GCSE
MATHEMATICS
8300/2H

Higher Tier Paper 2 Calculator

Mark scheme

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2 1 6 G 8 3 0 0 / 2 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.

Further copies of this mark scheme are available from aqa.org.uk

Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

M	Method marks are awarded for a correct method which could lead to a correct answer.
A	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
B	Marks awarded independent of method.
ft	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
SC	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
M dep	A method mark dependent on a previous method mark being awarded.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
oe	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
[a, b]	Accept values between a and b inclusive.
[a, b)	Accept values $a \leq$ value $< b$
3.14 …	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
Use of brackets	It is not necessary to see the bracketed work to award the marks.

Examiners should consistently apply the following principles

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Responses which appear to come from incorrect methods

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

Questions which ask students to show working

Instructions on marking will be given but usually marks are not awarded to students who show no working.

Questions which do not ask students to show working

As a general principle, a correct response is awarded full marks.

Misread or miscopy

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

Further work

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

Choice

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

Work not replaced

Erased or crossed out work that is still legible should be marked.

Work replaced

Erased or crossed out work that has been replaced is not awarded marks.

Premature approximation

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

Continental notation

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.

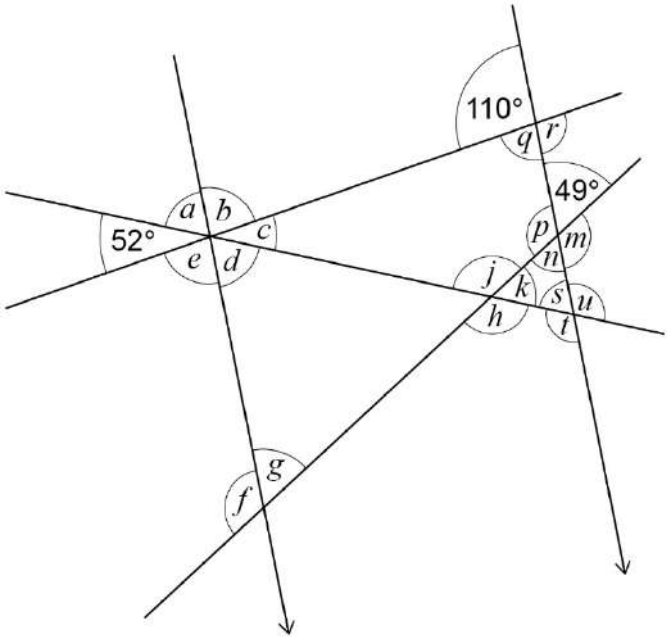
Q	Answer	Mark	Comments
1	$x - 5$	B1	

Q	Answer	Mark	Comments
2	1 : 2	B1	

Q	Answer	Mark	Comments
3	$\frac{16}{81}$	B1	

Q	Answer	Mark	Comments
4	SSS	B1	

Q	Answer	Mark	Comments
5	$10x + 3x$ or $13x$ or $-3x - 10x$ or $-13x$	M1	may be implied eg 62.4 ÷ 13 or $-62.4 \div -13$
	4.8 or $4\frac{4}{5}$ or $\frac{24}{5}$	A1	oe eg $\frac{624}{130}$
	Additional Guidance		
	$\frac{-24}{-5}$		M1A0
	Correct answer embedded eg 10 × 4.8 = 62.4 – 3 × 4.8		M1A0
	Ignore conversion attempt after correct answer seen		

Q	Answer	Mark	Comments
6	Using these letters for the unknown angles  		
	73	B3	B2 $180 - 110 + 52 - 49$ oe calculation or $h = 107$ or $j = 107$ or $k = 73$ or $g = 49$ and $d = 58$ or $g = 49$ and $e = 70$ or $f = 131$ and $d = 58$ B1 any angle correct (others may be incorrect)
	Additional Guidance		
	Angles will usually be seen on the diagram		
	Angles must be unambiguously linked to the correct position eg 131 seen in working but not on the diagram or in wrong position		B0
	$a = 58$ $b = 70$ $c = 52$ $d = 58$ $e = 70$ $f = 131$ $g = 49$ $h = 107$ $j = 107$ $k = 73$ $m = 131$ $n = 49$ $p = 131$ $q = 70$ $r = 110$ $s = 58$ $t = 122$ $u = 122$		

Q	Answer	Mark	Comments
7	**Alternative method 1**		
	102×68.5 or 6987 or 85×72.4 or 6154 or 13 141	M1	values may be seen by the table
	$\frac{102 \times 68.5 + 85 \times 72.4}{102 + 85}$ or $\frac{13\,141}{187}$ or 70.2(7…) or 70.3	M1dep	oe
	70.2(7…) and Yes or 70.3 and Yes	A1	
	Alternative method 2		
	102×68.5 or 6987 or 85×72.4 or 6154 or 13 141	M1	values may be seen by the table
	$(102 + 85) \times 70$ or 187×70 or 13 090	M1	oe
	13 141 and 13 090 and Yes	A1	
	Additional Guidance		
	Yes may be implied eg $70.27 > 70$		M1M1A1
	M1 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
8	Enlargement	B1	
	$\frac{1}{4}$	B1	scale factor oe eg 0.25
	(3, 9) or *A*	B1	centre do not allow $\begin{pmatrix}3\\9\end{pmatrix}$
	Additional Guidance		
	Do not accept reduction or unenlargement or negative		1st B0
	Do not accept ÷ 4		2nd B0
	A combination of transformations cannot score the first B1 eg1 Enlarge sf $\frac{1}{4}$ Translate $\begin{pmatrix}0\\6\end{pmatrix}$ eg2 Enlarge sf $\frac{1}{4}$ 1.5 right up 6 (3, 9)		 B0B1B0 B0B1B1
	Do not allow $\begin{pmatrix}3\\9\end{pmatrix}$ for (3, 9) but do not regard as implying a combination of transformations eg Enlargement sf 0.25 $\begin{pmatrix}3\\9\end{pmatrix}$		 B1B1B0
	Enlargement, sf 4 about (3, 9)		B1B0B1
	Enlarge(d) 0.25 *A*		B1B1B1
	Condone *ABC* is an enlargement of *ADE*		1st B1
	Condone enlargement with other words unless referring to another transformation eg1 Enlargement making shapes bigger eg2 Enlarged then moved using a vector eg3 Enlarged which means *B* moves to *D* and *C* moves to *E*		 1st B1 1st B0 1st B1
	If more than one point is listed it must be clear which point is their centre eg (1, 1) (5, 1) (3, 9) (2, 7)		 3rd B0
	Reflected in the point (3, 9)		B0B0B1

Q	Answer	Mark	Comments
9	**Alternative method 1** Working out time to fill the ball		
	$4 \div 3 \times 15^3 \times \pi$ or $[4488, 4500]\pi$ or [14 092, 14 139]	M1	oe allow 1.33 or better
	their [14 092, 14 139] – 5000 or [9092, 9139] or their [14 092, 14 139] ÷ 160 or [88, 88.37]	M1dep	oe
	(their [14 092, 14 139] – 5000) ÷ 160 or [56, 57.12]	M1dep	oe eg their [9092, 9139] ÷ 160 or their [88, 88.37] – 5000 ÷ 160
	[56, 57.12] and Yes	A1	
	Alternative method 2 Comparing volume needed with volume that could be filled		
	$4 \div 3 \times 15^3 \times \pi$ or $[4488, 4500]\pi$ or [14 092, 14 139]	M1	oe allow 1.33 or better
	their [14 092, 14 139] – 5000 or [9092, 9139]	M1dep	
	[58, 60] × 160 or [9280, 9600]	M1	oe
	[9092, 9139] and [9280, 9600] and Yes	A1	

Mark scheme and Additional Guidance continue on next page

9 cont	**Alternative method 3** Volume of ball compared with volume that could be filled + 5000		
	$4 \div 3 \times 15^3 \times \pi$ or [4488, 4500]π or [14 092, 14 139]	M1	oe allow 1.33 or better
	[58, 60] × 160 or [9280, 9600]	M1	oe
	their [9280, 9600] + 5000 or [14 280, 14 600]	M1dep	dep on 2nd M1
	[14 092, 14 139] and [14 280, 14 600] and Yes	A1	
	Additional Guidance		
	Accept $\frac{4}{3}\pi 15^3$ without multiplication signs		
	Condone use of 1.3 for up to M3 if 1.3 shown		
	Up to M3 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Using an incorrect power eg 15^2, $15\pi^3$, $(15\pi)^3$ or omitting π unless recovered		1st M0
	NB 56.(59…) or 56.6 or 57 coming from 5000 ÷ 88.35…		M1M1M0
	Yes can be implied eg Alt 1 $57 < 60$		M3A1

Q	Answer	Mark	Comments
10	Sometimes true Always true Always true Never true	B4	B1 for each
	Additional Guidance		
	Allow any unambiguous indication eg all 4 correct boxes contain a cross with all other boxes blank		B4
	A row with one tick and some crosses – mark the tick		
	A row with more than one tick is B0 for that row		
	Mark the boxes not the working lines		

Q	Answer	Mark	Comments
11(a)	Any one of 0.24 or 0.19 or 0.22 in the correct cell	M1	oe fraction, decimal or percentage eg $\frac{36}{150}$ or $\frac{38}{200}$ or $\frac{55}{250}$ implied by any correct point for these three values
	At least two of their relative frequencies plotted accurately	M1dep	$\pm \frac{1}{2}$ square
	(150, 0.24), (200, 0.19) and (250, 0.22) plotted and graph completed with straight lines	A1	$\pm \frac{1}{2}$ square allow dotted or solid lines
	Additional Guidance		
	Mark intention for straightness of lines		
	Ignore any continuation of line after the last point or any other lines drawn on the graph, for example a line of best fit		

Q	Answer	Mark	Comments
11(b)	0.22	B1ft	oe fraction, decimal or percentage eg $\frac{55}{250}$ ft their relative frequency for 250 trains (> 0 and < 1) given in table or plotted on graph
	Additional Guidance		
	The mark may be awarded for a correct restart or a follow through from their table or a follow through from their graph		
	Ignore attempts to convert a correct relative frequency once seen in (b)		
	NB $\frac{166}{750} = 0.2213\ldots$ is incorrect (unless it is given as their relative frequency for 250 trains)		B0ft

Q	Answer	Mark	Comments
12	**Alternative method 1** Shows algebraically that the angles are equal		
	$4x + 40$	M1	may be embedded or on the diagram
	$x + 2(2x + 20)$ or $x + 4x + 40$	M1	
	$x + 4x + 40 = 5x + 40$ and Yes	A1	
	Alternative method 2 Derives and solves an equation for angles at a point and substitutes into $5x + 40$ or $x + 2(2x + 20)$		
	$4x + 40$	M1	may be embedded or on the diagram or implied eg implied by $10x + 80 = 360$
	$x + 2(2x + 20) + 5x + 40 = 360$ or $x + 4x + 40 + 5x + 40 = 360$ or $(x =) 28$	M1	oe equation eg $10x + 80 = 360$ $(x =)$ 28 may be on the diagram
	$140 + 40 = 180$ and Yes or $28 + 152 = 180$ and Yes	A1	oe must obtain $(x =)$ 28 from one expression and substitute $(x =)$ 28 into a different expression
	Alternative method 3 Assumes line is a diameter. Derives and solves an equation for angles on a line using $5x + 40$ and substitutes into $x + 2(2x + 20)$ or $x + 2(2x + 20) + 5x + 40$		
	$5x + 40 = 180$	M1	
	$(x =) (180 - 40) \div 5$ or $(x =) 28$	M1dep	oe $(x =)$ 28 may be on the diagram
	$28 + 152 = 180$ and Yes or $28 + 152 + 140 + 40 = 360$ and Yes	A1	oe must obtain $(x =)$ 28 from one expression and substitute $(x =)$ 28 into a different expression

Mark scheme and Additional Guidance continue on next two pages

12 cont	**Alternative method 4** Assumes line is a diameter. Derives and solves an equation for angles on a line using $x + 2(2x + 20)$ and substitutes into $5x + 40$ or $x + 2(2x + 20) + 5x + 40$		
	$x + 2(2x + 20) = 180$ or $x + 4x + 40 = 180$	M1	
	$(x =)\ (180 - 40) \div 5$ or $(x =)\ 28$	M1dep	oe $(x =)\ 28$ may be on the diagram
	$140 + 40 = 180$ and Yes or $28 + 152 + 140 + 40 = 360$ and Yes	A1	oe must obtain $(x =)\ 28$ from one expression and substitute $(x =)\ 28$ into a different expression
	Alternative method 5 Assumes line is a diameter. Derives and solves two equations for angles on a line/angles at a point		
	$5x + 40 = 180$ or $x + 2(2x + 20) = 180$ or $x + 4x + 40 = 180$ or $x + 2(2x + 20) + 5x + 40 = 360$ or $x + 4x + 40 + 5x + 40 = 360$	M1	
	$(x =)\ (180 - 40) \div 5$ or $(x =)\ 28$	M1dep	oe $(x =)\ 28$ may be on the diagram
	Obtains $(x =)\ 28$ from two equations for angles on a line/ angles at a point and Yes	A1	

Additional Guidance is on the next page

12 cont	**Additional Guidance**	
	Choose the scheme that favours the student	
	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts	
	Correct response with other incorrect work	M1M1A0
	Alt 1 $2(2x + 20) = 4x + 20$ followed by $x + 4x + 20$ Alt 1 $x + 4x + 20$ with $2(2x + 20) = 4x + 20$ not seen Apply marks in a similar way in alts 2, 4 and 5	M0M1 M0M0
	$(x =)$ 28	M1M1
	Allow $(x =)$ 28 to be embedded	M1M1
	No method marks scored with a value of x ($\neq$ 28) substituted into $5x + 40$ and $x + 2(2x + 20)$ giving the same value	M0M0A0
	Yes can be implied eg Alt 1 $x + 4x + 40 = 5x + 40$ and It is a diameter	M1M1A1

Q	Answer	Mark	Comments
13	**Alternative method 1**		
	$6 \times 3 + c = 19$	M1	oe eg $18 + c = 19$
	$(c =)\ 19 - 6 \times 3$ or $(c =)\ 1$	M1dep	oe implied by (0, 1)
	$y = 6x + 1$	A1	SC1 $y = 6x + c \quad c \neq 1$
	Alternative method 2		
	$y - 19 = 6(x - 3)$	M1	oe
	$y - 19 = 6x - 18$	M1dep	oe correct equation with brackets expanded
	$y = 6x + 1$	A1	SC1 $y = 6x + c \quad c \neq 1$
	Additional Guidance		
	Allow $y = 6 \times x + 1$		
	$6x + 1$ on answer line, $y = 6x + 1$ seen in working		M1M1A1
	$6x + 1$ on answer line, $y = 6x + 1$ not seen in working		M1M1A0
	$m = 6$, $c = 1$ on answer line, $y = 6x + 1$ seen in working		M1M1A1
	$m = 6$, $c = 1$		M1M1A0
	$y = mx + 1$		M1M1A0
	Allow embedded value for c eg $19 = 6 \times 3 + 1$		M1M1A0
	$y = 6x + c$		SC1
	$y = 6x$		SC1
	$6x + c$ on answer line with $c \neq 1$, $y = 6x + c$ seen in working		SC1
	$6x + c$ on answer line with $c \neq 1$, $y = 6x + c$ not seen in working		M0M0A0

Q	Answer	Mark	Comments
14(a)	4200×1.12^{20}	M1	oe allow $4200 \times [9.64, 9.65]$
	40 514(…) or 40 515 or 40 500 or 40 510 or 40 489 or 40 509 or 40 548	A1	
	Additional Guidance		
	Year on year calculations Consistently rounding down to nearest integer leads to 40 489 Consistently rounding to nearest integer leads to 40 509 Consistently rounding up to nearest integer leads to 40 548		

Q	Answer	Mark	Comments
14(b)	$4200 \times 1.13^{19} \times 0.92$ or [39 402, 39 403] or 39 400 or 39 372 or 39 407 or 39 435	M1	oe allow $4200 \times [10.19, 10.2] \times 0.92$
	No and [39 402, 39 403] or No and 39 400 or No and 39 372 or No and 39 407 or No and 39 435	A1	
	Additional Guidance		
	Year on year calculations Consistently rounding down to nearest integer leads to 39 372 Consistently rounding to nearest integer leads to 39 407 Consistently rounding up to nearest integer leads to 39 435		

Q	Answer	Mark	Comments
14(c)	0.4 × 700 or 280 or (1 – 0.4) × 900 or 0.6 × 900 or 540 or 30 × 0.4 or 12 or 30 × (1 – 0.4) or 30 × 0.6 or 18	M1	oe implied by 820
	30 × 0.4 × 700 or 8400 or 30 × (1 – 0.4) × 900 or 16 200	M1dep	oe implied by 820 × 30
	24 600	A1	
	Additional Guidance		
	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
15(a)	**Alternative method 1**		
	$L = kD^2$	M1	oe equation
	$85 = 10^2k$ or $85 = 100k$ or $(k =)$ 0.85	M1dep	oe implies M2
	$L = 0.85D^2$	A1	oe equation
	Alternative method 2		
	$cL = D^2$	M1	oe equation
	$85c = 10^2$ or $85c = 100$ or $(c =) \frac{100}{85}$	M1dep	oe allow $(c =)$ [1.176, 1.18] implies M2
	$\frac{100}{85}L = D^2$	A1	oe equation allow [1.176, 1.18]$L = D^2$
	Additional Guidance		
	Condone use of α for up to M1M1A0 eg Alt 1 L α kD^2 85 α $100k$ L α $0.85D^2$		 M1 M1 A0
	$L = 0.85D^2$ oe		M1M1A1
	L α D^2 is M0 with no further correct working		

Q	Answer	Mark	Comments
15(b)	**Alternative method 1** If using alt 1 in (a)		
	their $k \times 5^2$	M1	oe their k from (a)
	21.25	A1ft	oe correct or ft their $k \times 5^2$
	Alternative method 2 If using alt 2 in (a)		
	$5^2 \div$ their c	M1	oe their c from (a)
	21.25	A1ft	oe correct or ft $5^2 \div$ their c do not follow through an approximated value for $\frac{100}{85}$
	Additional Guidance		
	L α 21.25 on answer line		M1A0
	Alt 2 (a) $1.18L = D^2$ (scores 3 marks in (a)) (b) $25 \div 1.18 = 21.19$		M1A0

Q	Answer	Mark	Comments
16(a)	$\sqrt{3}\,x$	B1	

Q	Answer	Mark	Comments
16(b)	x might be a whole number	B1	

Q	Answer	Mark	Comments
17(a)	**Alternative method 1**		
	$\frac{2}{11} \times \frac{5}{9}$ or $\frac{10}{99}$ or $\frac{9}{11} \times \frac{4}{9}$ or $\frac{36}{99}$	M1	oe fractions, decimals or percentages
	$\frac{2}{11} \times \frac{5}{9} + \frac{9}{11} \times \frac{4}{9}$ or $\frac{10}{99} + \frac{36}{99}$	M1dep	oe fractions, decimals or percentages
	$\frac{46}{99}$	A1	oe fraction, decimal or percentage allow 0.465 or better allow 46.5% or better SC2 $\frac{54}{99}$ oe

Mark scheme and Additional Guidance continue on next page

17(a) cont	**Alternative method 2**		
	$\frac{2}{11} \times \frac{4}{9}$ or $\frac{8}{99}$ or $\frac{9}{11} \times \frac{5}{9}$ or $\frac{45}{99}$	M1	oe fractions, decimals or percentages
	$1 - \frac{2}{11} \times \frac{4}{9} - \frac{9}{11} \times \frac{5}{9}$ or $1 - \frac{8}{99} - \frac{45}{99}$ or $1 - \frac{53}{99}$	M1dep	oe fractions, decimals or percentages
	$\frac{46}{99}$	A1	oe fraction, decimal or percentage allow 0.465 or better allow 46.5% or better SC2 $\frac{54}{99}$ oe
	Additional Guidance		
	For M marks, accept values given as recurring decimals or correctly rounded to 2 dp or better eg Alt 1 $0.18 \times 0.56 + 0.818 \times 0.44$		M1M1
	M1 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore conversion attempt if correct answer seen		

Q	Answer	Mark	Comments
17(b)	$\frac{9}{11} \times \frac{8}{10}$	M1	oe fractions, decimals or percentages
	$\frac{72}{110}$ or $\frac{36}{55}$	A1	oe fraction, decimal or percentage allow [0.65, 0.655] allow [65%, 65.5%]
	Additional Guidance		
	For M1, accept $\frac{9}{11}$ given as a recurring decimal or correctly rounded to 2 dp or better eg 0.82 × 0.8		M1
	Ignore conversion attempt after correct answer seen		

Q	Answer	Mark	Comments
18	$x = 5$ and $y = 4$ drawn as solid lines and $x + y = 6$ drawn as dashed line and correct region identified	B3	B2 $x = 5$ and $y = 4$ drawn as solid lines and $x + y = 6$ drawn as dashed line and correct region not identified or $x = 5$ and $y = 4$ and $x + y = 6$ drawn as solid or dashed lines and correct region identified B1 $x = 5$ and $y = 4$ drawn as solid or dashed lines or $x + y = 6$ drawn as solid or dashed line
	Additional Guidance		
	Allow any unambiguous identification of the correct region eg Labelled R or shaded in or shaded out		
	Mark intention for straight lines		

Q	Answer	Mark	Comments
19(a)	6 seconds	B1	

Q	Answer	Mark	Comments
19(b)	Correct tangent drawn at 6 seconds	B1	
	Correct gradient for their tangent	B1ft	ft their tangent, which must be an increasing straight line
	m/s	B1	oe eg metres per second or mps
	Additional Guidance		
	If no tangent is drawn the maximum mark possible is B0B0B1		
	Allow the units to be given in working lines if no units on the answer line		

Q	Answer	Mark	Comments
20	50 cm	B1	

Q	Answer	Mark	Comments
21	$9x^2 + 3x + 3x + 1$ or $9x^2 + 6x + 1$ or $-(8x^2 - 6x)$ or $-8x^2 + 6x$	M1	
	$35 + 9x^2 + 3x + 3x + 1 - 8x^2 + 6x$ or $35 + 9x^2 + 6x + 1 - 8x^2 + 6x$	M1dep	
	$x^2 + 12x + 36$	A1	
	$(x + 6)^2$	A1	allow $(x + 6)(x + 6)$
	Additional Guidance		
	Condone inclusion of $= 0$ in all working		
	Ignore any solution attempt for $(x + 6)^2 = 0$		
	Ignore substitution of values		

Q	Answer	Mark	Comments
22	**Alternative method 1**		
	All three of 1, 8 and 1, 2, 4, 8 and 1, 3, 5, 7, 9 or all three of 2, 4 and 5	B2	B1 any two correct do not allow 2, 4 or 5 from an incorrect list of numbers
	their 2 × their 4 × their 5 or 40	M1	working out the number of possible codes ft their non-zero number of options for each digit implied by $\frac{1}{\text{their 2}} \times \frac{1}{\text{their 4}} \times \frac{1}{\text{their 5}}$
	$\frac{1}{40}$	A1ft	oe fraction, decimal or percentage ft their non-zero number of options for each digit
	Alternative method 2		
	All three of $\frac{1}{2}$ and $\frac{1}{4}$ and $\frac{1}{5}$	B2	B1 any two correct oe fractions, decimals or percentages do not allow $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{1}{5}$ from an incorrect list of numbers
	their $\frac{1}{2}$ × their $\frac{1}{4}$ × their $\frac{1}{5}$	M1	oe fractions, decimals or percentages allow their $\frac{1}{2}$ to be 1 their $\frac{1}{4}$ must be < 1 their $\frac{1}{5}$ must be < 1
	$\frac{1}{40}$	A1ft	oe fraction, decimal or percentage ft their probabilities

Additional Guidance is on the next page

22 cont	**Additional Guidance**	
	If 0 is taken to be a cube number, $\frac{1}{3} \times \frac{1}{4} \times \frac{1}{5} = \frac{1}{60}$	B1M1A1ft
	If they only have one cube number, $1 \times \frac{1}{4} \times \frac{1}{5} = \frac{1}{20}$	B1M1A1ft
	8, 9 and 1, 2, 4, 8 and 1, 3, 5, 7, 9 $\frac{1}{2} \times \frac{1}{4} \times \frac{1}{5} = \frac{1}{40}$	B1 M1A1ft
	Ignore conversion attempt after correct answer seen	
	Allow 1^3, 2^3 for 1, 8	

Q	Answer	Mark	Comments
23	105	B1	may be seen on the diagram
	$12^2 + 28^2 - 2 \times 12 \times 28 \times \cos$ their 105 or [1101, 1102]	M1	oe eg $144 + 784 - 672 \cos$ their 105 or $928 - 672 \cos$ their 105 their 105 cannot be 0 or 90 their 105 must be < 180
	$\sqrt{\text{their } [1101, 1102]}$	M1dep	
	[33.19, 33.2] or 33	A1ft	ft B0M2
	Additional Guidance		
	Follow through answers must be rounded to 2 sf or better		

Q	Answer	Mark	Comments
24	$\frac{731}{x} + \frac{287}{x-24} = 2$	M1	oe equation
	$731(x-24) + 287x$ or $731x - 17\,544 + 287x$	M1dep	oe allow with denominator $x(x-24)$ oe
	$2x^2 - 1066x + 17\,544\ (= 0)$ or $x^2 - 533x + 8772\ (= 0)$	A1	oe eg $x^2 - 533x = -8772$
	$\frac{-(-1066) \pm \sqrt{(-1066)^2 - 4 \times 2 \times 17\,544}}{2 \times 2}$ or $\frac{1066 \pm \sqrt{1\,136\,356 - 140\,352}}{2 \times 2}$ or $\frac{1066 \pm \sqrt{996\,004}}{2 \times 2}$ or $\frac{1066 \pm 998}{2 \times 2}$ or $(2x-34)(x-516)$ or 17 and 516	M1	ft their 3-term quadratic oe eg $\frac{-(-533) \pm \sqrt{(-533)^2 - 4 \times 1 \times 8772}}{2 \times 1}$ or $\frac{533 \pm \sqrt{284\,089 - 35\,088}}{2 \times 1}$ or $\frac{533 \pm \sqrt{249\,001}}{2 \times 1}$ or $\frac{533 \pm 499}{2}$ or $(x-17)(x-516)$
	516	A1	must discard 17
	Additional Guidance		
	First M1 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	3rd M1 Allow ft of their 3-term quadratic even if discriminant is $\leqslant 0$		
	In quadratic formula, allow eg 1066^2 for $(-1066)^2$		

Q	Answer	Mark	Comments
25	$(x + 7)^2$ …	M1	
	$(x + 7)^2 - 7^2 + 52$ or $(x + 7)^2 - 49 + 52$ or $(x + 7)^2 + 3$	M1dep	
	M2 seen and $(-7, 3)$	A1	
	Additional Guidance		
	Answer from other methods or with no method seen		M0M0A0
	Allow $(x + 7)(x + 7)$ for $(x + 7)^2$ throughout		
	Condone inclusion of $= 0$ in all working		
	Ignore any solution attempt for $(x + 7)^2 + 3 = 0$		