.44) 9563 9560 with no incorrect evaluations seen	B2	B1 $9.563 \times 10^3$ or 9560 or 564 508 (.44) or $5.6(450844) \times 10^5$  SC1 $9.56 \times 10^3$ 9563 $9.56 \times 3^{10}$ with no incorrect evaluations seen
	<b>Additional Guidance</b>		
	Allow numbers to be written in original or converted form or as a mixture for B2 or SC1		
	Incorrect evaluation seen scores a maximum of B1		
<b>12</b>	<i>AD</i>	B1	
	<b>Additional Guidance</b>		



Question	Answer	Mark	Comments
13	<b>Alternative method 1</b>		
	Valid number of bread rolls and cheese slices	M1	eg 30 bread and 60 cheese or 60 bread and 120 cheese or 90 bread and 180 cheese or 120 bread and 240 cheese Valid number means ratio 1 : 2 and can be bought in exact numbers of packs May be implied by valid number of packs
	Valid number of packs of bread rolls and cheese slices	M1dep	eg 2 packs bread and 3 packs cheese or 4 packs bread and 6 packs cheese or 6 packs bread and 9 packs cheese or 8 packs bread and 12 packs cheese Valid number of packs means ratio 2 : 3
	their number of packs of bread $\times$ 1.88 and their number of packs of cheese $\times$ 2.15	M1dep	eg 15.04 and 25.8(0)
40.84	A1	SC2 27.94 or 42.98	

**Alternative method 2 and Additional Guidance continue on the next page**

Question	Answer	Mark	Comments
<b>13 cont</b>	<b>Alternative method 2</b>		
	Valid number of sandwiches	M1	eg Common multiple of 15 and 20 identified eg 15 30 45 <u>60</u> 75 and 20 40 <u>60</u> Valid number means can be bought in exact numbers of packs
	1.88 ÷ 15 + 2.15 ÷ 10 or 0.125(...) + 0.215 or 0.34(0...)	M1	oe Cost of one sandwich
	their 0.34(0...) × their number of sandwiches	M1dep	dep on M2
	40.84	A1	SC2 27.94 or 42.98
	<b>Additional Guidance</b>		
	Alt 1 3rd M1 Allow working in pence		
	Alt 2 2nd M1 Allow working in pence		
	30 bread and 60 cheese/2 packs bread and 3 packs cheese 2 × 1.88 or 3.76 <b>and</b> 3 × 2.15 or 6.45 (Answer £10.21)		M3 A0
	60 bread and 120 cheese/4 packs bread and 6 packs cheese 4 × 1.88 or 7.52 <b>and</b> 6 × 2.15 or 12.9(0) (Answer £20.42)		M3 A0
	90 bread and 180 cheese/6 packs bread and 9 packs cheese 6 × 1.88 or 11.28 <b>and</b> 9 × 2.15 or 19.35 (Answer £30.63)		M3 A0
	150 bread and 300 cheese/10 packs bread and 15 packs cheese 10 × 1.88 or 18.8(0) <b>and</b> 15 × 2.15 or 32.25 (Answer £51.05)		M3 A0
	SC2 from 120 bread and 120 cheese or 240 bread and 120 cheese		

Question	Answer	Mark	Comments
14	$C = 0.6(0)n + 2.5(0)$	B3	oe Must have $C =$ for B3 B2 $C = 0.6n + k$ ( $k \neq 0$ ) or $C = an + 2.5$ ( $a \neq 0$ ) or $0.6n + 2.5$ B1 $0.6n$ or $an + 2.5$ ( $a \neq 0$ ) or $C = 60n + 250$
	<b>Additional Guidance</b>		
	Allow correct fractions eg $\frac{3}{5}$ or $\frac{1}{1.6}$ for 0.6 and/or $\frac{5}{2}$ for 2.5		
	Allow $0.6 \times n$ or $n \times 0.6$ for $0.6n$ eg $C = 0.6 \times n + 2.5$ $n \times 0.6 + 2.5$ $0.6 \times n$		B3 B2 B1
	Penalise by one mark the use of $n0.6$ for $0.6n$ eg $C = n0.6 + 2.5$ $n0.6 + 2.5$ $n0.6$		B2 B1 B0
	Penalise by one mark the use of different letters eg $y = 0.6x + 2.5$ $0.6x + 2.5$ $2p + 2.5$		B2 B1 B0
	Transposing 0.6 and 2.5 scores zero eg $C = 2.5n + 0.6$		B0
	Ignore £ signs eg $\pounds C = \pounds 0.6n + \pounds 2.5$ or $C = \pounds 0.60n + \pounds 2.5$		B3
	$C = 1.2n + 2.5$		B2
	$1.2n + 2.5$		B1
	$C = 0.6n + 2.5$ in working with $0.6n + 2.5$ on answer line		B3
Equivalent formula but $C$ not the subject scores B2 eg $100C = 60n + 250$		B2	

Question	Answer	Mark	Comments
<b>15(a)</b>	Identifies error in working	B1	eg $2y^2$ should be $4y^2$ 2 should be 4 2 should be squared Should have worked out $(2y)^2$ but has only worked out $y^2$
	<b>Additional Guidance</b>		
	Answer may be seen next to Sami's method below the diagram		
	Adding brackets around $2y$ to Sami's working in line 2 (working lines may be blank)	B1	
	Showing the error being corrected eg1 $(2y)^2 = 100$ and $2y = 10$ eg2 $4y^2 = 36 + 64$	B1 B1	
	She hasn't squared the bracket	B1	
	Has only squared $y$	B1	
	The brackets have been left out	B1	
	$(2y)^2$ is not equal to $2y^2$	B1	
	Should have square rooted 100 before dividing by 2 because the $2y$ should not have been taken out of the bracket	B1	
	Should have square rooted 100 before dividing by 2 (could be referring to working from line 3 to line 4)	B0	
	Line 2 is wrong (has not identified which part of line 2 is wrong)	B0	
	Answer should be $y = 5$ (has not shown what the error is)	B0	
Ignore non-contradictory work if correct response seen			

Question	Answer	Mark	Comments
<b>15(b)</b>	No and valid reason	B1	eg No and the hypotenuse is 10 No and $2y$ is 10 No and if you double $y$ it is more than 8
	<b>Additional Guidance</b>		
	Valid reason must be for Mel's argument		
	Neither box ticked with valid reason can score B1 if decision in words eg $2y$ is 10 so Mel is wrong	B1	
	No and she didn't double it to 10	B1	
	No and she didn't double $y$	B0	
	No and she has to double 5 which makes it 10	B1	
	No and she has to double 5	B0	
	No and the hypotenuse is $2y$ so that's more than 8	B1	
	No and the hypotenuse is $2y$	B0	
	No and the hypotenuse is the longest side	B0	
	No and $y$ is 5	B0	
	No and if you double $y$ it is more than 6 and 8	B1	
	No and if you double $y$ it is more than 6	B0	
Yes and valid reason	B0		
<b>16</b>	28	B1	
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
<b>17</b>	<b>Alternative method 1</b>		
	50 × 1.2 or 60	M1	oe length of Q May be on the diagram
	50 × x × 0.9 or 45 × x	M1	oe area of P reduced by 10% May be on the diagram
	their 60 × y = their 45 × x or $\frac{y}{x} = \frac{\text{their } 45}{\text{their } 60}$ or y : x = their 45 : their 60 or equivalent ratio to 4: 3 not in simplest form or equivalent fraction to $\frac{4}{3}$ not in simplest form	M1dep	oe dep on M2  M3 $\frac{1.2}{0.9}$
	4 : 3 or 1 : $\frac{3}{4}$ or 1 : 0.75 or $\frac{4}{3} : 1$	A1	

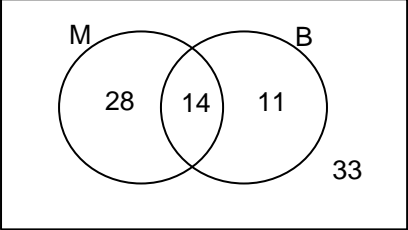
**Alternative method 2 and Additional Guidance continue on the next two pages**

Question	Answer	Mark	Comments
<b>17 cont</b>	<b>Alternative method 2</b>		
	50 × 1.2 or 60	M1	oe length of Q May be on the diagram
	Chooses a value for $x$ and reduces area of P by 10%	M1	oe eg ( $x = 8$ ) $50 \times 8 \times 0.9$
	their $60 \times y =$ their area of P reduced by 10% or equivalent ratio to 4 : 3 not in simplest form or equivalent fraction to $\frac{4}{3}$ not in simplest form	M1dep	oe eg $60y = 50 \times 8 \times 0.9$ or $60y = 360$ or ( $y =$ ) $360 \div 60$ or 6 dep on M2  M3 $\frac{1.2}{0.9}$
	$4 : 3$ or $1 : \frac{3}{4}$ or $1 : 0.75$ or $\frac{4}{3} : 1$	A1	

**Additional Guidance continues on the next page**

		<b>Additional Guidance</b>	
<b>17 cont</b>		Allow 1.33(...) for $\frac{4}{3}$	
		4 : 3 in working with 3 : 4 on answer line	M3A0
		1 : $\frac{45}{60}$	M3A0
		(Alt 1) $50x = 60y \times 0.9$	M1M0M0A0
		(Alt 1) $50x = 60y \times 1.1$	M1M0M0A0
		(Alt 1) $45x : 60y$ Answer 3 : 4	M1M1 M0A0
		(Alt 1) $y : x = 3 : 4$ Answer 3 : 4	M3A0
		Alt 2 example $50 \times 10 = 500$ (working not seen for reduction by 10% but completed correctly in next line) $450 \div 60 = 7.5$ (60 here gains first M1) $10 : 7.5 = 20 : 15$	M1M1 M1A0
		Do not allow misreads eg increases length of P by 10% (instead of 20%)	
		Alt 2 Allow choice of $x$ to be 50	



Question	Answer	Mark	Comments	
18(a)	Fully correct diagram $\xi$ 	B3	B2 Two or three correct numbers in correct positions B1 One correct number in correct position	
	<b>Additional Guidance</b>			
	Three correct numbers in correct positions and one missing		B2	
	Two correct numbers in correct positions and two missing		B2	
18(b)	$\frac{14}{25}$ or 0.56 or 56%	B1ft	Correct or ft their diagram oe fraction	
	<b>Additional Guidance</b>			
	$\frac{14}{25}$ or 0.56 or 56% always scores B1			
	ft answer correct with subsequent incorrect simplification	B1ft		
	Ratio eg 14 : 25	B0		
	Expressed only in words eg 14 out of 25	B0		
	$\frac{14}{25}$ and 14 out of 25	B1		
	$\frac{14}{25}$ seen with change to incorrect decimal or incorrect percentage eg $\frac{14}{25}$ and answer 0.8	B1		
	Ignore chance words if $\frac{14}{25}$ seen eg $\frac{14}{25}$ and answer likely	B1		
For a ft answer that is only seen as a decimal or %, accept truncation or rounding to at least 2sf				

Question	Answer	Mark	Comments
19	<b>Alternative method 1</b>		
	$192 \div (7 + 6 + 11)$ or $192 \div 24$ or 8	M1	May be implied
	7 × their 8 or 56 and 6 × their 8 or 48 and 11 × their 8 or 88	M1dep	56 : 48 : 88 is M2
	their 56 (× 1) + their 48 × 2 + their 88 × 3 or $56 + 96 + 264$ or 416	M1dep	May use $x$ , $2x$ and $3x$ (any letter)
	$532.48 \div$ their 416	M1dep	Allow working in pence
	1.28	A1	
	<b>Alternative method 2</b>		
	$7 (\times 1) + 6 \times 2 + 11 \times 3$ or $7 + 12 + 33$ or 52	M1	May use $x$ , $2x$ and $3x$ (any letter)
	$532.48 \div$ their 52 or 10.24	M1dep	Allow working in pence
	$192 \div (7 + 6 + 11)$ or $192 \div 24$ or 8	M1	May be implied
	their 10.24 ÷ their 8	M1dep	dep on M3 oe eg their $10.24 \times 7$ or 71.68 and their $71.68 \div (7 \times \text{their } 8)$
	1.28	A1	
	<b>Additional Guidance</b>		
	(Alt 1) 56 : 96 : 264 with no subsequent addition	M1M1M0M0A0	
	$532.48 \div 24$ (= 22.18... or 22.19) with no further valid working	Zero	
	$532.48 \div 192$ (= 2.77...) with no further valid working	Zero	
	(Alt 1) 56 and 48 and 88 (or correct method leading to them) but not subsequently used	M2	
	(Alt 1) 8 (or correct method leading to it) but not subsequently used	M1	
	(Alt 2) 10.24 (or correct method leading to it)	M2	
1.28 in working with Answer 71.68 (from $1.28 \times 56$ )	M4A0		

Question	Answer	Mark	Comments
20	$\frac{\sin x}{6} = \frac{\sin 125}{14}$ or $\frac{6}{\sin x} = \frac{14}{\sin 125}$	M1	oe eg $\frac{\sin x}{6} = 0.058(\dots)$ or 0.059 or 0.06 or $\frac{6}{\sin x} = 17.(0\dots)$ or 17.1
	$(\sin x =) \frac{\sin 125}{14} \times 6$ or 0.35(1...)	M1dep	oe eg $\sin^{-1}\left(\frac{\sin 125}{14} \times 6\right)$
	[20.5, 20.6] or 21	A1	
	<b>Additional Guidance</b>		
	Condone incorrect notation if recovered eg $x = \frac{\sin 125}{14} \times 6$ Answer 20.6		M2 A1
	$\frac{\sin}{6} = \frac{\sin 125}{14}$ not recovered		Zero
	Answer [20.5, 20.6] from scale drawing		M1M1A1
	Answer 21 from scale drawing		Zero
Answer only [20.5, 20.6] or 21		M1M1A1	

Question	Answer	Mark	Comments
<b>21</b>	<b>Alternative method 1</b>		
	$5x^2 - 10x - 4 (= 0)$ or $-5x^2 + 10x + 4 (= 0)$	<b>B1</b>	If no rearrangement seen implied by $a = 5, b = -10, c = -4$ or $a = -5, b = 10, c = 4$ seen or used correctly
	$\frac{-(-10) \pm \sqrt{(-10)^2 - 4 \times 5 \times -4}}{2 \times 5}$	<b>M1</b>	ft their 3-term quadratic (equation) <b>seen</b> Allow one sign error Allow $10^2$ for $(-10)^2$ (do not count as a sign error) Allow recovery of invisible brackets Conceptual error (omission of square root, incomplete square root symbol, $\pm$ not included, short fraction line) is M0 unless recovered
	$\frac{-(-10) \pm \sqrt{(-10)^2 - 4 \times 5 \times -4}}{2 \times 5}$ or $\frac{10 \pm \sqrt{100 + 80}}{10}$ or $\frac{10 \pm \sqrt{180}}{10}$ or $\frac{10 \pm 6\sqrt{5}}{10}$ or 2.341(...) or 2.342 and -0.341(...) or -0.342	<b>A1ft</b>	Fully correct substitution ft their 3-term quadratic (equation) <b>seen</b> oe eg $\frac{5 \pm 3\sqrt{5}}{5}$ Allow $10^2$ for $(-10)^2$ Allow recovery of invisible brackets Two correct solutions > 2 dp for their 3-term quadratic equation
2.34 and -0.34	<b>A1ft</b>	ft B0M1A1ft ft answers must be rounded to 2 dp	

**Alternative method 2 and Additional Guidance continue on the next two pages**

Question	Answer	Mark	Comments
<b>21 cont</b>	<b>Alternative method 2</b>		
	$5(x^2 - 2x - \frac{4}{5}) (= 0)$ or $x^2 - 2x - \frac{4}{5} (= 0)$ or $5(x^2 - 2x) = 4$ or $x^2 - 2x = \frac{4}{5}$	B1	May be implied
	$5[(x - 1)^2 - 1^2 - \frac{4}{5}] (= 0)$ or $(x - 1)^2 - 1^2 - \frac{4}{5} (= 0)$ or $5[(x - 1)^2 - 1^2] = 4$ or $(x - 1)^2 - 1^2 = \frac{4}{5}$	M1	ft their 3-term quadratic (equation) <b>seen</b> Allow one sign error but $(x - 1)^2$ must be correct
	$1 \pm \sqrt{1^2 + \frac{4}{5}}$ or 2.341(...) or 2.342 and -0.341(...) or -0.342	A1ft	Fully correct ft their 3-term quadratic (equation) <b>seen</b> oe eg $\frac{5 \pm 3\sqrt{5}}{5}$ Two correct solutions > 2 dp for their 3-term quadratic equation <b>seen</b>
2.34 and -0.34	A1ft	ft B0M1A1ft ft answers must be rounded to 2 dp	

**Additional Guidance continues on the next page**

		<b>Additional Guidance</b>	
<b>21 cont</b>		Do not count a sign error in $a$ (or $b$ ) as two sign errors eg If $a$ should be $-5$ but $a = 5$ is used in both $4ac$ and $2a$ , only count as one sign error	
		Final A1 mark can be awarded if both answers seen in working but only one is written on answer line	
		$5x^2 + 10x - 4 (= 0)$ <b>seen</b> with solutions $-2.34$ and $0.34$ (no incorrect method seen)	B0M1A1ftA1ft
		$5x^2 - 10x + 4 (= 0)$ <b>seen</b> with solutions $0.55$ and $1.45$ (no incorrect method seen)	B0M1A1ftA1ft
		$5x^2 + 10x + 4 (= 0)$ <b>seen</b> with solutions $-0.55$ and $-1.45$ (no incorrect method seen)	B0M1A1ftA1ft
		Note that the pairs of solutions seen in the three rows above can come from incorrect method so will not always score 3 marks	
		$2.34$ and $-0.34$ with no working or from T & I	4 marks
		$2.34$ or $-0.34$ with no working or from T & I	Zero
		$2.3$ and/or $-0.3$ with no working or from T & I	Zero

Question	Answer	Mark	Comments
22	<b>Alternative method 1</b>		
	$d = kt^2$ or $45 = k \times 3^2$ or $45 \div 9$	M1	oe equation
	$d = 5t^2$ or $(k =) 5$	M1dep	oe equation 245 implies M2
	their $5 \times 10^2$ or 500	M1dep	oe M3 $\left(\frac{10}{3}\right)^2 \times 45$ oe
	455	A1	
	<b>Alternative method 2</b>		
	$kd = t^2$ or $k \times 45 = 3^2$ or $9 \div 45$	M1	oe equation
	$0.2d = t^2$ or $(k =) 0.2$	M1dep	oe equation 245 implies M2
	$10^2 \div$ their 0.2 or 500	M1dep	oe M3 $45 \div \left(\frac{3}{10}\right)^2$ oe
	455	A1	
	<b>Additional Guidance</b>		
	$d \propto t^2$ with no further valid working		Zero
	$d = kt$ or $d = kt^3$ or $d = \frac{k}{t^2}$ etc not recovered		Zero
	45 : 9 with no further valid working		Zero
	$d = 5t^2$ or $(k =) 5$ scores M2 even if not subsequently used		M2
$d = kt^2$ or $45 = k \times 3^2$ or $45 \div 9$ scores M1 even if not subsequently used		M1	
$0.2d = t^2$ or $(k =) 0.2$ scores M2 even if not subsequently used		M2	
$kd = t^2$ or $k \times 45 = 3^2$ or $9 \div 45$ scores M1 even if not subsequently used		M1	
Allow use of other letters			

Question	Answer	Mark	Comments
	( <b>BC</b> =) $5a - 2b - 3a - b$ or $2a - 3b$ or ( <b>CD</b> =) $3a + b + 3a - 9b$ or $6a - 8b$ or ( <b>BD</b> =) $5a - 2b + 3a - 9b$ or $8a - 11b$	M1	oe eg ( <b>CB</b> =) $3a + b - 5a + 2b$ or $-2a + 3b$ or ( <b>DC</b> =) $-3a + 9b - 3a - b$ or $-6a + 8b$ or ( <b>DB</b> =) $-3a + 9b - 5a + 2b$ or $-8a + 11b$  Allow with brackets eg ( <b>BC</b> =) $5a - 2b - (3a + b)$
23	Correct expressions for any two of <b>BC</b> , <b>CD</b> and <b>BD</b>	M1dep	oe eg1 correct expressions for <b>BC</b> and <b>DB</b> eg2 correct expressions for <b>CB</b> and <b>DC</b>  Allow with brackets eg ( <b>BC</b> =) $5a - 2b - (3a + b)$ and ( <b>DB</b> =) $-(3a - 9b) - (5a - 2b)$
	Correct simplified expressions for any two of <b>BC</b> , <b>CD</b> and <b>BD</b> and valid explanation and No	A1	oe eg correct expressions for <b>BC</b> and <b>DB</b> and valid explanation and No  eg <b>BC</b> = $2a - 3b$ and <b>CD</b> = $6a - 8b$ and $3(2a - 3b) = 6a - 9b$ and No or <b>DC</b> = $-6a + 8b$ and <b>BD</b> = $8a - 11b$ and <b>DC</b> is not a multiple of <b>BD</b> and not straight

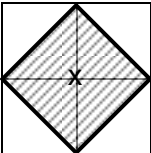
Additional Guidance continues on the next page

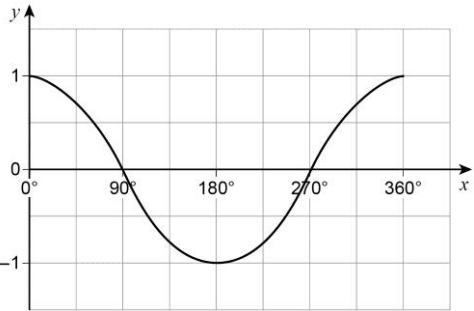


		Additional Guidance	
23 cont		Award marks for correct expressions, ignoring any incorrect ones unless contradictions of correct ones	
		<b>BAD</b> means <b>BD</b>	
		<b>BD</b> = $5a - 2b + 3a - 9b$ or $8a - 11b$ and <b>BAD</b> = their <b>BC</b> + their <b>CD</b> and answer not $8a - 11b$ Do not take <b>BAD</b> to be a contradiction to <b>BD</b>	
		Two correct simplified expressions used for a valid explanation and saying No with any incorrect non-contradictory expressions seen	M2A1
		Condone absence of vector notation eg Condone CD to mean the vector from C to D	
		$\vec{CD}$ means the vector from C to D and $\overleftarrow{CD}$ means the vector from D to C	
		Do not allow any misreads	
		Missing brackets may be recovered	
		Allow for up to M2 expressions like ( <b>BC</b> =) $5a - 2b + -3a + -b$	
		Valid explanations: eg1 <b>BC</b> = $2a - 3b$ and <b>CD</b> = $6a - 8b$ and $3(2a - 3b) = 6a - 9b$ is acceptable as there is a matching coefficient of <b>a</b> eg2 <b>CD</b> = $6a - 8b$ and <b>BD</b> = $8a - 11b$ and $2(6a - 8b) = 12a - 16b$ is <u>not</u> acceptable because there is no matching coefficient of <b>a</b> or <b>b</b> eg3 <b>BC</b> = $2a - 3b$ and <b>CD</b> = $6a - 8b$ and $6a - 8b = 3(2a - 2.6b)$ is acceptable because there is a matching coefficient of <b>a</b> and no error in factorisation (just a truncation) eg4 <b>BC</b> = $2a - 3b$ and <b>CD</b> = $6a - 8b$ and $3(2a - 3b) = 6a - 10b$ is <u>not</u> acceptable because there is an error in expansion	
		Allow not parallel or not same gradient for No	
		Allow <b>DC</b> is not a factor of <b>BD</b> as a valid explanation	
		Do not allow <b>DC</b> is not a scalar of <b>BD</b> as a valid explanation	
		Look for decision in working lines if answer line is blank	
		Note that <b>BD</b> = <b>BC</b> + <b>CD</b> is a fact but is not a valid explanation	

Question	Answer	Mark	Comments	
24	<b>Alternative method 1</b>			
	(LQ =) 10 and (UQ =) 33 and answer 23	B4	B3 (LQ =) 10 <b>and</b> (UQ =) 33 B2 (LQ =) 10 <b>or</b> (UQ =) 33 B1 Any two correct frequencies from 8, 8, 12 and 20	
	<b>Alternative method 2</b>			
	(LQ =) 10.3125 and (UQ =) 33.75 and answer 23.4375	B4	B3 (LQ =) 10.3125 <b>and</b> (UQ =) 33.75 B2 (LQ =) 10.3125 <b>or</b> (UQ =) 33.75 B1 Any two correct frequencies from 8, 8, 12 and 20	
	<b>Additional Guidance</b>			
	Alt 2 is using $\frac{48+1}{4} = 12.25$ and $\frac{3(48+1)}{4} = 36.75$ to work out quartiles			
	Correct frequencies must be for the correct bar			
	33.75 may come from $\frac{3}{4} \times 45$			B0
	Allow B1 for two correct frequencies even if not subsequently used			B1
	Frequency of 8 seen once with no other correct frequencies counts as one correct			
	Frequency of 8 seen twice counts as two correct			B1
	36 – 12 = 24 or 36.75 – 12.25 = 24.5 with < 2 correct frequencies			B0
	Answer 23 with neither quartile correct and < 2 correct frequencies			B0
10-33 and 23			B4	
10-33			B3	
Do not allow dashes or vertical lines at 10 and/or 33 to imply correct quartiles				

Question	Answer	Mark	Comments	
25	$15^2 + 26^2 - 2 \times 15 \times 26 \times \cos 38$ or [286, 286.4] or [16.9, 17]	M1	May be seen in a square root May be seen on diagram	
	$\frac{108}{360}$ or 0.3 or $\frac{360}{108}$ or 3.33(...)	M1	oe eg $108 \div 360$ or 30% May be seen in two steps eg $\times 108 \div 360$	
	their $\frac{108}{360} \times \pi \times [286, 286.4]$ or $\pi \times \text{their } [286, 286.4] \div \text{their } \frac{360}{108}$ or [269, 272.4114]	M1dep	dep on 1st and 2nd M1 oe eg $\frac{108}{360} \times \pi \times (\text{their } [16.9, 17])^2$	
	$(2 \times) \frac{1}{2} \times 15 \times 26 \times \sin 38$ or [120, 120.1] or [240, 240.2]	M1	oe	
	[509, 512.6114] and 510	A1	Must see a value in range [509, 512.6114] and 510	
	<b>Additional Guidance</b>			
	15 × 26 × sin 38 scores 4th M1 unless subsequently doubled			
	If (sector) 270 and (2 triangles) 240 followed by 270 + 240 = 510			M4A1
	Working back from 510. Apply scheme but maximum mark is M4A0			
	Assuming angle $AEB = 72$ and then using sine rule to work out $BE$ does lead to area = 510 to 2sf but can score a maximum of M0M1M0M1depA0 $BE = \frac{26}{\sin 72} \times \sin 38 = 16.8$ (or 17) $\frac{108}{360} \times \pi \times 16.8^2 = 266$ $2 \times \frac{1}{2} \times 15 \times 26 \times \sin 38 = 240.2$ 506.2 → 510			M0 M1M0depM1 A0
$BE = [16.9, 17]$ seen with no working scores first M1 (and possibly all other marks)				
$BE = 35 \div 2 = 17.5 \rightarrow 17$ does not score first M1				

Question	Answer	Mark	Comments
26(a)	<i>B</i>	B1	
	<b>Additional Guidance</b>		
26(b)	<i>P</i>	B1	
	<b>Additional Guidance</b>		
27(a)	Fully correct graph passing through (-2, -8) (-1, -1) (0, 0) (1, 1) and (2, 8)	B2	B1 $x^3$ or $y^3 = x$ or at least 4 points from (-2, -8) (-1, -1) (0, 0) (1, 1) and (2, 8) plotted or seen in a table Tolerance of $\pm 1$ small square Points can be implied by graph passing through them
	<b>Additional Guidance</b>		
	Tolerance of $\pm 1$ small square means it is on the edges of or within the shaded area		
			
	Ignore graph drawn outside of $-2 \leq x \leq 2$		
	Ruled straight lines joining (-2, -8) (-1, -1) (0, 0) (1, 1) and (2, 8)		B1
	Condone positive gradient at (0, 0)		
Ignore working lines if fully correct graph seen		B2	

Question	Answer	Mark	Comments	
27(b)	<p>Fully correct graph</p> 	<p>B2</p>	<p>B1 <math>\sin(x + 90)</math> or <math>\cos x</math>                      or at least 4 points from <math>(0, 1)</math> <math>(90, 0)</math> <math>(180, -1)</math> <math>(270, 0)</math> and <math>(360, 1)</math> plotted or seen in a table</p> <p>Mark intention</p>	
	<b>Additional Guidance</b>			
	Ignore graph drawn outside of $0^\circ \leq x \leq 360^\circ$			
	Ignore working lines if fully correct graph seen		B2	
	Ruled straight lines joining $(0, 1)$ $(90, 0)$ $(180, -1)$ $(270, 0)$ and $(360, 1)$		B1	
$\sin x + 90$ with $< 4$ correct points and incorrect graph	B0			