Level 2 Certificate
FURTHER MATHEMATICS
8365/2

Paper 2 Calculator

Mark scheme

June 2024

Version: 1.0 Final

2 4 6 G 8 3 6 5 / 2 / 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

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.
M dep	A method mark dependent on a previous method mark being awarded.
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.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
ft	Follow through marks. Marks awarded following a mistake in an earlier step.
SC	Special case. Marks awarded within the scheme for a common misinterpretation which has some mathematical worth.
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.
3.14…	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416

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 candidate has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the candidate. In cases where there is no doubt that the answer has come from incorrect working then the candidate should be penalised.

Questions which ask candidates to show working

Instructions on marking will be given but usually marks are not awarded to candidates who show no working.

Questions which do not ask candidates to show working

As a general principle, a correct response is awarded full marks.

Misread or miscopy

Candidates often copy values from a question incorrectly. If the examiner thinks that the candidate 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 candidate intended it to be a decimal point.

<table>
<tr><th>Q</th><th>Answer</th><th>Mark</th><th>Comments</th></tr>
<tr><td rowspan="6">1</td><td>Line from (–3, –4) to (3, 5)</td><td>B3</td><td>B2 line of at least two squares width with gradient $\frac{3}{2}$ passing through (–1, –1)
or
line with gradient $\frac{3}{2}$ for values of x from –3 to 3
or
correct equation of line
eg $y = \frac{3}{2}x + \frac{1}{2}$ or $y - -1 = \frac{3}{2}(x - -1)$

B1 line of at least two squares width with gradient $\frac{3}{2}$
or
equation of line with gradient $\frac{3}{2}$
eg $y = \frac{3}{2}x + c$</td></tr>
<tr><td colspan="3">Additional Guidance</td></tr>
<tr><td colspan="2">Up to B2 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">Mark intention</td><td></td></tr>
<tr><td colspan="2">Ignore any graph drawn for $x < -3$ and/or $x > 3$</td><td></td></tr>
<tr><td colspan="2">Examples of lines of at least two squares width
eg1 Line from (–3, –4) to (1, 2) $\left(\text{grad} = \frac{3}{2} \text{ passing through } (-1, -1)\right)$
eg2 Line from (0, 0) to (2, 3) $\left(\text{grad} = \frac{3}{2}\right)$</td><td>B2

B1</td></tr>
<tr><td colspan="2">Correct equation of a line scores B2 even if there are subsequent errors
eg $y + 1 = \frac{3}{2}(x + 1)$ followed by $y + 1 = \frac{3}{2}x + 1$</td><td>B2</td></tr>
<tr><td colspan="2">$y = \frac{3}{2}x + c$ with c an unknown constant</td><td>B1</td></tr>
</table>

Q	Answer	Mark	Comments
2	-2 -1 0 1 2 with no other values	B2	B1 -2 -1 0 1 2 with one other value or four of -2 -1 0 1 2 with no other values SC1 $-2 \leqslant n \leqslant 2$ or $-3 < n < 3$ or 5 with B2 response in working
	Additional Guidance		
	Mark the answer line eg B2 seen in working with -2 -1 1 2 on answer line		B1
	Integers can be in any order		
	Accept eg x for n		
	[–2, 2] is equivalent to $-2 \leqslant n \leqslant 2$		SC1
	(–3, 3) is equivalent to $-3 < n < 3$		SC1
	Answer -2 -1 0 1 2 and $-2 \leqslant n \leqslant 2$		SC1
	Accept eg ± 1 for -1 and 1		

Q	Answer	Mark	Comments
3	$4x^3$ or $-6kx$	M1	oe eg $4x^{4-1}$ or $-2 \times 3kx^{2-1}$
	$4 \times 2^3 - 6k \times 2 = 23$ or $32 - 12k = 23$ or $12k = 9$	M1dep	oe substitutes $x = 2$ into their 2-term derivative and equates to 23 their 2-term derivative must have one term involving x and one term involving k and x
	0.75 or $\frac{3}{4}$	A1	oe value eg $\frac{9}{12}$
	Additional Guidance		
	Ignore simplification or conversion attempt after correct answer seen		
	$4x^3 - 3kx$ (for $4x^3$) $32 - 6k = 23$ (used their 2-term derivative with conditions met)		M1 M1
	$4x^3 - 6kx$ (for $4x^3$ or $-6kx$) $16 - 12k = 23$ (16 is incorrect)		M1 M0
	Condone eg $y = 4x^3 - 6kx$		1st M1

Q	Answer	Mark	Comments
4	**Alternative method 1: works out nth term of B**		
	Common difference of 8 or $8n$	M1	implied by $8(n-1)$
	$8n+6$	M1dep	oe eg $14+8(n-1)$
	$42-3n-$ their $(8n+6)$ or $36-11n$	M1	oe expression for nth term of A their $8n+6$ must be of the form $an+b$ with a and b non-zero missing brackets must be recovered $36-11n$ or $36-11\times 20$ is M3
	-184	A1	
	Alternative method 2: works out 20th term of B		
	Common difference of 8 or $8n$	M1	implied by $8(n-1)$
	$14+8\times 19$ or 166	M1dep	oe eg $38+8\times 16$
	$42-3\times 20$ or -18	M1	
	-184	A1	
	Alternative method 3: works out consecutive terms of C		
	39 36	M1	
	$39-14$ and $36-22$ **or** 25 and 14	M1dep	oe
	$25-11\times 19$	M1dep	oe
	-184	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		
	Condone -184 seen in working with answer 184		M3A1
	1st M1 Common difference of 8 may be seen by the sequence for B		
	Alt 3 may be seen using any pair of consecutive terms of C		

Q	Answer	Mark	Comments
5(a)	$-2c+7$ and $-10d+21$ **or** $-2c+7=-5$ **or** $-10d+21=0$	M1	oe the two expressions may be seen in a matrix or embedded in two equations
	$c=6$	A1	
	$d=\frac{21}{10}$ or $d=2.1$	A1	oe value
	Additional Guidance		
	Ignore simplification or conversion attempt after correct answer seen for d eg $d=\frac{-21}{-10}$ in working with $d=-2.1$ on answer line		2nd A1
	The two expressions may be seen in an incorrect matrix or two incorrect equations eg1 $\begin{pmatrix}-2c+7 & -10d+21\\ 2 & 9\end{pmatrix}$ eg2 $-2c+7=3$ and $-10d+21=9$		M1 M1
	A correct equation is not implied by a matrix equation eg $\begin{pmatrix}-2c+7 & 3\\ 10d+10 & 9\end{pmatrix}=\begin{pmatrix}-5 & 3\\ 0 & 9\end{pmatrix}$		M0

Q	Answer	Mark	Comments
5(b)	$\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}$	B1	do not accept I or identity unless the correct 2 by 2 matrix is also seen

Q	Answer	Mark	Comments
6	$2 \leqslant f(x) \leqslant 50$	B2	B1 … $\leqslant f(x) \leqslant 50$ or $2 \leqslant f(x) \leqslant$ …
	Additional Guidance		
	… may be incorrect or blank		
	$50 \leqslant f(x) \leqslant 2$		B0

Q	Answer	Mark	Comments
7(a)	(0, –5)	B1	

Q	Answer	Mark	Comments
7(b)	(3, 4)	B1	

Q	Answer	Mark	Comments
8	$1 + 15x^{-6}$	B3	B2 answer (… +) $15x^{-6}$ **or** answer (… +) $\frac{15}{x^6}$ **or** x and $-3x^{-5}$ B1 x or $-3x^{-5}$ SC2 $1 - 15x^{-6}$
	Additional Guidance		
	Answer must be in the required form eg $1 + 15x^{-6}$ in working with answer $1 + \frac{15}{x^6}$		B2
	Accept equivalents for x eg $\frac{1}{2} \times 2x^{2-1}$		
	Accept equivalents for $-3x^{-5}$ eg $-\frac{3}{x^5}$ or $\frac{3}{4} \times -4 \times x^{-4-1}$		
	… may be incorrect or blank		
	Condone $15x^{-6} + 1$		B3
	Condone $1 + - 15x^{-6}$ or $1 + - \frac{15}{x^6}$		SC2
	Condone eg $y = x - 3x^{-5}$		B2

Q	Answer	Mark	Comments
9	480	B3	B2 $3 \times 8 \times 10 \times 2$ with at least three correct B1 $3 \times 8 \times 10 \times 2$ with at least two correct or 3, 8, 10 and 2 identified with no others SC2 $\frac{480}{10\,000}$ or $\frac{1}{480}$ SC1 2400 or 720 or 189

Additional Guidance	
eg1 $3 \times 8 \times 10 \times 10$ product of exactly four numbers	B2
eg2 $6 \times 7 \times 10 \times 2$ product of exactly four numbers	B1
eg3 $3 \times 8 \times 10$ product of only three numbers	B0
eg4 $24 \times 10 \times 10$ product of only three numbers	B0
eg5 840 no products	B0
Products may be seen in any order	
eg1 $2 \times 3 \times 8 \times 10$	B2
eg2 $10 \times 10 \times 2 \times 6$	B1
Multiplication by 2 may be implied for B2 or B1	
eg1 $3 \times 10 \times 10 \times 1 + 3 \times 10 \times 10 \times 1$	B2
eg2 $3 \times 8 \times 10 \times 10 \div 5$	B2
eg3 $3 \times 7 \times 6 \times 1 + 3 \times 7 \times 6 \times 1$	B1
eg4 $3 \times 7 \times 10 \times 10 \div 5$	B1
Examples of 3, 8, 10 and 2 identified with no others	
eg1 $3 + 8 + 10 + 2$	B1
eg2 $\frac{3}{10} \times \frac{8}{10} \times \frac{10}{10} \times \frac{2}{10}$ (must be products)	B1
eg3 $\frac{1}{3} \times \frac{1}{8} \times \frac{1}{10} \times \frac{1}{2}$ (must be products)	B1
Ignore attempts to list the 4-digit integers	
2400 is for ignoring the requirement for multiples of 5	
720 is for including 6 and 8	
189 is for excluding zero	

Q	Answer	Mark	Comments
10	True False True	B2	B1 one or two correct
	Additional Guidance		
	Any unambiguous indication eg only crosses in all three correct boxes		B2
	A tick and a cross in a row – mark the tick		

Q	Answer	Mark	Comments
11	$\frac{AC}{\sin 59} = \frac{18}{\sin 66}$	M1	oe equation in AC eg $\frac{\sin 59}{AC} = \frac{\sin 66}{18}$ accept [0.85, 0.86] for $\sin 59$ accept [0.91, 0.914] for $\sin 66$
	$\frac{18}{\sin 66} \times \sin 59$ or [16.7, 17.011]	M1dep	oe calculation for AC accept [0.85, 0.86] for $\sin 59$ accept [0.91, 0.914] for $\sin 66$
	$\frac{1}{2} \times 15 \times$ their [16.7, 17.011] $\sin 70$	M1dep	oe accept [0.93, 0.94] for $\sin 70$
	[119, 119.11]	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		
	Allow any indication of AC eg x or b		
	An equivalent method for the first two marks may be from using sine rule and cosine rule eg $AB = \frac{18}{\sin 66} \times \sin(180 - 59 - 66)$ or [16.1, 16.140124] $AC^2 = 18^2 + 16.14^2 - 2 \times 18 \times 16.14 \times \cos 59$ $AC = \sqrt{18^2 + 16.14^2 - 2 \times 18 \times 16.14 \times \cos 59}$	 M1 M1dep	
	[119, 119.11] seen with area of $ABCD$ or ABC as final answer	M3A0	

Q	Answer	Mark	Comments
12(a)	$x^2 - 4x + 4$ or $y^2 + 6y + 9$ or $49 - 14x + x^2$	M1	oe expansion eg $x^2 - 2x - 2x + 4$ or $y^2 + 3y + 3y + 9$ or $49 - 7x - 7x + x^2$ may be embedded eg in an equation
	$x^2 - 4x + 4 + 49 - 14x + x^2 = 16$ or $x^2 - 4x + 4 + 16 - 8x + x^2 + 24 - 6x + 9 = 16$	M1dep	oe equation in x with all relevant expansions seen eg $x^2 - 2x - 2x + 4 + 49 - 7x - 7x + x^2 = 16$
	M2 seen and $2x^2 - 18x + 37 = 0$ with no rearrangement errors seen	A1	
	Additional Guidance		
	After M1 an expression may be simplified when forming an equation eg $x^2 - 4x + 4 + 49 - 14x + x^2$ $2x^2 - 18x + 53 = 16$ (equation with all relevant expansions seen) $2x^2 - 18x + 37 = 0$ (no rearrangement errors seen)		M1 M1 A1
	For M1dep the oe equation cannot be $2x^2 - 18x + 37 = 0$		

Q	Answer	Mark	Comments
12(b)	$\frac{--18 \pm \sqrt{(-18)^2 - 4 \times 2 \times 37}}{2 \times 2}$ or $\frac{18 \pm \sqrt{28}}{4}$ or [5.8, 5.823] or [3.17, 3.2]	M1	oe calculation or value for at least one x-coordinate eg $\frac{9 \pm \sqrt{7}}{2}$ or $\frac{9}{2} \pm \sqrt{\frac{7}{4}}$ condone + for ± condone – for ±
	$4 - \frac{18 + \sqrt{28}}{4}$ or 4 – their [5.8, 5.823] or [–1.823, –1.8] or $4 - \frac{18 - \sqrt{28}}{4}$ or 4 – their [3.17, 3.2] or [0.8, 0.83]	M1dep	oe calculation or value for at least one y-coordinate
	(3.18, 0.82)	A1	both coordinates must be to 2 dp
	Additional Guidance		
	Marks may be awarded from working in (a)		
	Using -18^2 in the discriminant is M0 unless recovered		
	Substitution into equation of circle is possible for the 2nd M1 eg $(y+3)^2 = 16 - (3.17-2)^2$ (1st M1 for 3.17 but no calculation or value of y) $(y =)\ \sqrt{16-(3.17-2)^2} - 3$		M1 M1

Q	Answer	Mark	Comments
13	**Alternative method 1: expands $(3x - 1)(4 - x)$ first**		
	Exactly 4 terms with at least 3 correct from $(+)12x \quad -3x^2 \quad -4 \quad (+)x$	M1	oe eg $13x - 3x^2 - 4$ terms may be seen in a grid implied by $13x - 3x^2 + k$ or $13x + px^2 - 4$ where k and p are non-zero constants
	Full expansion of their 3 or 4 term quadratic with $(2x + 5)$ with correct multiplication of their 3 or 4 terms by $2x$ or by $(+)5$	M1	eg $24x^2 - 6x^3 - 8x + 2x^2 + 60x - 15x^2 - 20 + 5x$ or $26x^2 - 6x^3 - 8x + 65x - 15x^2 - 20$ terms may be seen in a grid
	$-6x^3 + 11x^2 + 57x - 20$	A1	terms in any order
	Alternative method 2: expands $(4 - x)(2x + 5)$ first		
	Exactly 4 terms with at least 3 correct from $(+)8x \quad (+)20 \quad -2x^2 \quad -5x$	M1	oe eg $3x + 20 - 2x^2$ terms may be seen in a grid implied by $3x + 20 + kx^2$ or $3x + p - 2x^2$ where k and p are non-zero constants
	Full expansion of their 3 or 4 term quadratic with $(3x + 1)$ with correct multiplication of their 3 or 4 terms by $3x$ or by -1	M1	eg $24x^2 + 60x - 6x^3 - 15x^2 - 8x - 20 + 2x^2 + 5x$ or $9x^2 + 60x - 6x^3 - 3x - 20 + 2x^2$ terms may be seen in a grid
	$-6x^3 + 11x^2 + 57x - 20$	A1	terms in any order

Question 13 continues on the next page

13 cont	**Alternative method 3: expands $(3x - 1)(2x + 5)$ first**		
	Exactly 4 terms with at least 3 correct from $(+)6x^2 \quad (+)15x \quad -2x \quad -5$	M1	oe eg $6x^2 + 13x - 5$ terms may be seen in a grid implied by $6x^2 + 13x + k$ or $px^2 + 13x - 5$ where k and p are non-zero constants
	Full expansion of their 3 or 4 term quadratic with $(4 - x)$ with correct multiplication of their 3 or 4 terms by 4 or by $-x$	M1	eg $24x^2 + 60x - 8x - 20 - 6x^3 - 15x^2 + 2x^2 + 5x$ or $24x^2 + 52x - 20 - 6x^3 - 13x^2 + 5x$ terms may be seen in a grid
	$-6x^3 + 11x^2 + 57x - 20$	A1	terms in any order
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Condone one transcription error for A1 after fully correct answer seen		
	Alt 1 $12x + 3x^2 - 5 + x$ only 2 terms correct $(12x + 3x^2 - 5 + x)(2x + 5)$ $= 24x^2 + 6x^3 - 10x + 2x^2 + 17x + 15x^2 + 25 + 5x^2$ 8 terms (full expansion) with correct multiplication of their 4 terms by $2x$		M0 M1
	Alt 2 $3x + 20 + 2x^2$ implied 4 terms with 3 correct $(3x - 1)(3x + 20 + 2x^2)$ $= 6x^2 + 60x + 5x^3 - 3x - 20 - 2x^2$ 6 terms (full expansion) with correct multiplication of their 3 terms by -1		M1 M1
	If the 1st M1 is scored with a 4-term expansion but this is then incorrectly simplified to 3 terms, the 2nd M1 can still be scored using their 3 terms		
	Accept eg $+ -3x^2$ as a correct term for M marks but not for A1		
	M2A1 response followed by further work eg1 $-6x^3 + 11x^2 + 57x - 20$ in working with answer $x(-6x^2 + 11x + 57) - 20$ eg2 $-6x^3 + 11x^2 + 57x - 20$ in working with answer $-(6x^3 - 11x^2 - 57x + 20)$		 M2A0 M2A0
	One single expansion is full marks or zero		

Q	Answer	Mark	Comments
14	3^2 or 9	M1	oe value for y eg 3^{--2}
	$\left(\frac{1}{2}\right)^x = \frac{\text{their } 9}{1152}$ or $\frac{1}{2^x} = \frac{1}{128}$	M1dep	oe equation with exponential term isolated eg $2^{-x} =$ [0.0078, 0.007813] or $2^x = 128$
	7	A1	
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Missing brackets must be recovered eg1 $\frac{1}{2}^x = \frac{9}{1152}$ with no further correct work		M1M0A0
	eg2 $\frac{1}{2}^x = \frac{9}{1152}$ with answer 7		M2A1
	Logarithms may be seen eg $\log\left(\frac{1}{2}\right)^x = \log\frac{9}{1152}$ or $(x =) \log_{0.5}\frac{1}{128}$		M1M1

Q	Answer	Mark	Comments
15	$(2x-3)(x+6)$ or $(6x+5)(2x-3)$	M1	oe factorisation using two brackets eg $2(x-1.5)(x+6)$
	$(2x-3)(x+6)$ and $(6x+5)(2x-3)$	M1dep	oe factorisations using two brackets with a common algebraic factor eg $2(x-1.5)(x+6)$ and $(x-1.5)(12x+10)$
	$\frac{x+6}{6x+5}$	A1	
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Condone one transcription error for A1 after fully correct answer seen		
	Accept use of multiplication signs throughout		
	Condone missing final bracket in factorisations and ignore irrelevant brackets eg1 $(2x-3)(x+6$ eg2 $\frac{(6+x)}{(6x+5)}$		M1 M2A1
	$(2x+3)(x+6)$ and $(6x+5)(2x+3)$ Answer $\frac{x+6}{6x+5}$		M0M0A0
	$\frac{x+6}{6x+5}$ followed by further incorrect work eg $\frac{6x}{6x+5}$		M2A0

Q	Answer	Mark	Comments
16	$x^{\frac{5}{2}} + x^4$	B3	B2 $x^{\frac{5}{2}}(+\ldots)$ or $(\ldots +)\,x^4$ B1 correct expansion of numerator eg $\sqrt{x^3} \times \sqrt{x^3} + \sqrt{x^3} \times x^3$ or $x^3 + x^{\frac{9}{2}}$ **or** correct expression with fraction eliminated eg $\sqrt{x^2}\,(\sqrt{x^3} + x^3)$ or $x(\sqrt{x^3} + x^3)$ or $\sqrt{x^3}\,(\sqrt{x^2} + x^{\frac{5}{2}})$
	Additional Guidance		
	B1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	B1 may be awarded after multiplication by $\frac{\sqrt{x}}{\sqrt{x}}$ eg $\frac{\sqrt{x^3}(\sqrt{x^3} + x^3)}{\sqrt{x}} \times \frac{\sqrt{x}}{\sqrt{x}} = \frac{\sqrt{x^4}(\sqrt{x^3} + x^3)}{x}$ $\frac{\sqrt{x^7} + x^3\sqrt{x^4})}{x}$ (B1 at this stage for correct expansion of numerator)	B1	
	Check the answer line and award B3 or B2 if possible Otherwise check the working for B2 or B1		
	Condone $x^4 + x^{\frac{5}{2}}$	B3	
	Accept oe values for fractional powers for up to B2		
	Accept eg $x^{\frac{10}{4}} + x^4$	B3	

Q	Answer	Mark	Comments
17(a)	**Alternative method 1: works out value for slant height**		
	$224\pi - \pi \times 7 \times 7$ or 175π or $224 - 7 \times 7 = 7l$ or $175 = 7l$	M1	oe curved surface area accept a value [3.14, 3.142] for π eg $224 \times 3.14 - 3.14 \times 49$ or oe equation with $7l$ as the subject eg $7l = 224 - 49$
	$(224\pi - \pi \times 7 \times 7) \div (\pi \times 7)$ or $175 \div 7$ or 25	M1dep	oe eg $(224 \times 3.14 - 3.14 \times 49) \div (3.14 \times 7)$
	$\cos x = \frac{7}{\text{their } 25}$ or $\cos x = 0.28$ or $\cos^{-1} \frac{7}{\text{their } 25}$ or $\cos^{-1} 0.28$	M1dep	oe eg $\sin x = \frac{\sqrt{\text{their } 25^2 - 7^2}}{\text{their } 25}$ or $\sin x = 0.96$ or $\tan x = \frac{\sqrt{\text{their } 25^2 - 7^2}}{7}$ or $\tan x =$ [3.4, 3.43]
	[73.7, 73.74]	A1	accept 74 with correct method seen SC2 [76.5, 76.51] or [77.3, 77.4]
	Alternative method 2: works out expression for slant height		
	$\frac{7}{\cos x}$	M1	oe slant height
	$\pi \times 7 \times \text{their } \frac{7}{\cos x} + \pi \times 7 \times 7$ $= 224\pi$	M1dep	oe equation
	$\cos x = \frac{\pi \times 7 \times 7}{224\pi - \pi \times 7 \times 7}$ or $\cos^{-1} \frac{\pi \times 7 \times 7}{224\pi - \pi \times 7 \times 7}$ or $\cos^{-1} 0.28$	M1dep	oe
	[73.7, 73.74]	A1	accept 74 with correct method seen SC2 [76.5, 76.51] or [77.3, 77.4]

Question 17(a) continues on the next page

17(a) cont	**Additional Guidance**	
	x may be eg θ	
	SC2 is for using $\pi \times 14$ for area of circle or 224π for curved surface area	
	If using cosine rule or sine rule for 3rd M there must be rearrangement to make $\cos x$ or $\sin x$ as the subject	

Q	Answer	Mark	Comments
17(b)	$\tan 36 = \frac{25}{CN}$ or $\tan(90-36) = \frac{CN}{25}$	M1	oe equation in *CN* or calculation for *CN* eg $(CN =) \frac{25}{\tan 36}$ or $CN^2 + 25^2 = \left(\frac{25}{\sin 36}\right)^2$ or $\frac{CN}{\sin(90-36)} = \frac{25}{\sin 36}$ accept [0.72, 0.73] for tan 36 accept [1.37, 1.38] for tan (90 – 36) accept [0.58, 0.59] for sin 36 accept [0.8, 0.81] for sin (90 – 36) accept [42.3, 43.11] for $\frac{25}{\sin 36}$
	[34.4, 34.41]	A1	accept 34 with M1 seen
	Additional Guidance		
	Allow any indication of *CN* eg x or b		
	$\frac{25}{\tan 36}$ but not for *CN*		M0

Q	Answer	Mark	Comments
18	$m(5m-3k^3)=2k^3-7$	M1	oe elimination of fraction eg $5m^2-3mk^3=2k^3-7$
	$5m^2+7=2k^3+3mk^3$	M1dep	oe expansion of brackets and collection of terms in k^3 eg $-3mk^3-2k^3=-7-5m^2$
	$5m^2+7=k^3(2+3m)$	M1dep	oe factorisation eg $k^3(-3m-2)=-7-5m^2$ may be implied eg $\frac{5m^2+7}{2+3m}=k^3$ or $\sqrt[3]{\frac{5m^2+7}{2+3m}}$
	$k=\sqrt[3]{\frac{5m^2+7}{2+3m}}$	A1	oe with k the subject eg $\left(\frac{5m^2+7}{2+3m}\right)^{\frac{1}{3}}=k$ or $k=\frac{\sqrt[3]{-7-5m^2}}{\sqrt[3]{-2-3m}}$
	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		
	Condone one transcription error for A1 after fully correct answer seen		
	Condone eg $k=\sqrt[3]{\frac{5m^2+7}{2+3m}}$ in working lines with $\sqrt[3]{\frac{5m^2+7}{2+3m}}$ on answer line		M3A1
	Correct answer followed by incorrect further work eg $k=\sqrt[3]{\frac{5m^2+7}{2+3m}}=\sqrt[3]{\frac{5m^2+7}{5m}}$		M3A0

Q	Answer	Mark	Comments
19	$10 \times 3^3 \times a^2$ or $10 \times 27 \times a^2$ or $270a^2$	M1	oe eg $\binom{5}{2} \times 3^3 \times a^2$ or ${}^5C_2\, 3^{5-2}a^2$ a may be (ax) may be implied eg $2160a^2$ or $2160a^2x^2$
	$5 \times 3^{(1)} \times a^4$ or $15a^4$	M1	oe eg $\binom{5}{4} \times 3 \times a^4$ or ${}^5C_4\, 3^{5-4}a^4$ a may be (ax) may be implied eg $15a^4x^4$
	8 × their $270a^2 =$ their $15a^4$ or $2160a^2 = 15a^4$	M1dep	oe eg $a^2 = 144$ or $(a =)\ 12$ or $(a =) -12$ their $270a^2$ must be ka^2 where k is a non-zero constant their $15a^4$ must be ma^4 where m is a non-zero constant dep on M2
	$(a =)\ 12$ and $(a =) -12$ with no other values	A1	oe eg $(a =) \pm 12$ with no other values
	Additional Guidance		
	After M1M1 an equation in terms of x and a cannot score M1dep even if recovered		
	Ignore other terms in the expansions		
	$(a =)\ 12$ and $(a =) -12$ and $(a =)\ 0$		M3A0

Q	Answer	Mark	Comments
20	$\frac{9-4}{5-3}$ or $\frac{5}{2}$	M1	oe gradient of radius through (5, 9)
	$-1 \div$ their $\frac{5}{2}$ or $-\frac{2}{5}$	M1	oe gradient of *AB* may be seen in equation of *AB* eg $y = -\frac{2}{5}x + c$ their $\frac{5}{2}$ cannot be $\sqrt{29}$ or 29 gradient of *AB* $= -\frac{2}{5}$ with no incorrect working is M1M1
	$\frac{y-9}{0-5}$ = their $-\frac{2}{5}$ or $(y =)$ 11 or $\frac{9-0}{5-x}$ = their $-\frac{2}{5}$ or $(x =)$ $\frac{55}{2}$	M1	oe eg $y = -\frac{2}{5} \times 0 + 11$ or $0 = -\frac{2}{5} \times x + 11$ must have scored 2nd M1 **or** must have scored 1st M1 and their 'perpendicular' gradient must be either $1 \div$ their $\frac{5}{2}$ or $-$ their $\frac{5}{2}$ $(y =)$ 11 or $(x =)$ $\frac{55}{2}$ may be seen on diagram
	$\frac{y-9}{0-5}$ = their $-\frac{2}{5}$ or $(y =)$ 11 **and** $\frac{9-0}{5-x}$ = their $-\frac{2}{5}$ or $(x =)$ $\frac{55}{2}$	M1dep	oe eg $y = -\frac{2}{5} \times 0 + 11$ and $0 = -\frac{2}{5} \times x + 11$ dep on 3rd M1 $(y =)$ 11 and $(x =)$ $\frac{55}{2}$ may be seen on diagram
	$\frac{605}{4}$ or $151\frac{1}{4}$ or 151.25	A1	oe value

Question 20 continues on the next page

20 cont	**Additional Guidance**	
	Ignore conversion or simplification attempt after correct answer seen	
	3rd M1 and 4th M1 If using the equation of *AB* in the form $y = mx + c$ they must use their gradient and have either (i) a correct value for c or (ii) a correct calculation for c eg for (ii) if c should be –2 for their gradient a correct calculation for c might be $c = 1 - 3$	
	After M0M0 no other marks can be awarded	
	$\frac{9}{5}$ (gradient of radius) $-\frac{5}{9}$ (gradient of *AB*)	M0M1
	$y = -\frac{5}{9}x + \frac{106}{9}$ (correct equation of *AB* for their gradient)	
	$y = \frac{106}{9}$ $x = \frac{106}{5}$ (two correct values for their line)	M1M1A0
	$\frac{5}{2}$ (gradient of radius) $\frac{2}{5}$ (gradient of *AB*)	M1M0
	$y = \frac{2}{5}x + 7$ (correct equation of *AB* for their gradient)	
	$y = 7$ $x = -\frac{35}{2}$ (two correct values for their line)	M1M1A0

Q	Answer	Mark	Comments
21	$2-3x$ or $2-3y$	B1	oe accept $2-3f$ or $2-3f(x)$
	$15\left(\frac{2-x}{3}\right)$ or $18\left(\frac{2-x}{3}\right)^2$	M1	may be implied eg $5(2-x)$ or $2(2-x)^2$
	$\frac{30-15x}{3}$ or $10-5x$	M1	expansion of $15\left(\frac{2-x}{3}\right)$ implies 1st M1
	$18\left(\frac{4-2x-2x+x^2}{9}\right)$ or $18\left(\frac{4-4x+x^2}{9}\right)$ or $8-8x+2x^2$	M1	oe squaring of bracket in $18\left(\frac{2-x}{3}\right)^2$ eg $2(4-2x-2x+x^2)$ or $2(4-4x+x^2)$ implies 1st M1
	$8-4x-4x+2x^2+10-5x$ or $2x^2-13x+18$	M1dep	oe $gf(x)$ with elimination of brackets and fractions eg $8-8x+2x^2+10-5x$ dep on M3 $2x^2-16x+20$ is B1M4
	$a=2 \quad b=-16 \quad c=20$	A1ft	ft their $2-3x$ if B0M4 their $2-3x$ must be of the form $px+q$ with p and q non-zero their $2-3x$ cannot be $\frac{2-x}{3}$
	Additional Guidance		
	Missing brackets must be recovered		
	Ignore irrelevant brackets eg $(8-4x-4x+2x^2)+(10-5x)$		M4
	$3x-2$ $8-4x-4x+2x^2+10-5x$ ($3x-2$ added to the above expression is $2x^2-10x+16$) $a=2 \quad b=-10 \quad c=16$		B0 M4 A1ft

Q	Answer	Mark	Comments
22	Fully correct proof with • a correct unsimplified equation in x and y • rearrangement to $x = 90 - \frac{3}{2}y$ with no rearrangement errors seen • all valid reasons stated	B5	B4 a correct unsimplified equation in x and y and rearrangement to $x = 90 - \frac{3}{2}y$ with no rearrangement errors seen B3 a correct unsimplified equation in x and y eg $x + y = \frac{180 - y}{2}$ or $y = 180 - (2x + 2y)$ or $x + \frac{180 - y}{2} + y + y = 180$ or $180 - (x + y) + \frac{180 - y}{2} = 180$ B2 two expressions for angles correct in terms of x and/or y eg two of angle $ACB = y$ angle $PAB = 180 - (x + y)$ angle $CAB = x + y$ angle $CAB = \frac{180 - y}{2}$ angle $CBQ = x + y$ angle $CBQ = \frac{180 - y}{2}$ B1 expression for one angle correct in terms of x and/or y

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	Additional Guidance	
22 cont	Up to B2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	Q is the end of *PB* extended (*Q* may be eg *D*)	
	angle *PCB* = angle *ACB*	
	Condone eg *PCB* for angle *PCB*	
	Accept unambiguous indication of angles eg1 angle $C = y$ in working is unambiguous eg2 angle $A = 180 - (x + y)$ in working is ambiguous unless shown in correct position on diagram	
	Missing brackets must be recovered	
	Up to B2 may be awarded from the diagram	
	B2 can be awarded for two different expressions for the same angle	
	B2 can be awarded for the same expression for angles *CAB* and *ABC*	
	Most unsimplified equations will be from one of (i) equating two expressions for angle *CAB* (ii) equating two expressions for angle *ACB* (iii) angle sum of triangle *PBC* = 180 (iv) angle *PAB* + angle *CAB* = 180 (v) angle sum of triangle *ABC* = 180 (vi) angle *ABP* + angle *ABC* + angle *CBQ* = 180	