GCSE
Mathematics

Paper 3 Higher Tier

Mark scheme

8300
November 2017

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.

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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 $a \leq$ 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	$-4 < x \leqslant 5$	B1	
	Additional Guidance		
2	1 : 2	B1	
	Additional Guidance		
3	$2n - 12$	B1	
	Additional Guidance		
4	$y = -5$	B1	
	Additional Guidance		
5	$x^2 - 8x - 8x + 64$	M1	allow one error or omission terms may be seen in a grid
	$x^2 - 16x + 64$	A1	Ignore fw eg if attempting to solve Do not ignore fw if attempting to simplify
	Additional Guidance		
	$x^2 - 16x$ (+ k) k ≠ 64		M1A0
	$x^2 - 8x + 64$		M1A0
	$x^2 - 16x + 64 = -15x^3 + 64$		M1A0
	$x^2 - 8x + 8x + 64$ (one error)		M1A0
	$x^2 + 8x + 8x + 64$ (one error)		M1A0
	$x^2 - 6x + 8x + 64$ (two errors)		M0A0
	$x^2 + 64$ (two errors)		M0A0

Question	Answer	Mark	Comments
6	Lists three from 3, 9, 27, 81, 243, 729 or lists three from 1, 4, 9, 16, …, 225, 256, 289 or correctly evaluating a power of 3 + a square number or correctly evaluating 268 – a power of 3 or correctly evaluating 268 – a square number	M1	eg 27 + 25 = 52 or $3^3 + 5^2 = 52$ eg 268 – 27 = 241 eg 268 – 49 = 219
	243 + 25 or $3^5 + 5^2$	A1	oe Addition sign must be seen in working or on answer line
	Additional Guidance		
	3^5, 5^2 or 3^5 and 5^2 on answer line		M1A0
	268 – 243 = 25		M1A0
	243, 25 or 243 and 25 on answer line		M1A0
	Beware of $5^3 + 5^2$		

7	$10 < t \leq 15$	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
8 **Alt 1 of 2**	**Alternative method 1**		
	PAB = 51 or *PAD* = 51 or *APC* = 180 – 51 or *APC* = 129	M1	
	ABP = 180 – 51 – their 51 or *ABP* = 180 – 102 or *ABP* = 78 or *ADC* = 180 – their 51 – their 51 *ADC* = 180 – 102 *ADC* = 78	M1dep	*PAB* = 51 and *PAD* = 51 or *BAD* = 102
	BCD = 180 – their 78 or *BCD* = 360 – their 129 – their 51 – their 78 or *BCD* = 360 – 258 or *BCD* = 102 or 4*x* = 180 – their 78 or 4*x* = 360 – their 129 – their 51 – their 78 or 4*x* = 360 – 258 or 4*x* = 102 or 102 ÷ 4	M1dep	oe eg *BCD* = (360 – 2 × their 78) ÷ 2 or 4*x* = (360 – 2 × their 78) ÷ 2
	25.5	A1	

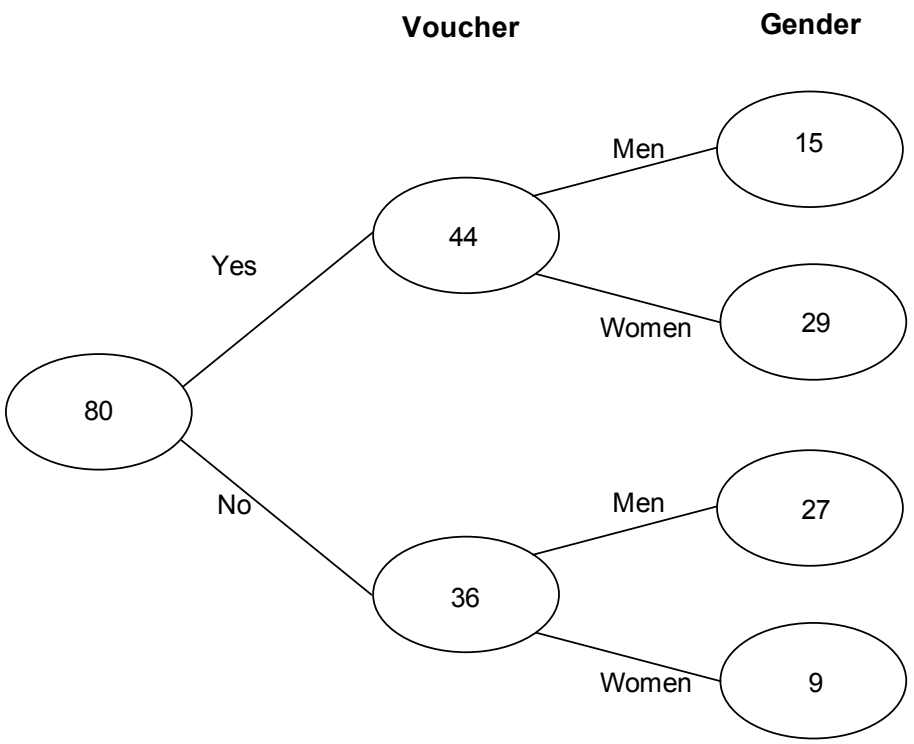
Question	Answer	Mark	Comments
8 Alt 2 of 2	**Alternative method 2**		
	$ABC = 180 - 3x - x$ or $ABC = 180 - 4x$ or $APC = 180 - 51$ or $APC = 129$	M1	
	$PAB = 2x$ or $APB = 2x$ or $2x = 51$	M1dep	
	$51 \div 2$	M1dep	
	25.5	A1	
	Additional Guidance		
	Angles must be labelled or shown on diagram		

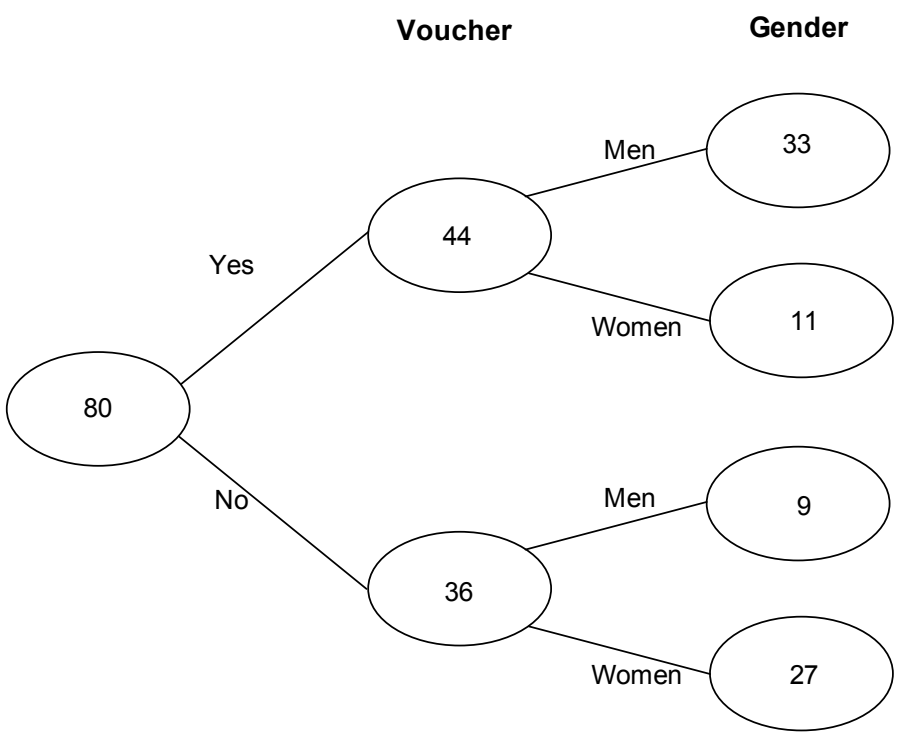
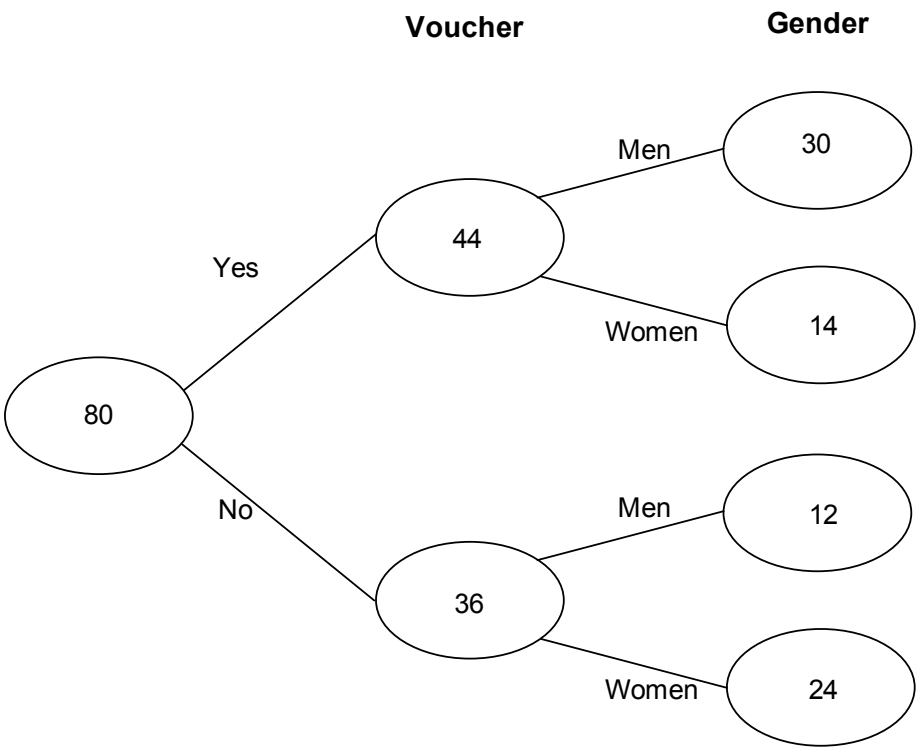
Question	Answer	Mark	Comments

9(a)	**Alternative method 1**			
	$v - u = at$	$-at = u - v$	M1	
	$t = \frac{v-u}{a}$	$t = \frac{u-v}{-a}$	A1	oe
	Alternative method 2			
	$\frac{v}{a} = \frac{u}{a} + t$		M1	
	$t = \frac{v}{a} - \frac{u}{a}$		A1	oe
	Additional Guidance			
	$t = (v - u) \div a$			M1A1
	$v - u = at$ and $t = v - u \div a$			M1A0
	$\frac{v-u}{a}$ or $\frac{u-v}{-a}$ or $\frac{v}{a} - \frac{u}{a}$			M1A0
	$a = \frac{v-u}{t}$ with or without working			M1A0
	$t = v - u \div a$			M0A0
	$t = \frac{v+u}{a}$			M0A0

Question	Answer	Mark	Comments
9(b)	(Speed) m/s or ms^{-1} (Acceleration) m/s^2 or ms^{-2} or m/s/s	B2	B1 for one correct or two mutually consistent units eg km/h and km/h^2 Accept mps for m/s and mps^2 for m/s^2
	Additional Guidance		
	Allow units given in words eg metres per second metres per second squared or metres per second per second		
	m/s^{-1} (speed)		B0
	m/s^{-2} (acceleration)		B0

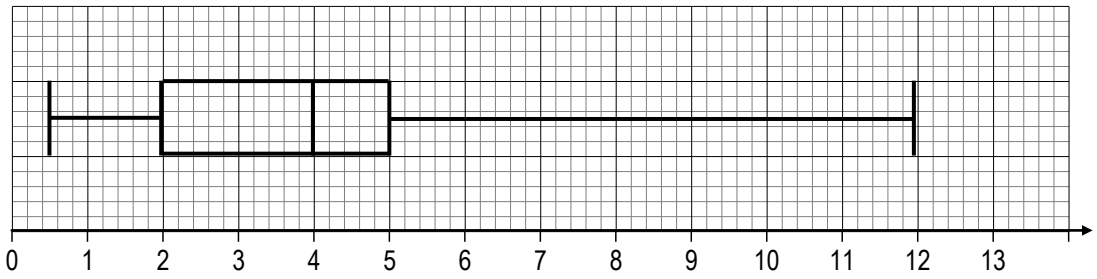
Question	Answer	Mark	Comments
10	Two pairs of intersecting arcs with equal radii > 0.5 *AB*	M1	tolerance ± 0.1 cm
	Perpendicular bisector drawn with correct method seen	A1	tolerance ± 0.1 cm
	Additional Guidance		

Question	Answer	Mark	Comments
11(a)	80	B1	
	44 and 36	B1ft	ft their 80 – 44
	27 and 9	B1ft	ft their 36 ÷ 4 × 3 and ft their 36 ÷ 4
	15 and 29	B1ft	ft 42 – their 27 and ft 38 – their 9 Total on ft must be 44
	Additional Guidance		
			B1B1B1B1
	Mark diagram only, do not allow misread		
	Values may be rounded up or down to whole numbers provided the total is correct		
	Penalise the use of relative frequencies on the first occurrence only		
	If relative frequencies are shown the denominator must be 80 and not simplified eg ¾ and ¼ is B0		

		B1B1B0B1ft
		B1B1B0B1ft

Question	Answer	Mark	Comments
11(b)	85% or 0.85	M1	
	27.2 ÷ 0.85 or 27.2 ÷ 85 (× 100) or 0.32	M1dep	
	32(.00)	A1	Correct money notation Allow £32.00p
	Additional Guidance		
	32.0		M1M1A0
12(a)	140 ÷ 50 or 2.8 or 140 ÷ 50 × 60 or 168	M1	oe
	2 (hours) 48 (minutes)	A1	258 (minutes) (after midday) implies M1A1
	4.18 (pm)	A1ft	oe ft their time in hours and minutes with M1 awarded
	Additional Guidance		
	140 ÷ 50 or 2.8 = 2 hours 80 minutes = 3 hours 20 minutes, Answer 4.50		M1A0A1ft
	140 ÷ 50 or 2.8 = 2 hours 8 minutes, Answer 3.38		M1A0A1ft
	140 ÷ 50 or 2.8 = 2 hours 80 minutes = 3 hours 20 minutes, Answer 4.5		M1A0A0
	140 ÷ 50 or 2.8, Answer 4.10		M1A0A0
	2 hours 8 minutes implies attempt at 140 ÷ 50		M1

Question	Answer	Mark	Comments
12(b)	Valid statement	B1ft	eg the arrival time will be later it will be later time will be more ft their time in (a) eg it will be after 4.18pm
	Additional Guidance		
	It will be delayed	B1	
	The arrival time will be increased	B1	
	He will reach there late	B1	
	The time will go up	B1	
	It will go up	B1	
	The journey will take longer so the arrival time is later	B1	
	Take longer	B0	
	Longer	B0	
	Slower (restating question)	B0	
	You won't get there as quick	B0	
	Time will be longer	B0	
	Journey will be longer	B0	
	'Longer' is referring to a time period rather than an arrival time		

Question	Answer	Mark	Comments
13	Fully correct box plot Minimum = 0.5 LQ = 2 Median = 4 UQ = 5 Maximum = 12	B3	B2 for box plot with 3 or 4 correct plots or 1 omission B1 for at least 3 correct plots tolerance $\pm \frac{1}{2}$ square
	Additional Guidance		
			
	Any indication of correct plots		
	Whiskers may be omitted		
	Not a box plot scores a maximum of B1		
	½, 2, 3, 4, 12 plotted correctly in a box plot	B2	
	½, 2, 3, 4, 12 plotted correctly in a box plot with one point out of tolerance	B1	
	½, 2, 3, 4, 12 not in a box plot	B1	

Question	Answer	Mark	Comments
14(a)	$6 + 5 + 2x + x + 2 = 31$ or $3x + 13 = 31$ or $3x = 18$ or $\frac{5+2x}{31}$ or $\frac{5+2x}{3x+13}$	M1	oe equation 6 + 5 + 2(6) + 6 + 2 = 31 (embedded answer)
	(x =) 6	A1	
	$\frac{17}{31}$ or 0.548… or 0.55 or 54.8…% or 55%	A1ft	ft $\frac{5 + \text{their } 2x}{31}$ and M1 A0 or ft $\frac{23 - \text{their } x}{31}$ and M1 A0
	Additional Guidance		
	x = 6, answer $\frac{12}{31}$ or answer $\frac{12}{31}$ alone (implied x = 6)		M1A1A0
	$3x = 18$, $x = 5$, answer $\frac{15}{31}$ or $\frac{18}{31}$		M1A0A1ft
14(b)	$\frac{5}{11}$ or 0.45… or 45.(…)%	B1	oe
	Additional Guidance		
15	$2xy$	B1	
	Additional Guidance		
16	36	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
17	$13 - 5 \rightarrow 4152$ or $8 \rightarrow 4152$	M1	oe eg 4152 ÷ 8 or 519 seen or 8 parts is 4152
	$\frac{x + 4152}{x} = \frac{13}{5}$ or $5x + 20\,760 = 13x$ or $20\,760 = 8x$ or $2595 = x$ or (number of men =) 6747 or (number of women =) 2595 or (total number of people =) 12 926 or 4152 ÷ 8 × 7 or 519 × 7	M1dep	oe
	3633	A1	
	Additional Guidance		

Question	Answer	Mark	Comments
18	$-6x^3 + 18x$ or $(-)(6x^3 - 18x)$	B1	
	$6x^3 + 15x^2 + 4x + 10$	M1	Allow one error
	$6x^3 + 15x^2 + 4x + 10 - 6x^3 + 18x$	A1ft	oe ft B0M1 only
	$15x^2 + 22x + 10$	A1ft	ft their 6 terms if at least M1 scored Do not ignore fw
	Additional Guidance		
	$-6x^3 - 18x$ $6x^3 + 15x^2 + 4x + 10$ $6x^3 + 15x^2 + 4x + 10 - 6x^3 - 18x$ $15x^2 - 14x + 10$		B0 M1 A1ft A1ft
	$-6x^2 - 18x$ $6x^2 + 15x^2 + 4x + 10$ $6x^2 + 15x^2 + 4x + 10 - 6x^2 - 18x$ $15x^2 - 14x + 10$		B0 M1 A1ft A1ft
	$-6x^2 + 18x$ $6x^2 + 15x^2 + 4x + 10$ $6x^2 + 15x^2 + 4x + 10 - 6x^2 + 18x$ $15x^2 + 22x + 10$		B0 M1 A1ft A1ft
	$-6x^3 + 18x$ $6x^3 + 15x^2 + 4x + 7$ $6x^3 + 15x^2 + 4x + 7 - 6x^3 + 18x$ $15x^2 + 22x + 7$		B1 M1 A0 A1ft

Question	Answer	Mark	Comments
19	65	B1	
	Alternate segment (theorem)	B1dep	
	Additional Guidance		
	65 alternative segment (theorem)		B1 B0
	65 alternate angles		B1 B0
20	3rd box indicated	B1	
	Additional Guidance		
21	3^8 or 3^9 or y^6 or $2 \times 3^4 \times y^3 \times 2 \times 3^4 \times y^3$ or $3 \times 2 \times 3^4 \times y^3 \times 2 \times 3^4 \times y^3$	M1	78 732 or 19 683
	$2^2 \times 3^8 \times y^6$ or $3 \times 2^2 \times 3^8 \times y^6$ or 2^2 and 3^9 and y^6 or $2^a \times 3^b \times y^c$ with two powers correct	M1dep	$2^2 \times 19\,683y^6$ $78\,732y^6$
	$2^2 \times 3^9 \times y^6$	A1	Must be in index form Do not ignore fw
	Additional Guidance		
	$2^2 \times 3^8 \times y^6$		M1 M1 A0
	$2^2 + 3^9 \times y^6$		M1 M1 A0
	$2^2 + 3^8 + y^6$		M1 M0 A0

Question	Answer	Mark	Comments
22	$6^2 + 9^2 - 2 \times 6 \times 9 \times \cos 120$ or $36 + 81 - 108 \cos 120$ or $36 + 81 + 54$ or 171	M1	oe
	$\sqrt{6^2 + 9^2 - 2 \times 6 \times 9 \times \cos 120}$ or $\sqrt{36 + 81 - 108 \cos 120}$ or $\sqrt{36 + 81 + 54}$	M1dep	oe
	[13, 13.1] or $\sqrt{171}$ or $3\sqrt{19}$	A1	
	Additional Guidance		
	$6^2 + 9^2 = 36 + 81$ $= 117$ Answer $\sqrt{117}$		M0

Question	Answer	Mark	Comments
23	Line $x = 3$ should be dashed or not included	B1	oe eg vertical line should be dotted
	R is in the wrong place	B1	oe eg region is not correct May be shown on diagram
	Additional Guidance		
	x is not equal to 3		B1
	R does not include $x = 3$		B1
	Straight line should be less than 3		B1
	$x = 3$ is not in the region		B1
	Line at $x = 3$ is closed not open		B1
	Lines are not drawn correctly (not enough)		B0
	Should have shaded above the dotted line ($y > 3 – x$)		B1
	R should be where (2, 2) is		B1
	R should be shaded		B0

Question	Answer	Mark	Comments
24	**Alternative method 1**		
	$4a = 9b$	M1	oe $\frac{a}{b} = \frac{9}{4}$
	$4a = 9 \times \frac{7c}{10}$ or $40a = 63c$ and $40a = 90b$ and $90b = 63c$	M1dep	oe $9 : \frac{40}{7}$
	63 : 40	A1	Accept $\frac{63}{40} : 1$ or 1.575 : 1 or $1 : \frac{40}{63}$
	Alternative method 2		
	$b : c = 7 : 10$	M1	
	$a : b = 63 : 90$ and $b : c = 90 : 40$ or 63 : 90 : 40	M1dep	oe common value for b
	63 : 40	A1	Accept $\frac{63}{40} : 1$ or 1.575 : 1 or $1 : \frac{40}{63}$

Question	Answer	Mark	Comments
24 cont	**Alternative method 3**		
	$a = \frac{9b}{4}$ or $c = \frac{10b}{7}$	M1	
	$\frac{9b}{4} : \frac{10b}{7}$ or $\frac{9}{4} : \frac{10}{7}$	M1dep	oe
	63 : 40	A1	Accept $\frac{63}{40}$: 1 or 1.575 : 1 or 1 : $\frac{40}{63}$
	Alternative method 4		
	$c = \frac{10}{7}b$	M1	eg $a : c = a : \frac{10}{7}b$
	9 : $\frac{10}{7}$ × 4 or 9 : $\frac{40}{7}$	M1dep	oe
	63 : 40	A1	Accept $\frac{63}{40}$: 1 or 1.575 : 1 or 1 : $\frac{40}{63}$
	Additional Guidance		
	2nd method mark is for a link between a and c or a correct ratio in an unsimplified form		
	40 : 63 on answer line		M1M1A0

Question	Answer	Mark	Comments
25	Attempt to draw a tangent	M1	
	Attempt at slope of a tangent drawn at (10, 15)	M1dep	tolerance ± ½ square Must be an attempt at change in y divided by change in x Accept positive or negative
	[0.6, 0.8] from tangent drawn at (10, 15)	A1ft	Condone –[0.6, 0.8] from tangent drawn at (10, 15) ft from their tangent drawn at (10, 15)
	Additional Guidance		
	Tangent drawn at incorrect point		M1M0A0
	No tangent		M0
	Tangent drawn at (10, 15) 10 ÷ 15 = 0.6		M1 M0 A0
	Misread of scale for tangent drawn at (10, 15) could score M1M1		
26	Full explanation stating one of $a + b$ or $a – b$ must be 1 and $a + b$ cannot be 1 and $a – b$ must be 1	B2	B1 partial explanation ie $a + b$ or $a – b$ must be 1 or $a + b$ cannot be 1 or $a – b$ must be 1
	Additional Guidance		

Question	Answer		Mark	Comments
27	$10^2 + 10^2$ or 200	$5^2 + 5^2$ or 50	M1	oe
	$\sqrt{\text{their } 200}$ or $10\sqrt{2}$ or [14, 14.2]	$\sqrt{\text{their } 50}$ or $5\sqrt{2}$ or [7, 7.1]	M1dep	oe
	$\tan 68 = \frac{h}{\text{their } 7.1}$		M1dep	
	their 7.1 × tan 68 or [17.3, 17.6]		M1dep	
	$\frac{1}{3}$ × 10 × 10 × their [17.3, 17.6]		M1dep	
	[576, 587] or 590		A1	
	Additional Guidance			

Question	Answer	Mark	Comments
28	$p \times q^{1-1} = 10$ or $p \times q^{0} = 10$ or $p \times q^{6-1} = 0.3125$ or $p \times q^{5} = 0.3125$	M1	oe
	$p = 10$ or $10 \times q^{6-1} = 0.3125$ or $q^{5} = 0.3125 \div$ their 10 or $q^{5} = 0.03125$	M1dep	
	$\sqrt[5]{\text{their } 0.03125}$ or 0.5	M1dep	oe
	their $10 \times$ their 0.5^{2} or their $10 \times$ their $(\sqrt[5]{\text{their } 0.03125})^{2}$ or their $10 \times$ their $0.03125^{\frac{2}{5}}$	M1dep	
	2.5	A1	
	Additional Guidance		

29	–3 –2 –1 0 1 2	B2	B1 for 5 correct and 0 incorrect or 6 correct and 1 incorrect
	Additional Guidance		
	Do not accept coordinates		

Question	Answer	Mark	Comments
30	$\frac{6x^2+3}{3}$ or $2x^2 + 1$ or $\frac{6x^2+3}{3} + 4$ or $2x^2 + 1 + 4$	M1	oe
	$2x^2 + 5$	A1	
	Additional Guidance		