GCSE
MATHEMATICS
8300/3H

Higher Tier Paper 3 Calculator

Mark scheme

June 2023

Version: 1.0 Final

2 3 6 G 8 3 0 0 / 3 H / M S

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 Examiner.

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.

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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 $a \leqslant$ 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.

Q	Answer	Mark	Comments
1	7	B1	

Q	Answer	Mark	Comments
2	$\frac{15}{8}$ or $1\frac{7}{8}$	B1	oe fraction eg $\frac{1875}{1000}$
	Additional Guidance		
	Ignore attempts to simplify after correct answer seen		
	Do not allow fractions with decimal numerators or denominators eg $\frac{18.75}{10}$		B0

Q	Answer	Mark	Comments
3	$5x - 3x$ or $2x$ or $3x - 5x$ or $-2x$ or $19 - 11$ or 8 or $11 - 19$ or -8	M1	
	4	A1	
	Additional Guidance		
	Answer 4 with no working or no incorrect working		M1A1
	Embedded answer eg $5 \times 4 + 11 = 3 \times 4 + 19$		M1A0

Q	Answer	Mark	Comments
4	4.5×5000 or $22\,500$ or $5000 \div 100$ or 50 or $4.5 \div 100$ or 0.045	M1	
	225	A1	

Q	Answer	Mark	Comments	
5	1 – 0.04 or 0.96 or 0.04 × 1 000 000 or 40 000 or 960 000	M1	oe eg $1 - \frac{4}{100}$ 1 040 000 implies M1	
	Full method for exactly 5 compounded percentage calculations with their multiplier	M1	oe eg 1 000 000 × their 0.96^5	
	[800 000, 820 000] with M2 awarded	A1		
	Additional Guidance			
	815 372.(…) or 815 373 with M2 awarded			M1M1A1
	Answer 800 000 from 40 000 × 5			M1M0A0
	Answer 800 000 without either 40 000 shown or M2 awarded			M0M0A0
	Intermediate values for separate calculations are 960 000, 921 600, 884 736, 849 346.(…)			

Q	Answer	Mark	Comments
6	No ticked and correct reason or correct evaluation of the surface areas for any numerical or algebraic values or correct ratio of the surface areas	B2	eg 2 faces are hidden B1 No ticked
	Additional Guidance		
	Ignore irrelevant reasons or evaluations alongside a correct reason or evaluation, unless contradictory		
	"No" may be implied by a correct reason		
	Accept reasoning that uses A as a cube		
	No ticked and A has 6, B has 10 (condone sides for faces) A has 3, B has 5 A has 6 sides, on B each cube only has 5 Ratio is 3:5 (accept equivalent ratios) The bottom and the top are missing (or covered) When they are put together you lose two faces You wouldn't count two sides (condone sides for faces) Some of the faces are covered You cannot see one side because they are stacked together One face covered Part of the area of A is covered where it joins B Both touching sides		 B2 B2 B2 B2 B2 B2 B2 B2 B2 B2 B2 B2
	Yes ticked or Cannot tell ticked		B0

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="3">7(a)</td><td colspan="2">0 and 3 in the correct positions</td><td>B1 0 or 3 in the correct position</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2"><table>
<tr><td>x</td><td>–3</td><td>–2</td><td>–1</td><td>0</td><td>1</td></tr>
<tr><td>y</td><td>3</td><td>0</td><td>–1</td><td>0</td><td>3</td></tr>
</table></td><td>B2</td></tr>
</table>

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="6">7(b)</td><td>Plots at least three points correctly</td><td>M1</td><td>correct or ft their table in (a)
$\pm\frac{1}{2}$ small square
points may be implied by graph passing through them</td></tr>
<tr><td>Correct graph drawn through the five correct points</td><td>A1</td><td>$\pm\frac{1}{2}$ small square
smooth quadratic curve</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Correct graph drawn without plotting the correct points</td><td>M1A1</td></tr>
<tr><td colspan="2">Ignore any extra points plotted</td><td></td></tr>
<tr><td colspan="2">Ignore any part of graph drawn for $x < -3$ or $x > 1$</td><td></td></tr>
<tr><td colspan="2">Ruled straight lines</td><td>A0</td></tr>
</table>

Q	Answer	Mark	Comments
8	**Alternative method 1**		
	2450 ÷ (2 + 5) or 2450 ÷ 7 or 350	M1	oe
	their 350 × 5 or 1750 or their 350 × 2 or 700 or their 350 ÷ 4 or 87.5(0)	M1dep	oe $2450 \times \frac{5}{7}$ is M2 $2450 \times \frac{2}{7}$ is M2 2450 ÷ 28 is M2
	their 1750 ÷ 4 or (2450 – their 700) ÷ 4 or their 87.5(0) × 5 or 437.5(0)	M1dep	oe dep on M2 $350 \times \frac{5}{4}$ is M3
	437.5(0) and Yes	A1	accept 437.5(0) > 430
	Alternative method 2		
	2450 ÷ 4 or 612.5(0)	M1	oe
	their 612.5(0) ÷ (2 + 5) or their 612.5(0) ÷ 7 or 87.5(0)	M1dep	oe 2450 ÷ 28 is M2
	their 87.5(0) × 5 or their 612.5(0) – their 87.5(0) × 2 or 437.5(0)	M1dep	oe dep on M2 $612.5(0) \times \frac{5}{7}$ is M3
	437.5(0) and Yes	A1	accept 437.5(0) > 430

Mark scheme and Additional Guidance continue on the next page

8 cont	**Alternative method 3**		
	430 × 4 or 1720	M1	
	2450 ÷ (2 + 5) or 2450 ÷ 7 or 350	M1	oe
	their 350 × 5 or 1750 or their 350 × 2 or 700	M1dep	oe dep on 2nd M $2450 \times \frac{5}{7}$ is M2 $2450 \times \frac{2}{7}$ is M2
	1720 and 1750 and Yes	A1	2450 – 1720 = 730 and 700 and Yes
	Alternative method 4		
	430 × 4 or 1720	M1	
	their 1720 ÷ 5 or 344 or their 1720 × 2 or 3440	M1dep	oe
	their 344 × 2 or their 3440 ÷ 5 or 688	M1dep	oe dep on M2 $1720 \times \frac{2}{5}$ is M3
	2408 and Yes	A1	
	Additional Guidance		
	Up to M3 may be awarded for correct work, with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	2450 ÷ 7 × 1.25 or 350 × 1.25		M1M1M1
	Yes may be implied eg They receive 7.50 more than 430		M3A1
	Condone £437.50p and Yes		M3A1

Q	Answer	Mark	Comments
9	$80 - 25$ or 55 or $360 - 80 - 25$ or 255	M1	oe implied by 1 degree = 2.4 people or 5 degrees = 12 people
	$\frac{132}{\text{their } 55} \times 360$ or 864 or $\frac{132}{\text{their } 55} \times 80$ or 192 or $\frac{132}{\text{their } 55} \times 25$ or 60 or $\frac{132}{\text{their } 55} \times \text{their } 255$ or $\frac{132}{\text{their } 55} \times (80 + 25)$ or 252 or their $255 \div \frac{\text{their } 55}{132}$	M1dep	oe 2.4 × their 255 is M2 12 × 51 is M2 2.4 × 105 is M2
	612	A1	
	Additional Guidance		
	Up to M2 may be awarded for correct work, with no answer or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
10	**Alternative method 1 – using tangent of an angle**		
	tan chosen or used	M1	
	$\tan 58 = \frac{x}{46}$ or $46 \times \tan 58$ or $\tan 32 = \frac{46}{x}$ or $\frac{46}{\tan 32}$	M1dep	oe
	[73.6, 74]	A1	
	Alternative method 2 – finding hypotenuse first		
	$\frac{46}{\cos 58}$ or $\frac{46}{\sin 32}$ or 86.8(...) or 87	M1	oe
	$\sqrt{(\text{their } 86.8(...))^2 - 46^2}$ or $\sqrt{5418.(...)}$ or their 86.8(…) × sin 58 or their 86.8(…) × cos 32	M1dep	oe
	[73.6, 74]	A1	
	Additional Guidance		
	Do not accept scale drawing		
	Answer 73 after answer in range seen		M1M1A1
	$\frac{\sin 32}{46} = \frac{\sin 58}{x}$		M1

Q	Answer	Mark	Comments
11(a)	8 or 10	M1	8 may be implied by 2^2 or 4
	8 and 10 and $\frac{1}{40}$ or 0.025	A1	8 may be implied by 2^2 or 4 accept 0.03 with $\frac{1}{40}$ or 0.025 seen
	Additional Guidance		
	Do not allow exact calculations for M1A1 eg $4.113 = 4$ and $10.21 = 10$ and $\frac{1}{40}$		M1A0
	$\frac{1}{40}$ or 0.025 with 8 or 10 seen (8 may be implied by 2^2 or 4)		M1A0
	$\frac{1}{40}$ or 0.025 without 8 or 10 seen (8 may be implied by 2^2 or 4)		M0A0

Q	Answer	Mark	Comments
11(b)	Valid explanation	B1	eg both numbers have been rounded down
	Additional Guidance		
	Ignore irrelevant reasons alongside a correct reason, unless contradictory		
	Ignore a calculation using exact values alongside a correct reason eg 0.025 is greater than 0.0238… and both numbers rounded down	B1	
	0.025 is greater than 0.0238…	B0	
	The denominator is smaller	B1	
	The denominator using the exact values is bigger	B1	
	(Decimals) rounded down	B1	
	Because 8.34 is more than 8 and 10.21 is more than 10	B1	
	One is divided by less (with answer more)	B1	
	Estimating rounds the numbers down which makes the denominator less	B1	
	Estimating rounds the numbers down which makes it less	B0	
	Because it rounds up	B0	
	Because she rounded each number to one significant figure	B0	
	The numbers get rounded up so more than the exact value	B0	
	Rounded up when estimating	B0	
	Removing the decimals makes the number bigger	B0	

Q	Answer	Mark	Comments
12(a)	Ben and valid reason	B1	eg spun the most times
	Additional Guidance		
	Do not accept an incorrect reason alongside a correct response		
	Do not accept reasons which refer to the probability increasing		
	Ignore reasons that refer to results being more accurate		

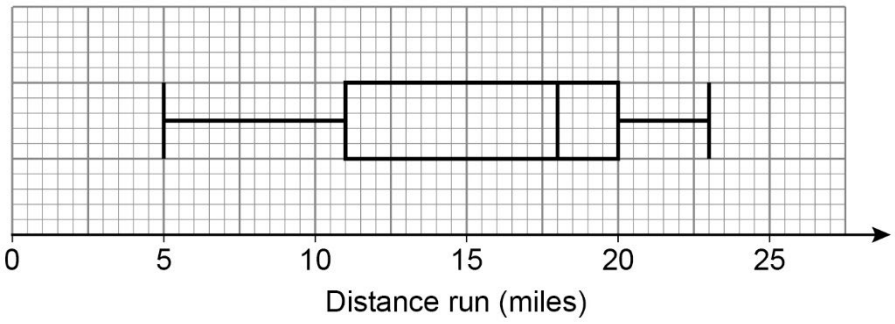
Q	Answer	Mark	Comments
12(b)	Valid reason	B1	eg 14.8 is not a whole number
	Additional Guidance		
	Do not accept an incorrect reason alongside a correct response		
	0.185×80 is not a whole number		B1
	Number of spins would be a decimal		B1
	Number of spins must be a whole number		B1
	Cannot land on the spinner 14.8 times		B1
	Have to spin 14.8 times		B0
	$0.185 \times 80 = 14.8$		B0
	14.8		B0
	It is a decimal		B0
	Must be a whole number		B0

Q	Answer	Mark	Comments
12(c)	125×0.32 or 40 or $1 - 0.32$ or 0.68	M1	oe
	85	A1	

Q	Answer	Mark	Comments
13	176 ÷ 48 or 3.66… or 3.67 or $\frac{11}{3}$ or 3 h 40 mins	M1	oe eg 220 mins implied by 12 40 pm
	(293 – 176) ÷ 65 or 117 ÷ 65 or 1.8 or $\frac{9}{5}$ or 1 h 48 mins	M1	oe eg 108 mins
	their 3.66… + their 1.8 or $\frac{82}{15}$ or [5.46, 5.47] or 5 h 28 mins or [2 27 (pm), 2 28.2 (pm)]	M1dep	oe eg 328 mins dep on M2 implied by adding times eg 9 + 3 40 + 1 48
	5.5 and [5.46, 5.47] and Yes or 5 h 30 mins and 5 h 28 mins and Yes or 330 mins and 328 mins and Yes or [2 27 (pm), 2 28.2 (pm)] and Yes	A1	oe arrival time must be in a comparable time format
	Additional Guidance		
	Up to M3 may be awarded for correct work seen in multiple attempts even if not subsequently used		
	Accept use of 24 hour clock throughout		
	Do not accept 2 28 am as a correct arrival time		
	$\frac{176}{48} = 3.6$, $\frac{117}{65} = 1.8$, 3.6 + 1.8 = 5.4, 2 24 pm and Yes		M1M1M1A0
	$\frac{176}{48} = 3.7$, $\frac{117}{65} = 1.8$, 3.7 + 1.8 = 5.5, 2 30 pm and Arrives on time		M1M1M1A0
	3.6 + 1.8 = 5.4, 2 24 pm and Yes		M0M1M0A0
	3.7 + 1.8 = 5.5, 2 30 pm and Arrives on time		M0M1M0A0

Q	Answer	Mark	Comments
14	5186 ÷ 0.2 or 5186 × 5 or 25 930	M1	oe
	38 500	A1	
	(their 38 500 – 9880) × 0.1325 or 28 620 × 0.1325	M1	their 38 500 must be > 9880 full method to calculate National Insurance
	3792(.15)	A1ft	ft their 38 500, which must be > 9880
	Additional Guidance		
	Accept final answer rounded or truncated to the nearest pound if a more accurate value is seen in working		
	Do not accept '13.25% of 28 620' or 13.25% × 28 620 for M mark unless accompanied by a correct method or value		
	(25 930 – 9880) × 0.1325 = 2126.62 or 2126.63		M1A0M1A1ft
	25 930 × 0.1325 or 3435.72 or 3435.73		M1A0M0A0ft

Q	Answer	Mark	Comments
15(a)	20 × 0.8 or 16 or 20 × 1.8 or 36 or 40 × 1.2 or 48 or 40 × 0.7 or 28 or 60 × 0.4 or 24	M1	one correct area calculation or frequency value may be on diagram
	20 × 0.8 + 20 × 1.8 + 40 × 1.2 + 40 × 0.7 + 60 × 0.4 or 16 + 36 + 48 + 28 + 24 or 152	M1dep	allow 1 error or 1 omission or 1 misread of a frequency density value
	28	A1	

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="11">15(b)</td><td>Rectangular box plot with whiskers to 5 and 23</td><td>B1</td><td></td></tr>
<tr><td>Lower quartile drawn at 11 and median drawn at 18</td><td>B1</td><td></td></tr>
<tr><td>Upper quartile drawn at 20</td><td>B1ft</td><td>correct or ft their lower quartile + 9
must be the vertical line at right side of their box</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Mark intention eg any height and allow horizontal line through centre of box</td><td></td></tr>
<tr><td colspan="2">Allow ends of whiskers to be vertical lines of any length, dots, crosses or stops</td><td></td></tr>
<tr><td colspan="2">$\pm\frac{1}{2}$ small square tolerance</td><td></td></tr>
<tr><td colspan="2">Median must be the second vertical line of a box with three vertical lines</td><td></td></tr>
<tr><td colspan="2">Only vertical lines or points plotted</td><td>B0</td></tr>
<tr><td colspan="2">
</td><td>B3</td></tr>
</table>

Q	Answer	Mark	Comments
16	**Alternative method 1 – using Pythagoras' theorem or 3, 4, 5 triangle**		
	$16 \div 4 \times 5$ or 20 (cm) or identifies triangle as 3, 4, 5	M1	oe length of c may be on diagram
	$\sqrt{(\text{their } 20)^2 - 16^2}$ or $\sqrt{400 - 256}$ or $\sqrt{144}$ or 4×3	M1dep	
	12 (cm)	A1	length of b may be on diagram
	96	A1ft	ft $\frac{1}{2} \times 16 \times$ their 12 with M2 awarded
	Alternative method 2 – using trigonometry and ½*ab* sin *C* formula		
	$16 \div 4 \times 5$ or 20 (cm)	M1	oe length of c may be on diagram
	$\cos^{-1}\left(\frac{16}{20}\right)$ or 36.8(…) or 36.9	M1dep	angle between sides a and c
	$\frac{1}{2} \times 16 \times 20 \times \sin(\text{their } 36.8(\ldots))$	M1dep	dep on M2
	96	A1	
	Additional Guidance		
	$\frac{1}{2} \times 16 \times 12 \times \sin 90$		M1M1M1

Q	Answer	Mark	Comments
17	**Alternative method 1 – multiplies through by 10 or common denominator of 10**		
	$5(x + 8) + 2(9 - x)$ or $5x + 40 + 18 - 2x$	M1	oe numerator on the left-hand side if written as a fraction allow one error or omission in the expansion if brackets not seen eg $5x + 18 - 2x$
	$3x + 58$	A1	may be implied by eg $3x + 18 = 0$ or $3x = -18$
	their $(3x + 58) = 4 \times$ (their 10) or their $(3x + 58) = 40$ or $3x + 18 = 0$ or $3x = -18$	M1	oe allow an unsimplified expression for their $(3x + 58)$ equation may be implied by answer
	-6	A1ft	ft M1A0M1
	Alternative method 2 – collects terms with fractions		
	$\frac{x}{2} + 4 + \frac{9}{5} - \frac{x}{5}$	M1	oe eg $0.5x + 4 + 1.8 - 0.2x$ allow one error
	$\frac{3}{10}x + \frac{29}{5}$	A1	oe eg $0.3x + 5.8$
	$\frac{3}{10}x = \frac{20}{5} - \frac{29}{5}$ or $\frac{3}{10}x = -\frac{9}{5}$	M1	oe eg $0.3x = -1.8$ terms must be collected
	-6	A1ft	ft M1A0M1

Additional Guidance is on the next page

17 cont	**Additional Guidance**	
	Accept decimal answers for follow through correct to 1 dp or better	
	Apply the principles of alt 1 for any use of other common denominators eg common denominator of 20 (or multiplication through by 20) $10(x + 8) + 4(9 - x) = 6x + 116$ $6x + 116 = 80 \quad x = -6$	M1A1 M1A1
	An incorrect simplification of $5x + 40 + 18 - 2x$ may still gain the third and fourth marks eg $5x + 40 + 18 - 2x = 3x + 68$ followed by $3x + 68 = 40$ and $x = -\frac{28}{3}$ eg $5x + 40 + 18 - 2x = 2x + 68$ followed by $2x + 68 = 40$ and $x = -14$	M1A0M1 A1ft M1A0M1 A1ft
	An incorrect denominator may still gain the third and fourth marks $\frac{5x+40+18-2x}{7}$ followed by $5x + 40 + 18 - 2x = 28$ and $x = -10$	M1A0M1 A1ft
	Denominator not processed $3x + 58 = 4$ followed by $3x = -54$ and $x = -18$	M1A1M0A0
	$(x + 8) + (9 - x) = 40$	M0A0M1A0
	Two errors in the expansion but with brackets seen may go on to get the third and fourth marks $5(x + 8) + 2(9 - x) = 5x + 8 + 18 - x$	1st M1A0
	Two errors in the expansion and no brackets seen, no follow through allowed $5x + 8 + 18 - x$ followed by $4x + 26 = 40$ and $x = \frac{14}{4}$	M0A0M1A0

Q	Answer	Mark	Comments
18(a)	$(2x + 4)^2 + 6(2x + 4)$	M1	may be seen in a grid
	$4x^2 + 8x + 8x + 16 + 12x + 24$ or $4x^2 + 16x + 16 + 12x + 24$	M1dep	fully expanded expression with terms summed allow one omission or one arithmetic error
	$4x^2 + 8x + 8x + 16 + 12x + 24$ or $4x^2 + 16x + 16 + 12x + 24$ and $4x^2 + 28x + 40$	A1	
	Additional Guidance		
	$4x^2 + 16 + 12x + 24$ is two errors		

Q	Answer	Mark	Comments
18(b)	$4x^2 + 28x + 45\ (= 0)$	M1	must be correct
	$(2x + 5)(2x + 9)\ (= 0)$ or $(2x + 7)^2 - 49 + 45\ (= 0)$ or $\frac{-28 \pm \sqrt{28^2 - 4 \times 4 \times 45}}{2 \times 4}$ or $\frac{-28 \pm \sqrt{64}}{8}$ or $\frac{-28 \pm 8}{8}$ or $\frac{-7 \pm \sqrt{4}}{2}$	M1dep	oe implies first M1
	$(x =) -2.5$ and $(x =) -4.5$	A1	oe fraction or decimal SC2 $(x =)$ [–1.63, –1.629] and $(x =)$ [–5.371, –5.37]
	Additional Guidance		
	SC2 from using $4x^2 + 28x + 35\ (= 0)$		
	Trial and improvement with both answers correct and chosen from any list		M1M1A1
	Trial and improvement with one answer correct		M0M0A0

Q	Answer	Mark	Comments
19	Creates an algebraic product in the form $(x + a)(x + b)$ where there is a difference of 6 between a and b	M1	accept any letter for x eg $x(x + 6)$ or $x^2 + 6x$ or $x(x - 6)$ or $x^2 - 6x$
	Correctly expands their product, adds 9 and simplifies to a quadratic expression	M1dep	eg $x^2 + 6x + 9$ or $x^2 - 6x + 9$
	Correctly factorises their quadratic expression to the form $(x + c)^2$ with M2 awarded	A1	eg $(x + 3)^2$ or $(x - 3)^2$
	Additional Guidance		
	Trialling integers scores no marks, but ignore any testing of values alongside correct algebra		
	Ignore any further work or attempts to solve after correct answer seen		
	Missing brackets may be recovered eg $x \times x + 6$ followed by $x^2 + 6x + 9$		M1M1
	$(x + 3)(x + 3)$ without $(x + 3)^2$ seen does not score the A mark		
	$(x - 2)(x - 8)$ $x^2 - 2x - 8x + 16 + 9 = x^2 - 10x + 25$ $(x - 5)^2$		M1 M1 A1

Q	Answer	Mark	Comments
20(a)	Substitutes a correct pair of coordinates and states that the equation is correct	B1	eg $18 = \frac{36}{2}$ so he is right
	Additional Guidance		
	Accept 'Yes' or a tick or any clear indication that he is correct		
	Do not accept pairs of values not on the graph		
	Do not accept a correct answer alongside an incorrect response unless clearly chosen		
	Do not accept a coordinate with no substitution seen		
	Pairs with integer x or y include $18 = \frac{36}{2}$, $15 = \frac{36}{2.4}$, $12 = \frac{36}{3}$, $10 = \frac{36}{3.6}$ $9 = \frac{36}{4}$, $8 = \frac{36}{4.5}$, $7.2 = \frac{36}{5}$, $6 = \frac{36}{6}$		
	Substituting values incorrectly eg $2 = \frac{36}{18}$ or $4 = \frac{36}{9}$		B0

Q	Answer	Mark	Comments
20(b)	**Alternative method 1**		
	G α $\sqrt{H}$ or $G = k\sqrt{H}$ or $16 \div 2 \times 3 = k\sqrt{16}$ or $24 = k\sqrt{16}$	M1	oe equation k may be any letter
	$k = \frac{\text{their } 24}{\sqrt{16}}$ or $k = 6$ or $G = \text{their } 6\sqrt{H}$	M1dep	their 24 must be the result of $16 \div 2 \times 3$
	their $6 \times$ their $\sqrt{100}$ or 60	M1dep	dep on M2
	60 : 100 or 3 : 5	A1	oe ratio
	Alternative method 2		
	$100 \div 16$ or 6.25	M1	
	$\sqrt{\text{their } 6.25}$ or 2.5	M1dep	
	$2 \times$ their 2.5 or 5 or $24 \times$ their 2.5 or 60	M1dep	dep on M2
	60 : 100 or 3 : 5	A1	oe ratio
	Additional Guidance		
	Ignore an incorrect attempt to simplify a correct ratio eg 60 : 100 followed by 3 : 4		M1M1M1A1
	$k = 6$ implies M2 unless from incorrect working		
	G α $k\sqrt{H}$ is M0 unless recovered		
	$G = k\sqrt{H}$ $\sqrt{16} = 4$ $G : H = 6 : 4$ $6 = k \times 4$ $k = \frac{6}{4}$ followed by $G = 1.5 \times 10$ 150 :100		M1M0M0A0
	$G = 24$ with no correct further work		M0

Q	Answer	Mark	Comments
21	72 (–) 6 or 66 or 63 (–) 6 or 57 or 45 (+) 21 or 66 or 36 (+) 21 or 57 or 56 (+) 10 or 66 or 49 (+) 8 or 57	M1	large rectangle subtract missing rectangle, implied by volumes of 864 and 72 splits side elevation vertically, implied by volumes of 540 and 252 splits side elevation horizontally, implied by volumes of 672 and 120 oe may be on diagram
	792 or 165	A1	
	Maximum 792 and Minimum 165	A1	

Q	Answer	Mark	Comments
22	Enlargement	B1	accept Enlarge
	(Scale factor) $-\frac{1}{2}$	B1	oe
	(Centre) (7, 4)	B1	oe
	Additional Guidance		
	Do not accept reduces, gets smaller, shrinks or negative enlargement		
	Do not accept $\div -\frac{1}{2}$ or $\div -2$ for scale factor		
	Ignore missing brackets on 7, 4		
	Do not accept $\begin{pmatrix}7\\4\end{pmatrix}$ for centre of enlargement, however this does not imply a combined transformation		
	Enlarge, $-\frac{1}{2}$, (7, 4)		B1B1B1
	Combined transformation		B0B0B0

Q	Answer	Mark	Comments
23(a)	$35^2 + 65^2 - 2 \times 35 \times 65 \times \cos 100$	M1	oe valid trigonometric method used must be correct
	$\sqrt{35^2 + 65^2 - 2\times35\times65\times\cos100}$ $= 78.9(\ldots)$ or $\sqrt{6240.(0992...)} = 78.9(\ldots)$	A1	$CA = 78.99429858$
	Additional Guidance		
	Using sine rule with $CA = 79$ to obtain AB or BC		M0A0

Q	Answer	Mark	Comments
23(b)	**Alternative method 1 – sine rule to find *ACB***		
	$\frac{\sin ACB}{35} = \frac{\sin 100}{79}$	M1	oe 79 may be 78.9(…)
	$\sin ACB = 35 \times \frac{\sin 100}{79}$ or $\sin ACB = 35 \times 0.0124\ldots$ or $\sin ACB = 0.436\ldots$	M1dep	oe
	$ACB = [25.8, 26]$	A1	
	234.(…)	A1ft	ft 360 – 100 – their *ACB* with M2 scored
	Alternative method 2 – cosine rule to find *ACB*		
	$35^2 = 79^2 + 65^2 - 2 \times 79 \times 65 \times \cos ACB$	M1	oe 79 may be 78.9(…)
	$\cos ACB = \frac{79^2 + 65^2 - 35^2}{2 \times 79 \times 65}$ or $\cos ACB = \frac{9241}{10270}$ or $\cos ACB = 0.899\ldots$	M1dep	
	$ACB = [25.8, 26]$	A1	
	234.(…)	A1ft	ft 360 – 100 – their *ACB* with M2 scored

Mark scheme and Additional Guidance continue on the next page

23(b) cont	**Alternative method 3 – sine rule to find *BAC***		
	$\frac{\sin BAC}{65} = \frac{\sin 100}{79}$	M1	oe 79 may be 78.9(…)
	$\sin BAC = 65 \times \frac{\sin 100}{79}$ or $\sin BAC = 65 \times 0.0124\ldots$ or $\sin BAC = 0.81(0\ldots)$	M1dep	oe
	BAC = [54.1, 54.3]	A1	
	234.(…)	A1ft	ft their $BAC + 180$ with M2 scored
	Alternative method 4 – cosine rule to find *BAC*		
	$65^2 = 79^2 + 35^2 - 2 \times 79 \times 35 \times \cos BAC$	M1	oe 79 may be 78.9(…)
	$\cos BAC = \frac{79^2 + 35^2 - 65^2}{2 \times 79 \times 35}$ or $\cos BAC = \frac{3241}{5530}$ or $\cos BAC = 0.586\ldots$	M1dep	
	BAC = [54.1, 54.3]	A1	
	234.(…)	A1ft	ft their $BAC + 180$ with M2 scored
	Additional Guidance		
	$CA = 79$ is given in part (a) or 78.9(…) can be used. There is no follow through from part (a).		
	Accept any notation for the angle eg $\sin x$ or $\sin C$ for angle ACB		
	Correct work for part (b) seen in part (a) may be awarded method marks in part (b)		