GCSE
MATHEMATICS
8300/2H

Higher Tier Paper 2 Calculator

Mark scheme

November 2022

Version: 1.0 Final

22BG8300/2H/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	Comment
1	–20.425	B1	

Q	Answer	Mark	Comment
2	9.61×10^{18}	B1	

Q	Answer	Mark	Comment
3	(0, –6)	B1	

Q	Answer	Mark	Comment
4	$\frac{c}{b^4}$	B1	

Q	Answer	Mark	Comments
5	At least two of 2^3, 3^2, 7 selected eg $2^3 \times 3^2 \times 7$ or 2 2 2 3 3 7 7 or $2^2 + 3^2 + 7$ or $2^3 \times 3^2$ or $2^3 + 7$ or $3^2 . 7$	M1	allow 2^3 to be $2 \times 2 \times 2$ or 8 allow 3^2 to be 3×3 or 9 allow 7 to be 7^1 selection is implied by inclusion in intersection of overlapping circles M0 inclusion of 5 in selection
	504	A1	

Additional Guidance	
$8 \times 9 \times 7$	M1
8, 9, 49	M1
$4 + 9 + 7$	M1
Intersecting circles with eg only 9 and 7 in the intersection	M1
Allow inclusion of 1 for up to M1 eg $1 \times 2^3 \times 3^2 \times 7$	M1
$2^3 \times 3^2 \times 5 \times 7$	M0
Answer 504	M1A1
M1 seen with answer the LCM	M1A0

Q	Answer	Mark	Comments
6(a)	$\frac{90-42}{100} \times 24\,000$ or $\frac{48}{100} \times 24\,000$ or 11 520 or $\frac{42}{100} \times 24\,000$ or 10 080 or $\frac{48-42}{100} \times 24\,000$ or 6 and 48 and 42 seen	M1	oe
	1440	A1	SC1 1920 or answer with digits 144
	Additional Guidance		
	Up to M1 may be awarded for correct work with no answer, or incorrect answer, even if this is seen amongst multiple attempts		
	Build-up to 48% or 42% must be correct or full method must be shown		
	eg only 48% × 24 000 with no or incorrect evaluation		M0

Q	Answer	Mark	Comments
6(b)	Ticks Cannot tell and valid reason	B1	eg ticks Cannot tell and We don't know the number sold (in 2019)
	Additional Guidance		
	Ignore calculations using percentages from the bar chart		
	Allow any unambiguous indication of Cannot tell with a valid reason		
	Ticks Cannot tell and They might have sold fewer drinks (in 2019)	B1	
	Ticks Cannot tell and It (only) gives percentages	B1	
	Ticks Cannot tell and It doesn't tell you how many coffees were sold	B1	
	Ticks Cannot tell and Don't have enough information	B1	
	Ticks Cannot tell and Both bars the same height	B0	
	Ticks Yes or ticks No	B0	

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="11">7(a)</td><td>Correct evaluation of the cube root of an integer [40, 50]
or
correct evaluation of the cube of a decimal or fraction (3, 3.5]</td><td>M1</td><td>eg $\sqrt[3]{40} = 3.4$ or $40 \rightarrow 3.4$

eg $3.5^3 = 42.8$ or $3.5 \rightarrow 42.8$</td></tr>
<tr><td>42</td><td>A1</td><td>SC1 answer given as $\sqrt[3]{42}$</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Up to M1 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">Condone eg $40 = 3.4$ or $\sqrt{40} = 3.4$ to mean $\sqrt[3]{40} = 3.4$</td><td></td></tr>
<tr><td colspan="2">Answer only 42</td><td>M1A1</td></tr>
<tr><td colspan="2">Must select 42 as final answer for M1A1 ie 42 as the last in a list with a blank answer line is not enough for A1 unless 42 selected</td><td></td></tr>
<tr><td colspan="2">If $\sqrt[3]{42}$ or 3.5^3 is evaluated then it must be correct to award the A1 for 42</td><td></td></tr>
<tr><td colspan="2">NB 42 only from incorrect method eg listing multiples of 3 or 42 ÷ 3 seen or 42 is divisible by 3 as the working</td><td>M0A0</td></tr>
<tr><td colspan="3">Acceptable values for cube roots of integers in range
<table>
<tr><td>40</td><td>3.4(19…) or 3.42(0)</td></tr>
<tr><td>41</td><td>3.4(48…) or 3.45</td></tr>
<tr><td>42</td><td>3.4(76…) or 3.48 or 3.5</td></tr>
<tr><td>43</td><td>3.5(03…)</td></tr>
<tr><td>44</td><td>3.5(30…)</td></tr>
<tr><td>45</td><td>3.5(56…) or 3.557 or 3.56 or 3.6</td></tr>
</table>
<table>
<tr><td>46</td><td>3.5(83…) or 3.6</td></tr>
<tr><td>47</td><td>3.6(08…) or 3.609 or 3.61</td></tr>
<tr><td>48</td><td>3.6(34…)</td></tr>
<tr><td>49</td><td>3.6(59…) or 3.66 or 3.7</td></tr>
<tr><td>50</td><td>3.6(84…) or 3.7</td></tr>
</table></td></tr>
<tr><td colspan="3">Examples of cubes of numbers in range with their acceptable values
<table>
<tr><td>3.1</td><td>29(.791) or 29.8 or 30</td></tr>
<tr><td>3.2</td><td>32(.768) or 32.77 or 32.8 or 33</td></tr>
<tr><td>3.3</td><td>35(.937) or 35.94 or 36</td></tr>
</table>
<table>
<tr><td>3.4</td><td>39(.304)</td></tr>
<tr><td>3.5 or $3.4\dot{9}$</td><td>42(.875) or 42.88 or 42.9 or 43</td></tr>
</table></td></tr>
</table>

Q	Answer	Mark	Comments
7(b)	Valid response that indicates there is one (negative) answer missing	B1	eg -10 (is also an answer) or there is a negative value as well or square roots have two answers or answer is 10 and -10
	Additional Guidance		
	-10×-10 (= 100)		B1
	Another number can square to make 100 (implies exactly two)		B1
	She has forgotten the other value (implies exactly two)		B1
	There is another value it could be (implies exactly two)		B1
	It could be a different number (implies exactly two)		B1
	It could be negative (bod means 10 could be -10)		B1
	-10^2 (= 100) (condone missing brackets around -10)		B1
	$\pm \sqrt{100}$		B1
	Indication that there might be **more** than two possible values for x eg There are other possible numbers eg There could be other values eg Other numbers square to make 100 eg She hasn't included negatives		 B0 B0 B0 B0
	Repeating the question eg There is more than 1 possible value eg 10 is not the only possible value eg More than 1 number works		 B0 B0 B0
	A partially correct statement eg x could be negative or decimal eg $-10 \times -10 = -100$ eg $x^2 = -10$		 B0 B0 B0

Q	Answer	Mark	Comments
8(a)	11 5 4 or 10 7 3 or 10 6 4 or 9 8 3 or 9 7 4 or 9 6 5 or 8 7 5	B2	any order B1 answer of three positive numbers in any order with sum 20 eg 17 2 1 or $9\frac{1}{2}$ $8\frac{1}{2}$ 2 or 10 5 5 or $6\frac{2}{3}$ $6\frac{2}{3}$ $6\frac{2}{3}$ or correct equation in w, x and y eg $4w + 4x + 4y = 80$ or $w + x + y = 20$

Additional Guidance	
Ignore attempts to work out the volume or surface area eg 10 5 5 volume calculated as 500	B1
Negative numbers and/or zero used	B0
$wxy > 200$ or $wxy = 200$	B0
Allow $6.\dot{6}$ for $6\frac{2}{3}$	

Q	Answer	Mark	Comments
8(b)	$54a^2$	B1	

Q	Answer	Mark	Comment
9	1225	B1	

Q	Answer	Mark	Comment
10	**Alternative method 1** Works out nth term of new sequence		
	Common difference of 5 identified	M1	implied by $5n$ …
	$5n + 3$	A1	oe eg $8 + 5(n - 1)$
	their $(5n + 3) - (n + 1)$	M1	oe their $(5n + 3)$ must be a linear expression condone missing brackets
	$4n + 2$	A1ft	oe eg $6 + 4(n - 1)$ ft their $5n + 3$ which must be a linear expression missing brackets must be recovered
	Alternative method 2 Works out terms of sequence A and sequence B		
	2, 3, 4	M1	sequence A
	6, 10, 14	A1	sequence B
	Common difference of 4 identified	M1	ft their 6, 10, 14 which must be a linear sequence for B
	$4n + 2$	A1ft	oe eg $6 + 4(n - 1)$ ft their 6, 10, 14 which must be a linear sequence for B
	Additional Guidance		
	Choose the scheme that favours the student		

Q	Answer	Mark	Comments
11(a)	$1.2 \times 20 = 24$ and $40 - 24 = 16$	B1	oe eg $1.2 \times 20 = 24$ and $24 + 16 = 40$ or $40 - 16 = 24$ and $24 \div 20 = 1.2$ or $24 + 16 = 40$ and $24 \div 1.2 = 20$ may be seen as one calculation eg $40 - 1.2 \times 20 = 16$ or $16 + 1.2 \times 20 = 40$ or $40 - 16 = 1.2 \times 20$
	Additional Guidance		
	$40 - 24 = 16$ and $40 - 16 = 24$ and $24 + 16 = 40$ are equivalent		
	$1.2 \times 20 = 24$ and $24 \div 1.2 = 20$ and $24 \div 20 = 1.2$ are equivalent		
	$40 - 24 = 16$ or $16 + 24 = 40$ or $40 - 16 = 24$		B0
	(20 minutes =) 24 litres leak out $40 - 24 = 16$		B0
	$1.2 \times 20 = 24$ 16 litres left		B0
	Allow unambiguous working in ml and/or seconds		
	For eg $40 - 24 = 16$ condone $24 - 40 = 16$ or $24 - 40 = -16$		
	Condone incorrect use of equals sign eg $1.2 \times 20 = 24 + 16 = 40$ or $1.2 \times 20 = 24 - 40 = 16$		B1
	Correct response with irrelevant work		B1
	16 from two different ways with one way incorrect is choice eg $1.2 \times 20 = 24$ and $40 - 24 = 16$ and $20 \div 1.2 = 16$		B0

Q	Answer	Mark	Comments
11(b)	3	B1	
	Correct method for gradient eg $\frac{40-16}{15-\text{their } 3}$ or $\frac{24}{12}$	M1	oe eg $\frac{30-25}{10-7.5}$ or $\frac{10}{5}$ or $40-38$
	2	A1ft	correct or ft their 3
	Additional Guidance		
	Note that their 3 can be used to work out the rate but does not have to be		
	Values seen on graph must be used correctly eg 24 and 12 seen on the graph is M0 unless subsequently used correctly in attempt to work out the gradient		
	A1ft answers must be to 1 dp or better eg 3.5 $\frac{40-16}{15-3.5}$ 2.1 (accept 2.08…)		B0 M1 A1ft
	After B0 the method may be implied (use $\frac{40-16}{15-\text{their } 3}$ to check) eg 6 2.7 (accept 2.66…)		B0 M1A1ft
	If the report is blank, 3 and 2 must be unambiguously identified in working to be acceptable		
	Allow 2 to be written as $\frac{2}{1}$		

Q	Answer	Mark	Comments
12	**Alternative method 1**		
	$6x + x + 5x + 6x + x + 6x + x$ or $26x$ or $6 + 1 + 5 + 6 + 1 + 6 + 1$ or 26	M1	oe eg $7x + 6x - x + 6x + x + 6x + x$ $26x$ or 26 is implied by 3.8 oe if addition not seen
	their $26x = 98.8$ or 98.8 ÷ their 26 or 3.8 or $\frac{19}{5}$	M1	oe equation must have terms collected if 1st M1 **not** awarded their $26x$ must be $24x$ or $25x$ or $27x$ if 1st M1 **not** awarded their 26 must be 24 or 25 or 27
	their 3.8 × 14	M1dep	dep on 2nd M1 oe eg 45.6 + 7.6
	53.2	A1ft	oe ft their 3.8 if M0M2 awarded

Mark scheme and Additional Guidance continue on the next page

12 cont	**Alternative method 2**		
	$6x + x + 6x$ or $13x$ or $6 + 1 + 6$ or 13	M1	oe eg $6x + x + 5x + x$ $13x$ or 13 is implied by 3.8 oe if addition not seen
	their $13x = 98.8 \div 2$ or $49.4 \div$ their 13 or 3.8 or $\frac{19}{5}$	M1	oe equation must have terms collected if 1st M1 **not** awarded their $13x$ must be $12x$ if 1st M1 **not** awarded their 13 must be 12
	their 3.8×14	M1dep	dep on 2nd M1 oe eg $49.4 + 3.8$
	53.2	A1ft	oe ft their 3.8 if M0M2 awarded
	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		
	Follow through must be to at least 1 dp and their 26 or their 13 must be seen For information: 24 → 57.6… 25 → 55.3… 27 → 51.2… 12 → 57.6…		M0M1M1A1ft
	Both 2nd and 3rd method marks may be implied by their answer. If not using 24, 25, 26, 27, 12 or 13 you must have seen the first M1.		
	$27x = 98.8$ (1st M0, no addition seen, but $27x$ allowed) $\frac{98.8}{27} \times 14$, answer 51.2		M0M1 M1A1ft
	$7x + 5x + 6x + x + 6x + x = 20x$ (correct terms added with incorrect total) $98.8 \div 20 = 4.94$ 69.16 (multiplication by 14 implied)		M1 M1 M1A0
	$98.8 \div 20 = 4.94$ (1st M0, no addition seen, and 20 not allowed) 4.94×14, answer 69.16		M0M0 M0A0
	$6x + x + 5x + 6x + x + 6x + x = 26x^7$		M1M0M0A0

Q	Answer	Mark	Comment
13	**Alternative method 1** Works out *BC* using Pythagoras then works out *EH*		
	7^2 or 49 and 4.2^2 or 17.64	M1	oe
	$\sqrt{7^2 - 4.2^2}$ or $\sqrt{49 - 17.64}$ or $\sqrt{31.36}$ or 5.6	M1dep	oe implied by 11.76 as the area of the smaller triangle may be on diagram
	6 ÷ 4.2 × their 5.6 or 8	M1dep	oe full method to work out *EH* may be on diagram as *EH* or *FG* implied by 24 as the area of the larger triangle or 60 as the area of the rectangle
	0.5 × their 8 × 6 or 24 and their 8 × 7.5 or 60	M1dep	oe eg 0.5 × their 5.6 × 4.2 × $(6 \div 4.2)^2$ and their 8 × 7.5 **or** 0.5 × their 8 × (7.5 + 13.5)
	84	A1	

Mark scheme and Additional Guidance continues on the next two pages

13 cont	**Alternative method 2** Works out *ED* using similar triangles then works out *EH*		
	$6 \div 4.2 \times 7$ or 10	M1	oe may be on diagram
	(their 10)^2 or 100 and 6^2 or 36	M1dep	oe
	$\sqrt{(\text{their } 10)^2 - 6^2}$ or $\sqrt{100 - 36}$ or $\sqrt{64}$ or 8	M1dep	oe full method to work out *EH* may be on diagram as *EH* or FG implied by 24 as the area of the larger triangle or 60 as the area of the rectangle
	$0.5 \times$ their 8×6 or 24 and their 8×7.5 or 60	M1dep	oe eg $0.5 \times$ their $5.6 \times 4.2 \times (6 \div 4.2)^2$ and their 8×7.5 **or** $0.5 \times$ their $8 \times (7.5 + 13.5)$
	84	A1	

Mark scheme and Additional Guidance continue on the next page

13 cont	**Alternative method 3** Uses trigonometry to work out *BC* then works out *EH* or uses trigonometry to work out *EH*		
	(angle *ABC* =) $\sin^{-1}\left(\frac{4.2}{7}\right)$ or (angle *ABC* =) [36.8, 36.9] or (angle *BAC* =) $\cos^{-1}\left(\frac{4.2}{7}\right)$ or (angle *BAC* =) [53.1, 53.2]	M1	oe full method to work out *ABC* or *BAC*
	7 × cos (their [36.8, 36.9]) or 7 × sin (their [53.1, 53.2]) or 5.6 or tan (their [36.8, 36.9]) = $\frac{6}{EH}$ or tan (their [53.1, 53.2]) = $\frac{EH}{6}$	M1dep	oe full method to work out *BC* or partial method to work out *EH*
	6 ÷ 4.2 × their 5.6 or 8 or 6 ÷ tan (their [36.8, 36.9]) or 6 × tan (their [53.1, 53.2])	M1dep	oe full method to work out *EH* may be on diagram as *EH* or FG implied by 24 as the area of the larger triangle or 60 as the area of the rectangle
	0.5 × their 8 × 6 or 24 and their 8 × 7.5 or 60	M1dep	oe eg 0.5 × their 5.6 × 4.2 × $(6 \div 4.2)^2$ and their 8 × 7.5 **or** 0.5 × their 8 × (7.5 + 13.5)
	84	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		

Q	Answer	Mark	Comment
14	137 500 × 0.08 or 11 000	M1	oe eg 137 500 × 1.08 − 137 500
	their 11 000 ÷ 0.4 or 27 500	M1dep	oe may be seen in stages eg 11 000 ÷ 40 = 275 and 275 × 100
	their 27 500 × 6	M1dep	oe eg 137 500 + 27 500
	165 000	A1	SC2 2 227 500
	Additional Guidance		
	Up to M1 may be awarded for correct work with no answer, or incorrect answer, even if this is seen amongst multiple attempts		
	SC2 is from starting with 137 500 × 1.08		

Q	Answer	Mark	Comments
15	1 cm^2 = 100 mm^2	B1	

Q	Answer	Mark	Comment
16	$y = x^3 + 1$	B1	

Q	Answer	Mark	Comment
17	$\frac{5}{2}$	B1	

Q	Answer	Mark	Comment
18(a)	Median = 99	B1	implied by correct line on box plot
	Lower quartile = 96	B1	implied by correct start of box
	Upper quartile = 109	B1	implied by correct end of box
	Fully correct box plot	B1ft	ft their stated median, LQ and UQ whiskers must be correct
	Additional Guidance		
	First 3 marks can be awarded even if a box plot is not drawn		

Q	Answer	Mark	Comment
18(b)	Home and valid reason referring to median	B1ft	eg Home and median is higher (in home games) ft their box plot or their values
	Additional Guidance		
	Strict ft		
	Values for the medians do not need to be stated, but if stated they must be 106 and correct for their box plot		
	Use of any other measure along with correct response is B0 eg Home as median is higher and so is the biggest value	B0	
	106 is bigger than 99 so Home	B1	
	Home matches as the average was 7 more	B1	
	Median home 106 Median away is 99 So Home	B1	
	Median home 106 Median away is 99	B0	
	Home as my box plot shows it	B0	
	Home. The mean is 7 more	B0	
	Home as the average is higher	B0	
	They generally do better in home matches so Home	B0	

Q	Answer	Mark	Comment
18(c)	Away and valid reason referring to interquartile range	B1ft	eg Away and interquartile range is lower (in away games) ft their box plot or their values
	Additional Guidance		
	Strict ft		
	Values for the interquartile ranges do not need to be stated, but if stated they must be 22 and correct for their box plot		
	Answer states that ranges are equal alongside a correct response		B1
	Answer based on range only		B0
	Use of any other measure (apart from range) along with correct response is B0 eg Away as IQR is lower and the upper quartile is also lower		B0
	13 is lower than 22 so Away		B1
	Away matches as the spread was 9 less		B1
	Away matches as the spread was lower		B0
	Away because the box is narrower		B1
	IQR home 22 IQR away is 13 So Away		B1
	IQR home 22 IQR away is 13		B0
	Away as my box plot shows it		B0
	Away. The LQ is bigger		B0
	Away as the average is lower		B0
	They generally do worse in away matches so Away		B0

Q	Answer	Mark	Comment
19	$\frac{-1\pm\sqrt{1^2-4\times3\times-5}}{2\times3}$ or $-\frac{1}{6}\pm\sqrt{\frac{5}{3}+\frac{1}{36}}$	M1	oe eg $\frac{-1\pm\sqrt{1+60}}{6}$ or $-\frac{1}{6}\pm\sqrt{\frac{60}{36}+\frac{1}{36}}$
	$\frac{-1\pm\sqrt{61}}{6}$ or $-\frac{1}{6}\pm\sqrt{\frac{61}{36}}$ or 1.135… and −1.468…	A1	oe two solutions eg $-\frac{1}{6}+\frac{1}{6}\sqrt{61}$ and $-\frac{1}{6}-\frac{1}{6}\sqrt{61}$ allow decimal solutions rounded to at least 1 dp eg allow 1.14 and −1.5

Additional Guidance	
Both solutions correct	M1A1
Both solutions seen in working but only one on answer line	M1A0
Ignore conversion attempt after correct surd form solutions seen unless only one solution is subsequently selected	
Working must be for two solutions to score eg $\frac{-1+\sqrt{1^2-4\times3\times-5}}{2\times3}$ not recovered	M0
Square root sign should cover all appropriate work unless recovered eg $-\frac{1}{6}\pm\sqrt{\frac{5}{3}}+\frac{1}{36}$ not recovered	M0
Fraction line should be under all appropriate work unless recovered eg $-1\pm\frac{\sqrt{61}}{6}$ not recovered	M0
One solution correct does not imply M1	
Both solutions seen in working but signs transposed on answer line	M1A0
$\sqrt{(1^2-4\times3\times-5)}$ is correct for $\sqrt{1^2-4\times3\times-5}$	

Q	Answer	Mark	Comment
20	**Alternative method 1**		
	$7 \times 5 \times 11$ or 385 or $3 \times 2 \times 4$ or 24 or $\frac{3}{7}$ or $\frac{2}{5}$ or $\frac{4}{11}$	M1	oe
	$\frac{3\times2\times4}{7\times5\times11}$ or $\frac{24}{385}$ or 0.062(…)	M1dep	oe eg $\frac{3}{7} \times \frac{2}{5} \times \frac{4}{11}$
	6.2(...) **or** 0.062(…) and 0.05	A1	allow 6 with M2 scored **or** allow 0.06 and 0.05 with M2 scored
	Alternative method 2		
	$3 \times 2 \times 4$ or 24	M1	oe
	$0.05 \times 7 \times 5 \times 11$ or 0.05×385 or 19(.25) or 19.3	M1	oe
	24 and 19(.25) **or** 24 and 19.3	A1	
	Additional Guidance		
	Up to M1 may be awarded for correct work with no answer, or incorrect answer, even if this is seen amongst multiple attempts		
	Alt 1 6 or 0.06 without M2 scored is A0		
	Alt 1 6.2(...) with no working		M2A1
	Alt 2 24 and 19 with no working		M2A1
	Do not allow any misreads		

Q	Answer	Mark	Comment
21(a)	**Alternative method 1**		
	$6\left(\frac{3x+9}{5}\right)-1$	M1	oe eg $\frac{18x+49}{5}$
	17	A1	SC1 8.4 oe value
	Alternative method 2		
	$\frac{3\times2+9}{5}$ or 3 or g(3)	M1	oe eg $6 \times 3 - 1$
	17	A1	SC1 8.4 oe value
	Additional Guidance		
	Answer 17		M1A1
	Working out f(2) and g(2) is M0 unless recovered eg1 $\frac{3\times2+9}{5}=3$ $6 \times 2 - 1 = 11$ eg2 $3 \times 11 = 33$		M0A0 M0A0
	17 followed by further work eg $17 \times 3 = 51$		M1A0
	SC1 is for fg(2)		

Q	Answer	Mark	Comment
21(b)	**Alternative method 1**		
	$\frac{5x-9}{3}$ or $\frac{5y-9}{3}$ or $\frac{5\times 8-9}{3}$	M1	oe
	$\frac{31}{3}$ or $10\frac{1}{3}$ or 10.3(…)	A1	
	Alternative method 2		
	$\frac{3x+9}{5}=8$	M1	oe equation
	$\frac{31}{3}$ or $10\frac{1}{3}$ or 10.3(…)	A1	
	Additional Guidance		
	$\frac{31}{3}$ or $10\frac{1}{3}$ or 10.3(…)		M1A1
	Ignore conversion attempt after correct answer seen		

Q	Answer	Mark	Comment
22	$x(x^2 - 49)$ or $(x^2 + 7x)(x - 7)$ or $(x^2 - 7x)(x + 7)$	M1	oe partial factorisation eg $x(x^2 - 7^2)$ any order eg $(x^2 - 49)x$
	$x(x + 7)(x - 7)$	A1	oe full factorisation any order eg $(x + 7)x(x - 7)$
	Additional Guidance		
	M1 may be awarded for correct work with no answer, or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore correctly placed multiplication signs		
	Ignore missing final bracket eg $x(x - 7)(x + 7$		M1A1
	Allow x to be $1x$ throughout		
	Allow x to be $(x + 0)$ or $(x - 0)$ throughout		
	Ignore any equating to zero		
	Ignore any attempt to 'solve'		
	$x(-7 + x)(7 + x)$		M1A1

Q	Answer	Mark	Comment
23(a)	1.5 × 6 or 9 or 3.5 × 4 or 14 or 5 × 2 or 10 or 4.5 × 4 or 18 or 2.5 × 4 or 10	M1	oe values 9, 14, 10 or 18 must be in the correct row in the table or linked to the correct bar on the histogram
	1.5 × 6 × 3 or 9 × 3 or 27 or 3.5 × 4 × 8 or 14 × 8 or 112 or 5 × 2 × 11 or 10 × 11 or 110 or 4.5 × 4 × 14 or 18 × 14 or 252 or 2.5 × 4 × 18 or 10 × 18 or 180 or 681	M1dep	oe values 27, 112, 110, 252 or 180 must be in the correct row in the table
	(their 27 + their 112 + their 110 + their 252 + their 180) ÷ (their 9 + their 14 + their 10 + their 18 + their 10) or 681 ÷ 61	M1dep	oe full correct method eg (their 27 + their 112 + their 110 + their 252 + their 180) ÷ 61
	[11.16, 11.2]	A1	accept 11 with M3 scored and no errors

Additional Guidance is on the next page

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

23(a) cont

Time, x, (hours)	Frequency	Midpoint	
$0 \leqslant x < 6$	9	3	27
$6 \leqslant x < 10$	14	8	112
$10 \leqslant x < 12$	10	11	110
$12 \leqslant x < 16$	18	14	252
$16 \leqslant x < 20$	10	18	180

M1M1

Time, x, (hours)	Frequency	Midpoint	
$0 \leqslant x < 6$	9	3	27
$6 \leqslant x < 10$	16	8	128
$10 \leqslant x < 12$	10	11	110
$12 \leqslant x < 16$	20	14	280
$16 \leqslant x < 20$	10	18	180

M1M1

Time, x, (hours)	Frequency	Midpoint	
$0 \leqslant x < 6$	1.5	3	4.5
$6 \leqslant x < 10$	3.5	8	28
$10 \leqslant x < 12$	5	11	55
$12 \leqslant x < 16$	4.5	14	63
$16 \leqslant x < 20$	2.5	18	45

M0M0

$(4.5 + 28 + 55 + 63 + 45) \div (1.5 + 3.5 + 5 + 4.5 + 2.5)$

$= 195.5 \div 17 = 11.5$

M0A0

Q	Answer	Mark	Comment
23(b)	Valid reason	B1	eg the data is grouped or the exact values are not used or the midpoints are estimates
	Additional Guidance		
	Because we are using midpoints		B1
	Midpoint is an average		B1
	There are no raw data		B1
	Numbers are rounded		B0
	There are no data to use		B0
	The answer is a decimal		B0
	Valid reason with an irrelevant statement		B1

Q	Answer	Mark	Comment
24	$247 - 170$ or 77	M1	oe may be on diagram
	$23 \times 1\frac{1}{2}$ or 34.5	M1	oe eg $23 + 11.5$ or $23 \times 90 \div 60$ or 23×1.5 may be on diagram
	(their 34.5)$^2 + 60^2 - 2 \times$ their 34.5 $\times$ 60 $\times$ cos (their 77) or [3858, 3859]	M1dep	oe dep on at least one M scored
	$\sqrt{\text{their } [3858, 3859]}$ or 62.1(…)	M1dep	oe eg $\sqrt{34.5^2 + 60^2 - 2 \times 34.5 \times 60 \times \cos 77}$ dep on 3rd M1
	No and 62.1(…)	A1	oe eg 62.1 and the ship is further away accept No and 62 with M4 scored
	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		
	2nd M1 Do not accept 23×1.30 unless recovered		

Q	Answer	Mark	Comment
25	Any one of $(\overrightarrow{QW} =) \mathbf{a} + \mathbf{b} - \frac{1}{3}\mathbf{a}$ $(\overrightarrow{WX} =) \frac{1}{3}\mathbf{a} + \frac{1}{2}\mathbf{b}$ $(\overrightarrow{QX} =) \mathbf{a} + \mathbf{b} + \frac{1}{2}\mathbf{b}$	M1	oe eg $(\overrightarrow{QW} =) \frac{2}{3}\mathbf{a} + \mathbf{b}$ or $(\overrightarrow{WX} =) -\frac{2}{3}\mathbf{a} + \mathbf{b} + \mathbf{a} - \frac{1}{2}\mathbf{b}$ or $(\overrightarrow{QX} =) \mathbf{a} + \frac{3}{2}\mathbf{b}$ allow use of $\overrightarrow{WQ}$ and/or $\overrightarrow{XW}$ and/or $\overrightarrow{XQ}$
	Any two of $(\overrightarrow{QW} =) \mathbf{a} + \mathbf{b} - \frac{1}{3}\mathbf{a}$ $(\overrightarrow{WX} =) \frac{1}{3}\mathbf{a} + \frac{1}{2}\mathbf{b}$ $(\overrightarrow{QX} =) \mathbf{a} + \mathbf{b} + \frac{1}{2}\mathbf{b}$	M1dep	oe allow use of $\overrightarrow{WQ}$ and/or $\overrightarrow{XW}$ and/or $\overrightarrow{XQ}$
	Any valid pair of vectors and indication that one vector is a multiple of the other eg $\overrightarrow{QW} = \frac{2}{3}\mathbf{a} + \mathbf{b}$ and $\overrightarrow{WX} = \frac{1}{3}\mathbf{a} + \frac{1}{2}\mathbf{b}$ and $\frac{2}{3}\mathbf{a} + \mathbf{b} = 2\left(\frac{1}{3}\mathbf{a} + \frac{1}{2}\mathbf{b}\right)$	A1	eg $\overrightarrow{QW} = \frac{2}{3}\mathbf{a} + \mathbf{b}$ and $\overrightarrow{XQ} = -\mathbf{a} - \frac{3}{2}\mathbf{b}$ and $3\overrightarrow{QW} = -2\overrightarrow{XQ}$ **or** $\overrightarrow{QX} = \mathbf{a} + \frac{3}{2}\mathbf{b}$ and $\overrightarrow{WX} = \frac{1}{3}\mathbf{a} + \frac{1}{2}\mathbf{b}$ and WX is $\frac{1}{3}$ of QX and WX is parallel to QX
	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		

Q	Answer	Mark	Comment
26	$6 \times 10 \div 2$ or 30 or 6×90 or 540 or 570	M1	oe eg $\frac{1}{2} \times \frac{6}{10} \times 10^2$ or $\frac{1}{2} \times (100 + 90) \times 6$ may be on diagram
	$800 - 6 \times 10 \div 2 - 6 \times 90$ or 800 – their 30 – their 540 or 800 – their 570 or 230	M1dep	oe full method for remaining distance may be on diagram may be embedded eg $230 \div 40$
	$\frac{1}{2} \times (v + 6) \times 40 =$ their 230 $2 \times$ their $230 \div 40 - 6$	M1dep	oe eg $20v + 120 =$ their 230 any letter
	5.5	A1	oe value
	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		

Q	Answer	Mark	Comment
27	$\frac{n}{25}$ and $\frac{n-1}{24}$	M1	oe may be implied eg $\frac{n(n-1)}{600}$
	$n^2 - n - 210$ (= 0)	M1dep	oe with all terms fully simplified eg $n^2 - n = 210$
	$(n - 15)(n + 14)$ or $\frac{-(-1) \pm \sqrt{(-1)^2 - 4 \times 1 \times -210}}{2 \times 1}$ or $\frac{1}{2} \pm \sqrt{210 + \frac{1}{4}}$	M1	oe eg $\frac{1 \pm \sqrt{841}}{2}$ or $\frac{1 \pm 29}{2}$ or 0.5 ± 14.5 ft their 3-term quadratic
	15	A1	15 and –14 is A0
	Additional Guidance		
	Answer 15 with no working or from trial		M3A1
	Beware Answer 15 from incorrect working eg $\frac{n}{25} \times \frac{n}{25} = \frac{7}{20}$ $n^2 = 218.75$ $n = 15$		M0M0M0A0
	Allow n to be N or x etc		
	3rd M1 Allow $(-1)^2$ to be 1^2		
	3rd M1 Do not allow $(-1)^2$ to be -1^2 unless recovered		
	3rd M1 Allow ± to be +		
	3rd M1 Square root sign should cover all appropriate work unless recovered eg $\frac{1 \pm \sqrt{1} + 840}{2}$ not recovered		M0
	3rd M1 Fraction line should be under all appropriate work unless recovered eg $1 \pm \frac{\sqrt{841}}{2}$ not recovered		M0
	3rd M1 $\sqrt{((-1)^2 - 4 \times 1 \times -210)}$ is correct for $\sqrt{(-1)^2 - 4 \times 1 \times -210}$		

Q	Answer	Mark	Comment
28	$\frac{EP}{\sin 35} = \frac{29}{\sin 114}$ or $\frac{29 \sin 35}{\sin 114}$	M1	oe eg $\frac{\sin 35}{EP} = \frac{\sin 114}{29}$ or $\frac{EP}{\sin 35} =$ [31.7, 31.7445]
	[18.2, 18,21]	A1	accept 18 with M1 scored
	Additional Guidance		
	EP may be *PE* or x etc		
	Do not regard 31 as a misread of 35		