GCSE
MATHEMATICS
8300/2H

Higher Tier Paper 2 Calculator

Mark scheme

June 2024

Version: 1.0 Final

2 4 6 G 8 3 0 0 / 2 H / M S

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

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

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

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

Copyright information

AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Copyright © 2024 AQA and its licensors. All rights reserved.

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	segment	B1	region A
	sector	B1	region B

Q	Answer	Mark	Comments
2	88(%) or 0.88	M1	oe eg $1 - 0.12$
	$2\,200\,000 \div 88$ ($\times 100$) or $25\,000$ ($\times 100$)	M1dep	oe eg $2.2 \times 10^6 \div (100 - 12)$ ($\times 100$) or $2\,200\,000 \times$ [1.136, 1.14] or $2\,500\,000$
	2.5×10^6	A1	oe standard form eg $2.500\,000 \times 10^6$ SC1 2.2×10^6 oe standard form seen SC1 any value seen converted to standard form
	Additional Guidance		
	M1 or SC1 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 or incorrect working eg $3\,000\,000 \times 0.88$ or 88% of $2\,200\,000$		M1
	$2\,200\,000 \div 88\%$ not recovered		M1M0
	$2\,200\,000 \times 1.12 = 2\,464\,000$ $2.464 \times 10^6 = 2.5 \times 10^6$		SC1

Q	Answer	Mark	Comments
3(a)	The number of blueberries in the tub	B1	

Q	Answer	Mark	Comments
3(b)	<table><tr><td>2</td><td>6</td><td>8</td></tr><tr><td>120</td><td>40</td><td>30</td></tr></table>	B2	B1 40 or 8 in the correct position or (k =) 120 × 2 or (k =) 240 seen
	Additional Guidance		
	(k =) 240 or (k =) 120 × 2 may be seen anywhere on the page		
	240 may be seen embedded in the formula eg $120 = \frac{240}{2}$		B1

Q	Answer	Mark	Comments
4(a)	The same number of 7s as even numbers	M1	any order may be in a list or on the spinner must be at least one 7
	5, 5, 6, 7, 7, 8	A1	any order may be in a list or on the spinner may be implied
	$\frac{2}{6}$	A1ft	oe fraction, decimal or percentage ft M1A0 with completed spinner or list of six numbers
	Additional Guidance		
	Ignore simplification or conversion attempt after correct answer seen		
	Accept 0.33(…) or 33.(…)% for $\frac{2}{6}$		
	A list/spinner with blanks and/or using other numbers may still score M1 eg 5, 5, 7, 10 or 5, 6, 7, 7, 8, 9		M1
	$\frac{2}{6}$ with no incorrect working eg 5, 6, 7, 8 on spinner with 2 blanks answer $\frac{2}{6}$ (M1A1 is implied)		M1A1A1
	5, 5, 6, 6, 7, 7 with answer $\frac{2}{6}$		M1A0A1ft
	5, 5, 5, 5, 6, 7 with answer $\frac{4}{6}$		M1A0A1ft
	5, 6, 6, 7, 7, 9 with answer $\frac{2}{6}$		M1A0A0ft
	5, 5, 5, 5, 5, 6 with answer $\frac{5}{6}$		M0A0A0ft

Q	Answer	Mark	Comments
4(b)	Valid reason	B1	eg sum of probabilities is not 1
	Additional Guidance		
	Ignore irrelevant statements alongside a correct statement eg the sum of the probabilities is not 1 and the probabilities are not percentages	B1	
	Do not ignore incorrect statements alongside a correct statement eg the sum of the probabilities is 0.11 not 1	B0	
	They add up to 1.1	B1	
	They add up to 110%	B1	
	It is 0.1 too much	B1	
	One of the probabilities is 0.1 too much	B1	
	It should be something like 0.1, 0.2, 0.3, 0.4	B1	
	B should be 0.4	B1	
	They don't add up correctly	B0	
	They add up to 0.11	B0	
	It's not a fair spinner	B0	

Q	Answer	Mark	Comments
5(a)	*C* (0, 6)	B1	if answer space is blank, accept (0, 6) written at *C* on the diagram
	D (3, 0)	B1	if answer space is blank, accept (3, 0) written at *D* on the diagram
	Additional Guidance		
	For each part mark the answer space unless blank		
	Allow x and y written above the coordinates but do not allow eg (0x, 6y)		

Q	Answer	Mark	Comments
5(b)	5	B1	
	3	B1	
	Additional Guidance		
	Mark the answer lines only		
	Do not allow eg (0, 5)		

Q	Answer	Mark	Comments
6	6.4×10^{-14}	B1	oe standard form eg 6.40×10^{-14}

Q	Answer	Mark	Comments
7	$\frac{52}{200}$ or $\frac{26}{100}$ or $\frac{13}{50}$	B1	oe fraction, decimal or percentage eg 0.26 or 26%
	Valid reason involving the number of trials	B1	eg it is from using the largest number of flips
	Additional Guidance		
	1st B1 Ignore simplification or conversion attempt after correct answer seen eg $\frac{52}{200} = 0.28$		1st B1
	52 out of 200 or 52 : 200		1st B0
	Probability from incorrect working eg $\frac{10+30+40+50}{50+100+150+200} = \frac{130}{500}$		1st B0
	Ignore irrelevant statements alongside a correct statement eg Using most flips and they could have done more		2nd B1
	Do not ignore incorrect statements alongside a correct statement eg Uses all the flips but they could have used 100 flips		2nd B0
	It uses all the flips		2nd B1
	More spins		2nd B1
	200 is the largest amount of data		2nd B1
	200 is the highest number		2nd B1
	200 is the total number of flips		2nd B0
	200 flips gives 52 heads		2nd B0
	200 is the final result		2nd B0
	That is the highest number in the table		2nd B0
	The highest results are more accurate		2nd B0
	100 flips is easier to work out		2nd B0
	He could use any of the results		2nd B0
	B0B1 is possible eg Answer 27% Reason Use the one from most spins		B0B1

Q	Answer	Mark	Comments
8	A change in distance for an integer time interval or a change in distance for a non-integer time interval with the corresponding time interval	M1	integer time intervals are [88, 92] [70, 74] [52, 56] [34, 38] [16, 20] may be seen on graph
	$\frac{\text{their change in distance}}{\text{corresponding time interval}}$	M1dep	oe eg $\frac{[88, 92]}{5}$ must see their change in distance and the corresponding time interval division by 1 may be implied
	18	A1	SC1 24
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	90×5		M1M0
	(1 second) Answer [16, 20] is awarded at least M2		
	18 from incorrect working cannot score A1		
	18 followed by further work eg $18 \div 5 = 3.6$		M1M0

Q	Answer	Mark	Comments
9	Only intersection shaded	B1	mark intention

Q	Answer	Mark	Comments
10	**Alternative method 1: works year by year**		
	$90\,000 \times 1.03$ or $92\,700$ or $90\,000 \times 1.08$ or $97\,200$	M1	oe eg $90\,000 + 90\,000 \times 0.03$
	$90\,000 \times 1.03 \times 1.08$ or $100\,116$	M1dep	oe eg $92\,700 \times 1.08$
	$100\,116$ and Yes	A1	oe eg $100\,116 > 100\,000$ SC1 $99\,900$ seen
	Alternative method 2: uses multipliers		
	1.03×1.08 or $1.112(4)$	M1	oe
	$\frac{100\,000}{90\,000}$ or $1.111(\ldots)$ or $\frac{100\,000}{1.03 \times 1.08}$ or $[89\,895, 89\,900]$	M1	oe $\frac{100\,000}{1.03 \times 1.08}$ or $[89\,895, 89\,900]$ is M2
	$1.112(4)$ and $1.111(\ldots)$ and Yes or $[89\,895, 89\,900]$ and Yes	A1	oe eg $1.112(4)$ and $1.111(\ldots)$ so it is more SC1 $99\,900$ seen
	Additional Guidance		
	M1 or SC1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	A correct value is sufficient for showing working eg1 Alt 1 $100\,116$ eg2 Alt 1 $100\,116$ and Yes		 M2A0 M2A1
	Alt 1 $90\,000 \times 103\%$ not recovered		M0
	Alt 2 Yes cannot be implied only by an inequality		
	SC1 is from increasing $90\,000$ by 11%		

Q	Answer	Mark	Comments
11	$15 \times 20\,000 \div 100 \div 1000$	M2	oe full method eg $300\,000 \div 100 \div 1000$ or 0.2×15 or $0.00015 \times 20\,000$ M1 one correct step eg $15 \times 20\,000$ or $300\,000$ or $20\,000 \div 100$ or 200 or $20\,000 \div 1000$ or 20 or $15 \div 100$ or 0.15 or $15 \div 1000$ or 0.015 or 100×1000 or $100\,000$
	3	A1	
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	M2 will usually be seen in stages eg $20\,000 \div 100 = 200$ $200 \times 15 = 3000$ $3000 \div 1000$		M2
	M1 may be seen embedded in more than one step (extra steps could be incorrect) eg $15 \times 20\,000 \div 100$ or 3000 or $15 \times 20\,000 \div 1000$ or 300 or $20\,000 \div 100 \div 1000$ or 0.2 or $15 \div 100 \div 1000$ or 0.00015		M1
	Ignore their units for method marks		

Q	Answer	Mark	Comments
12	SSS	B1	

Q	Answer	Mark	Comments
13	15 × 7.2 or 108 **and** 18 × 7.6 or 136.8 **and** 7 × 8 or 56	M1	oe implied by 300.8 allow one product or fx value to be incorrect
	(108 + 136.8 + 56) ÷ 40 or 300.8 ÷ 40 or $\frac{188}{25}$	M1dep	oe do not allow if any exact fx or Σfx value is approximated
	7.52	A1	accept 7.5 if 7.52 in working lines with no incorrect method
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	15 × 7.2 18 × 7.6 7 × 8 (108 + 137 + 56) ÷ 40 (fx value 137 is approximated)		M1 M0
	108 + 136.8 + 56 = 300.8 300 ÷ 40 (Σfx value 300 is approximated)		M1 M0
	M1dep Missing brackets must be recovered eg 108 + 136.8 + 56 ÷ 40 not recovered		M1M0
	7.52 in working with answer $7.4 \leqslant d < 7.8$		M2A0

Q	Answer	Mark	Comments
14(a)	$15 = 3^2 + c$ or $(c =)$ 6	M1	oe
	7^2 + their 6	M1dep	oe
	55	A1	

Q	Answer	Mark	Comments
14(b)	It is impossible to tell	B1	

Q	Answer	Mark	Comments
15	**Alternative method 1: works out concrete poured in 30 minutes**		
	10.9 × 30 × 60 ÷ 1000 or 19.6(2) **or** 10.9 × 30 × 60 or 19 620 and 20 × 1000 or 20 000	M3	oe full method eg 10.9 × 1800 ÷ 1000 or 30 × 654 ÷ 1000 or 19 620 ÷ 1000 M2 two correct steps eg 10.9 × 30 × 60 or 19 620 or 10.9 × 30 ÷ 1000 or 0.327 or 10.9 × 60 ÷ 1000 or 0.654 or 30 × 60 ÷ 1000 or 1.8 M1 one correct step eg 10.9 × 30 or 327 or 10.9 × 60 or 654 or 10.9 ÷ 1000 or 0.0109 or 30 × 60 or 1800 or 30 ÷ 1000 or 0.03 or 60 ÷ 1000 or 0.06 or 20 × 1000 or 20 000
	19.6(2) and No **or** 19 620 and 20 000 and No	A1	oe eg 19.62 so it isn't

Question 15 continues on the next page

<table>
<tr><td rowspan="11">15
cont</td><td colspan="3">Alternative method 2: works out time for 20 tonnes at given rate</td></tr>
<tr><td>$20 \times 1000 \div 10.9 \div 60$ or [30.5, 30.6]

or

$20 \times 1000 \div 10.9$ or [1834, 1835]
and
30×60 or 1800</td><td>M3</td><td>oe full method
eg $20\,000 \div 10.9 \div 60$
or $20 \times$ [91.7, 91.74312] $\div 60$
or [1834, 1835] $\div 60$
M2 two correct steps
eg $20 \times 1000 \div 10.9$ or [1834, 1835]
or $20 \times 1000 \div 60$ or 333.(…)
or $20 \div 10.9 \div 60$ or [0.0305, 0.031]
or $1000 \div 10.9 \div 60$ or [1.52, 1.53]
M1 one correct step
eg 20×1000 or $20\,000$
or $20 \div 10.9$ or [1.83, 1.835]
or $20 \div 60$ or 0.33(…)
or $1000 \div 10.9$ or [91.7, 91.74312]
or $1000 \div 60$ or [16.6, 16.7]
or 10.9×60 or 654
or 30×60 or 1800</td></tr>
<tr><td>[30.5, 30.6] and No
or
[1834, 1835] and 1800 and No</td><td>A1</td><td>oe eg 30.6 so it isn’t</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Up to M2 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">M3 or M2 will usually be seen in stages
eg Alt 1 $10.9 \times 30 = 327$ $327 \times 60 = 19\,620$ $19\,620 \div 1000$</td><td>M3</td></tr>
<tr><td colspan="2">M2 or M1 may be seen embedded in more than one step (extra steps could be incorrect)</td><td></td></tr>
<tr><td colspan="2">No may be indicated by selecting the box or a statement in the working lines</td><td></td></tr>
<tr><td colspan="2">No cannot be implied only by an inequality</td><td></td></tr>
<tr><td colspan="2">A correct value is sufficient for showing working eg Alt 1 19.62 and No</td><td>M3A1</td></tr>
<tr><td colspan="2">Ignore their units throughout</td><td></td></tr>
<tr><td colspan="2">Other approaches are possible eg works out rate in kg per s for 20 tonnes in 30 minutes and compares to 10.9</td><td></td></tr>
</table>

Q	Answer	Mark	Comments
16	Fully correct box plot with shortest at 2.4 cm LQ at 4 cm median at 6 cm UQ at 7 cm longest at 9 cm	B3	mark intention B2 box plot with four correct plots and one incorrect/omitted plot or box plot with five correct plots and at most one extra plot B1 at least three correct plots
	Additional Guidance		
	A box plot must be a rectangle with 'whiskers'		
	Accept 'whiskers' ending in points rather than vertical lines		
	For B2 condone the median given as a point in the rectangle		

Q	Answer	Mark	Comments
17	$\frac{1}{4}x + 15 + \frac{2}{3}x - 44 = 180$	M1	oe equation
	$\frac{1}{4}x + \frac{2}{3}x = 180 - 15 + 44$ or $3x + 180 + 8x - 528 = 2160$	M1dep	oe equation with terms collected eg $\frac{11}{12}x = 209$ or oe equation with fractions eliminated eg $11x = 2508$
	$(x =)\ 209 \div \frac{11}{12}$ or $(x =)\ 228$	M1dep	oe calculation that leads to $(x =)\ 228$ eg $(x =)\ 2508 \div 11$ implied by 72 and 108
	72 : 108	A1	oe ratio eg 2 : 3 or 1 : 1.5 or $\frac{2}{3}$: 1
	Additional Guidance		
	Ignore simplification attempt after correct ratio seen eg 72 : 108 in working with answer 36 : 52		M3A1
	Accept [0.66, 0.67] for $\frac{2}{3}$		
	Accept [0.91, 0.92] for $\frac{11}{12}$		
	Accept [1.09, 1.1] for $\frac{12}{11}$		

Q	Answer	Mark	Comments
18	**Alternative method 1: only uses trigonometry**		
	$\cos 52 = \frac{x}{23.7}$	M1	oe eg $\sin(90 - 52) = \frac{x}{23.7}$ or $\frac{x}{\sin 38} = \frac{23.7}{\sin 90}$ accept [0.61, 0.62] for cos 52 or sin 38
	$23.7 \times \cos 52$	M1dep	oe eg $23.7 \times \sin 38 \div \sin 90$ accept [0.61, 0.62] for cos 52 or sin 38
	[14.59, 14.6]	A1	SC1 [18.4, 18.723]
	Alternative method 2: uses trigonometry and Pythagoras		
	23.7^2 and $(23.7 \times \sin 52)^2$ **or** [561.6, 561.7] and [338, 351]	M1	oe accept [0.78, 0.79] for sin 52 accept [18.4, 18.723] for $23.7 \times \sin 52$
	$\sqrt{23.7^2 - (23.7 \times \sin 52)^2}$ or $\sqrt{[210.6, 223.7]}$	M1dep	oe accept [0.78, 0.79] for sin 52 accept [18.4, 18.723] for $23.7 \times \sin 52$
	[14.59, 14.6]	A1	SC1 [18.4, 18.723]
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	SC1 is from a diagonal making an angle of 38° with x		

Q	Answer	Mark	Comments
19(a)	One of $12x^2 + 8x$ $-12x^2 + 10x$ $-18x - 42$	M1	may be seen in a grid
	Two of $12x^2 + 8x$ $-12x^2 + 10x$ $-18x - 42$	M1dep	may be seen in a grid
	$12x^2 + 8x$ and $-12x^2 + 10x$ and $-18x - 42$ and -42	A1	must see 6 correct terms and a final simplification to -42
	Additional Guidance		
	For terms seen in a grid accept eg $8x$ for $+8x$		
	Accept multiplication signs between coefficients and algebra eg $12 \times x^2 + 8 \times x$		1st M1
	Accept eg $+ -12x^2$ for $-12x^2$		
	Do not accept unprocessed brackets eg do not accept $-(18x + 42)$		
	Crossed out terms are likely to be their working rather than deleted work		

Q	Answer	Mark	Comments
19(b)	$(4x + 5)(2x – 7)$	B2	oe factorisation eg $(–2x + 7)(–4x – 5)$ B1 $(ax + b)(cx + d)$ where $ac = 8$ and $bd = –35$ or $(ax + b)(cx + d)$ where $ac = 8$ and $ad + bc = –18$ allow multiplication signs for B2 or B1
	Additional Guidance		
	B1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	$(8x – 7)(x + 5)$ ($ac = 8$ and $bd = –35$)		B1
	$(2x – 3)(4x – 3)$ ($ac = 8$ and $ad + bc = –18$)		B1
	For B1 allow use of fractions or decimals eg $(4x + 10)(2x – 3.5)$		B1
	For B1 allow eg $8(x + 1.25)(x – 3.5)$		B1
	Condone missing final bracket for B2 or B1		
	Ignore any attempt to ‘solve’ eg $(4x + 5)(2x – 7)$ in working lines with –1.25 and 3.5 on answer lines		B2

Q	Answer	Mark	Comments
20	$x^2 - 9x + 3x - 27$ or $x^2 - 6x - 27$	M1	oe implied by eg $\frac{1}{2}x^2 - \frac{9}{2}x + \frac{3}{2}x - \frac{27}{2}$ may be seen in a grid
	their $(x^2 - 9x + 3x - 27) = 12 - 2x^2$	M1dep	oe equation with brackets expanded eg their $\left(\frac{1}{2}x^2 - \frac{9}{2}x + \frac{3}{2}x - \frac{27}{2}\right) = 6 - x^2$
	$3x^2 - 6x - 39$ (= 0) or $3x^2 - 6x = 39$	M1dep	oe $ax^2 + bx + c$ (= 0) or $px^2 + qx = r$ eg $x^2 - 2x - 13$ (= 0) or $\frac{3}{2}x^2 - 3x - \frac{39}{2}$ (= 0) implied by eg $\frac{2 \pm \sqrt{56}}{2}$
	$d = k \quad e = 14k^2 \quad f = k$ where k is a non-zero constant	A1	eg $d = 1 \quad e = 14 \quad f = 1$ or $d = 2 \quad e = 56 \quad f = 2$ or $d = 6 \quad e = 504 \quad f = 6$
	Additional Guidance		
	Take the values on the answer lines as the final answer eg $\frac{2 \pm \sqrt{56}}{2}$ in working with $d = 2 \quad e = \sqrt{56} \quad f = 2$ on answer lines		M3A0
	$1 \pm \sqrt{14}$ in working with $d = 1 \quad e = 14 \quad f =$ (blank)		M3A0
	For terms seen in a grid accept eg $3x$ for $+3x$		
	For up to M2 accept algebraic fractions but do not allow 3rd M1 unless recovered eg $\frac{x^2 - 9x + 3x - 27}{x + 3} = \frac{12 - 2x^2}{x + 3}$		M1M1

Q	Answer	Mark	Comments
21	**Alternative method 1: uses total and proportion in S with W**		
	$4480 \times \frac{9}{7}$ or 5760	M1	oe total in S with W eg 640×9
	$1 - \frac{1}{4} - \frac{3}{10}$ or $\frac{9}{20}$	M1	oe proportion in S with W eg 0.45 or 45%
	their 5760 ÷ their $\frac{9}{20}$	M1dep	oe full method dep on M2
	12 800	A1	
	Alternative method 2: uses total in S with W and total in N with E		
	$4480 \times \frac{9}{7}$ or 5760	M1	oe total in S with W eg 640×9
	$4480 \times \frac{11}{7}$ or 7040	M1	oe total in N with E eg 640×11
	their 5760 + their 7040	M1dep	oe full method eg 640×20 dep on M2
	12 800	A1	
	Alternative method 3: sets up an equation		
	$4480 \times \frac{9}{7}$ or 5760	M1	oe total in S with W eg 640×9
	$\frac{1}{4}x + \frac{3}{10}x$ + their 5760 = x	M1dep	oe equation in any variable eg $10x + 12x + 230\,400 = 40x$
	their 5760 ÷ $\left(1 - \frac{1}{4} - \frac{3}{10}\right)$	M1dep	oe full method eg 230 400 ÷ 18
	12 800	A1	

Question 21 continues on the next page

21 cont	**Alternative method 4: works out proportion in W or proportion in S**		
	$1-\frac{1}{4}-\frac{3}{10}$ or $\frac{9}{20}$	M1	oe proportion in S with W eg 0.45 or 45%
	$\frac{7}{9}$ × their $\frac{9}{20}$ or $\frac{7}{20}$ or $\frac{2}{9}$ × their $\frac{9}{20}$ or $\frac{2}{20}$	M1dep	oe proportion in W eg 0.35 or 35% eg $\frac{7}{7+2}$ × their $\frac{9}{20}$ or oe proportion in S eg 0.1 or 10% eg $\frac{2}{7+2}$ × their $\frac{9}{20}$
	4480 ÷ their $\frac{7}{20}$ or 4480 × $\frac{2}{7}$ ÷ their $\frac{2}{20}$	M1dep	oe full method eg 640 × 20
	12 800	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		
	Proportions can be percentages but in calculations values must be used eg Alt 1 5760 ÷ 45% is awarded M2 but cannot be awarded the 3rd M1 unless $\frac{9}{20}$ or 0.45 is subsequently used correctly		

Q	Answer	Mark	Comments
22	4.791	B3	B2 [4.789, 4.7913] B1 4 or 4.75
	Additional Guidance		
	Ignore values written as fractions		
	Ignore the suffixes		

Q	Answer	Mark	Comments
23	One correct expression eg $(\overrightarrow{DE} =)$ 6**a** + **b** + 2**a** – 5**b** or $(\overrightarrow{DF} =)$ 6**a** + **b** + 4**a** – 6**b** or $(\overrightarrow{EF} =)$ –2**a** + 5**b** + 4**a** – 6**b**	M1	oe eg $(\overrightarrow{ED} =)$ –6**a** – **b** – 2**a** + 5**b** or $(\overrightarrow{FD} =)$ –6**a** – **b** – 4**a** + 6**b** or $(\overrightarrow{FE} =)$ 2**a** – 5**b** – 4**a** + 6**b** accept unprocessed brackets eg $(\overrightarrow{EF} =)$ –(2**a** – 5**b**) + 4**a** – 6**b**
	Two correct expressions from $\overrightarrow{DE}$ $\overrightarrow{DF}$ $\overrightarrow{EF}$	M1dep	oe eg $\overrightarrow{DE}$ and $\overrightarrow{FD}$ accept unprocessed brackets
	Two fully simplified expressions from $(\overrightarrow{DE} =)$ 8**a** – 4**b** $(\overrightarrow{DF} =)$ 10**a** – 5**b** $(\overrightarrow{EF} =)$ 2**a** – **b**	A1	oe eg $(\overrightarrow{DE} =)$ 8**a** – 4**b** and $(\overrightarrow{FD} =)$ –10**a** + 5**b**
	Two fully simplified expressions from $(\overrightarrow{DE} =)$ 8**a** – 4**b** $(\overrightarrow{DF} =)$ 10**a** – 5**b** $(\overrightarrow{EF} =)$ 2**a** – **b** and valid indication that the vectors are parallel	A1	eg $(\overrightarrow{DE} =)$ 8**a** – 4**b** and $(\overrightarrow{FE} =)$ –2**a** + **b** and 8**a** – 4**b** = –4(–2**a** + **b**) or $(\overrightarrow{DF} =)$ 10**a** – 5**b** and $(\overrightarrow{EF} =)$ 2**a** – **b** and $\overrightarrow{DF} = 5\overrightarrow{EF}$
	Additional Guidance		
	Condone absence of vector notation		
	Condone eg $\overrightarrow{DCE}$ or *D* to *E* for $\overrightarrow{DE}$		
	If the only two correct expressions are eg $\overrightarrow{DE}$ and $\overrightarrow{ED}$ the maximum possible mark is M1		
	Only combining the three given vectors		Zero
	$\overrightarrow{DF} = \overrightarrow{DE} + \overrightarrow{EF}$ is not a valid indication		
	Stating eg $\overrightarrow{DF}$ is a (scalar) multiple of $\overrightarrow{EF}$ is not enough for the final A1		

Q	Answer	Mark	Comments
24(a)	$(k =)\ 21 \times 6$ or $(k =)\ 126$	M1	oe may be implied eg $y = \frac{126}{x}$
	10.5 or $\frac{21}{2}$	A1	oe value eg $\frac{126}{12}$ ignore units
	Additional Guidance		
	Ignore simplification or conversion attempt after correct answer seen		
	10.5 only seen embedded eg $10.5 \times 12 = 126$		M1A0

Q	Answer	Mark	Comments
24(b)	$21 = A \times \frac{1}{3}$ or $(A =)\ 21 \times 3$ or $(A =)\ 63$	M1	oe eg $21 = A \times \left(\frac{1}{3}\right)^{\frac{1}{6} \times 6}$ implied by $(y =)\ 7$
	$(y =)\ 7$ and middle box ticked	A1ft	ft decision using their 10.5 in (a) must have $(y =)\ 7$
	Additional Guidance		
	A correct value is sufficient for showing working		
	Decision may be indicated by selecting a box or a statement in the working lines		
	Decision cannot be implied only by an inequality		

Q	Answer	Mark	Comments
25	**Alternative method 1: works out a scale factor**		
	$\frac{1}{2} \times 3(L) \times 4(L) \times 12(L)$ or $72(L^3)$ where L is any variable or any positive value	M1	oe volume eg $(L = 2)$ $\frac{1}{2} \times 6 \times 8 \times 24$ or 576
	1125 ÷ their 72 or $\frac{125}{8}$ or 15.625	M1dep	oe eg $1125 \times 2 \div (3 \times 4 \times 12)$ eg $(L = 2)$ 1125 ÷ their 576 or $\frac{125}{64}$
	$\sqrt[3]{\text{their } \frac{125}{8}}$ or $\frac{5}{2}$ or 2.5	M1dep	oe eg $(L = 2)$ $\sqrt[3]{\text{their } \frac{125}{64}}$ or $\frac{5}{4}$ or 1.25
	2 × 3 × their 2.5 + 2 × 4 × their 2.5 + 2 × 5 × their 2.5 + 3 × 12 × their 2.5	M1dep	oe eg $(L = 2)$ 2 × 6 × their 1.25 + 2 × 8 × their 1.25 + 2 × 10 × their 1.25 + 3 × 24 × their 1.25
	150	A1	SC4 [119, 119.1]

Question 25 continues on the next page

25 cont	**Alternative method 2: works out a value of a, b, c or d**		
	Correct expression for volume in terms of a or b eg $\frac{1}{2} \times a \times \frac{4a}{3} \times \frac{12a}{3}$ or $\frac{8a^3}{3}$ or $\frac{1}{2} \times \frac{3b}{4} \times b \times \frac{12b}{4}$ or $\frac{9b^3}{8}$	M1	oe in terms of c or d eg $\frac{1}{2} \times \frac{3c}{5} \times \frac{4c}{5} \times \frac{12c}{5}$ or $\frac{72c^3}{125}$ or $\frac{1}{2} \times \frac{3d}{12} \times \frac{4d}{12} \times d$ or $\frac{d^3}{24}$ may be implied by an equation eg $a \times \frac{4a}{3} \times \frac{12a}{3} = 1125 \times 2$
	$a^3 = 1125 \div$ their $\frac{8}{3}$ or $a^3 = \frac{3375}{8}$ or $b^3 = 1125 \div$ their $\frac{9}{8}$ or $b^3 = 1000$	M1dep	oe eg $c^3 = 1125 \div$ their $\frac{72}{125}$ or $c^3 = \frac{15\,625}{8}$ or $d^3 = 1125 \div$ their $\frac{1}{24}$ or $d^3 = 27\,000$
	$a = \sqrt[3]{\text{their } \frac{3375}{8}}$ or $a = 7.5$ or $b = \sqrt[3]{1000}$ or $b = 10$	M1dep	oe eg $c = \sqrt[3]{\text{their } \frac{15\,625}{8}}$ or $c = 12.5$ or $d = \sqrt[3]{27\,000}$ or $d = 30$
	$2 \times$ their $a + 2 \times \frac{4}{3} \times$ their a $+ 2 \times \frac{5}{3} \times$ their $a + 3 \times \frac{12}{3} \times$ their a or $2 \times \frac{3}{4} \times$ their $b + 2 \times$ their b $+ 2 \times \frac{5}{4} \times$ their $b + 3 \times 3 \times$ their b	M1dep	oe correct method using their c or their d
	150	A1	SC4 [119, 119.1]
	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		