GCSE
MATHEMATICS
8300/2H

Higher Tier Paper 2 Calculator

Mark scheme

June 2023

Version: 1.0 Final

236G8300/2H/MS

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 $a \leqslant$ 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	$\frac{30}{12}$ or 2.5	B1	oe fraction, mixed number or decimal eg $\frac{5}{2}$ or $2\frac{1}{2}$
	Additional Guidance		
	Ignore simplification or conversion attempt after correct answer seen eg $\frac{30}{12}$ in working with 2.6 on answer line	B1	
	30 ÷ 12 with no further correct work	B0	

Q	Answer	Mark	Comments
2	28	B1	
	Additional Guidance		

Q	Answer	Mark	Comments
3	$\frac{7}{4}$ or 1.75	B1	oe fraction, mixed number or decimal eg $1\frac{3}{4}$
	Additional Guidance		
	Ignore conversion attempt after correct answer seen eg $\frac{7}{4} = 1.8$	B1	
	Condone answer $\frac{1}{4/7}$	B1	
	Condone answer $\left(\frac{4}{7}\right)^{-1}$ (without brackets B0)	B1	
	Do not allow $1 \div \frac{4}{7}$	B0	
	$\frac{-7}{-4}$	B1	

Q	Answer	Mark	Comments
4	112.5% or 1.125 or $\frac{9}{8}$ or 19.53 ÷ 112.5 (× 100) or 0.1736 (× 100)	M1	oe eg 1 + 0.125 or 19.53 ÷ 9 × 8 or 2.17 × 8
	17.36	A1	
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	M1 may be seen in a trial (the answer to the trial can be ignored) eg 15 × 1.125		M1
	19.53 × 1.125		M1
	Do not allow misreads for 12.5% eg1 19.53 ÷ 1.0125 eg2 19.53 ÷ 112		M0 M0
	112.5 not recovered		M0

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="7">5</td><td>45 × 8 or 360</td><td>M1</td><td>oe
number of 2p coins
may be embedded</td></tr>
<tr><td>45 × 8 × 2
or 360 × 2
or 720 or 7.2(0)</td><td>M1dep</td><td>oe
value of 2p coins
implied by 1170 or 11.7(0)</td></tr>
<tr><td>17.7(0) – their 7.2(0) – 45 × 0.1(0)
or
1770 – their 720 – 45 × 10
or
6(.00) or 600</td><td>M1dep</td><td>oe
value of 5p coins
implied by 7.2 : 6 oe ratio not in simplest form
or 6 : 7.2 oe ratio</td></tr>
<tr><td>6 : 5</td><td>A1</td><td>accept 1.2 : 1 or $\frac{6}{5}$: 1 or $1\frac{1}{5}$: 1
or 1 : 0.83(…) or 1 : $\frac{5}{6}$</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts</td><td></td></tr>
<tr><td colspan="2">Allow working in pence or pounds throughout</td><td></td></tr>
<tr><td colspan="2">Must work consistently in pence or pounds for the third mark (or recover)</td><td></td></tr>
<tr><td colspan="2">Ignore units in the ratio eg 6p : 5p or £1.20 : £1</td><td>M3A1</td></tr>
<tr><td colspan="2">720 may be seen in a ratio with the value of the 10p coins
eg 720 : 450 or 7.2 : 4.5</td><td>M2</td></tr>
<tr><td colspan="2">600 may be seen in a ratio with the value of the 10p coins
eg 600 : 450 or 6 : 4.5</td><td>M3</td></tr>
<tr><td colspan="3">For information:
<table>
<tr><td>Coin</td><td>10p</td><td>2p</td><td>5p</td></tr>
<tr><td>Number</td><td>45</td><td>360</td><td>120</td></tr>
<tr><td>Value</td><td>£4.50</td><td>£7.20</td><td>£6.00</td></tr>
</table></td></tr>
</table>

Q	Answer	Mark	Comments
6(a)	360 ÷ 8 or 135 seen	M1	oe eg 45 × 8 = 360 or $180 - \frac{(8-2)\times 180}{8}$ may be on diagram
	45	A1	
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	45 seen but not chosen as answer, even if linked to the wrong angle		M1A0

Q	Answer	Mark	Comments
6(b)	It is less than the answer to part (a)	B1	

Q	Answer	Mark	Comments
7(a)	All values correct	B2	B1 1 or 2 rows correct
	Additional Guidance		
			B2

	1	**2**	**3**	**4**	**5**	**6**
2*x*	2	4	6	8	10	12
3*x*	3	6	9	12	15	18
x^2	1	4	9	16	25	36

Q	Answer	Mark	Comments
7(b)	$\frac{8}{18}$ or $\frac{4}{9}$ or 0.44(4…) or 44(.4…)%	B1ft	oe fraction, decimal or percentage ft their table with $\geqslant$ 12 values must be using 18 for the total number of possible scores
	Additional Guidance		
	Ignore simplification or conversion attempt (not ratio) after correct probability seen		
	Ratio answer eg 8 : 18, even alongside a correct probability is B0		
	ft decimals or percentages must be correct to the same accuracy as in the scheme eg 10 winning values in their table $\frac{10}{18}$ or 0.55(5…) or 0.56 or 0.556 or 55(.5…)% or 56% or 55.6%	B1ft	

Q	Answer	Mark	Comments
7(c)	711 × their $\frac{8}{18}$	M1	oe ft their probability from (b) or if no probability in (b), ft their table with $\geqslant$ 12 values where 0 < their probability < 1 probabilities, if rounded in (c), must be truncated or rounded to at least 2 sf
	316	A1	SC2 395
	Additional Guidance		
	Answer 316		M1A1
	$\frac{316}{711}$ on answer line		M1A0
	Condone 316 out of 711		M1A1
	Do not treat estimating by rounding as a misread eg1 700 used instead of 711 eg2 (b) 0.44 (c) 0.4 × 711 (rounded to 1sf in (c) for the probability) eg3 (b) 0.4 (c) 0.4 × 711 (follows through their (b))		 M0A0 M0A0 M1A0
	Do not allow ft for a ratio from (b) but may ft their (a) instead		
	For 0.44 × 711, accept 44% × 711 but do not accept 44% of 711 unless recovered		
	The method mark may be implied by a ft answer (decimal or truncated to the nearest integer or rounded up to the nearest integer) eg1 (b) $\frac{7}{18}$ (c) 276.5 or 276 or 277 (correct ft method implied using (b)) eg2 (a) completed table has 7 winning values (b) no probability shown (c) 276.5 or 276 or 277 (correct ft method implied using (a))		 M1A0 M1A0

Q	Answer	Mark	Comments
8	$a = 8$ and $b = 6$	B2	B1 $a - 3 = 5$ or $a = 3 + 5$ or $a = 8$ or $2b = 12$ or $b = 12 \div 2$ or $b = 6$ SC1 $a = 6$ and $b = 8$
	Additional Guidance		
	Ignore working if B2 or B1 or SC1 seen		
	$(a - 3)x^2 = 5x^2$ with no further correct work		B0
	For B1 do not allow embedded values eg $2 \times 6 = 12$		B0

Q	Answer	Mark	Comments
9	Identifies (6, 3) or (7, 9) or (–4, 3) or (–3, 9)	M1	may be seen on the grid mark intention on diagram eg parallelogram drawn with one of the vertices at (6, 3) or (6, 3) plotted
	Identifies (6, 3) and (7, 9) **or** identifies (–4, 3) and (–3, 9)	M1dep	may be seen on the grid mark intention on diagram eg parallelogram drawn with two of the vertices at (6, 3) and (7, 9) **or** (6, 3) and (7, 9) plotted
	Both diagonals drawn for one of the correct parallelograms or centre of one of the correct parallelograms identified or (4, 6) or (–1, 6)	M1dep	mark intention on diagram M3 may be implied eg $\left(\frac{1+7}{2}, \frac{9+3}{2}\right)$ or $\left(\frac{-4+2}{2}, \frac{9+3}{2}\right)$
	(4, 6) and (–1, 6)	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	
Both answers correct (ignore working)	M3A1
One answer correct (ignore working)	M3A0
For first 2 marks condone correct points plotted even if labelled incorrectly	
Up to M2 can be awarded for coordinates given as answers	
Arc centre *A* radius 5 cm passing through (6, 3) and/or (–4 , 3) is not sufficient to award M1 etc	

Q	Answer	Mark	Comments
10	$\begin{pmatrix} 4 \\ -3 \end{pmatrix}$	B2	B1 $\begin{pmatrix} 4 \\ ... \end{pmatrix}$ or $\begin{pmatrix} ... \\ -3 \end{pmatrix}$ SC1 $\begin{pmatrix} -4 \\ 3 \end{pmatrix}$
	Additional Guidance		
	(4, –3) or $\begin{pmatrix} -3 \\ 4 \end{pmatrix}$		B0
	Ignore words if a vector is also seen eg1 Reflection $\begin{pmatrix} 4 \\ -3 \end{pmatrix}$ eg2 4 right 3 up and $\begin{pmatrix} 4 \\ 3 \end{pmatrix}$ eg3 4 right 3 down eg4 Rotate 4 left and 3 up and $\begin{pmatrix} -4 \\ 3 \end{pmatrix}$		B2 B1 B0 SC1
	Condone any type of brackets		
	Condone missing brackets for B2 or B1 or SC1 but must have two numbers in a column		
	Condone 'fraction line' for B2 or B1 or SC1 but must have two numbers in a column		
	$\begin{pmatrix} 4x \\ -3y \end{pmatrix}$ or $\begin{pmatrix} x4 \\ -y3 \end{pmatrix}$ or $\begin{pmatrix} x+4 \\ y-3 \end{pmatrix}$ or $\begin{pmatrix} 4 \text{ right} \\ 3 \text{ down} \end{pmatrix}$ or $\begin{pmatrix} 4 \text{ r} \\ 3 \text{ d} \end{pmatrix}$ or $\begin{pmatrix} 4 \rightarrow \\ 3 \downarrow \end{pmatrix}$		B0

Q	Answer	Mark	Comments
11	**Alternative method 1** Compares 70% of volume of hemisphere with volume of water		
	$\frac{4}{3} \times \pi \times 12^3$ or 2304π or [7216, 7239.2] or $\frac{2}{3} \times \pi \times 12^3$ or 1152π or [3581, 3638]	M1	oe eg $\frac{4}{3}\pi \times 1728$ allow without any multiplication signs eg $\frac{4}{3}\pi 12^3$
	$0.7 \times$ their 1152π or 806.4π or [2506, 2547]	M1dep	oe $0.7 \times$ their [3581, 3638] or $\frac{4032}{5}\pi$ must be using volume of hemisphere
	325×8 or 2600	M1	oe
	[2506, 2547] and 2600 and Yes	A1	oe
	Alternative method 2 Works out volume of water as proportion of volume of hemisphere		
	$\frac{4}{3} \times \pi \times 12^3$ or 2304π or [7216, 7239.2] or $\frac{2}{3} \times \pi \times 12^3$ or 1152π or [3581, 3638]	M1	oe eg $\frac{4}{3}\pi \times 1728$ allow without any multiplication signs eg $\frac{4}{3}\pi 12^3$
	325×8 or 2600	M1	oe
	their 2600 ÷ their 1152π or [0.71, 0.73]	M1dep	oe eg their 2600 ÷ their [3581, 3638] or 72% dep on M2 must be using volume of hemisphere
	[71, 73](%) and Yes	A1	oe eg 0.72 and 0.7 and Yes

Question 11 continues on the next page

11 cont	**Alternative method 3** Works out time to fill 70% of volume of hemisphere		
	$\frac{4}{3} \times \pi \times 12^3$ or 2304π or [7216, 7239.2] or $\frac{2}{3} \times \pi \times 12^3$ or 1152π or [3581, 3638]	M1	oe eg $\frac{4}{3}\pi \times 1728$ allow without any multiplication signs eg $\frac{4}{3}\pi 12^3$
	0.7 × their 1152π or 806.4π or [2506, 2547] or their $1152\pi \div 325$ or [11, 11.2]	M1dep	oe 0.7 × their [3581, 3638] or $\frac{4032}{5}\pi$ or their [3581, 3638] ÷ 325 must be using volume of hemisphere
	0.7 × their $1152\pi \div 325$ or 0.7 × their [3581, 3638] ÷ 325 or [7.7, 7.84]	M1dep	oe their [2506, 2547] ÷ 325 or 0.7 × their [11, 11.2]
	[7.7, 7.84] and Yes	A1	oe

Question 11 continues on the next page

11 cont	**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	
	Allow 1.33(…) for $\frac{4}{3}$	
	Allow 0.66(…) or 0.67 for $\frac{2}{3}$	
	π may be seen as [3.14, 3.142] eg Alt 1 $\frac{2}{3} \times 3.14 \times 12^3$	M1
	If a number (or calculation) in terms of π is seen but π is subsequently omitted, treat as a miscopy for M marks eg Alt 1 1152π $0.7 \times 1152 = 806.4$ $325 \times 8 = 2600$ Yes	 M1 M1dep M1A0
	Yes cannot be implied by inequalities	
	Alts 1 and 2 $325\,\text{cm}^3 \times 8$ seen is M1 even if evaluated incorrectly $325^3 \times 8$ seen is M0 unless recovered to 2600	
	Do not allow misreads of the given formula unless recovered eg1 using 12^2 instead of 12^3 eg2 using $\frac{3}{4}$ instead of $\frac{4}{3}$	
	For $0.7 \times$ their 1152π, do not accept $70\% \times$ their 1152π unless recovered	

Q	Answer	Mark	Comments
12	$8 \div 5$ or $19.2 \div 12$ or $\frac{8}{5}$ or $\frac{19.2}{12}$ or 1.6 or $12 \div 5$ or $19.2 \div 8$ or $\frac{12}{5}$ or $\frac{19.2}{8}$ or 2.4	M1	oe use of a valid pair of sides to make an appropriate calculation or value eg $5 \div 8$ or 0.625 or $5 \div 12$ or [0.416, 0.417]
	$8 \div 5 = 19.2 \div 12$ or $\frac{8}{5} = \frac{19.2}{12}$ or $12 \div 5 = 19.2 \div 8$ or $\frac{12}{5} = \frac{19.2}{8}$	A1	oe showing sides are in proportion eg $5 \div 8 = 12 \div 19.2$ or $\frac{5}{12} = \frac{8}{19.2}$
	Additional Guidance		
	For A1 equating may be implied by two calculations or two fractions with correct evaluation eg $8 \div 5 = 19.2 \div 12$ is implied by $8 = 5 \times 1.6$ and $19.2 = 12 \times 1.6$		M1A1
	For A1 equating may be implied by calculations eg1 $8 \div 5 = 19.2 \div 12$ is implied by $8 \div 5 = 1.6$ and $12 \times 1.6 = 19.2$ eg2 $8 \div 5 = 19.2 \div 12$ is implied by $\frac{8}{5} \times 12 = 19.2$		M1A1 M1A1
	$5 \times 19.2 = 8 \times 12$		M1A1
	$5 \times 19.2 = 96$ and $8 \times 12 = 96$		M1A1
	Non-contradictory working can be ignored eg correct response along with area calculations		M1A1
	Ignore words eg references to scale factors, enlargement, angles		
	Working on diagrams may be seen eg1 Arrows or lines from 5 to 8 and 12 to 19.2 with × 1.6 on them eg2 Arrows or lines from 5 to 8 and 12 to 19.2 with 1.6 on them Arrows or lines must unambiguously link relevant numbers		M1A1 M1A0
	For $8 \div 5$ or $\frac{8}{5}$ allow 8 : 5 etc		

Q	Answer	Mark	Comments
13	$80 \times x$ or $80x$ or $x \times 80$ or $x80$ or $x \div 60$ or $\frac{x}{60}$ or $\frac{1}{60}x$ or $x\frac{1}{60}$ or $80 \div 60$ or $\frac{80}{60}$	M1	teabags per hour boxes per minute
	$\frac{80x}{60}\left(=\frac{4x}{3}\right)$ or $80 \div 60 \times x\left(=\frac{4x}{3}\right)$	A1	oe showing 80 and 60 and x eg $\frac{80 \times x}{60}\left(=\frac{4x}{3}\right)$ or $x\frac{80}{60}\left(=\frac{4x}{3}\right)$ or $\frac{80}{60} \times x\left(=\frac{4x}{3}\right)$ or $80x \div 60\left(=\frac{4x}{3}\right)$

Additional Guidance	
M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
Do not allow M1 if only seen embedded in an incorrect expression or calculation eg $80x \times 4 = 320x$	M0
$60 \times \frac{4x}{3} = 80x$ (M1 allowed as $80x$ is not embedded in an incorrect expression or calculation, A0 because using the given answer)	M1A0
Condone $x = 80 \div 60$	M1A0
$\frac{80x}{60}\left(=\frac{4x}{3}\right)$	M1A1
$\frac{80}{60} = \frac{4}{3}$ and $\frac{4}{3} \times x\left(=\frac{4x}{3}\right)$	M1A1
$\frac{80}{60} = \frac{4}{3}$ and $\frac{4x}{3}$	M1A0
No equivalents allowed for M1	
Ignore units	
Condone 1.33(…) for $\frac{4}{3}$	
Ignore non-contradictory working after M1A1 seen	

Q	Answer	Mark	Comments
14(a)	**Alternative method 1** Works out best estimate of the percentage of employees with hourly rate more than £17		
	32 ÷ 2 or 16	M1	oe implied by 41 or 82
	(15 + 10 + their 16) ÷ 123 or 41 ÷ 123 or $\frac{1}{3}$ or 0.33(...) or (66 + their 16) ÷ 123 or 82 ÷ 123 or $\frac{2}{3}$ or 0.66(…) or 0.67	M1dep	oe eg (123 – 66 – their 16) ÷ 123 or 13(.0…)(%) + [12, 12.2](%) + 8(.1…)(%)
	33(.3…)(%)	A1	oe eg 0.33(3…) and 0.3 allow 33.2(%) from 13(%) + 12.2(%) + 8(%) SC3 37 (or 36.9) and explains that a minimum of 12 of 32 people earn more than £17
	Alternative method 2 Compares best estimate of the number of employees with hourly rate more than £17 with 30% of number of employees		
	32 ÷ 2 or 16	M1	oe implied by 41 or 82
	0.3 × 123 or 36.9 or 0.7 × 123 or 86.1	M1	oe accept 36 or 37 for 36.9 accept 86 or 87 for 86.1
	41 and 36.9 or 82 and 86.1	A1	accept 36 or 37 for 36.9 accept 86 or 87 for 86.1 SC3 37 (or 36.9) and explains that a minimum of 12 of 32 people earn more than £17

Question 14(a) continues on the next page

14(a) cont	**Alternative method 3** Shows that a value of x gives a percentage > 30%		
	$(15 + 10 + x) \div 123$ where $12 \leqslant x \leqslant 32$	M2	oe eg $(25 + x) \div 123$ must see 15 and 10 **or** 25
	$(15 + 10 + x) \div 123$ where $12 \leqslant x \leqslant 32$ and evaluates $(15 + 10 + x) \div 123 \times 100$ correctly	A1	evaluations rounded or truncated to nearest integer or better SC3 37 (or 36.9) and explains that a minimum of 12 of 32 people earn more than £17
	Alternative method 4 Shows a number of employees that gives a percentage > 30%		
	0.3×123 or 36.9	M1	oe accept 36 or 37 for 36.9
	$15 + 10 + x$ or $25 + x$ where $12 \leqslant x \leqslant 32$	M1dep	must see 15 and 10 **or** 25
	36.9 and evaluates $15 + 10 + x$ correctly where $12 \leqslant x \leqslant 32$	A1	accept 36 or 37 for 36.9 SC3 37 (or 36.9) and explains that a minimum of 12 of 32 people earn more than £17
	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		
	16 may be seen by the table		
	Alt 1 67% needs further explanation to score A1		
	Ignore irrelevant working in an otherwise fully correct response		
	For the SC3, minimum of 12 may be implied by an explanation that $10 + 15 + x$ is at least 37 or $25 + x$ is at least 37		
	Responses involving interpolation should be escalated		

Q	Answer	Mark	Comments
14(b)	Valid reason	B1	eg all employees in the second interval may earn less than £17
	Additional Guidance		
	Fewer than 12 employees could earn more than £17 per hour		B1
	Only 10 might get more than £17 in second class interval (10 could be replaced by any integer from 0 to 11 inclusive)		B1
	More than 12 in group 2 earn less than £17		B0
	Everyone in second group may earn 14 or 15 or 16		B1
	21 people may earn between £14 and £17 (21 could be replaced by any integer from 22 to 32 inclusive)		B1
	More people may earn between £14 and £17		B0
	People in the 14 to 20 group aren't evenly distributed		B0
	Not everyone in 14 – 20 earns more than £17		B0
	Not many in second group may get more than £17		B0
	Some of second group may get more than £17		B0
	14 to 20 includes people who get less than £17		B0
	2nd group includes some getting less than 17 and some getting more than 17		B0
	We don't know what each person earns		B1
	We don't know how many of 2nd group earn less than £17 per hour		B1
	Under £17 isn't in the data		B1
	Grouped data or it is only an estimate or using midpoints or data is wrong		B0
	Ignore irrelevant working but do not ignore incorrect working		

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="6">14(c)</td><td>12 × 66 or 792
and
17 × 32 or 544
and
30 × 15 or 450
and
70 × 10 or 700</td><td>M1</td><td>oe
implied by 2486
may be seen by the table
allow one product or fx value to be incorrect</td></tr>
<tr><td>(their 792 + their 544 + their 450 + their 700) ÷ 123
or
2486 ÷ 123</td><td>M1dep</td><td>oe eg $\frac{792+544+450+700}{66+32+15+10}$
condone bracket error if working seen
eg 792 + 544 + 450 + 700 ÷ 123</td></tr>
<tr><td>20.2(1…)</td><td>A1</td><td>allow 20.20 if M2 seen and no errors</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Four values with three correct from 792, 544, 450, 700 can score up to M2 if they add and divide by 123</td><td></td></tr>
<tr><td colspan="2">Correct products or values seen but a different method used eg 123 ÷ 4</td><td>M0M0</td></tr>
<tr><td colspan="2">20.2(1…) in working with answer given as the interval $20 \leqslant p < 40$</td><td>M2A0</td></tr>
<tr><td colspan="2">Ignore any references to statement B
eg £20.21 which makes B wrong</td><td>M2A1</td></tr>
<tr><td colspan="2">Condone $20.\dot{2}$, $20.\dot{2}\dot{1}$ etc for $20.\dot{2}1138\dot{}$</td><td></td></tr>
<tr><td colspan="2">Do not allow rounding of any of their 4 values in the second mark
eg 792 544 450 700
(800 + 544 + 450 + 700) ÷ 123</td><td>M1
M0</td></tr>
</table>

Q	Answer	Mark	Comments
14(d)	Valid reason referring to the distribution	B1	eg 98 employees earned below £20
	Additional Guidance		
	Less than a half earned more than £20		B1
	Over a half earned between £10 and £14		B1
	Lots earned 10 to 14		B0
	Only 25 people were over £20		B1
	25 people were over £20		B0
	Not many earned more than the mean		B0
	Most earned less than £20		B1
	Some earned less than the mean, some earned more		B0
	Mean is not a real amount of money		B0
	Median is between £10 and £14		B1
	Median is better or mode is better		B0
	Modal class is $10 \leqslant p < 14$		B1
	The mode is between £10 and £14 (condone mode as modal class)		B1
	We don't know what each person earns		B0
	Grouped data or it is only an estimate or using midpoints or data is wrong		B0
	The range is large		B0
	The data has extreme values or outliers or anomalous values		B1
	The data is (positively) skewed		B1
	The distribution is not symmetrical		B1
	The distribution is not evenly spread		B1
	Not representative		B0
	Lots of low values or high values can make the mean inaccurate		B0
	Ignore irrelevant working but do not ignore incorrect working		

Q	Answer	Mark	Comments
15	$2x^3 - 18x^2y + 5x^2y - 45xy^2$	M1	exactly 4 terms with 3 correct terms in any order may be seen in a grid implied by $2x^3 - 13x^2y$ with one other term or $-13x^2y - 45xy^2$ with one other term
	$2x^3 - 18x^2y + 5x^2y - 45xy^2$ or $2x^3 - 13x^2y - 45xy^2$	A1	terms in any order do not allow if only seen in a grid

Additional Guidance

A correct term includes the sign (in a grid allow eg $5x^2y$ for $+ 5x^2y$)	
Condone four correct terms followed by incorrect simplification of x^2y terms, otherwise do not allow further incorrect work eg1 $2x^3 - 18x^2y + 5x^2y - 45xy^2 = 2x^3 + 13x^2y - 45xy^2$ eg2 $2x^3 - 18x^2y + 5x^2y - 45xy^2 = 36x^5y + 5x^2y - 45xy^2$	M1A1 M1A0
Allow equivalent fully simplified terms eg $5x^2y$ may be seen as $5yx^2$	
For M1 allow coefficients to be incorrectly positioned eg $x^32 - 18x^2y + y5x^2 - 45xy^2$	M1A0
$2x^3 + - 18x^2y + 5x^2y + - 45xy^2$ has 4 correct terms but needs further simplification to score A1	M1A0
Terms must be processed eg do not allow $x^2 \times 2x$ for $2x^3$	

Q	Answer	Mark	Comments
16	$13 = 7a - 1$ or $(a =)\ 2$	M1	oe eg $\frac{13 - -1}{7 - 0}$ may be implied eg $(y =)\ 2x - 1$
	$(y =)\ \frac{3}{5}x \ldots$ or (gradient B =) $\frac{3}{5}$	M1	oe eg (gradient B =) 0.6 allow $(y =)\ \frac{3x + 4}{5}$
	gradient A = 2 and gradient B = $\frac{3}{5}$	A1	oe eg $2 > \frac{3}{5}$ condone $2x > \frac{3}{5}x$
	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		
	Condone incorrect y-intercept eg $a = 2$ $\quad y = \frac{3}{5}x + 4$ gradient A = 2 $\quad$ gradient B = $\frac{3}{5}$		M1M1 A1
	It must be clear that the values 2 and $\frac{3}{5}$ are being used to answer the question to award A1 eg1 gradient A = 2 and gradient B = $\frac{3}{5}$ (no statement needed) eg2 $a = 2$ $\quad y = \frac{3}{5}x + \frac{4}{5}$ eg3 $y = 2x - 1$ and $y = \frac{3}{5}x + \frac{4}{5}$ $\quad$ 2 is greater than $\frac{3}{5}$ eg4 $y = 2x - 1$ and $y = \frac{3}{5}x + \frac{4}{5}$ $\quad$ gradient of A > gradient of B		M2A1 M2A0 M2A1 M2A0
	$13 = 7x - 1$ or $x = 2$ must be recovered to award 1st M1		

Q	Answer	Mark	Comments
17	**Alternative method 1** Works out *AC* and uses it in triangle *ABC*		
	$\cos 37 = \frac{AC}{4}$	M1	oe eg $\sin 53 = \frac{AC}{4}$ allow [0.798, 0.8] for cos 37 or sin 53
	(*AC* =) 4 × cos 37 or (*AC* =) [3.19, 3.2]	M1dep	oe eg (*AC* =) 4 × sin 53 allow [0.798, 0.8] for cos 37 or sin 53 may be seen on diagram
	$\sin x = \frac{\text{their } [3.19, 3.2]}{9.3}$ or (x =) $\sin^{-1}$[0.34, 0.3441]	M1dep	oe eg $\cos x = \frac{\sqrt{9.3^2 - \text{their } [3.19, 3.2]^2}}{9.3}$ or (x =) 90 – $\cos^{-1}$[0.34, 0.3441]
	[19.87, 20.13]	A1	
	Alternative method 2 Works out angle *ADC* and uses it in triangle *ABD*		
	(angle *ADC* =) 90 – 37 or (angle *ADC* =) 53	M1	oe eg (angle *ADC* =) 180 – 90 – 37 may be seen on diagram
	$\frac{\sin x}{4} = \frac{\sin(90-37)}{9.3}$	M1dep	oe eg $\frac{4}{\sin x} = \frac{9.3}{\sin 53}$
	(sin x =) $\frac{\sin(90-37)}{9.3} \times 4$ or (x =) $\sin^{-1}$[0.34, 0.3441]	M1dep	oe
	[19.87, 20.13]	A1	

Question 17 continues on the next page

17 cont	**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	
	Allow any unambiguous notation for angles eg allow *B* for x	
	Alt 1 Allow any unambiguous notation for *AC* eg y (condone x if clearly referring to *AC*)	
	Alt 1 1st M1 must be an equation where *AC* is the only variable eg $AC^2 + (4\sin 37)^2 = 4^2$	M1
	Alt 1 A calculation that leads to *AC* scores M1M1 eg $\sqrt{4^2 - (4\sin 37)^2}$	M1M1
	Alt 1 3rd M1 must have sin x (or cos x) as the subject or be a calculation that leads to x	
	Alt 2 53 only marked at angle *BAC* on diagram	M0

Q	Answer	Mark	Comments
18	$xy = x + 8$ or $y = 1 + \frac{8}{x}$	M1	oe equation with fraction eliminated or oe equation with single fraction split into two terms eg $y \times x = x + 8$ or $y = \frac{x}{x} + \frac{8}{x}$
	$xy - x = 8$ or $x(y - 1) = 8$	M1dep	oe equation with x terms collected eg $x - xy = -8$
	$x = \frac{8}{y-1}$ or $x = \frac{-8}{1-y}$	A1	oe equation with x the subject eg $-\frac{8}{1-y} = x$
	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		
	Correct answer in working with answer repeated on answer line without $x =$ eg $x = \frac{8}{y-1}$ seen in working with answer $\frac{8}{y-1}$		M1M1A1
	Do not allow incorrect simplification after correct answer seen eg $x = \frac{8}{y-1}$ $x = \frac{8}{y} - 8$		M2A0
	$xy - x - 8 = 0$ with no further correct working		M1M0

Q	Answer	Mark	Comments
19	**Alternative method 1** nth term = $an^2 + bn + c$		
	(second differences =) 10 or $a = 5$ or $5n^2$	M1	second difference seen at least once and not contradicted by a different value unless recovered may be seen by the sequence
	$3 - 5 \times 1^2$ and $20 - 5 \times 2^2$ **or** -2 and 0 **or** $b = 2$ **or** $2n$	M1dep	oe subtraction of $5n^2$ from any two consecutive terms eg $47 - 5 \times 3^2$ and $84 - 5 \times 4^2$ **or** 2 and 4 implied by $5n^2 + 2n$ …
	$5 \times 1^2 + 2 \times 1 + c = 3$ or $5 + 2 + c = 3$ or ($2n + c$ and) $2 \times 1 + c = -2$	M1dep	oe substitution of $a = 5$ and $b = 2$ eg $5 \times 2^2 + 2 \times 2 + c = 20$ or oe use of $2n + c$ and another term eg ($2n + c$ and) $2 \times 2 + c = 0$
	$5n^2 + 2n - 4$	A1	terms in any order SC2 $a = 5$ and $c = -4$ SC1 $c = -4$
	Alternative method 2 nth term = $an^2 + bn + c$		
	(second differences =) 10 or $a = 5$ or $5n^2$	M1	second difference seen at least once and not contradicted by a different value unless recovered may be seen by the sequence
	$3 \times 5 + b = 17$ or $b = 2$ or $2n$	M1dep	oe substitution of $a = 5$ eg $5 \times 5 + b = 27$ implied by $5n^2 + 2n$ …
	$5 \times 1^2 + 2 \times 1 + c = 3$ or $5 + 2 + c = 3$	M1dep	oe substitution of $a = 5$ and $b = 2$ eg $5 \times 2^2 + 2 \times 2 + c = 20$
	$5n^2 + 2n - 4$	A1	terms in any order SC2 $a = 5$ and $c = -4$ SC1 $c = -4$

Question 19 continues on the next page

19 cont	**Alternative method 3** nth term = $an^2 + bn + c$		
	Any 3 of $a + b + c = 3$ $4a + 2b + c = 20$ $9a + 3b + c = 47$ $16a + 4b + c = 84$	M1	oe 3 equations
	$3a + b = 17$ and $5a + b = 27$ **or** $a = 5$ and $b = 2$	M1dep	oe pair of equations in a and b eg $8a + 2b = 44$ and $15a + 3b = 81$ implied by $5n^2 + 2n$ …
	$5 \times 1^2 + 2 \times 1 + c = 3$ or $5 + 2 + c = 3$	M1dep	oe substitution of $a = 5$ and $b = 2$ eg $5 \times 2^2 + 2 \times 2 + c = 20$
	$5n^2 + 2n - 4$	A1	terms in any order SC2 $a = 5$ and $c = -4$ SC1 $c = -4$
	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		
	Second differences = 10 scores M1 even if used incorrectly eg $10n$ ….		
	Condone $n = 5n^2 + 2n - 4$ or $5n^2 + 2n - 4 = 0$		M3A1
	Condone working in a different variable eg $5x^2 + 2x - 4$		M3A1
	The 3rd method mark cannot be implied ie $c = -4$ is only awarded M3 if the previous two method marks are seen		
	Alt 1 2nd M1 cannot be awarded for subtracting in the wrong order unless recovered		
	SC2 or SC1 can be awarded from work seen in the working lines		
	SC2 or SC1 can be implied by a quadratic answer eg1 answer $5n^2 + 6n - 4$ eg2 answer $10n^2 + 3n - 4$		SC2 SC1

Q	Answer	Mark	Comments
20(a)	65	B1	
	Additional Guidance		
	65 unambiguously linked to x on diagram with answer line blank		B1

Q	Answer	Mark	Comments
20(b)	It is greater than the answer to part (a)	B1	
	Additional Guidance		

Q	Answer	Mark	Comments
20(c)	No and valid statement	B1	eg no it is angle *ACD* that is 70°
	Additional Guidance		
	Angles may be seen on the diagram		
	No may be implied eg1 angle *ADC* is not 70 eg2 angle *y* is 55		 B1 B1
	Allow unambiguous indication of angles eg *y* and *D* are both 55 so he is wrong		 B1
	No and angle *ADC* = 55°		B1
	y is not 70 so no		B1
	No, neither angle is correct		B1
	No, he thinks *AB* and *DC* are parallel		B1
	No, he's used alternate angles		B1
	It should say alternate angles (no implied)		B1
	He has made mistakes		B0
	He used the alternate segment theorem incorrectly		B1
	Ignore irrelevant working but do not ignore incorrect working eg No it is angle *ACD* that is 70° and angle *y* is 65		 B0
	Responses saying he is correct		B0

Q	Answer	Mark	Comments
21	**Alternative method 1**		
	560 ÷ 500 or 1.12	M1	oe
	$\sqrt[3]{\text{their } 1.12}$ or [1.038, 1.0385] or [3.8, 3.85]	M1dep	may be implied eg $\frac{r}{100}$ = [0.038, 0.0385]
	3.9	A1	
	Alternative method 2		
	Trial of the form $500 \times x^3$ with $1 < x \leqslant 1.1$ and correct evaluation	M1	allow correct evaluation truncated or rounded to nearest integer or better allow working year by year value of x used must be seen
	Two trials of the form $500 \times x^3$ each with $1 < x \leqslant 1.1$ and correct evaluations, one with answer < 560 and one with answer > 560	M1dep	allow correct evaluations truncated or rounded to nearest integer or better allow working year by year values of x used must be seen
	3.9	A1	

Question 21 continues on the next page

	Additional Guidance	
21 cont	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	<table><tr><td>1.01</td><td>515.1505</td></tr><tr><td>1.02</td><td>530.604</td></tr><tr><td>1.03</td><td>546.3635</td></tr><tr><td>1.038</td><td>559.193436</td></tr></table> <table><tr><td>1.0385</td><td>560.0019083</td></tr><tr><td>1.039</td><td>560.8111595</td></tr><tr><td>1.04</td><td>562.432</td></tr><tr><td>1.05</td><td>578.8125</td></tr><tr><td>1.06</td><td>595.508</td></tr><tr><td>1.07</td><td>612.5215</td></tr><tr><td>1.08</td><td>629.856</td></tr><tr><td>1.09</td><td>647.5145</td></tr><tr><td>1.1</td><td>665.5</td></tr></table> eg of accepted values For 578.8125 allow 578, 579, 578.8, 578.81, 578.812, 578.813	
	Alt 2 example of working year by year (allow intermediate values to be truncated or rounded to the nearest penny, also allow if given to the next penny) $500 \times 1.035 = 517.5$ $517.5 \times 1.035 = 535.6125$ (allow 535.61 or 535.62) $535.61 \times 1.035 = 554.35635$	
	Incorrect trials and evaluations can be ignored	
	3.9 from incorrect working eg $560 - 500 = 60$ $\sqrt[3]{60} = 3.9$	M0M0A0
	Wrong answer (eg 4) with no correct method seen	M0M0A0
	Apply the scheme that favours the student eg 500×1.038^3 scores M1M1 using Alt 1	
	$\frac{560-500}{500}$ with no further correct work	M0M0

Q	Answer	Mark	Comments
22(a)	(x_2 =) 4.1(0…)	B1	
	(x_3 =) [4.176, 4.178] or 4.18	B1ft	ft their 4.1(0…) rounded to at least 2 dp SC1 x_2 = [4.176, 4.178] or 4.18
	Additional Guidance		
	Allow second B1 for x_3 = 4.2 with acceptable answer seen in working		
	x_2 = 7.8 x_3 = 6.59		B0 B1ft
	SC1 is for using x_0 = 4		

Q	Answer	Mark	Comments
22(b)	4.25 < value ⩽ 4.39	B1	ignore any iteration number
	Additional Guidance		
	Ignore other values if B1 response seen		

Q	Answer	Mark	Comments
23	$\frac{3}{8}$ (×) $\frac{2}{7}$ or $\frac{6}{56}$ or $\frac{3}{28}$	M1	oe fraction, decimal or percentage allow $\frac{2}{7}$ to be [0.285, 0.286] or [28.5, 28.6]% allow $\frac{6}{56}$ to be [0.107, 0.107143] or [10.7, 10.7143]% may be seen on a tree diagram allow 6 out of 56
	$\frac{1}{7}$ (×) $\frac{1}{4}$ (× 2) or $\frac{1}{28}$ (× 2) or $\frac{2}{28}$ or $\frac{1}{14}$	M1	oe fraction, decimal or percentage allow $\frac{1}{7}$ to be [0.142, 0.143] or [14.2, 14.3]% allow $\frac{1}{28}$ to be [0.035, 0.036] or [3.5, 3.6]% allow $\frac{2}{28}$ to be [0.071, 0.07143] or [7.1, 7.143]% may be seen on a tree diagram allow 1 out of 28 or 2 out of 28
	$\frac{6}{56}$ and $\frac{2}{28}$	A1	oe fractions, decimals or percentages allow 6 out of 56 and 2 out of 28
	Probabilities in comparable form and Option 1	A1ft	ft their $\frac{6}{56}$ and their $\frac{2}{28}$ with M2A0 correct comparisons include $\frac{3}{28}$ and $\frac{2}{28}$ $\frac{6}{56}$ and $\frac{4}{56}$ 0.107 and 0.071 10.7% and 7.1% 6 out of 56 and 4 out of 56

Question 23 continues on the next page

	Additional Guidance	
23 cont	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	3 ways to win in Option 1 and 2 ways to win in Option 2 so Option 1	M0M0A0A0
	$\frac{3}{8} \times \frac{2}{7} = \frac{6}{56}$ $\quad$ $\frac{1}{7} \times \frac{1}{4} = \frac{1}{28}$	M1M1
	$\frac{6}{56}$ and $\frac{2}{56}$ and Option 1	A0A1ft
	Assuming replacement can score a maximum of M0M1A0A0	
	Choosing Option 1 cannot be implied by inequalities	

Q	Answer	Mark	Comments
24	64.5 or 65.5 or 25 or 35	M1	allow $65.4\dot{9}$ or $34.\dot{9}$ implied by 4160.25 or 4290.25 or 8320.5 or 8580.5 or 625 or 1225
	$2 \times$ their $65.5^2 -$ their 25^2 or $2 \times 4290.25 - 625$ or $8580.5 - 625$	M1	their 65.5 must be (65, 66] their 25 must be [20, 30)
	65.5 and 25 and 7955.5	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		
	If multiple attempts are seen and one is fully correct, the correct one must be unambiguously selected (eg ticked or circled) to award A1 if the answer line is blank		
	Note that M0M1A0 is possible eg $2 \times 66^2 - 21^2$		M0M1A0
	Condone eg 65.50 for 65.5		

Q	Answer	Mark	Comments
25	$\frac{(x-5)(x+2)}{(x-2)(x+2)}$ and $\frac{(x+5)(x-2)}{(x+2)(x-2)}$	M1	$(x-2)(x+2)$ or $x^2-2x+2x-4$ must be seen (expansion may be seen in a grid) brackets in any order if the brackets are not shown for the numerators, expansions must be correct may be seen as a single fraction
	$x^2-5x+2x-10$ or $x^2-3x-10$ or $x^2+5x-2x-10$ or $x^2+3x-10$	M1	correct expansion of $(x-5)(x+2)$ or $(x+5)(x-2)$ ignore denominators may be seen in a grid implied by $2x^2-20$ if no errors seen in expansions
	M2 seen with no errors and $\frac{2x^2-20}{x^2-4}$	A1	allow M2 seen with no errors and $a=2$ $b=20$
	Additional Guidance		
	Missing brackets must be recovered but condone missing closing bracket at the end of a numerator or denominator eg $\frac{(x-5)(x+2)}{(x-2)(x+2)} + \frac{(x+5)(x-2)}{(x+2)(x-2}$		1st M1
	2nd M1 is awarded for four correct terms even if subsequently simplified incorrectly		
	For terms seen in a grid, signs must be correct (allow eg $2x$ for $+2x$)		
	For 1st M1 allow multiplication signs		
	After M2A1 ignore incorrect values stated eg $a=2$ $b=-20$		
	$\frac{2x^2-20}{x^2-4}$ may come from wrong working or incomplete working eg $\frac{(x-5)(x+2)}{(x-2)(x+2)} + \frac{(x+5)(x-2)}{(x+2)(x-2)}$ $\frac{x^2-10+x^2-10}{x^2-4} = \frac{2x^2-20}{x^2-4}$		M1 M0A0

Q	Answer	Mark	Comments
26(a)	(0, 2)	B1	
	Additional Guidance		

Q	Answer	Mark	Comments
26(b)	$y = -x^2$	B1	oe equation eg $x^2 = -y$
	Additional Guidance		
	$y = -1x^2 + 0$	B1	
	$y = -(x^2)$	B1	
	$-x^2$	B0	

Q	Answer	Mark	Comments
26(c)	Translation	B1	allow eg translate(d)
	$\begin{pmatrix} -3 \\ 0 \end{pmatrix}$	B1	
	Additional Guidance		
	Do not accept a vector given as coordinates or with missing brackets or with 'fraction line'		
	Translation from (0, 0)		B1B0
	Translation horizontally by 3		B1B0
	Translate 3 to the left and 3 down		B1B0
	Reflect by $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$		B0B1
	Giving a combined transformation is B0B0 Rotate by $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$ and reflect in the x-axis		B0B0
	Ignore references to movement if vector is correct eg Move to the right by $\begin{pmatrix} -3 \\ 0 \end{pmatrix}$		B0B1