



GCSE
MATHEMATICS
8300/2H

Higher Tier Paper 2 Calculator

Mark scheme

June 2025

Version: 1.0 Final



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.

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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.

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 $a \leq \text{value} < b$
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(a)	8	B1	

Q	Answer	Mark	Comments
1(b)	30	B1	

Q	Answer	Mark	Comments
1(c)	$2 \times 3 \times 7$	B1	numbers in any order
	Additional Guidance		
	Condone full stops for multiplication signs		B1
	Ignore irrelevant brackets		
	Do not allow multiplication by one(s)		B0
	2, 3 and 7 circled on a factor tree with no evidence of multiplication		B0

Q	Answer	Mark	Comments
2	(first answer) $x = 3$ and (second answer) 0	B2	B1 (first answer) $x = 3$ or (second answer) 0
	Additional Guidance		
	$3 = x$ is equivalent to $x = 3$		
	Allow 'zero' for 0		
	Do not allow the second answer to be unprocessed eg do not allow $\frac{0}{4}$		

Q	Answer	Mark	Comments
3(a)	All six given points plotted correctly and joined with straight lines	B2	± half square B1 at least four of the given points plotted correctly
	Additional Guidance		
	Mark intention for straight lines		
	Lines can be dashed (do not regard as short lines if intention clear) or continuous		
	Ignore lines drawn to the left of day 1 and to the right of day 6		
	The top of the lines in a vertical line graph can imply points plotted correctly (other vertical lines can be ignored)		
	Ignore horizontal lines		
	Ignore extra points		
	Ignore a line of best fit and/or a histogram and/or a bar chart		

Q	Answer	Mark	Comments	
3(b)	[20 000, 40 000]	B1	may be implied	
	their [20 000, 40 000] \times 0.018 (\div 100) or [360, 720] (\div 100)	M1	oe eg their [20 000, 40 000] \times 0.000 18 1000 < their [20 000, 40 000] < 48 000 condone 0.02 for 0.018	
	[3.60, 7.20]	A1ft	ft B0M1 answer must be an amount of money	
	Additional Guidance			
	Accept an answer in pence only if £ has been crossed out and p(ence) is given			
	For A1 or A1ft accept answers rounded or truncated to the nearest penny eg $28\,700 \times 0.018 \div 100$ Answer 5.17 (or 5.16)			B1M1A1
	Using 0.02 can score a maximum of B1M1A0 eg1 $30\,000 \times 0.02 = 600$ Answer 6 eg2 $46\,000 \times 0.02 = 920$ Answer 9.20			B1M1A0 B0M1A0
	Estimating their final answer can score a maximum of B1M1A0 unless correct answer also seen eg1 $32\,000 \times 0.018 \div 100$ Answer 5.80 eg2 $32\,000 \times 0.018 \div 100 = 5.76$ Answer 5.80			B1M1A0 B1M1A1
	$30\,000 \times 0.018$ Answer 5.4			B1M1A0
	If part (b) is blank, B1 may be awarded for [20 000, 40 000] unambiguously stated for day 7 in part (a)			

Q	Answer	Mark	Comments	
4	Correct method for 40% of 70%	M1	eg 0.4×70 or 28 or 0.4×0.7 or $40\% \times 70\%$ or 0.28	
	Correct method for 50% of $(100 - 70)\%$	M1	eg 0.5×30 or 15 or 0.5×0.3 or $50\% \times 30\%$ or 0.15 0.43 or $1 - 0.42 - 0.15$ or $100 - 42 - 15$ implies M2	
	43	A1	SC2 57 SC1 0.57	
	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			
	Do not accept 'of' for 'x' eg 40% of 70% with no further correct method			1st M0
	0.4×0.7 and $0.5 \times (1 - 0.7)$ may be seen embedded eg1 (200 discs) $0.4 \times 0.7 \times 200$ $0.5 \times 0.3 \times 200$ eg2 (d discs) $0.4 \times 0.7 \times d$ $0.5 \times 0.3 \times d$			M1 M1 M1 M1
SC2 is for working out the percentage of discs that are not removed				

Q	Answer	Mark	Comments
5(a)	155 cm \leq length < 165 cm	B2	oe B1 155 or 165 in correct position SC1 165 cm \leq length < 155 cm
	Additional Guidance		
	Accept 164.9 for 165		
	Accept eg 155.0 for 155		

Q	Answer	Mark	Comments
	2.05 or $6.2 \div 3$ or $2.0\dot{6}$	M1	oe eg in cm
	2.05 × 3 and 6.15 or 205 × 3 and 6.15 or 205 × 3 and 615 and 620 or 2.0 $\dot{6}$ and 2.05 or 206. $\dot{6}$ and 205	A1	accept eg 2.05 + 2.05 + 2.05 for 2.05 × 3
5(b)	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Accept rounding or truncating of 2.0 $\dot{6}$ or 206. $\dot{6}$ to at least 4 sf Accept rounding or truncating of 2.0 $\dot{6}$ to 3 sf only if $6.2 \div 3$ is seen Accept rounding or truncating of 206. $\dot{6}$ to 3 sf only if $620 \div 3$ is seen		
	Accept 2.04 $\dot{9}$ for 2.05		
	Ignore any reference to lower bounds		
	Ignore reference to units		
	2.05 or 205 may be embedded eg $2.05 + 2.06 + 2.09 = 6.2$ with no further work or explanation	M1A0	
	2.06 + 2.06 + 2.08 = 6.2 with no further work or explanation 2.06 + 2.06 + 2.06 = 6.18 with a clear reference to 2.05 and a full explanation	M0A0 M1A1	

Q	Answer	Mark	Comments
6	$x + 5$	B1	

Q	Answer	Mark	Comments
7	$0.2 + 0.1$ or 0.3	M1	oe fractions, decimals or percentages
	$1 - 0.18 - 0.2$ – their P(C) or 0.32	M1	oe fractions, decimals or percentages $0 < \text{their P(C)} < 0.62$ implied by correct answer from their P(C)
	0.16	A1	oe fraction, decimal or percentage
	Additional Guidance		
	Probabilities may be seen in the table		
	Ignore conversion or simplification attempt after correct answer		

Q	Answer	Mark	Comments
8(a)	$20 \div \pi$ or [6.36, 6.37] or 6.4 or $20 \div 2\pi$ or [3.18, 3.185] or 3.2	M1	oe
	$\pi \times (20 \div 2\pi)^2 \times \frac{90}{360}$ or $\frac{100}{\pi} \times \frac{90}{360}$ or $\frac{25}{\pi}$	M1dep	oe full method
	[7.93, 7.97]	A1	
	Additional Guidance		
	Accept [3.14, 3.142] for π throughout		
	Ignore subsequent rounding after answer [7.93, 7.97] seen in working		

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

Q	Answer	Mark	Comments
9	No with correct reason	B1	eg of correct reasons it's gone up by 100% or going up by 200% would be 105 000
	Additional Guidance		
	Ignore non-contradictory statements alongside a correct reason eg No and Up 100% and influencers don't get that many followers		B1
	Incorrect statement with a correct reason is choice eg No and It's increased 100% as increase of 200% would be 140 000		B0
	Ticking Yes with a correct reason is choice eg Yes and It would be 105 000 if it was up 200%		B0
	No and If up by 200% you'd do 70 000 + 35 000		B1
	No and Adding 100% gives 70 000		B1
	No and $\frac{70000 - 35000}{35000} = 100\%$		B1
	No and $\frac{70000 - 35000}{35000}$		B0
	No and It is up 50%		B0
No and It is only up by 35 000		B0	

Q	Answer	Mark	Comments
10	Alternative method 1: uses or states tan		
	tan stated or used	M1	implied by [0.726, 0.73] or [1.376, 1.4]
	$\tan 36 = \frac{x}{4}$ or $4 \times \tan 36$ or $\tan 54 = \frac{4}{x}$ or $\frac{4}{\tan 54}$	M1dep	oe accept [0.726, 0.73] for tan 36 accept [1.376, 1.4] for tan 54
	[2.9, 2.91] with M2 awarded	A1	accept 3 with M2 awarded
	Alternative method 2: works out hypotenuse first		
	(hypotenuse =) $\frac{4}{\sin 54}$ or $\frac{4}{\cos 36}$ or 4.9(...)	M1	oe accept [0.8, 0.81] for sin 54 or cos 36
	$\sqrt{(\text{their } 4.9(\dots))^2 - 4^2}$ or $\sqrt{[8, 8.45]}$ or their $4.9(\dots) \times \sin 36$ or their $4.9(\dots) \times \cos 54$	M1dep	oe
	[2.9, 2.91] with M2 awarded	A1	accept 3 with M2 awarded
	Additional Guidance		
	Alt 1 SOHCAHTOA with TOA selected (eg circled)		M1
	[2.9, 2.91] with no working		M0M0A0
	[2.9, 2.91] from accurate/scale drawing only		M0M0A0

Q	Answer	Mark	Comments
11	67.5	B3	oe value eg $\frac{135}{2}$
			B2 135
			B1 45 or 1080
Additional Guidance			
	67.5 must be their answer for B3		

Q	Answer	Mark	Comments
12(a)	Correct reason	B1	eg the sample is biased or he hasn't asked enough people
	Additional Guidance		
	Ignore non-contradictory statements alongside a correct reason eg It is too small a sample to get the average view		B1
	Incorrect statement with a correct reason is choice eg Biased sample and he should have asked all the pupils in the school		B0
	He only asks people at the chess club		B1
	He is asking people who go to a club		B1
	It is biased		B1
	These 15 play chess, he doesn't ask anyone at any of the other clubs		B0
	He's asked people who went to chess club		B0
	A small group may be biased		B1
	It is too small		B1
	He has only asked 15 people		B1
	He has asked 15 people		B0
	These 15 people are random		B0

Q	Answer	Mark	Comments
12(b)	$100 - 62 - 24$ or 14 or $1 - 0.62 - 0.24$ or 0.14 or $93 \div 62$ or 1.5 or $93 \div 0.62$ or 150	M1	oe
	$(100 - 62 - 24) \times 93 \div 62$ or 14×1.5 or $(1 - 0.62 - 0.24) \times 93 \div 0.62$ or 0.14×150	M1dep	oe full method may be seen in stages
	21	A1	
	Additional Guidance		
	M1 may be implied eg 36 implies 150		M1
	Example of full method seen in stages $93 \div 0.62 = 150$ $0.24 \times 150 = 36$ $150 - 93 - 36$		M1 M1dep

Q	Answer	Mark	Comments
13	Alternative method 1: compares total times		
	154 ÷ 56 or 2.75 or 2 h 45 min	M1	oe time for Emma eg 165
	85 ÷ 50 or 1.7 or 1 h 42 min	M1	oe time for first 85 miles for Chan eg 102
	85 ÷ 50 + (154 – 85) ÷ 60 or 1.7 + 1.15 or 2.85 or 2 h 51 min	M1dep	oe total time for Chan eg 171 dep on 2nd M1
	2.75 and 2.85 and Emma or 2 h 45 min and 2 h 51 min and Emma	A1	oe two correct times in comparable form eg 165 and 171 and Emma
	Alternative method 2: compares average speeds		
	85 ÷ 50 or 1.7 or 1 h 42 min	M1	oe time for first 85 miles for Chan eg 102
	85 ÷ 50 + (154 – 85) ÷ 60 or 1.7 + 1.15 or 2.85 or 2 h 51 min	M1dep	oe total time for Chan eg 171
	154 ÷ their 2.85 or [54, 54.04]	M1dep	oe calculation for Chan's average speed
	[54, 54.04] and Emma	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		
	Ignore attempts to find the difference in times or speeds after A1 awarded		

Q	Answer	Mark	Comments
	$a = 5 \quad b = 2 \quad c = 4$ or $a = 5 \quad b = 3 \quad c = 1$ or $a = 5 \quad b = 1 \quad c = 7$	B3	B2 $3b + c = 10$ oe equation or $a = 5$ and values for b and c other than the correct values such that $3b + c = 10$ B1 $a = 5$ or values for b and c such that $3b + c = 2 \times$ their a
14	Additional Guidance		
	The value of a letter omitted on the answer line and not evaluated in working is not taken to mean the value is zero		
	$a = 5 \quad b = 0 \quad c = 10$	B2	
	$a = 5 \quad b = 4 \quad c = -2$	B2	
	$a = 5 \quad b = \frac{5}{3} \quad c = 5$	B2	
	$a = 50 \quad b = 40 \quad c = -20$	B1	
Condone use of \equiv for = eg $3b + c \equiv 10$	B2		

Q	Answer	Mark	Comments
15	$\frac{-5 \pm \sqrt{5^2 - 4 \times 3 \times -9}}{2 \times 3}$ or $\pm \sqrt{\left(\frac{5}{6}\right)^2 + 3} - \frac{5}{6}$	M1	oe eg $\frac{-5 \pm \sqrt{133}}{6}$ may be seen as two separate calculations
	[1.08, 1.09] or 1.1 and [-2.76, -2.75] or -2.8	A1	two decimal solutions in either order
	Additional Guidance		
	One value correct from T & I	M0	
	Only using one of + or – instead of ± is M0 unless recovered		
	$\sqrt{5^2 - 4 \times 3 \times -9}$ is M0 unless recovered		
	$-\frac{5}{6} \pm \sqrt{5^2 - 4 \times 3 \times -9}$ is M0 unless recovered		
	Both decimal solutions seen in working but only one on answer line	M1A0	
Both decimal solutions seen in working but signs transposed on answer line	M1A0		

Q	Answer	Mark	Comments
16	Alternative method 1: uses a starting price		
	100 – 12.1 or 87.9 or 1 – 0.121 or 0.879	M1	oe may be seen embedded eg 87.9% of 1000 or 0.879x
	price × 0.879 ⁵ or price × 0.879 ⁶	M1dep	oe a correct value from price × 0.879 ⁵ or price × 0.879 ⁶ implies M2 (allow rounding or truncating to nearest £ or better) ignore price × other powers of 0.879
	Correct value for price × 0.879 ⁵ and 6 or correct value for price × 0.879 ⁶ and 6	A1	allow rounding or truncating to nearest £ or better
	Alternative method 2: does not use a starting price		
	100 – 12.1 or 87.9 or 1 – 0.121 or 0.879	M1	oe may be seen embedded eg 87.9% of 1000 or 0.879x
	0.879 ⁵ or [0.52, 0.525] or 0.879 ⁶ or [0.46, 0.462]	M1dep	oe eg [52, 52.5](%) or [46, 46.2](%) ignore other powers of 0.879
	[0.52, 0.525] and 6 or [0.46, 0.462] and 6	A1	oe eg [52, 52.5](%) and 6 or [46, 46.2](%) and 6
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	An answer of 6 may come from other correct methods eg using logarithms Escalate if unsure		

Q	Answer	Mark	Comments
17	$\left(\frac{5}{5+2}\right)^4$ or $\left(\frac{5}{7}\right)^4$ or $\frac{625}{2401}$ or $\left(\frac{5}{7}\right)^2 \times \left(1 - \frac{5}{7}\right)^2$ or $\left(\frac{5}{7}\right)^2 \times \left(\frac{2}{7}\right)^2$ or $\frac{100}{2401}$	M1	oe eg $[0.71, 0.72]^4$ or $[0.25, 0.27]$ or $[0.71, 0.72]^2 \times [0.28, 0.29]^2$ or $[0.039, 0.044]$
	$\left(\frac{5}{7}\right)^4 \div \left[\left(\frac{5}{7}\right)^2 \times \left(\frac{2}{7}\right)^2\right]$ or $\frac{625}{2401} \div \frac{100}{2401}$	M1dep	oe full method eg $[0.71, 0.72]^4$ $\div ([0.71, 0.72]^2 \times [0.28, 0.29]^2)$ or $[0.25, 0.27] \div [0.039, 0.044]$
	6.25 or $6\frac{1}{4}$	A1	oe value eg $\frac{625}{100}$
	Additional Guidance		
Working in percentages can score up to 3 marks eg $[71, 72]^4$ or $[25\,000\,000, 27\,000\,000]$ or $[71, 72]^2 \times [28, 29]^2$ or $[3\,900\,000, 4\,400\,000]$ $[71, 72]^4 \div ([71, 72]^2 \times [28, 29]^2)$ 6.25			M1 M1dep A1
5^4 or 625 or $5^2 \times 2^2$ or 100 with no further correct working scores M0 but $5^4 \div (5^2 \times 2^2)$ or $625 \div 100$ scores M1M1			
Missing brackets must be recovered			

Q	Answer	Mark	Comments
18	116	B1	may be seen in CXB or AXD , where X is the common vertex
	$9.6^2 + 2.8^2 - 2 \times 9.6 \times 2.8 \times \cos(\text{their } 116)$ or [123.5, 123.7]	M1	oe $0 < \text{their } 116 < 180$ eg $92.16 + 7.84 - 53.76 \cos(\text{their } 116)$ accept $[-0.44, -0.438]$ for cos 116
	$\sqrt{\text{their } [123.5, 123.7]}$	M1dep	oe eg $\sqrt{9.6^2 + 2.8^2 - 2 \times 9.6 \times 2.8 \times \cos(\text{their } 116)}$ accept $[-0.44, -0.438]$ for cos 116
	[11.1, 11.1221]	A1	accept 11 with B1M2 awarded
	Additional Guidance		
Up to B1M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts			

Q	Answer	Mark	Comments	
19	$(80 - 65) \times 2.8$ or 15×2.8 or $(65 - 60) \times 2.8$ or 5×2.8	M1	oe method for frequency \geq age 65 or oe method for age $60 \leq$ frequency $<$ age 65	
	42 or 14	A1	frequency \geq age 65 or age $60 \leq$ frequency $<$ age 65 implied by 3850 or 131 368	
	their 42×129 or 5418 or $(4 \times 11.5 + 10 \times 13.2 + 10 \times 14.6 + 20 \times 6 + \text{their } 14) \times 275$ or $(46 + 132 + 146 + 120 + \text{their } 14) \times 275$ or $(500 - \text{their } 42) \times 275$ or 125 950	M1dep	oe method for total fee \geq age 65 or oe method for total fee $<$ age 65 5418 or 125 950 imply M1A1M1	
	131 368	A1	SC1 46 or 132 or 146 or 120 or 56 seen in working or on diagram implied by 12 650 or 36 300 or 40 150 or 33 000	
	Additional Guidance			
	Up to M1A1M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts			
	SC1 is for a correct frequency or total fee for any bar			

Q	Answer	Mark	Comments
20	Correct reason indicating that the circles should be unshaded or (x =) 4 is not a solution or (x =) -4 is not a solution	B1	eg the circles should be white or (x =) 4 doesn't satisfy $x^2 < 16$
	Additional Guidance		
	Ignore non-contradictory statements alongside a correct reason eg 4 is not a solution. Squaring a number is always ≥ 0	B1	
	Incorrect statement with a correct reason is choice eg Circles should be white and should be at -3 and 3	B0	
	Condone -4^2 if recovered to 16		
	Circles should be blank	B1	
	Circles crossed out and replaced with open circles above -4 and 4	B1	
	-4^2 is 16 so -4 shouldn't be a solution	B1	
	One circle should be white	B0	
	Coloured dot means equal to	B0	
	The circles are the wrong colour	B0	
	Both circles are black so he is doing x squared is 16	B0	
	4 squared is 16	B0	
	His solution is $-4 \leq x \leq 4$	B0	

Q	Answer	Mark	Comments
21(a)	$x^2 + y^2 = 45$	B1	oe accept $\sqrt{45}^2$ or $\sqrt{45^2}$ or $(3\sqrt{5})^2$ or $[6.7, 6.71]^2$ for 45
	Additional Guidance		
	Accept $(x - 0)^2$ for x^2 and $(y - 0)^2$ for y^2		
	Do not accept eg $a^2 + b^2 = 45$		

Q	Answer	Mark	Comments
21(b)	$\frac{-3-0}{6-0}$ or $-\frac{1}{2}$	M1	oe gradient of OP eg $\frac{0-(-3)}{0-6}$ may be embedded in an equation
	$-1 \div$ their $-\frac{1}{2}$ or 2	M1	oe gradient of tangent may be seen in equation of tangent their $-\frac{1}{2}$ cannot be from using 45 gradient of tangent = 2 with no incorrect working is M1M1
	$y - (-3) =$ their $2(x - 6)$ or $-3 =$ their $2 \times 6 + c$ or $c = -15$	M1dep	oe equation eg $y + 3 = 2x - 12$ dep on 2nd M1
	$y = 2x - 15$	A1	oe in form $y = mx + c$ eg $y = \frac{6}{3}x - 15$ accept $y = -15 + 2x$
	Additional Guidance		
	(gradient of $OP =$) $\frac{1}{2}$		M0
	(gradient of tangent =) -2		M1
	$y + 3 = -2(x - 6)$ $y = -2x + 9$		M1dep A0
(gradient of $OP =$) $\sqrt{45}$ (may be seen as $3\sqrt{5}$ or $[6.7, 6.71]$)		M0	
(gradient of tangent =) $-\frac{1}{\sqrt{45}}$		M0	

Q	Answer	Mark	Comments	
22	Enlarge(ment)	B1		
	$-\frac{1}{2}$	B1	condone minus half	
	(4, 5)	B1	condone missing bracket(s)	
	Additional Guidance			
	For third mark, do not accept $\begin{pmatrix} 4 \\ 5 \end{pmatrix}$			
	Combined transformation			B0B0B0
	Rotation, $-\frac{1}{2}$, about (4, 5)			B0B1B1

Q	Answer	Mark	Comments
	Two of $(\overrightarrow{AP}) = \mathbf{a} + 3\mathbf{b}$ $(\overrightarrow{PC}) = 2\mathbf{a} + 6\mathbf{b}$ $(\overrightarrow{AC}) = 3\mathbf{a} + 9\mathbf{b}$ and answer 2	B5	B4 two of $(\overrightarrow{AP}) = \mathbf{a} + 3\mathbf{b}$ $(\overrightarrow{PC}) = 2\mathbf{a} + 6\mathbf{b}$ $(\overrightarrow{AC}) = 3\mathbf{a} + 9\mathbf{b}$ B3 $(\overrightarrow{AP}) = \mathbf{a} + 3\mathbf{b}$ or $(\overrightarrow{PC}) = 2\mathbf{a} + 6\mathbf{b}$ B2 $(\overrightarrow{BP}) = 3\mathbf{a} - 6\mathbf{b}$ or $(\overrightarrow{PD}) = 2\mathbf{a} - 4\mathbf{b}$ B1 $(\overrightarrow{AC}) = 3\mathbf{a} + 9\mathbf{b}$ or $(\overrightarrow{BD}) = 5\mathbf{a} - 10\mathbf{b}$ or $(\overrightarrow{AD}) = 3\mathbf{a} - \mathbf{b}$
23	Additional Guidance		
	Accept eg $(\overrightarrow{PA}) = -\mathbf{a} - 3\mathbf{b}$ for $(\overrightarrow{AP}) = \mathbf{a} + 3\mathbf{b}$		
	Accept eg $9\mathbf{b} + 3\mathbf{a}$ or $3(\mathbf{a} + 3\mathbf{b})$ for $3\mathbf{a} + 9\mathbf{b}$ but do not accept $9\mathbf{b} - 2\mathbf{a} + 5\mathbf{a}$		
	Accept eg AC or $A \rightarrow C$ or ABC or $A \rightarrow B \rightarrow C$ for \overrightarrow{AC}		
	Condone upper case letters for lower case letters and vice-versa		
	Ignore incorrect vectors and award marks for any correct vectors		
	Vectors may be seen on the diagram		
Correct vectors may be seen in ratios and/or divisions eg $\mathbf{a} + 3\mathbf{b} : 2\mathbf{a} + 6\mathbf{b}$ Answer $\frac{1}{2}$	B4		

Q	Answer	Mark	Comments	
24	$m = k\sqrt[3]{t}$ or $km = \sqrt[3]{t}$ or $m = k\sqrt[3]{2t}$ or $km = \sqrt[3]{2t}$	M1	oe equation eg $m = k \times \sqrt[3]{t}$ or $\frac{m}{\sqrt[3]{t}} = k$	
	Expression or calculation for $\frac{m_2}{m_1} (\times 100)$ or $\frac{m_2 - m_1}{m_1} (\times 100)$	M1dep	m_1 is the mark for time t m_2 is the mark for time $2t$ eg $k\sqrt[3]{2t} \div k\sqrt[3]{t}$ or $\frac{\sqrt[3]{8} - \sqrt[3]{4}}{\sqrt[3]{4}}$	
	[25.9, 26]	A1		
	Additional Guidance			
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts			
	A common approach used (i) Work out values of m_1 , k and t that satisfy $m = k\sqrt[3]{t}$ (ii) Double their value of t and use their value of k to work out a value for m_2 (iii) Write down a calculation for $\frac{m_2}{m_1} (\times 100)$ or $\frac{m_2 - m_1}{m_1} (\times 100)$ eg $20 = 4 \times \sqrt[3]{125}$ (using $m_1 = 20$ $k = 4$ $t = 125$) $m_2 = 4 \times \sqrt[3]{250}$ $\frac{4 \times \sqrt[3]{250} - 20}{20}$ (award M1dep at this stage so 1st M1 is implied) 25.99			M1M1dep A1
	For M1 accept use of different letters if intention is clear eg $y = c\sqrt[3]{x}$			M1
	$m \propto \sqrt[3]{t}$ or $m \propto k\sqrt[3]{t}$ etc with no further correct working			M0
Writing square roots for cube roots must be recovered				

Q	Answer	Mark	Comments
25	$a\left(\frac{x+b}{a}\right) + b$	B1	oe expression for $fg(x)$ eg $x + b + b$ or $x + 2b$ implied by 3rd B1
	$\frac{x-b}{a}$	B1	oe expression for $f^{-1}(x)$ eg $\frac{x}{a} - \frac{b}{a}$ implied by $a\left(\frac{x-b}{a}\right)$ or $-a\left(\frac{x-b}{a}\right)$ implied by 3rd B1
	$a\left(\frac{x+b}{a}\right) + b - a\left(\frac{x-b}{a}\right)$	B1	oe correct full expression in terms of x eg $x + b + b - (x - b)$ or $x + 2b - x + b$ implies B3
	B3 awarded and $3b$ with no errors	B1	

The Additional Guidance for Question 25 is on the next page

		Additional Guidance	
25 cont	$a\left(\frac{x+b}{a}\right) + b = x + 2b$		B1
	$x + 2b - a\left(\frac{x-b}{a}\right)$		B1B1
	$= 3b$ (no errors)		B1
	$x + b + b - (x - b)$		B1B1B1
	$x + b + b - x - b$ (error)		
	$= 3b$		B0
	Ignore explanation about why $3b$ is a multiple of 3		
Substitution of values for letters with no further correct work		Zero	
Accept eg $a\left(\frac{x+b}{a}\right)$ written as $a\frac{x+b}{a}$			
$x + 2b$		B1	
$\frac{x-b}{a}$		B1	
$x + 2b - x - b$ (do not allow recovery of missing brackets)		B0	
$= 3b$		B0	