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# GCSE Mathematics

Paper 3 Higher Tier

Mark scheme

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8300  
November 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	$-4 < x \leq 5$	B1	
	<b>Additional Guidance</b>		
2	1 : 2	B1	
	<b>Additional Guidance</b>		
3	$2n - 12$	B1	
	<b>Additional Guidance</b>		
4	$y = -5$	B1	
	<b>Additional Guidance</b>		
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
	<b>Additional Guidance</b>		
	$x^2 - 16x (+ k) \quad k \neq 64$		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
	<b>Additional Guidance</b>		
	$3^5, 5^2$ 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	
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
8 Alt 1 of 2	<b>Alternative method 1</b>		
	$PAB = 51$ or $PAD = 51$ or $APC = 180 - 51$ or $APC = 129$	M1	
	$ABP = 180 - 51 - \text{their } 51$ or $ABP = 180 - 102$ or $ABP = 78$  or $ADC = 180 - \text{their } 51 - \text{their } 51$ $ADC = 180 - 102$ $ADC = 78$	M1dep	$PAB = 51$ and $PAD = 51$ or $BAD = 102$
	$BCD = 180 - \text{their } 78$ or $BCD = 360 - \text{their } 129 - \text{their } 51 - \text{their } 78$ or $BCD = 360 - 258$ or $BCD = 102$  or $4x = 180 - \text{their } 78$ or $4x = 360 - \text{their } 129 - \text{their } 51 - \text{their } 78$ or $4x = 360 - 258$ or $4x = 102$  or $102 \div 4$	M1dep	oe eg $BCD = (360 - 2 \times \text{their } 78) \div 2$  or $4x = (360 - 2 \times \text{their } 78) \div 2$
	25.5	A1	

Question	Answer	Mark	Comments
<p style="text-align: center;"><b>8</b> <b>Alt 2 of</b> <b>2</b></p>	<b>Alternative method 2</b>		
	$ABC = 180 - 3x - x$ 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	
	<b>Additional Guidance</b>		
	Angles must be labelled or shown on diagram		



Question	Answer	Mark	Comments	
<b>9(a)</b>	<b>Alternative method 1</b>			
	$v - u = at$	$-at = u - v$	M1	
	$t = \frac{v-u}{a}$	$t = \frac{u-v}{-a}$	A1	oe
	<b>Alternative method 2</b>			
	$\frac{v}{a} = \frac{u}{a} + t$		M1	
	$t = \frac{v}{a} - \frac{u}{a}$		A1	oe
	<b>Additional Guidance</b>			
	$t = (v - u) \div a$		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		

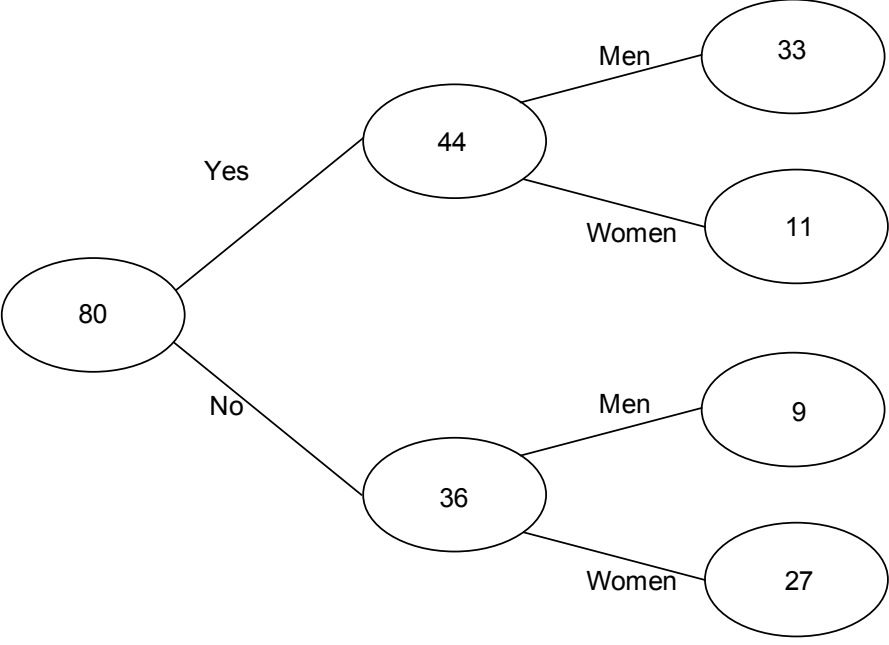
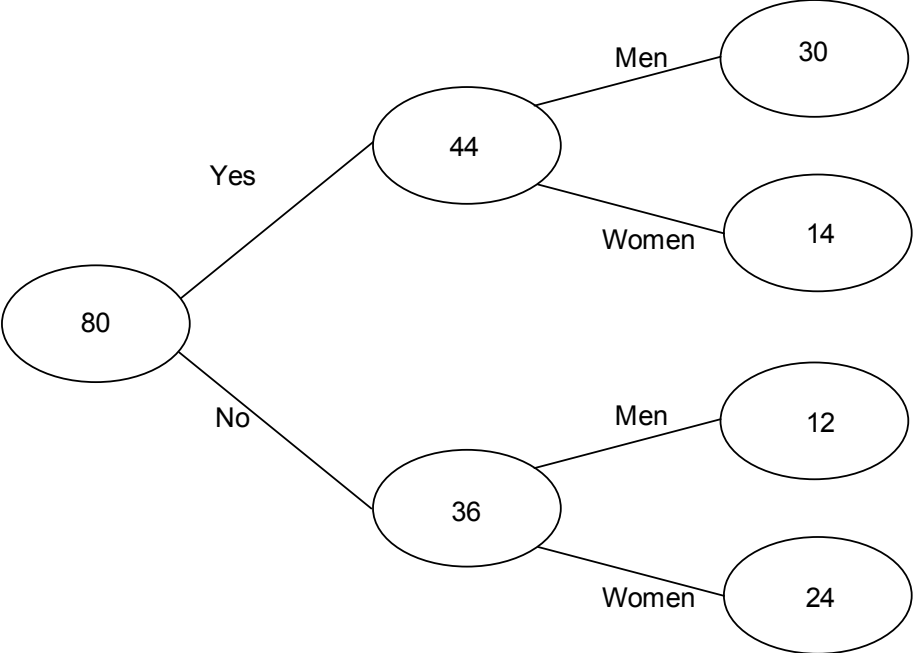
Question	Answer	Mark	Comments
9(b)	(Speed) $m/s$ or $ms^{-1}$ (Acceleration) $m/s^2$ or $ms^{-2}$ or $m/s/s$	B2	B1 for one correct or two mutually consistent units eg $km/h$ and $km/h^2$ Accept $mps$ for $m/s$ and $mps^2$ for $m/s^2$
	<b>Additional Guidance</b>		
	Allow units given in words eg metres per second metres per second squared or metres per second per second		
	$m/s^{-1}$ (speed)		B0
	$m/s^{-2}$ (acceleration)		B0
10	Two pairs of intersecting arcs with equal radii $> 0.5 AB$	M1	tolerance $\pm 0.1$ cm
	Perpendicular bisector drawn with correct method seen	A1	tolerance $\pm 0.1$ cm
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments
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11(a)	80	B1	
	44 and 36	B1ft	ft their 80 – 44
	27 and 9	B1ft	ft their $36 \div 4 \times 3$ and ft their $36 \div 4$
	15 and 29	B1ft	ft 42 – their 27 and ft 38 – their 9 Total on ft must be 44

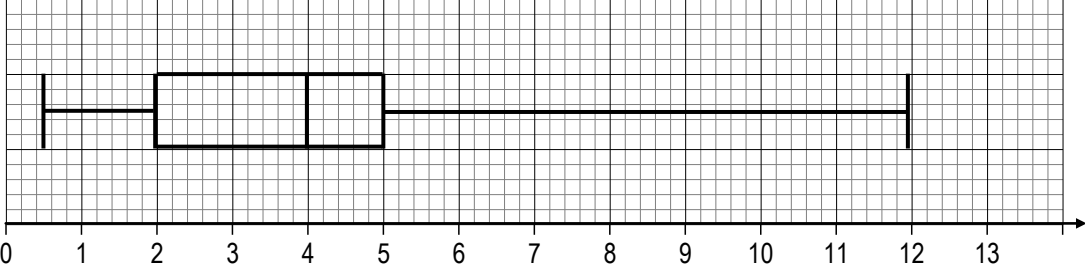
**Additional Guidance**

11(a)	<p style="text-align: center;"><b>Voucher</b>                      <b>Gender</b></p> <pre> graph LR     80((80)) -- Yes --&gt; 44((44))     80 -- No --&gt; 36((36))     44 -- Men --&gt; 15((15))     44 -- Women --&gt; 29((29))     36 -- Men --&gt; 27((27))     36 -- Women --&gt; 9((9))             </pre>		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 $\frac{3}{4}$ and $\frac{1}{4}$ is B0		

	<p style="text-align: center;"><b>Voucher</b>                      <b>Gender</b></p>  <pre> graph LR     80((80)) -- Yes --&gt; 44((44))     80 -- No --&gt; 36((36))     44 -- Men --&gt; 33((33))     44 -- Women --&gt; 11((11))     36 -- Men --&gt; 9((9))     36 -- Women --&gt; 27((27))             </pre>	<p>B1B1B0B1ft</p>
	<p style="text-align: center;"><b>Voucher</b>                      <b>Gender</b></p>  <pre> graph LR     80((80)) -- Yes --&gt; 44((44))     80 -- No --&gt; 36((36))     44 -- Men --&gt; 30((30))     44 -- Women --&gt; 14((14))     36 -- Men --&gt; 12((12))     36 -- Women --&gt; 24((24))             </pre>	<p>B1B1B0B1ft</p>

Question	Answer	Mark	Comments
11(b)	85% or 0.85	M1	
	$27.2 \div 0.85$ or $27.2 \div 85 (\times 100)$ or 0.32	M1dep	
	32(.00)	A1	Correct money notation Allow £32.00p
	<b>Additional Guidance</b>		
	32.0		M1M1A0
12(a)	$140 \div 50$ or 2.8 or $140 \div 50 \times 60$ 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
	<b>Additional Guidance</b>		
	$140 \div 50$ or $2.8 = 2$ hours 80 minutes = 3 hours 20 minutes, Answer 4.50		M1A0A1ft
	$140 \div 50$ or $2.8 = 2$ hours 8 minutes, Answer 3.38		M1A0A1ft
	$140 \div 50$ or $2.8 = 2$ hours 80 minutes = 3 hours 20 minutes, Answer 4.5		M1A0A0
	$140 \div 50$ or 2.8, Answer 4.10		M1A0A0
2 hours 8 minutes implies attempt at $140 \div 50$		M1	

Question	Answer	Mark	Comments
<b>12(b)</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
	<b>Additional Guidance</b>		
	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
	<b>Additional Guidance</b>		
			
	Any indication of correct plots		
	Whiskers may be omitted		
	Not a box plot scores a maximum of B1		
	$\frac{1}{2}$ , 2, 3, 4, 12 plotted correctly in a box plot		B2
$\frac{1}{2}$ , 2, 3, 4, 12 plotted correctly in a box plot with one point out of tolerance		B1	
$\frac{1}{2}$ , 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
	<b>Additional Guidance</b>		
	$x = 6$ , 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
	<b>Additional Guidance</b>		
15	$2xy$	B1	
	<b>Additional Guidance</b>		
16	36	B1	
	<b>Additional Guidance</b>		



Question	Answer	Mark	Comments
<b>17</b>	13 – 5 → 4152 or 8 → 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 $4152 \div 8 \times 7$ or $519 \times 7$	M1dep	oe
	3633	A1	
	<b>Additional Guidance</b>		

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
	<b>Additional Guidance</b>		
	$-6x^3 - 18x$ $6x^3 + 15x^2 + 4x + 10$ $6x^3 + 15x^2 + 4x + 10 - 6x^3 - 18x$ $15x^2 - 14x + 10$		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	
	<b>Additional Guidance</b>		
	65 alternative segment (theorem)		B1 B0
	65 alternate angles		B1 B0
20	3rd box indicated	B1	
	<b>Additional Guidance</b>		
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
	<b>Additional Guidance</b>		
	$2^2 \times 3^8 \times y^6$		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	
<b>22</b>	$6^2 + 9^2 - 2 \times 6 \times 9 \times \cos 120$ 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		
	<b>Additional Guidance</b>			
	$6^2 + 9^2 = 36 + 81$ $= 117$ 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
	<b>Additional Guidance</b>		
	$x$ 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	
<b>24</b>	<b>Alternative method 1</b>			
	$4a = 9b$	M1	oe $\frac{a}{b} = \frac{9}{4}$	
	$4a = 9 \times \frac{7c}{10}$ or $40a = 63c$	$40a = 90b$ and $90b = 63c$	M1dep	oe 9 : $\frac{40}{7}$
	$63 : 40$		A1	Accept $\frac{63}{40} : 1$ or $1.575 : 1$ or $1 : \frac{40}{63}$
	<b>Alternative method 2</b>			
	$b : c = 7 : 10$		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	<b>Alternative method 3</b>		
	$a = \frac{9b}{4}$ 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 $1 : \frac{40}{63}$
	<b>Alternative method 4</b>		
	$c = \frac{10}{7}b$	M1	eg $a : c = a : \frac{10}{7}b$
	$9 : \frac{10}{7} \times 4$ or $9 : \frac{40}{7}$	M1dep	oe
	63 : 40	A1	Accept $\frac{63}{40} : 1$ or 1.575 : 1 or $1 : \frac{40}{63}$
	<b>Additional Guidance</b>		
	2 <sup>nd</sup> 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 $\pm \frac{1}{2}$ 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)
	<b>Additional Guidance</b>		
	Tangent drawn at incorrect point		M1M0A0
	No tangent		M0
	Tangent drawn at (10, 15) $10 \div 15 = 0.6$		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
	<b>Additional Guidance</b>		



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 $\times$ $\tan 68$ or [17.3, 17.6]		M1dep	
	$\frac{1}{3} \times 10 \times 10 \times \text{their } [17.3, 17.6]$		M1dep	
	[576, 587] or 590		A1	
	<b>Additional Guidance</b>			

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 $q^5 = 0.3125 \div \text{their } 10$ or $q^5 = 0.03125$	M1dep	
	$\sqrt[5]{\text{their } 0.03125}$ or 0.5	M1dep	oe
	their $10 \times \text{their } 0.5^2$ or their $10 \times \text{their } (\sqrt[5]{\text{their } 0.03125})^2$ or their $10 \times \text{their } 0.03125^{\frac{2}{5}}$	M1dep	
	2.5	A1	
	<b>Additional Guidance</b>		
29	-3 -2 -1 0 1 2	B2	B1 for 5 correct and 0 incorrect or 6 correct and 1 incorrect
	<b>Additional Guidance</b>		
	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	
	<b>Additional Guidance</b>		