GCSE
MATHEMATICS
8300/3H

Higher Tier Shadow Paper 3 Calculator

Shadow Paper Mark scheme

June 2022

Version: 1.0

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	6.78	B1	

Q	Answer	Mark	Comments
2	$\begin{pmatrix} -2 \\ 5 \end{pmatrix}$	B1	

Q	Answer	Mark	Comments
3(a)	B	B1	

Q	Answer	Mark	Comments
3(b)	D	B1	

Q	Answer	Mark	Comments
4	**Alternative method 1**		
	tan identified	M1	oe eg $\tan^{-1}$
	$\tan x = \frac{12}{5}$ or $\tan x = 2.4$	M1dep	oe eg $\tan^{-1}\frac{12}{5}$ or $90 - \tan^{-1}\frac{5}{12}$
	[67, 67.4]	A1	SC1 [22.6, 23]
	Alternative method 2		
	$\sin x = \frac{12}{\sqrt{5^2+12^2}}$ or $\cos x = \frac{5}{\sqrt{5^2+12^2}}$	M2	oe eg $\sin x = \frac{12}{\sqrt{169}}$ or $\sin^{-1}\frac{12}{\sqrt{5^2+12^2}}$ or $\cos x = \frac{5}{\sqrt{169}}$ or $\cos^{-1}\frac{5}{\sqrt{5^2+12^2}}$ or $90 - \sin^{-1}\frac{5}{\sqrt{5^2+12^2}}$ or $90 - \cos^{-1}\frac{12}{\sqrt{5^2+12^2}}$
	[67, 67.4]	A1	SC1 [22.6, 23]
	Additional Guidance		
	Accept 13 for $\sqrt{169}$		
	Tan can be identified by, for example, circling TOA in SOHCAHTOA		
	Answer from accurate drawing		M0M0A0
	$\sin x = \frac{12\sin 90}{\sqrt{169}}$		M2
	$(x =)$ tan 2.4 or $(x =)$ tan 0.41666… or $(x =)$ tan $\left(\frac{12}{5}\right)^{-1}$ unless recovered		M1M0A0
	$\tan = \frac{12}{5}$ or $\tan = \frac{5}{12}$ or $\tan x = \frac{5}{12}$ with no further correct working		M1M0A0

Q	Answer	Mark	Comments
5	$2+3$ or 5 and $4\frac{1}{4}+3\frac{3}{4}$ or 8 **or** $4\frac{1}{4}-2$ or $2\frac{1}{4}$ and $3\frac{3}{4}-3$ or $\frac{3}{4}$ **or** 3	M1	oe eg $120+180$ or 300 and $255+225$ or 480 implied by $4\frac{1}{4}+3\frac{3}{4}-2-3$
	$\frac{8-5}{5}$ or $\frac{2\frac{1}{4}+\frac{3}{4}}{2+3}$ or $\frac{3}{5}$ or 0.6 or $\frac{4\frac{1}{4}+3\frac{3}{4}}{2+3}$ $(\times 100)$ or $\frac{8}{5}$ $(\times 100)$ or 1.6 $(\times 100)$ or 160	M1dep	oe eg $\frac{4\frac{1}{4}+3\frac{3}{4}-2-3}{2+3}$ eg $\frac{480-300}{300}$ or $\frac{180}{300}$ or $1.6-1$
	60	A1	
	Additional Guidance		
	Allow working fully in minutes but units must be consistent in a single calculation eg 2 h 15 and 0 h 45 eg $2+3=5$ and $255+225=480$ eg $3+120$ and $255+3\frac{3}{4}$ unless recovered	 M1 M1 M0	
	$2+3=6$, $4\frac{1}{4}+3\frac{3}{4}=8$, $8-6=2$, $2=40\%$	M1M1A0	
	$2+3=6$, $4\frac{1}{4}+3\frac{3}{4}=8$, answer 40% (2 is implied)	M1M1A0	
	$8-6=2$, $2=40\%$ (no method shown for 6)	M0M0A0	

Q	Answer	Mark	Comments
6(a)	–2 and 6	B1	either order
	Additional Guidance		
	Ignore $x =$ written before answers		
	(–2, 0) or (6, 0)		B0

Q	Answer	Mark	Comments
6(b)	(2, –16)	B2	B1 $x = 2$ or (2, …) or $y = -16$ or (…, –16) or $(x-2)^2 - 16$ B1ft correct y-coordinate for their x-coordinate with $x \neq -1$, 0 or 5 SC1 (–16, 2)
	Additional Guidance		
	If answer line is blank, check diagram for indication of x or y values		
	(3, –16)		B1
	(3, –15)		B1ft
	(1, –15)		B1ft
	(2.5, –15.75)		B1ft
	(0, –12)		B0ft

Q	Answer	Mark	Comments
7	(8th term =) 2^9 or 512	M1	oe may be implied
	Common difference of A indicated as 3	M1	may be implied eg $3n$ … or … + 3(n – 1)
	$3n + 8$ = their 512 or (their 512 – 8) ÷ 3 or (their 512 – 11) ÷ 3 or 167	M1dep	oe equation eg $11 + 3(n - 1) = 2^8$ dep on 2nd M1 their 512 may be any number and may be in index form
	168	A1	
	Additional Guidance		
	$n + 3$ implies 2nd M1		
	Do not award M1 for 512 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		
	8, (11, 14, 17, 20), 23 without common difference of 3 shown does not imply 2nd M1		
	168 from trial and improvement		M3A1
	Embedded answer $3 \times 168 + 8 = 512$		M3A0
	$3n + 8 = 512$ or $3n + 8 = 2^9$ or $3n = 504$		M1M1M1
	$3n - 8 = 512$		M1M1M0
	$3n + 8 = 32$ (2^9 not seen)		M0M1M1
	$3n + 6 = 2^9$		M1M1M0
	512 – 20 = 492, 492 ÷ 3 (indicating common difference of 3)		M1M1M0
	$3n - 8 = 256$ (2^9 not seen)		M0M1M0

Q	Answer	Mark	Comments
8	380 ÷ (3 + 2) or 380 ÷ 5 or 76	M1	oe eg $\frac{380}{5}$
	their 76 × 3 or 228	M1dep	oe $\frac{3}{5}$ × 380 scores M2
	99 ÷ 3 or 33 or 99 ÷ 3 × 7 or 231	M1	oe eg $\frac{99}{3}$ or $\frac{7}{3}$ × 99
	228 and 231 and B	A1	
	Additional Guidance		
	228 and 69.3 and A		M1M1M0A0

Q	Answer	Mark	Comments
9	**Alternative method 1 – compares speeds in m/s**		
	400 ÷ 52 or 7.69(2…)	M1	oe eg $\frac{400}{52}$ or $7\frac{9}{13}$
	28.8 × 1000 ÷ 60 ÷ 60 or 8	M1	oe eg 28 800 ÷ 3600 or 28.8 ÷ 3.6
	8 and 7.69(2…) and Anita	A1	oe eg 8 and $7\frac{9}{13}$ and Anita
	Alternative method 2 – compares speeds in km/h		
	400 ÷ 52 or 7.69(2…)	M1	oe eg $\frac{400}{52}$ or $7\frac{9}{13}$
	their 7.69(2…) ÷ 1000 × 60 × 60 or	M1dep	oe eg 0.007.69(2…) × 3600
	27.69… and Anita	A1	
	Alternative method 3 – time for Anita starting with m/s		
	28.8 × 1000 ÷ 60 ÷ 60 or 8	M1	oe eg 28 800 ÷ 3600
	400 ÷ their 8 or 25	M1dep	oe eg $\frac{400}{8}$
	50 and Anita	A1	oe eg Anita by 2s
	Alternative method 4 – time for Anita starting with km/h		
	$\frac{400 \div 1000}{28.8}$ or [0.0138, 0.0139] or $\frac{400}{28.8}$ or [13.8, 13.9]	M1	oe eg $\frac{0.4}{28.8}$ eg $\frac{125}{9}$
	their [0.0138, 0.0139] × 60 × 60 or their [13.8, 13.9] ÷ 1000 × 60 × 60 or 50	M1dep	oe eg $\frac{0.4}{28.8}$ × 3600
	50 and Anita	A1	oe eg Anita by 2s

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
9 cont	**Alternative method 5 – distance for Anita in 52s**		
	28 800 × 52 or 1 497 600 or 28.8 ÷ 60 ÷ 60 or 0.008 or 28.8 × 52 or 1497.6	M1	oe eg $\frac{7488}{5}$
	their 1 497 600 ÷ 60 ÷ 60 or their 0.008 × 1000 × 24 or their 1497.6 × 1000 ÷ 60 ÷ 60 or 416	M1dep	oe eg 28 800 × 52 ÷ 3600
	416 and Anita	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		
	Ignore all units		
	Allow other correct comparisons eg 461.53… and 480 (this is metres per minute) eg 461.53… and 480 and Anita		M1M1 M1M1A1
	400 m = 0.4 km, 52 s = 52 ÷ 60 ÷ 60 = $\frac{13}{900}$ hour, 0.4 ÷ $\frac{13}{900}$ = 27.69… and Anita		M1M1A1
	$\frac{400 \div 1000}{52} = \frac{1}{130}$ (or 0.00769…)		M1

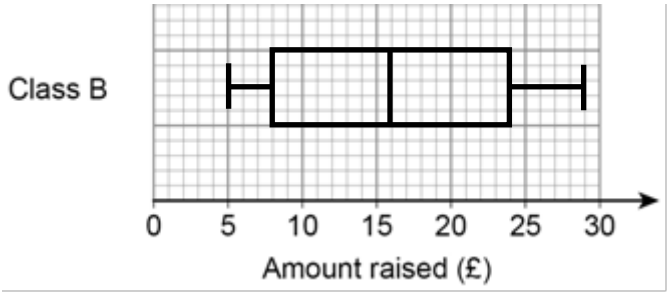
Q	Answer	Mark	Comments
10	120.35 ⩽ mass < 120.45	B1	

Q	Answer	Mark	Comments
11	kite	B1	

Q	Answer	Mark	Comments
12(a)	$\tan^{-1}\frac{3}{4}$ or 36.9 or 37	M1	oe may be seen on diagram eg $\sin^{-1}\left(\frac{3}{\sqrt{25}}\right)$
	306.9 or 307	A1	SC1 answer of 127 (bearing of *C* from *A*)
	Additional Guidance		
	$\tan\frac{3}{4}$ unless recovered		M0

Q	Answer	Mark	Comments
12(b)	Correct explanation that the ship would be on land or 248° is the bearing of *D* from *E* or the bearing must be less than 090° or the actual bearing is [66, 70]°	B1	eg that would take the ship over land 068° is from *D* 068° is the bearing from *D* to *E* the bearing is 068°
	Additional Guidance		
	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 [66, 70]° range		B0
	Examples of statements		
	Must be less than 090°		B1
	Should be acute		B1
	This is going from *D*		B1
	Makes the ship go in the opposite direction		B1
	248° needs to be 068°		B1
	Should be 068°		B1
	Her bearing cannot be obtuse		B1
	Bearings cannot be obtuse		B0
	068° without a statement		B0
	Ship would not land at *D*		B0
	She needs to go north east		B0

Q	Answer	Mark	Comments
13	$2\sqrt{7a}$	B1	

Q	Answer	Mark	Comments
14	Rectangular boxplot with whiskers to 5 and 29	B1	must have a rectangular box with whiskers
	Lower quartile at 8	B1	must be first vertical line of a box with three vertical lines
	Median at 16	B1	must be second vertical line of a box with three vertical lines
	Upper quartile at 24	B1ft	ft their LQ + 16 must be vertical line at right side of their box
	Additional Guidance		
	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	**Alternative method 1**		
	141 120 ÷ 294 or 480	M1	
	151 680 ÷ their 480	M1dep	
	316	A1	
	Alternative method 2		
	141 120 ÷ 151 680 or 0.930… or 0.93	M1	
	294 ÷ their 0.930…	M1dep	
	316	A1	
	Alternative method 3		
	151 680 ÷ 141 120 or 1.0748… or 1.075 or 1.07	M1	oe eg $1 + \frac{151680 - 141120}{141120}$ or $1 + \frac{10560}{141120}$
	294 × their 1.0748…	M1dep	
	316	A1	
	Additional Guidance		
	294 × 1.075 = 316		M1M1A1
	294 × 1.075 = 316.05 with 316 on answer line is evidence of premature rounding in their working		M1M1A0
	151 680 ÷ 141 120 = 1.07, 294 × 1.07 = 314.58 with answer 316		M1M1A0
	Embedded answer eg 151 680 ÷ 316 = 480		M1M1A0

Q	Answer	Mark	Comments
16(a)	3×600 or 1800	M1	actual radius of circle in metres
	(their 1800)$^2 \times \pi \times 19$ or $61\,560\,000\,\pi$	M1dep	
	[193 000 000, 193 400 000] or [1.93×10^8, 1.934×10^8]	A1	accept in words eg 193 million SC1 [537, 538] or [0.0537, 0.0538]
	Additional Guidance		
	Do not award A mark if incorrect further work is seen		

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="8">16(b)</td><td>It could be less than or greater than Vanessa's estimate (3rd box ticked)
and
statement that area is larger but depth is smaller</td><td>B2</td><td>B1
It is less than Vanessa's estimate (1st box ticked)
and statement that depth is smaller
or
It is greater than Vanessa's estimate (2nd box ticked)
and statement that area is larger
or
It could be less than or greater than Vanessa's estimate (3rd box ticked)
and statement that depth is smaller
or
It could be less than or greater than Vanessa's estimate (3rd box ticked)
and statement that area is larger</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">For B2 their statement must refer to larger area and smaller depth</td><td></td></tr>
<tr><td colspan="2">For B1 their statement must correctly refer to larger area or smaller depth for their box ticked</td><td></td></tr>
<tr><td colspan="2">Examples of statements implying actual depth is smaller:
height is less
depth is lower
it is shallower
Vanessa's estimate of the depth is bigger</td><td></td></tr>
<tr><td colspan="2">Examples of statements implying actual area is larger:
the width is bigger
cross section is bigger
shape is greater
Vanessa's estimate of the area is smaller</td><td></td></tr>
<tr><td colspan="2">The reservoir could be bigger (larger) or smaller</td><td>B0</td></tr>
<tr><td colspan="2">We do not know the depth</td><td>B0</td></tr>
</table>

Q	Answer	Mark	Comments
17(a)	$5 \times 10 \times 8$	M1	
	400	A1	
	Additional Guidance		
	$\frac{1}{5} \times \frac{1}{10} \times \frac{1}{8} = 400$ (recovered)		M1A1
	$\frac{1}{5} \times \frac{1}{10} \times \frac{1}{8}$		M0A0

Q	Answer	Mark	Comments
17(b)	$\frac{1}{400}$ or 0.0025 or 0.25% or 2.5×10^{-3}	B1ft	oe fraction, decimal or percentage ft $\frac{1}{\text{their answer to (a)}}$
	Additional Guidance		
	Ignore an attempt to convert a fraction to a decimal or round a decimal or percentage after a correct value is seen		
	1 : 400 or 1 in 400 or 1 out of 400		B0
	$\frac{1}{400} + \frac{1}{400} = \frac{2}{400} = \frac{1}{200}$		B0
	$\frac{1}{400} \times \frac{1}{400} = \frac{2}{800} = \frac{1}{400}$		B0

Q	Answer	Mark	Comments
18	**Alternative method 1 – using angles around *O* and angles inside arrowhead**		
	$ACO = 90 - 80$ or $ACO = 10$	M1	may be seen on diagram
	Acute $BOC = 2 \times 30$ or acute $BOC = 60$	M1	may be seen on diagram
	Reflex $BOC = 360 -$ their 60 or reflex $BOC = 300$	M1dep	may be seen on diagram dep on 2nd M1
	$ABO = 360 -$ their $300 -$ their $10 - 30$ or $ABO = 20$	M1dep	may be seen on diagram dep on M3
	$ACO = 10$ and $ABO = 20$ and and $10 : 20 = 1 : 2$	A1	all angle values must be seen
	Alternative method 2 – with line *OA* added		
	$ACO = 90 - 80$ or $ACO = 10$	M1	may be seen on diagram
	$OAC = 10$ or $ABO + ACO = 30$	M1dep	may be seen on diagram
	$OAB = 30 - 10$ or $OAB = 20$ or $ABO = 30 - 10$	M1dep	may be seen on diagram dep on M2
	$ABO = 20$	M1dep	may be seen on diagram dep on M3
	$ACO = 10$ and $ABO = 20$ and and $10 : 20 = 1 : 2$	A1	all angle values must be seen

Mark scheme continues on the next page

Q	Answer	Mark	Comments
18 cont	**Alternative method 3 – using alternate segment theorem**		
	$ACO = 90 - 80$ or $ACO = 10$	M1	may be seen on diagram
	Acute $BOC = 2 \times 30$ or acute $BOC = 60$	M1	may be seen on diagram
	$ABC = 80$	M1	may be seen on diagram
	$OBC = \frac{180 - 60}{2}$ or $OBC = 60$ and $ABO = 80 -$ their 60 or $ABO = 20$	M1dep	may be seen on diagram, dep on 2nd and 3rd M1
	$ACO = 10$ and $ABO = 20$ and and $10 : 20 = 1 : 2$	A1	all angle values must be seen

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Q	Answer	Mark	Comments
18 cont	**Alternative method 4 – using triangles *OBC* and *ABC***		
	$ACO = 90 - 80$ or $ACO = 10$	M1	may be seen on diagram
	Acute $BOC = 2 \times 30$ or acute $BOC = 60$	M1	may be seen on diagram
	$OBC = \frac{180 - 60}{2}$ or $OBC = 60$	M1dep	may be seen on diagram or angle *OCB* dep on 2nd M1
	$ABO = 180 - 30 - 60 - 60 - 10$ or $ABO = 20$	M1dep	oe may be seen on diagram dep on M3
	$ACO = 10$ and $ABO = 20$ and and $10 : 20 = 1 : 2$	A1	all angle values must be seen
	Additional Guidance		
	If angles are not correctly positioned on the diagram they must be correctly identified in the working, eg $BOC = 60$ is M0 if not correctly positioned on the diagram and not identified as acute		
	$ACO = 10$ and $ABO : ACO = 10 : 20$ with no other correct working		M1M0M0M0A0

Q	Answer	Mark	Comments
19(a)	**Alternative method 1 – horizontal split**		
	$x(x-2)$ and $4(x-6)$	M1	oe may be seen as two areas
	$x^2-2x+4x-24$ (= 119)	M1dep	oe expression with all brackets expanded
	$x^2-2x+4x-24=119$ and $x^2+2x-143=0$ or $x^2+2x-24=119$ and $x^2+2x-143=0$	A1	with full working seen
	Alternative method 2 – vertical split		
	$(x-6)(x+2)$ and $6(x-2)$	M1	oe may be seen as two areas
	$x^2-6x+2x-12+6x-12$ (= 119) or $x^2-4x-12+6x-12$ (= 119)	M1dep	oe expression with all brackets expanded
	$x^2-6x+2x-12+6x-12=119$ and $x^2+2x-143=0$ or $x^2-4x-12+6x-12=119$ and $x^2+2x-143=0$	A1	with full working seen
	Alternative method 3 – large rectangle subtract 4 × 6		
	$x(x+2)$ and 4 × 6	M1	oe may be seen as two areas
	$x^2+2x-24$ (= 119)	M1dep	oe expression with brackets expanded and 4 × 6 evaluated
	$x^2+2x-24=119$ and $x^2+2x-143=0$	A1	with full working seen

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Q	Answer	Mark	Comments
19(a) cont	**Alternative method 4 – split into three areas**		
	$4(x-6)$ and $(x-2)(x-6)$ and $6(x-2)$	M1	oe may be seen as three areas
	$4x-24+x^2-2x-6x+12+6x-12$ (= 119) or $4x-24+x^2-4x+12+6x-12$ (= 119)	M1dep	oe expression with all brackets expanded
	$4x-24+x^2-2x-6x+12+6x-12=119$ and $x^2+2x-143=0$ or $4x-24+x^2-4x+12+6x-12=119$ and $x^2+2x-143=0$	A1	with full working seen
	Additional Guidance		
	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 $4\times x-6$ recovered to $4x-24$		

Q	Answer	Mark	Comments
19(b)	$(x - 11)(x + 13)$ (= 0) and answer 11	B2	B1 $(x - 11)(x + 13)$ (= 0) and answer 11 and –13 SC1 $(x + 11)(x - 13)$ (= 0) and answer 13
	Additional Guidance		
	If no response is seen, check part (a) for any creditworthy work		
	Answer 11 with no working can be awarded up to B2 from correct factorising seen in part (a)		
	Answer 11 from quadratic formula or completing the square		B1
	Answer 11 and –13 from quadratic formula or completing the square		B0
	Answer from trial and improvement only		B0

Q	Answer	Mark	Comments
20	**Alternative method 1**		
	2509.20 ÷ 2448 or 1.025	M1	implied by correct value for 2, 3 or 4 years
	2509.20 × (their 1.025)^4 or 2448 × (their 1.025)^5 or 2769.69…	M1dep	oe eg full year by year method shown
	2769.68 or 2769.69 or 2769.7(0)	A1	accept 2770(.00) with M2 awarded SC2 2838.92 or 2838.93 or 2838.9(0)
	Alternative method 2		
	(2509.20 – 2448) ÷ 2448 or 61.20 ÷ 2448 or 0.025 or 2.5%	M1	
	2509.20 × $(1+\frac{\text{their } 2.5}{100})^4$ or 2448 × $(1+\frac{\text{their } 2.5}{100})^5$ or 2769.69…	M1dep	oe eg full year by year method shown
	2769.68 or 2769.69 or 2769.7(0)	A1	accept 2770(.00) with M2 awarded SC2 2838.92 or 2838.92 or 2838.92 or 2838.9(0)

Mark scheme and Additional Guidance continue on the next page

	Additional Guidance	
	Calculated by year, the amounts would be: 2 years 2571.93 3 years 2636.22 or 2636.23 4 years 2702.13	
	Condone 2770	M1M1A1
	2571.93, 2636.22, 2702.13, 2769.69, 2838.93 do not award A mark if further work seen after correct answer	M1M1A0
	$\frac{61.20}{2509.20} \times 100 = 2.5\%$ is incorrect working	M0M0A0

Q	Answer	Mark	Comments
21	$\frac{\sin x}{19} = \frac{\sin 66}{25}$ or $\sin x = \frac{19 \sin 66}{25}$ or $\sin x = \frac{17.357...}{25}$ or $\frac{\sin x}{19} = 0.0365\ldots$ or $\sin x = 0.69(4\ldots)$	M1	oe $\frac{19}{\sin x} = \frac{25}{\sin 66}$ or $\frac{19}{\sin x} = [27.36, 27.4]$
	$(x =) \sin^{-1} \frac{19 \sin 66}{25}$ or $(x =) \sin^{-1} 0.69(4\ldots)$	M1dep	
	[43.94, 44]	A1	
	Additional Guidance		
	Answer from accurate drawing		M0M0A0

Q	Answer	Mark	Comments
22	$9x^2$	B1	

Q	Answer	Mark	Comments
23	**Alternative method 1**		
	$6^2 + 5 \times 6 + a$ or $66 + a$ and $4 \times 6 - b$ or $24 - b$	M1	oe
	$66 + a + b = 24$ or $66 + a = 24 - b$ or $a = y - 66$ and $b = 24 - y$ and $a + b = y - 66 + 24 - y$	M1dep	oe equation with squaring and multiplications correctly completed
	–42	A1	
	Alternative method 2		
	$x^2 + 5x + a = 4x - b$ or $x^2 + 5x + a - (4x - b) = 0$ or $x^2 + 5x + a - 4x + b = 0$ or $4x - b - (x^2 + 5x + a) = 0$ or $4x - b - x^2 - 5x - a = 0$	M1	oe
	$(a + b =) -x^2 + 4x - 5x$ or $(a + b =) -x^2 - x$ and substitutes $x = 6$	M1dep	oe
	–42	A1	
	Additional Guidance		
	Once $a + b = -42$ is seen, ignore further attempts to find values for a or b		
	–42 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 + their 5 = 47.25 or $\sqrt{47.25 - \text{their } 5}$ or $\sqrt{42.25}$	M1dep	oe equation dep on previous mark
	6.5	A1	
	Additional Guidance		
	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 4×1 or 4 or 4×4 or 16	M1	may be seen written on correct bar correct method for any frequency
	$(125 - 124) \times 4 + 7.6 \times 5 + 1.6 \times 10$ or $\frac{1}{5} \times 5 \times 4 + 7.6 \times 5 + 1.6 \times 10$ or $4 + 38 + 16$ or 58 or $6 + 16 = 22$	M1dep	oe
	$58 \times \frac{42000}{80}$ or $42000 - 22 \times \frac{42000}{80}$ or 11550	M1dep	oe eg 58×525 $42000 - 22 \times 525$
	30450	A1	
	Additional Guidance		
	$\frac{4+38+16}{80} \times 42000$ or $\frac{58}{80} \times 42000$		M3

Q	Answer	Mark	Comments
26(a)	$3^3 \times 5 \times a^2$ or $135a^2$ $(= 6615)$ or $(a^2 =) \frac{6615}{3^3 \times 5}$ or $(a^2 =) 49$ or $\sqrt{49}$	M1	oe eg $27 \times 5 \times a^2$
	7	A1	
	Additional Guidance		
	Condone $a^2 \times 135$ for M1		
	Fully correct prime factor decomposition with values 3, 3, 3, 5, 7, 7 shown without 7 chosen as the final answer		M1A0
	Embedded answer $3^3 \times 5 \times 7^2$		M1A0
	± 7 or -7		M1A0
	$6615 \div 3^3 \times 5$ unless recovered to 49		M0A0

Q	Answer	Mark	Comments
26(b)	$3^4 \times 5^2 \times a^3$ or $2025a^3$ or $3^4 \times 5^2 \times$ (their 7)^3 or $7 \times 6615 \times 3 \times 5$ or 46305×15 or 99225×7	M1	oe eg $2025 \times$ (their 7)^3 $81 \times 25 \times 343$
	694 575	A1ft	ft their 7, which must be an integer > 7
	Additional Guidance		
	eg 8 on answer line in part (a) can follow through to $2025 \times 8^3 =$ 1 036 800		M1A1ft

Q	Answer	Mark	Comments

27	**Alternative method 1: multiplies $(x-5)(x+4)$ first**		
	$x^2-5x+4x-20$ or x^2-x-20	M1	four terms with at least three correct implied by x^2-x-k where k is a non-zero constant
	$x^3-5x^2+4x^2-20x-7x^2+35x-28x+140$ or $x^3-x^2-20x-7x^2+7x+140$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and –7
	$x^3-8x^2-13x+140$	A1	
	Alternative method 2: multiplies $(x-5)(x-7)$ first		
	$x^2-5x-7x+35$ or $x^2-12x+35$	M1	four terms with at least three correct implied by $x^2-12x+k$ where k is a non-zero constant
	$x^3-5x^2-7x^2+35x+4x^2-20x-28x+140$ or $x^3-12x^2+35x+4x^2-48x+140$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and 4
	$x^3-8x^2-13x+140$	A1	
	Alternative method 3: multiplies $(x+4)(x-7)$ first		
	$x^2+4x-7x-28$ or $x^2-3x-28$	M1	four terms with at least three correct implied by x^2-3x-k where k is a non-zero constant
	$x^3+4x^2-7x^2-28x-5x^2-20x+35x+140$ or $x^3-3x^2-28x-5x^2+15x+140$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and –5
	$x^3-8x^2-13x+140$	A1	
	Additional Guidance		
	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		