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**GCSE**  
**MATHEMATICS**  
**8300/3H**

Higher Tier Paper 3 Calculator

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Mark scheme  
June 2022

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

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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**Glossary for Mark Schemes**

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

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

<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.

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Q	Answer	Mark	Comments
1	4.301	B1	

Q	Answer	Mark	Comments
2	$\begin{pmatrix} -7 \\ 10 \end{pmatrix}$	B1	

Q	Answer	Mark	Comments
3(a)	D	B1	

Q	Answer	Mark	Comments
3(b)	B	B1	

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Q	Answer	Mark	Comments
4	<b>Alternative method 1</b>		
	tan identified	M1	oe eg $\tan^{-1}$
	$\tan x = \frac{10}{4}$ or $\tan x = \frac{5}{2}$ or $\tan x = 2.5$	M1dep	oe eg $\tan^{-1} \frac{10}{4}$ or $90 - \tan^{-1} \frac{4}{10}$
	[68, 68.2]	A1	SC1 [21.8, 22]
	<b>Alternative method 2</b>		
	$\sin x = \frac{10}{\sqrt{4^2 + 10^2}}$ or $\cos x = \frac{4}{\sqrt{4^2 + 10^2}}$	M2	oe eg $\sin x = \frac{10}{\sqrt{116}}$ or $\sin^{-1} \frac{10}{\sqrt{4^2 + 10^2}}$ or $\cos x = \frac{4}{\sqrt{116}}$ or $\cos^{-1} \frac{4}{\sqrt{4^2 + 10^2}}$ or $90 - \sin^{-1} \frac{4}{\sqrt{4^2 + 10^2}}$ or $90 - \cos^{-1} \frac{10}{\sqrt{4^2 + 10^2}}$
	[68, 68.2]	A1	SC1 [21.8, 22]
	<b>Additional Guidance</b>		
	Accept 10.77 or 10.8 or $2\sqrt{29}$ for $\sqrt{116}$		
	Tan can be identified by, for example, circling TOA in SOHCAHTOA		
	Answer from accurate drawing		M0M0A0
	$\sin x = \frac{10 \sin 90}{\sqrt{116}}$		M2
$(x =) \tan 2.5$ or $(x =) \tan 0.4$ or $(x =) \tan \left(\frac{10}{4}\right)^{-1}$ unless recovered		M1M0A0	
$\tan = \frac{10}{4}$ or $\tan = \frac{4}{10}$ or $\tan x = \frac{4}{10}$ with no further correct working		M1M0A0	

Q	Answer	Mark	Comments
	$3 + 2$ or $5$ and $5\frac{1}{2} + 3\frac{1}{2}$ or $9$ or $5\frac{1}{2} - 3$ or $2\frac{1}{2}$ and $3\frac{1}{2} - 2$ or $1\frac{1}{2}$ or $4$	M1	oe eg $180 + 120$ or $300$ and $330 + 210$ or $540$ implied by $5\frac{1}{2} + 3\frac{1}{2} - 3 - 2$
5	$\frac{9-5}{5}$ or $\frac{2\frac{1}{2}+1\frac{1}{2}}{3+2}$ or $\frac{4}{5}$ or $0.8$ or $\frac{5\frac{1}{2}+3\frac{1}{2}}{3+2} (\times 100)$ or $\frac{9}{5} (\times 100)$ or $1.8 (\times 100)$ or $180$	M1dep	oe eg $\frac{5\frac{1}{2}+3\frac{1}{2}-3-2}{3+2}$ eg $\frac{540-300}{300}$ or $\frac{240}{300}$ or $1.8 - 1$
	80	A1	
<b>Additional Guidance</b>			
Allow working fully in minutes but units must be consistent in a single calculation eg $2\text{ h }30$ and $1\text{ h }30$ eg $3 + 2 = 5$ and $330 + 210 = 540$ eg $3 + 120$ and $330 + 3\frac{1}{2}$ unless recovered			M1 M1 M0
$3 + 2 = 6$ , $5\frac{1}{2} + 3\frac{1}{2} = 9$ , $9 - 6 = 3$ , $3 = 50\%$			M1M1A0
$3 + 2 = 6$ , $5\frac{1}{2} + 3\frac{1}{2} = 9$ , answer $50\%$ ( $3$ is implied)			M1M1A0
$9 - 6 = 3$ , $3 = 50\%$ (no method shown for $6$ )			M0M0A0

Q	Answer	Mark	Comments
6(a)	-1 and 5	B1	either order
	<b>Additional Guidance</b>		
	Ignore $x =$ written before answers		
	$(-1, 0)$ or $(5, 0)$		B0

Q	Answer	Mark	Comments
6(b)	$(2, -9)$	B2	B1 $x = 2$ or $(2, \dots)$ or $y = -9$ or $(\dots, -9)$ or $(x - 2)^2 - 9$ B1ft correct $y$ -coordinate for their $x$ -coordinate with $x \neq -1, 0$ or $5$ SC1 $(-9, 2)$
	<b>Additional Guidance</b>		
	If answer line is blank, check diagram for indication of $x$ or $y$ values		
	$(3, -9)$		B1
	$(3, -8)$		B1ft
	$(1, -8)$		B1ft
	$(2.5, -8.75)$		B1ft
	$(0, -5)$		B0ft

Q	Answer	Mark	Comments	
7	(8th term $\Rightarrow$ ) $2^8$ or 256	M1	oe may be implied	
	Common difference of A indicated as 3	M1	may be implied eg $3n \dots$ or $\dots + 3(n - 1)$	
	$3n + 10 =$ their 256 or (their 256 $-$ 10) $\div$ 3 or (their 256 $-$ 13) $\div$ 3 or 81	M1dep	oe equation eg $13 + 3(n - 1) = 2^8$ dep on 2nd M1 their 256 may be any number and may be in index form	
	82	A1		
	<b>Additional Guidance</b>			
	$n + 3$ implies 2nd M1			
	Do not award M1 for 256 if it is in a list of powers of 2 unless it is indicated or it is the highest power evaluated			
	Common difference of 3 may be shown on the progression for the 2nd M1			
	10, (13, 16, 19, 22), 25 without common difference of 3 shown does not imply 2nd M1			
	82 from trial and improvement		M3A1	
	Embedded answer $3 \times 82 + 10 = 256$		M3A0	
	$3n + 10 = 256$ or $3n + 10 = 2^8$ or $3n = 246$		M1M1M1	
	$3n - 10 = 256$		M1M1M0	
	$3n + 10 = 16$ ( $2^8$ not seen)		M0M1M1	
	$3n + 6 = 2^8$		M1M1M0	
	$256 - 22 = 234$ , $234 \div 3$ (indicating common difference of 3)		M1M1M0	
$3n - 8 = 128$ ( $2^8$ not seen)		M0M1M0		

Q	Answer	Mark	Comments	
8	$330 \div (3 + 2)$ or $330 \div 5$ or 66	M1	oe eg $\frac{330}{5}$	
	their $66 \times 2$ or 132	M1dep	oe $\frac{2}{5} \times 330$ scores M2	
	$294 \div 7$ or 42 or $294 \div 7 \times 3$ or 126	M1	oe eg $\frac{294}{7}$ or $\frac{3}{7} \times 294$	
	132 and 126 and A	A1		
	<b>Additional Guidance</b>			
	132 and 88.2 and A			M1M1M0A0

Q	Answer	Mark	Comments
9	<b>Alternative method 1 – compares speeds in m/s</b>		
	$200 \div 24$ or $8.3(3\dots)$	M1	oe eg $\frac{200}{24}$ or $8\frac{1}{3}$
	$28.8 \times 1000 \div 60 \div 60$ or 8	M1	oe eg $28800 \div 3600$ or $28.8 \div 3.6$
	8 and $8.3(3\dots)$ and Tom	A1	oe eg 8 and $8\frac{1}{3}$ and Tom
	<b>Alternative method 2 – compares speeds in km/h</b>		
	$200 \div 24$ or $8.3(3\dots)$	M1	oe eg $\frac{200}{24}$ or $8\frac{1}{3}$
	their $8.3(3\dots) \div 1000 \times 60 \times 60$ or 30	M1dep	oe eg $0.0083(3\dots) \times 3600$
	30 and Tom	A1	
	<b>Alternative method 3 – time for Adil starting with m/s</b>		
	$28.8 \times 1000 \div 60 \div 60$ or 8	M1	oe eg $28800 \div 3600$
	$200 \div$ their 8 or 25	M1dep	oe eg $\frac{200}{8}$
	25 and Tom	A1	oe eg Tom by 1s
	<b>Alternative method 4 – time for Adil starting with km/h</b>		
	$\frac{200 \div 1000}{28.8}$ or $[0.0069, 0.007]$ or $\frac{200}{28.8}$ or $[6.9, 7]$	M1	oe eg $\frac{0.2}{28.8}$  eg $\frac{125}{18}$
	their $[0.0069, 0.007] \times 60 \times 60$ or their $[6.9, 7] \div 1000 \times 60 \times 60$ or 25	M1dep	oe eg $\frac{0.2}{28.8} \times 3600$
	25 and Tom	A1	oe eg Tom by 1s

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
9 cont	<b>Alternative method 5 – distance for Adil in 24s</b>		
	28 800 × 24 or 691 200 or 28.8 ÷ 60 ÷ 60 or 0.008 or 28.8 × 24 or 691.2	M1	oe eg $\frac{3456}{5}$
	their 691 200 ÷ 60 ÷ 60 or their 0.008 × 1000 × 24 or their 691.2 × 1000 ÷ 60 ÷ 60 or 192	M1dep	oe eg 28 800 × 24 ÷ 3600
	192 and Tom	A1	
	<b>Additional Guidance</b>		
	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore all units		
	Allow other correct comparisons eg 500 and 480 (this is metres per minute) eg 500 and 480 and Tom		M1M1 M1M1A1
	200 m = 0.2 km, 24 s = 24 ÷ 60 ÷ 60 = $\frac{1}{150}$ hour, 0.2 ÷ $\frac{1}{150}$ = 30 and Tom		M1M1A1
	$\frac{200 \div 1000}{24} = \frac{1}{120}$ (or 0.0083...)		M1

Q	Answer	Mark	Comments
10	$3.55 \leq \text{mass} < 3.65$	B1	

Q	Answer	Mark	Comments
11	trapezium	B1	

Q	Answer	Mark	Comments
12(a)	$\frac{180 - 90}{2}$ or $\tan^{-1} \frac{6}{6}$ or 45	M1	oe may be seen on diagram  eg $\sin^{-1}\left(\frac{6}{\sqrt{72}}\right)$
	315	A1	SC1 answer of 135 (bearing of C from A)
	<b>Additional Guidance</b>		
	$\tan \frac{6}{6}$ unless recovered	M0	

Q	Answer	Mark	Comments
12(b)	Correct explanation that the ship would be on land or 068° is the bearing of <i>D</i> from <i>E</i> or the bearing must be over 180° or the actual bearing is [246, 250]°	B1	eg that would take the ship over land 068° is from <i>E</i> 068° is the bearing from <i>E</i> to <i>D</i> the bearing is 248°
	<b>Additional Guidance</b>		
	Ignore irrelevant statements and compass points eg bearings go clockwise, bearings are measured from north, NE, south west		
	Do not accept incorrect statement or bearing alongside a correct statement		
	Bearings measured or stated outside of [246, 250]° range	B0	
	Examples of statements		
	Must be over 180°	B1	
	Should be reflex	B1	
	This is going from <i>E</i>	B1	
	Makes the ship go in the opposite direction	B1	
	68° needs to be 248°	B1	
	Should be 248°	B1	
	Her bearing cannot be acute	B1	
	Bearings cannot be acute	B0	
	248° without a statement	B0	
	Ship would not land at <i>E</i>	B0	
She needs to go south west	B0		

Q	Answer	Mark	Comments
13	$2\sqrt{5}a$	B1	

Q	Answer	Mark	Comments	
14	Rectangular boxplot with whiskers to 3 and 26	B1	must have a rectangular box with whiskers	
	Lower quartile at 11	B1	must be first vertical line of a box with three vertical lines	
	Median at 14	B1	must be second vertical line of a box with three vertical lines	
	Upper quartile at 23	B1ft	ft their LQ + 12 must be vertical line at right side of their box	
	<b>Additional Guidance</b>			
	Correct boxplot			
	Mark intention eg any height and allow horizontal line through centre of box			
	Allow ends of whiskers to be vertical lines of any length, dots, crosses or missing			
$\pm \frac{1}{2}$ small square tolerance				
Only vertical lines or points plotted			B0	

Q	Answer	Mark	Comments
15	<b>Alternative method 1</b>		
	158460 ÷ 278 or 570	M1	
	168720 ÷ their 570	M1dep	
	296	A1	
	<b>Alternative method 2</b>		
	158460 ÷ 168720 or 0.939... or 0.94	M1	
	278 ÷ their 0.939...	M1dep	
	296	A1	
	<b>Alternative method 3</b>		
	168720 ÷ 158460 or 1.0647... or 1.065 or 1.06	M1	oe eg $1 + \frac{168720 - 158460}{158460}$ or $1 + \frac{10260}{158460}$
	278 × their 1.0647...	M1dep	
	296	A1	
	<b>Additional Guidance</b>		
	278 × 1.065 = 296		M1M1A1
	278 × 1.065 = 296.07 with 296 on answer line is evidence of premature rounding in their working		M1M1A0
	168720 ÷ 158460 = 1.06, 278 × 1.06 = 294.68 with answer 294		M1M1A0
Embedded answer eg 168720 ÷ 296 = 570		M1M1A0	

Q	Answer	Mark	Comments	
16(a)	$3 \times 500$ or 1500	M1	actual radius of circle in metres	
	$(\text{their } 1500)^2 \times \pi \times 17$ or $38\,250\,000\pi$	M1dep		
	[120 000 000, 120 200 000] or $[1.2 \times 10^8, 1.202 \times 10^8]$	A1	accept in words eg 120 million SC1 [480, 481] or [0.048, 0.0481]	
	<b>Additional Guidance</b>			
	Do not award A mark if incorrect further work is seen			

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Q	Answer	Mark	Comments
16(b)	It could be less than or greater than Virat's estimate (3rd box ticked) and statement that area is larger but depth is smaller	B2	B1 It is less than Virat's estimate (1st box ticked) and statement that depth is smaller or It is greater than Virat's estimate (2nd box ticked) and statement that area is larger or It could be less than or greater than Virat's estimate (3rd box ticked) and statement that depth is smaller or It could be less than or greater than Virat's estimate (3rd box ticked) and statement that area is larger
	<b>Additional Guidance</b>		
	For B2 their statement must refer to larger area and smaller depth		
	For B1 their statement must correctly refer to larger area or smaller depth for their box ticked		
	Examples of statements implying actual depth is smaller: height is less depth is lower it is shallower Virat's estimate of the depth is bigger		
	Examples of statements implying actual area is larger: the width is bigger cross section is bigger shape is greater Virat's estimate of the area is smaller		
	The reservoir could be bigger or smaller	B0	
	The reservoir is larger	B0	
	We do not know the depth	B0	

Q	Answer	Mark	Comments
17(a)	$8 \times 4 \times 5$	M1	
	160	A1	
	<b>Additional Guidance</b>		
	$\frac{1}{8} \times \frac{1}{4} \times \frac{1}{5} = 160$ (recovered)		M1A1
	$\frac{1}{8} \times \frac{1}{4} \times \frac{1}{5}$		M0A0

Q	Answer	Mark	Comments
17(b)	$\frac{1}{160}$ or 0.00625 or 0.625% or $6.25 \times 10^{-3}$	B1ft	oe fraction, decimal or percentage ft $\frac{1}{\text{their answer to (a)}}$
	<b>Additional Guidance</b>		
	Accept decimal or percentage answers rounded to 2 sf or better for ft eg ft 17 gives 0.058823529... so accept 0.059 or better		
	Ignore an attempt to convert a fraction to a decimal or round a decimal or percentage after a correct value is seen		
	1 : 160 or 1 in 160 or 1 out of 160		B0
	$\frac{1}{160} + \frac{1}{160} = \frac{2}{320} = \frac{1}{160}$		B0
$\frac{1}{160} \times \frac{1}{160} = \frac{2}{320} = \frac{1}{160}$		B0	

Q	Answer	Mark	Comments
18	<b>Alternative method 1 – using angles around O and angles inside arrowhead</b>		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	Reflex $BOC = 360 -$ their 56 or reflex $BOC = 304$	M1dep	may be seen on diagram dep on 2nd M1
	$ABO = 360 -$ their 304 – their 7 – 28 or $ABO = 21$	M1dep	may be seen on diagram dep on M3
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen
	<b>Alternative method 2 – with line OA added</b>		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	$OAC = 7$ or $ABO + ACO = 28$	M1dep	may be seen on diagram
	$OAB = 28 - 7$ or $OAB = 21$ or $ABO = 28 - 7$	M1dep	may be seen on diagram dep on M2
	$ABO = 21$	M1dep	may be seen on diagram dep on M3
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen

Mark scheme continues on the next page

Q	Answer	Mark	Comments
<b>18 cont</b>	<b>Alternative method 3 – using alternate segment theorem</b>		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	$ABC = 83$	M1	may be seen on diagram
	$OBC = \frac{180 - \text{their } 56}{2}$ or $OBC = 62$ and $ABO = 83 - \text{their } 62$ or $ABO = 21$	M1dep	may be seen on diagram, dep on 2nd and 3rd M1
$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen	

**Mark scheme and Additional Guidance continue on the next page**

Q	Answer	Mark	Comments
<b>18 cont</b>	<b>Alternative method 4 – using triangles <i>OBC</i> and <i>ABC</i></b>		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	$OBC = \frac{180 - \text{their } 56}{2}$ or $OBC = 62$	M1dep	may be seen on diagram or angle $OCB$ dep on 2nd M1
	$ABO = 180 - 28 - 62 - 62 - 7$ or $ABO = 21$	M1dep	oe may be seen on diagram dep on M3
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen
	<b>Additional Guidance</b>		
	If angles are not correctly positioned on the diagram they must be correctly identified in the working, eg $BOC = 56$ is M0 if not correctly positioned on the diagram and not identified as acute		
	$ACO = 7$ and $ABO : ACO = 21 : 7$ with no other correct working		M1M0M0M0A0

Q	Answer	Mark	Comments
19(a)	<b>Alternative method 1 – horizontal split</b>		
	$x(x - 2)$ and $3(x - 5)$	M1	oe may be seen as two areas
	$x^2 - 2x + 3x - 15 (= 75)$	M1dep	oe expression with all brackets expanded
	$x^2 - 2x + 3x - 15 = 75$ and $x^2 + x - 90 = 0$ or $x^2 + x - 15 = 75$ and $x^2 + x - 90 = 0$	A1	with full working seen
	<b>Alternative method 2 – vertical split</b>		
	$(x - 5)(x + 1)$ and $5(x - 2)$	M1	oe may be seen as two areas
	$x^2 - 5x + x - 5 + 5x - 10 (= 75)$ or $x^2 - 4x - 5 + 5x - 10 (= 75)$	M1dep	oe expression with all brackets expanded
	$x^2 - 5x + x - 5 + 5x - 10 = 75$ and $x^2 + x - 90 = 0$ or $x^2 - 4x - 5 + 5x - 10 = 75$ and $x^2 + x - 90 = 0$	A1	with full working seen
	<b>Alternative method 3 – large rectangle subtract <math>3 \times 5</math></b>		
	$x(x + 1)$ and $3 \times 5$	M1	oe may be seen as two areas
	$x^2 + x - 15 (= 75)$	M1dep	oe expression with brackets expanded and $3 \times 5$ evaluated
	$x^2 + x - 15 = 75$ and $x^2 + x - 90 = 0$	A1	with full working seen

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
19(a) cont	<b>Alternative method 4 – split into three areas</b>		
	$3(x - 5)$ and $(x - 2)(x - 5)$ and $5(x - 2)$	M1	oe may be seen as three areas
	$3x - 15 + x^2 - 2x - 5x + 10 + 5x - 10 (= 75)$ or $3x - 15 + x^2 - 7x + 10 + 5x - 10 (= 75)$	M1dep	oe expression with all brackets expanded
	$3x - 15 + x^2 - 2x - 5x + 10 + 5x - 10 = 75$ and $x^2 + x - 90 = 0$ or $3x - 15 + x^2 - 7x + 10 + 5x - 10 = 75$ and $x^2 + x - 90 = 0$	A1	with full working seen
	<b>Additional Guidance</b>		
	Ignore attempts to solve the equation or substituting values for $x$		
	Condone missing end bracket for M1		
Condone missing pairs of brackets if recovered eg $3 \times x - 5$ recovered to $3x - 15$			

Q	Answer	Mark	Comments
	$(x - 9)(x + 10) (= 0)$ and answer 9	B2	B1 $(x - 9)(x + 10) (= 0)$ and answer 9 and $-10$ SC1 $(x + 9)(x - 10) (= 0)$ and answer 10
<b>19(b)</b>	<b>Additional Guidance</b>		
	If no response is seen, check part (a) for any creditworthy work		
	Answer 9 with no working can be awarded up to B2 from correct factorising seen in part (a)		
	Answer 9 from quadratic formula or completing the square	B1	
	Answer 9 and $-10$ from quadratic formula or completing the square	B0	
Answer from trial and improvement only	B0		

Q	Answer	Mark	Comments
<b>20</b>	<b>Alternative method 1</b>		
	2496.96 ÷ 2448 or 1.02	M1	implied by correct value for 2, 3 or 4 years
	2496.96 × (their 1.02) <sup>3</sup> or 2448 × (their 1.02) <sup>4</sup> or 2649.79...	M1dep	oe eg full year by year method shown
	2649.77 or 2649.78 or 2649.79 or 2649.8(0)	A1	accept 2650(.00) with M2 awarded SC2 2702.78 or 2702.79 or 2702.8(0)
	<b>Alternative method 2</b>		
	(2496.96 – 2448) ÷ 2448 or 48.96 ÷ 2448 or 0.02 or 2%	M1	
	2496.96 × (1 + $\frac{\text{their } 2}{100}$ ) <sup>3</sup> or 2448 × (1 + $\frac{\text{their } 2}{100}$ ) <sup>4</sup> or 2649.79...	M1dep	oe eg full year by year method shown
	2649.77 or 2649.78 or 2649.79 or 2649.8(0)	A1	accept 2650(.00) with M2 awarded SC2 2702.78 or 2702.79 or 2702.8(0)
	<b>Additional Guidance</b>		
	Calculated by year, the amounts would be: 2 years 2546.89 or 2546.90 3 years 2597.82 or 2597.83 or 2597.84		
Condone 2650.0		M1M1A1	
2546.89, 2597.83, 2649.78, 2702.77 do not award A mark if further work seen after correct answer		M1M1A0	
$\frac{48.96}{2496.96} \times 100 = 2\%$ is incorrect working		M0M0A0	

Q	Answer	Mark	Comments
21	$\frac{\sin x}{17} = \frac{\sin 64}{23}$ or $\sin x = \frac{17 \sin 64}{23}$ or $\sin x = \frac{15.279...}{23}$ or $\frac{\sin x}{17} = 0.039...$ or $\sin x = 0.66(4...)$	M1	oe $\frac{17}{\sin x} = \frac{23}{\sin 64}$ or $\frac{17}{\sin x} = [25.58, 25.6]$
	$(x =) \sin^{-1} \frac{17 \sin 64}{23}$ or $(x =) \sin^{-1} 0.66(4...)$	M1dep	
	[41.29, 41.64] or 42 or 41 from correct working	A1	
	<b>Additional Guidance</b>		
	Answer from accurate drawing		
Q	Answer	Mark	Comments
22	$3x^2$	B1	

Q	Answer	Mark	Comments
23	<b>Alternative method 1</b>		
	$5^2 + 7 \times 5 - c$ or $60 - c$ and $3 \times 5 + d$ or $15 + d$	M1	oe
	$25 + 35 - c = 15 + d$ or $60 - c = 15 + d$ or $c = 60 - y$ and $d = y - 15$ and $c + d = 60 - y + y - 15$	M1dep	oe equation with squaring and multiplications correctly completed
	45	A1	
	<b>Alternative method 2</b>		
	$x^2 + 7x - c = 3x + d$ or $x^2 + 7x - c - (3x + d) = 0$ or $x^2 + 7x - c - 3x - d = 0$ or $3x + d - (x^2 + 7x - c) = 0$ or $3x + d - x^2 - 7x + c = 0$	M1	oe
	$(c + d =) x^2 + 7x - 3x$ or $(c + d =) x^2 + 4x$ and substitutes $x = 5$	M1dep	oe
	45	A1	
	<b>Additional Guidance</b>		
	Once $c + d = 45$ is seen, ignore further attempts to find values for $c$ or $d$		
	45 on answer line with no working or no incorrect working		M1M1A1

Q	Answer	Mark	Comments	
24	$\sqrt[4]{81}$ or $81^{\frac{1}{4}}$ or $k = 3$	M1	may be seen on diagram and is implied by $p = 9$	
	(their value for $k$ ) $^2 = 2^2 + c$ or $9 = 4 + c$ or $c = 5$	M1	does not need to be evaluated	
	$r^2 + \text{their } 5 = 43.44$ or $\sqrt{43.44 - \text{their } 5}$ or $\sqrt{38.44}$	M1dep	oe equation dep on previous mark	
	6.2	A1		
	<b>Additional Guidance</b>			
	Coordinate (2, 9) implies $p = 9$			

Q	Answer	Mark	Comments
25	0.6 × 10 or 6 or 4 × 5 or 20 or 7.6 × 5 or 38 or 1.6 × 10 or 16 or 4 × 2 or 8 or 4 × 3 or 12	M1	may be seen written on correct bar correct method for any frequency
	0.6 × 10 + (122 – 120) × 4 or 0.6 × 10 + 2 × 4 or $0.6 \times 10 + \frac{2}{5} \times 4 \times 5$ or 6 + 8 or 14 or $16 + 38 + \frac{3}{5} \times 4 \times 5$ or 66	M1dep	oe
	$14 \times \frac{28\,000}{80}$ or $28\,000 - 66 \times \frac{28\,000}{80}$ or 23 100	M1dep	oe eg 14 × 350  28 000 – 66 × 350
	4900	A1	SC3 3850 or 6475
	<b>Additional Guidance</b>		
$0.3 \times 10 + 2 \times 4 = 11$ and $\frac{11}{80} \times 28\,000 = 3850$		SC3	
$1.3 \times 10 + 7.3 \times 5 + 4 \times 3 = 61.5$ and $28\,000 - \frac{61.5}{80} \times 28\,000 = 6475$		SC3	
$\frac{6+8}{80} \times 28\,000$ or $\frac{14}{80} \times 28\,000$		M3	

Q	Answer	Mark	Comments
26(a)	$2^3 \times 3 \times a^2$ or $24a^2$ (= 4056) or $(a^2 =) \frac{4056}{2^3 \times 3}$ or $(a^2 =) 169$ or $\sqrt{169}$	M1	oe eg $8 \times 3 \times a^2$
	13	A1	
	<b>Additional Guidance</b>		
	Condone $a^2 \times 24$ for M1		
	Fully correct prime factor decomposition with values 2, 2, 2, 3, 13, 13 shown without 13 chosen as the final answer		M1A0
	Embedded answer $2^3 \times 3 \times 13^2$		M1A0
	$\pm 13$ or $-13$		M1A0
4056 $\div 2^3 \times 3$ unless recovered to 169		M0A0	

Q	Answer	Mark	Comments
26(b)	$2^4 \times 3^2 \times a^3$ or $144a^3$ or $2^4 \times 3^2 \times (\text{their } 13)^3$ or $13 \times 4056 \times 2 \times 3$ or $52728 \times 6$ or $24336 \times 13$	M1	oe  eg $144 \times (\text{their } 13)^3$  $16 \times 9 \times 2197$
	316368	A1ft	ft their 13, which must be an integer $> 13$
	<b>Additional Guidance</b>		
	eg 14 on answer line in part (a) can follow through to $144 \times 14^3 = 395136$		M1A1ft

Q	Answer	Mark	Comments
27	<b>Alternative method 1: multiplies <math>(x - 3)(x - 4)</math> first</b>		
	$x^2 - 3x - 4x + 12$ or $x^2 - 7x + 12$	M1	four terms with at least three correct implied by $x^2 - 7x + k$ where $k$ is a non-zero constant
	$x^3 - 3x^2 - 4x^2 + 12x + 8x^2 - 24x - 32x + 96$ or $x^3 - 7x^2 + 12x + 8x^2 - 56x + 96$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by $x$ and 8
	$x^3 + x^2 - 44x + 96$	A1	
	<b>Alternative method 2: multiplies <math>(x - 3)(x + 8)</math> first</b>		
	$x^2 - 3x + 8x - 24$ or $x^2 + 5x - 24$	M1	four terms with at least three correct implied by $x^2 + 5x + k$ where $k$ is a non-zero constant
	$x^3 - 3x^2 + 8x^2 - 24x - 4x^2 + 12x - 32x + 96$ or $x^3 + 5x^2 - 24x - 4x^2 - 20x + 96$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by $x$ and $-4$
	$x^3 + x^2 - 44x + 96$	A1	
	<b>Alternative method 3: multiplies <math>(x - 4)(x + 8)</math> first</b>		
	$x^2 - 4x + 8x - 32$ or $x^2 + 4x - 32$	M1	four terms with at least three correct implied by $x^2 + 4x + k$ where $k$ is a non-zero constant
	$x^3 - 4x^2 + 8x^2 - 32x - 3x^2 + 12x - 24x + 96$ or $x^3 + 4x^2 - 32x - 3x^2 - 12x + 96$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by $x$ and $-3$
	$x^3 + x^2 - 44x + 96$	A1	
	<b>Additional Guidance</b>		
	Do not award A mark if further incorrect simplification or attempt to solve after correct answer seen		
For method marks, terms may be given in a table with correct signs shown			