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Cambridge International AS Level

MATHEMATICS **9709/21**

Paper 2 Pure Mathematics 2 **May/June 2025**

MARK SCHEME

Maximum Mark: 50

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

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- marks are awarded when candidates clearly demonstrate what they know and can do
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✗	Incorrect
Dep	Used to indicate DM0 or DM1

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Highlighter	Highlight a key point in the working
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JU	Judgement
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Mark Scheme Notes

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M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

B Mark for a correct result or statement independent of method marks.

DM or **DB** When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

FT Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
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- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

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Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
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CAO	Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed)
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WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1	Attempt use of product rule	**M1**	Allow for $6\cos\left(x^2+1\right)-12x\sin\left(x^2+1\right)$ $6\cos\left(x^2+1\right)-12\sin\left(x^2+1\right)$ $6\cos\left(x^2+1\right)-6x\sin\left(x^2+1\right)$ $6\cos\left(x^2+1\right)-6x^2\sin\left(x^2+1\right)$
	Obtain $6\cos(x^2+1)-12x^2\sin(x^2+1)$	**A1**	Allow unsimplified.
		2	

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Question	Answer	Marks	Guidance
2(a)	Apply logarithms to both sides and use relevant logarithm property	**M1**	Allow for $x < \log_4 0.05$.
	Obtain $x < \dfrac{\ln 0.05}{\ln 4}$ or equivalent and hence $x < -2.16$	**A1**	Allow greater accuracy.
		2	
2(b)	Attempt solution of equations $3x + 8 = \pm 9$ or of quadratic equation $(3x+8)^2 = 9^2$	**M1**	Need a complete method to obtain 2 values.
	Obtain values $-\frac{17}{3}$ and $\frac{1}{3}$	**A1**	
	Conclude $-\frac{17}{3} < x < \frac{1}{3}$	**A1**	OE
		3	
2(c)	State $-5, -4, -3$ only	**B1**	
		1	

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Question	Answer	Marks	Guidance
3(a)	Sketch decreasing positive curve for $y = 3e^{-2x}$	**B1**	
	Sketch curve for $y = \sec x$	**B1**	Correctly placed with reference to first sketch or correct with '1' marked on y-axis.
		2	
3(b)	Equate and arrange at least as far as $e^{-2x} = ...$ or $e^{2x} = ...$ with $\cos x$ present	**M1**	
	Confirm $x = \frac{1}{2}\ln(3\cos x)$	**A1**	AG – necessary detail needed.
		2	
3(c)	Use iterative process correctly at least once	**M1**	Calculator must be in radian mode.
	Obtain final answer 0.487	**A1**	Required to precisely 3 decimal places.
	Show sufficient iterations to justify answer, or show a sign change in the interval [0.4865, 0.4875]	**A1**	Allow iterations to greater accuracy.
		3	

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Question	Answer	Marks	Guidance
4(a)	Differentiate to obtain $12e^{2x} - 3e^{3x}$	**B1**	
	Attempt solution for x of equation of form $k_1e^{2x} + k_2e^{3x} = 0$ (but not for $y = 0$), to obtain $e^{\pm x} = k$	**M1**	SOI
	Obtain $x = \ln 4$ or $x = 2\ln 2$	**A1**	$x = 1.386$ scores A0.
		3	
4(b)	Identify $x = \ln 6$ as point where curve meets x-axis	**B1**	May see in part **(a)** but must be used here.
	Integrate to obtain the form $k_3e^{2x} + k_4e^{3x}$	**M1**	Where $k_3 \neq 6$ and $k_4 \neq -1$
	Obtain $3e^{2x} - \frac{1}{3}e^{3x}$	**A1**	May see inclusion of $+ c$.
	Apply limits to obtain answer $\frac{100}{3}$ only	**A1**	
		4	

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<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td rowspan="5">5(a)</td><td>Substitute $x=\frac{3}{2}$ equating to 0, and $x=-1$ equating to -15</td><td>M1</td><td>Allow algebraic long division, but must result in two expressions correctly equated to 0 and -15.
SC B1 for $b=9$ if M0 scored.</td></tr>
<tr><td>Obtain $\frac{27}{8}a+\frac{9}{4}b-\frac{3}{2}a-24=0$</td><td>A1</td><td>OE
Powers of $\frac{3}{2}$ must be evaluated.</td></tr>
<tr><td>Obtain $-a+b+a-24=-15$</td><td>A1</td><td></td></tr>
<tr><td>Solve to obtain $a=2$ and $b=9$</td><td>A1</td><td></td></tr>
<tr><td></td><td>4</td><td></td></tr>
<tr><td rowspan="4">5(b)</td><td>Divide p(x) by $2x-3$</td><td>M1</td><td>OE method, such as inspection.
For algebraic long division, must go as far as the term in x.
Allow attempt at synthetic division.
<table>
<tr><td>$\frac{3}{2}$</td><td>2</td><td>9</td><td>–2</td><td>–24</td></tr>
<tr><td></td><td></td><td>3</td><td>18</td><td>24</td></tr>
<tr><td></td><td colspan="4">$2x^2+12x+16$</td></tr>
</table>
Allow one sign error.</td></tr>
<tr><td>Obtain quotient x^2+6x+8</td><td>A1</td><td>Allow $2x^2+12x+16$ from synthetic division.</td></tr>
<tr><td>Conclude $(2x-3)(x+2)(x+4)$</td><td>A1</td><td></td></tr>
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</table>

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Question	Answer	Marks	Guidance
5(c)	Use factorised form to determine value of $\sin\theta$, with $-1<\sin\theta<1$	**M1**	
	Obtain finally $\sin\theta=-\frac{3}{4}$ only and hence angle 228.6	**A1**	Or greater accuracy 228.590… Ignore solutions outside the range.
		2	

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Question	Answer	Marks	Guidance
6(a)	Attempt use of quotient rule (or equivalent) for derivative of x	**M1**	
	Obtain $\frac{5}{(3t+4)^2}$ or unsimplified equivalent	**A1**	
	Obtain $\frac{6}{3t+4}$ for derivative of y	**B1**	Allow unsimplified.
	Attempt to express $\frac{dy}{dx}$ in terms of t	**M1**	
	Obtain $\frac{6}{5}(3t+4)$ stating or implying that $c=\frac{6}{5}$	**A1**	Form of answer given. Necessary detail needed.
		5	
6(b)	Attempt solution of $2\ln(3t+4)=\ln 100$	**M1**	Must be using logarithms correctly.
	Obtain $3t+4=10$ (or equivalent) and hence $t=2$ (only)	**A1**	May be implied by only one (correct) value for a.
	Substitute to obtain $a=\frac{1}{2}$	**A1**	
	Substitute to obtain $m=12$	**A1**	
		4	
6(c)	State increasing, with reference to positive gradient	**B1**	
		1	

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Question	Answer	Marks	Guidance
7(a)	Use correct identities to express in terms of $\sin x$ and $\cos x$	**M1**	Allow for $2\sin^2 x\cos^2 x + 4\cos^2 x\left(\cos^2 x - \sin^2 x\right)$, OE.
	Obtain $4\sin^2 x\cos^2 x + 4\cos^2 x(\cos^2 x - \sin^2 x)$	**A1**	OE
	Confirm $4\cos^4 x$	**A1**	
		3	
7(b)	Use identity from part **(a)** to obtain $k < 5$ or $k > 9$	**B1**	
	Obtain $k < 5$, $k > 9$	**B1**	
		2	
7(c)	State or imply integrand is $2\cos^2 \frac{1}{2}t$ or $\sqrt{4\cos^4 \frac{t}{2}}$	**M1***	
	Use double-angle identity to express in terms of $\cos t$	**M1**	
	Obtain $1 + \cos t$ and integrate to obtain $t + \sin t$	**A1**	
	Use limits to obtain $\frac{2}{3}\pi + \sqrt{3}$	**A1**	
		4	

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WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1	Integrate to obtain $2\ln(4x+1)$	**B1**	
	Apply limits correctly to $k\ln(4x+1)$ and use at least one relevant logarithm property	**M1**	
	Obtain $2\ln 45 - 2\ln 9 = 2\ln 5$ or equivalent, and conclude $\ln 25$	**A1**	
		3	

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Question	Answer	Marks	Guidance
2(a)	Draw V-shaped graph with vertex on positive x-axis	**B1**	
	Draw correct graph of $y = 4x - 5$	**B1**	Correctly placed with reference to modulus graph and with steeper gradient.
		2	
2(b)	Solve linear equation or inequality with signs of $2x$ and $4x$ different	**M1**	
	Obtain $-2x + 9 = 4x - 5$ and hence $x = \frac{7}{3}$	**A1**	OE
	Conclude $x > \frac{7}{3}$	**A1**	OE, e.g. $\left]\frac{7}{3}, \infty\right[$, or $\left(\frac{7}{3}, \infty\right)$.
	Alternative Method for Question 2(b)		
	State or imply non-modulus equation (or inequality) $(2x-9)^2 = (4x-5)^2$	**B1***	
	Attempt solution of three-term quadratic equation (or inequality)	**DM1**	$12x^2 - 4x - 56 = 0$ leading to $\frac{7}{3}$ and -2.
	Obtain at least $\frac{7}{3}$ and conclude $x > \frac{7}{3}$	**A1**	Must be from correct work. OE, e.g. $\left]\frac{7}{3}, \infty\right[$ or $\left(\frac{7}{3}, \infty\right)$
		3	

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Question	Answer	Marks	Guidance
3	Attempt use of quotient rule (or equivalent) to differentiate $\frac{8x}{2x+3}$ or $\frac{-12x^2+15}{(2x+3)}$	***M1**	
	Obtain $\frac{dy}{dx}=\frac{24}{(2x+3)^2}-6$	**A1**	OE Allow unsimplified.
	Equate first derivative to zero, and attempt solution of a quadratic equation to find two values of x	**DM1**	$4x^2+12x+5=0$
	Obtain at least one of the stationary points $(-\frac{5}{2},\ 30)$ and $(-\frac{1}{2},\ 6)$, or both x-values, $-\frac{5}{2}$ and $-\frac{1}{2}$	**A1**	
	Obtain both stationary points	**A1**	
		5	

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Question	Answer	Marks	Guidance
4(a)	State $4e^{-2x} = 1 + 0.5\sin 3x$ and confirm $x = -0.5\ln(0.25 + 0.125\sin 3x)$	**B1**	AG Necessary detail needed.
		1	
4(b)	Use iterative process correctly at least once	**M1**	
	Obtain final answer 0.4912	**A1**	Answer required to exactly 4 significant figures.
	Show sufficient iterations to 6 significant figures to justify answer or show a sign change in the interval [0.49115, 0.49125]	**A1**	
		3	
4(c)	Integrate to obtain the form $k_1e^{-2x} + k_2x + k_3\cos 3x$	***M1**	$k_1,\ k_2,\ k_3 \neq 0$ OE, with separate integrals or 'reversed'.
	Obtain correct $-2e^{-2x} - x + \frac{1}{6}\cos 3x$	**A1**	OE Allow for $2e^{-2x} + x - \frac{1}{6}\cos 3x$
	Apply limits 0 and *their* part **(b)** answer correctly and attempt evaluation	**DM1**	
	Obtain 0.61	**A1**	
		4	

Question	Answer	Marks	Guidance
5(a)	Substitute $x=\frac{1}{2}$ and $x=3$, and equate each to zero to produce two equations	**M1**	**SC B1** for a correct equation, if M0 otherwise.
	Obtain $\frac{1}{16}a+\frac{1}{8}b=-\frac{3}{4}$	**A1**	OE $a+2b+12=0$
	Obtain $81a+27b=-27$	**A1**	OE $3a+b+1=0$
	Solve simultaneous equations to obtain $a=2$ and $b=-7$	**A1**	
		4	
5(b)	Divide by $2x^2-7x+3$ or successively by $2x-1$ and $x-3$	**M1**	OE method, such as inspection.
	Obtain quotient x^2+5	**A1**	Condone $2\left(x^2+5\right)$ from synthetic division.
	State fully factorised form $(2x-1)(x-3)(x^2+5)$	**A1**	
		3	
5(c)	Attempt solution of at least $\cot 2\theta=3$	**M1**	
	Obtain $\tan 2\theta=\frac{1}{3}$ and hence $\theta=0.161$	**A1**	Or greater accuracy 0.16087…
		2	

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Question	Answer	Marks	Guidance
6(a)	Substitute $y = e^{-1}$ in equation and simplify to quadratic equation in x	***M1**	
	Evaluate discriminant	**DM1**	OE, such as completion of square or use of formula.
	Obtain $-x^2 + 6x - 11 = 0$, giving discriminant -8 and confirm result	**A1**	OE, such as $(x-3)^2 + 2 = 0$, etc. AG – necessary detail needed.
		3	
6(b)	Attempt use of product rule for differentiation of $(x^2 - 3)\ln y$	***M1**	May see in part **(a)**
	Obtain $2x\ln y + \frac{x^2-3}{y}\frac{dy}{dx}$	**A1**	OE
	Obtain complete $2x\ln y + \frac{x^2-3}{y}\frac{dy}{dx} + 6 = 0$	**A1 FT**	OE Following *their* derivative of $(x^2 - 3)\ln y$.
	Substitute $x = 2$ and $y = e^2$ to find value of gradient of tangent	**DM1**	Need to see attempt at substitution unless correct. -103 implies **M1**.
	Obtain gradient $-14e^2$	**A1**	
	Obtain equation $y = -14e^2x + 29e^2$ or equivalent of required form	**A1**	
		6	

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Question	Answer	Marks	Guidance
7(a)	Expand to obtain the form $k_1 \cos\theta \sin\theta + k_2 \cos^2\theta$	**M1**	
	Obtain $2\sqrt{3}\cos\theta\sin\theta + 2\cos^2\theta$ with exact coefficients	**A1**	
	Obtain $\sqrt{3}\sin 2\theta + \cos 2\theta + 1$	**A1 FT**	Following *their* expression in $\sin\theta$ and $\cos\theta$.
	State $R = 2$	**B1 FT**	Following *their* expression in $\sin 2\theta$ and $\cos 2\theta$.
	Use appropriate trigonometry to find value of α	**M1**	Must be of the form $a\sin 2\theta + b\cos 2\theta$.
	Conclude $2\cos(2\theta - 60) + 1$	**A1**	
		6	
7(b)	Attempt to express equation in form $\cos(4\phi - \alpha) = k$	***M1**	
	Use correct process to find one value of ϕ	**DM1**	
	Obtain $\cos(4\phi - 60) = \frac{1}{3}$ and hence 32.6	**A1**	Or greater accuracy 32.6321…
	Use correct process to find second value of ϕ	**DM1**	
	Obtain 87.4 and no others between 0 and 90	**A1**	Or greater accuracy 87.3678…
		5	

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International Education

Cambridge International AS Level

MATHEMATICS **9709/23**

Paper 2 Pure Mathematics 2 **May/June 2025**

MARK SCHEME

Maximum Mark: 50

Published

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Cambridge International is publishing the mark schemes for the May/June 2025 series for most Cambridge IGCSE, Cambridge International A and AS Level components, and some Cambridge O Level components.

This document consists of **15** printed pages.

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PUBLISHED

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Annotations

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A1	Accuracy mark awarded one
B0	Independent accuracy mark awarded zero
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BOD	Benefit of the doubt
BP	Blank Page
✗	Incorrect
Dep	Used to indicate DM0 or DM1

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Annotation	Meaning
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M1	Method mark awarded one
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SEEN	Indicates that work/page has been seen

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Annotation	**Meaning**
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TE	Transcription error
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Mark Scheme Notes

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

M Method mark, awarded for a valid method applied to the problem. Method marks are not lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

A Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated method mark is earned (or implied).

B Mark for a correct result or statement independent of method marks.

DM or **DB** When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly, when there are several B marks allocated. The notation DM or DB is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

FT Implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only.

- A or B marks are given for correct work only (not for results obtained from incorrect working) unless follow through is allowed (see abbreviation FT above).
- For a numerical answer, allow the A or B mark if the answer is correct to 3 significant figures or would be correct to 3 significant figures if rounded (1 decimal place for angles in degrees).
- The total number of marks available for each question is shown at the bottom of the Marks column.
- Wrong or missing units in an answer should not result in loss of marks unless the guidance indicates otherwise.
- Square brackets [ ] around text or numbers show extra information not needed for the mark to be awarded.

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Abbreviations

AEF/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
CAO	Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed)
CWO	Correct Working Only
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1	Integrate to obtain $2\ln(4x+1)$	**B1**	
	Apply limits correctly to $k\ln(4x+1)$ and use at least one relevant logarithm property	**M1**	
	Obtain $2\ln 45 - 2\ln 9 = 2\ln 5$ or equivalent, and conclude $\ln 25$	**A1**	
		3	

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Question	Answer	Marks	Guidance
2(a)	Draw V-shaped graph with vertex on positive x-axis	**B1**	
	Draw correct graph of $y = 4x - 5$	**B1**	Correctly placed with reference to modulus graph and with steeper gradient.
		2	
2(b)	Solve linear equation or inequality with signs of $2x$ and $4x$ different	**M1**	
	Obtain $-2x + 9 = 4x - 5$ and hence $x = \frac{7}{3}$	**A1**	OE
	Conclude $x > \frac{7}{3}$	**A1**	OE, e.g. $\left]\frac{7}{3}, \infty\right[$, or $\left(\frac{7}{3}, \infty\right)$.
	Alternative Method for Question 2(b)		
	State or imply non-modulus equation (or inequality) $(2x-9)^2 = (4x-5)^2$	**B1***	
	Attempt solution of three-term quadratic equation (or inequality)	**DM1**	$12x^2 - 4x - 56 = 0$ leading to $\frac{7}{3}$ and -2.
	Obtain at least $\frac{7}{3}$ and conclude $x > \frac{7}{3}$	**A1**	Must be from correct work. OE, e.g. $\left]\frac{7}{3}, \infty\right[$ or $\left(\frac{7}{3}, \infty\right)$
		3	

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Question	Answer	Marks	Guidance
3	Attempt use of quotient rule (or equivalent) to differentiate $\frac{8x}{2x+3}$ or $\frac{-12x^2+15}{(2x+3)}$	***M1**	
	Obtain $\frac{dy}{dx}=\frac{24}{(2x+3)^2}-6$	**A1**	OE Allow unsimplified.
	Equate first derivative to zero, and attempt solution of a quadratic equation to find two values of x	**DM1**	$4x^2+12x+5=0$
	Obtain at least one of the stationary points $(-\frac{5}{2},\ 30)$ and $(-\frac{1}{2},\ 6)$, or both x-values, $-\frac{5}{2}$ and $-\frac{1}{2}$	**A1**	
	Obtain both stationary points	**A1**	
		5	

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Question	Answer	Marks	Guidance
4(a)	State $4e^{-2x} = 1 + 0.5\sin 3x$ and confirm $x = -0.5\ln(0.25 + 0.125\sin 3x)$	**B1**	AG Necessary detail needed.
		1	
4(b)	Use iterative process correctly at least once	**M1**	
	Obtain final answer 0.4912	**A1**	Answer required to exactly 4 significant figures.
	Show sufficient iterations to 6 significant figures to justify answer or show a sign change in the interval [0.49115, 0.49125]	**A1**	
		3	
4(c)	Integrate to obtain the form $k_1e^{-2x} + k_2x + k_3\cos 3x$	***M1**	$k_1,\ k_2,\ k_3 \neq 0$ OE, with separate integrals or 'reversed'.
	Obtain correct $-2e^{-2x} - x + \frac{1}{6}\cos 3x$	**A1**	OE Allow for $2e^{-2x} + x - \frac{1}{6}\cos 3x$
	Apply limits 0 and *their* part **(b)** answer correctly and attempt evaluation	**DM1**	
	Obtain 0.61	**A1**	
		4	

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Question	Answer	Marks	Guidance
5(a)	Substitute $x=\frac{1}{2}$ and $x=3$, and equate each to zero to produce two equations	**M1**	**SC B1** for a correct equation, if M0 otherwise.
	Obtain $\frac{1}{16}a+\frac{1}{8}b=-\frac{3}{4}$	**A1**	OE $a+2b+12=0$
	Obtain $81a+27b=-27$	**A1**	OE $3a+b+1=0$
	Solve simultaneous equations to obtain $a=2$ and $b=-7$	**A1**	
		4	
5(b)	Divide by $2x^2-7x+3$ or successively by $2x-1$ and $x-3$	**M1**	OE method, such as inspection.
	Obtain quotient x^2+5	**A1**	Condone $2\left(x^2+5\right)$ from synthetic division.
	State fully factorised form $(2x-1)(x-3)(x^2+5)$	**A1**	
		3	
5(c)	Attempt solution of at least $\cot 2\theta=3$	**M1**	
	Obtain $\tan 2\theta=\frac{1}{3}$ and hence $\theta=0.161$	**A1**	Or greater accuracy 0.16087…
		2	

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Question	Answer	Marks	Guidance
6(a)	Substitute $y = e^{-1}$ in equation and simplify to quadratic equation in x	***M1**	
	Evaluate discriminant	**DM1**	OE, such as completion of square or use of formula.
	Obtain $-x^2 + 6x - 11 = 0$, giving discriminant -8 and confirm result	**A1**	OE, such as $(x-3)^2 + 2 = 0$, etc. AG – necessary detail needed.
		3	
6(b)	Attempt use of product rule for differentiation of $(x^2 - 3)\ln y$	***M1**	May see in part **(a)**
	Obtain $2x\ln y + \frac{x^2-3}{y}\frac{dy}{dx}$	**A1**	OE
	Obtain complete $2x\ln y + \frac{x^2-3}{y}\frac{dy}{dx} + 6 = 0$	**A1 FT**	OE Following *their* derivative of $(x^2 - 3)\ln y$.
	Substitute $x = 2$ and $y = e^2$ to find value of gradient of tangent	**DM1**	Need to see attempt at substitution unless correct. -103 implies **M1**.
	Obtain gradient $-14e^2$	**A1**	
	Obtain equation $y = -14e^2x + 29e^2$ or equivalent of required form	**A1**	
		6	

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Question	Answer	Marks	Guidance
7(a)	Expand to obtain the form $k_1 \cos\theta \sin\theta + k_2 \cos^2\theta$	**M1**	
	Obtain $2\sqrt{3}\cos\theta\sin\theta + 2\cos^2\theta$ with exact coefficients	**A1**	
	Obtain $\sqrt{3}\sin 2\theta + \cos 2\theta + 1$	**A1 FT**	Following *their* expression in $\sin\theta$ and $\cos\theta$.
	State $R = 2$	**B1 FT**	Following *their* expression in $\sin 2\theta$ and $\cos 2\theta$.
	Use appropriate trigonometry to find value of α	**M1**	Must be of the form $a\sin 2\theta + b\cos 2\theta$.
	Conclude $2\cos(2\theta - 60) + 1$	**A1**	
		6	
7(b)	Attempt to express equation in form $\cos(4\phi - \alpha) = k$	***M1**	
	Use correct process to find one value of ϕ	**DM1**	
	Obtain $\cos(4\phi - 60) = \frac{1}{3}$ and hence 32.6	**A1**	Or greater accuracy 32.6321…
	Use correct process to find second value of ϕ	**DM1**	
	Obtain 87.4 and no others between 0 and 90	**A1**	Or greater accuracy 87.3678…
		5	

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International Education

Cambridge International AS Level

MATHEMATICS **9709/25**

Paper 2 Pure Mathematics 2 **May/June 2025**

MARK SCHEME

Maximum Mark: 50

Published

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	Apply limits correctly to $k\ln(4x+1)$ and use at least one relevant logarithm property	**M1**	
	Obtain $2\ln 45 - 2\ln 9 = 2\ln 5$ or equivalent, and conclude $\ln 25$	**A1**	
		3	

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Question	Answer	Marks	Guidance
2(a)	Draw V-shaped graph with vertex on positive x-axis	**B1**	
	Draw correct graph of $y = 4x - 5$	**B1**	Correctly placed with reference to modulus graph and with steeper gradient.
		2	
2(b)	Solve linear equation or inequality with signs of $2x$ and $4x$ different	**M1**	
	Obtain $-2x + 9 = 4x - 5$ and hence $x = \frac{7}{3}$	**A1**	OE
	Conclude $x > \frac{7}{3}$	**A1**	OE, e.g. $\left]\frac{7}{3}, \infty\right[$, or $\left(\frac{7}{3}, \infty\right)$.
	Alternative Method for Question 2(b)		
	State or imply non-modulus equation (or inequality) $(2x-9)^2 = (4x-5)^2$	**B1***	
	Attempt solution of three-term quadratic equation (or inequality)	**DM1**	$12x^2 - 4x - 56 = 0$ leading to $\frac{7}{3}$ and -2.
	Obtain at least $\frac{7}{3}$ and conclude $x > \frac{7}{3}$	**A1**	Must be from correct work. OE, e.g. $\left]\frac{7}{3}, \infty\right[$ or $\left(\frac{7}{3}, \infty\right)$
		3	

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Question	Answer	Marks	Guidance
3	Attempt use of quotient rule (or equivalent) to differentiate $\frac{8x}{2x+3}$ or $\frac{-12x^2+15}{(2x+3)}$	***M1**	
	Obtain $\frac{dy}{dx}=\frac{24}{(2x+3)^2}-6$	**A1**	OE Allow unsimplified.
	Equate first derivative to zero, and attempt solution of a quadratic equation to find two values of x	**DM1**	$4x^2+12x+5=0$
	Obtain at least one of the stationary points $(-\frac{5}{2},\ 30)$ and $(-\frac{1}{2},\ 6)$, or both x-values, $-\frac{5}{2}$ and $-\frac{1}{2}$	**A1**	
	Obtain both stationary points	**A1**	
		5	

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Question	Answer	Marks	Guidance
4(a)	State $4e^{-2x} = 1 + 0.5\sin 3x$ and confirm $x = -0.5\ln(0.25 + 0.125\sin 3x)$	**B1**	AG Necessary detail needed.
		1	
4(b)	Use iterative process correctly at least once	**M1**	
	Obtain final answer 0.4912	**A1**	Answer required to exactly 4 significant figures.
	Show sufficient iterations to 6 significant figures to justify answer or show a sign change in the interval [0.49115, 0.49125]	**A1**	
		3	
4(c)	Integrate to obtain the form $k_1e^{-2x} + k_2x + k_3\cos 3x$	***M1**	$k_1,\ k_2,\ k_3 \neq 0$ OE, with separate integrals or 'reversed'.
	Obtain correct $-2e^{-2x} - x + \frac{1}{6}\cos 3x$	**A1**	OE Allow for $2e^{-2x} + x - \frac{1}{6}\cos 3x$
	Apply limits 0 and *their* part **(b)** answer correctly and attempt evaluation	**DM1**	
	Obtain 0.61	**A1**	
		4	

Question	Answer	Marks	Guidance
5(a)	Substitute $x=\frac{1}{2}$ and $x=3$, and equate each to zero to produce two equations	**M1**	**SC B1** for a correct equation, if M0 otherwise.
	Obtain $\frac{1}{16}a+\frac{1}{8}b=-\frac{3}{4}$	**A1**	OE $a+2b+12=0$
	Obtain $81a+27b=-27$	**A1**	OE $3a+b+1=0$
	Solve simultaneous equations to obtain $a=2$ and $b=-7$	**A1**	
		4	
5(b)	Divide by $2x^2-7x+3$ or successively by $2x-1$ and $x-3$	**M1**	OE method, such as inspection.
	Obtain quotient x^2+5	**A1**	Condone $2\left(x^2+5\right)$ from synthetic division.
	State fully factorised form $(2x-1)(x-3)(x^2+5)$	**A1**	
		3	
5(c)	Attempt solution of at least $\cot 2\theta=3$	**M1**	
	Obtain $\tan 2\theta=\frac{1}{3}$ and hence $\theta=0.161$	**A1**	Or greater accuracy 0.16087…
		2	

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Question	Answer	Marks	Guidance
6(a)	Substitute $y = e^{-1}$ in equation and simplify to quadratic equation in x	***M1**	
	Evaluate discriminant	**DM1**	OE, such as completion of square or use of formula.
	Obtain $-x^2 + 6x - 11 = 0$, giving discriminant -8 and confirm result	**A1**	OE, such as $(x-3)^2 + 2 = 0$, etc. AG – necessary detail needed.
		3	
6(b)	Attempt use of product rule for differentiation of $(x^2 - 3)\ln y$	***M1**	May see in part **(a)**
	Obtain $2x\ln y + \frac{x^2-3}{y}\frac{dy}{dx}$	**A1**	OE
	Obtain complete $2x\ln y + \frac{x^2-3}{y}\frac{dy}{dx} + 6 = 0$	**A1 FT**	OE Following *their* derivative of $(x^2 - 3)\ln y$.
	Substitute $x = 2$ and $y = e^2$ to find value of gradient of tangent	**DM1**	Need to see attempt at substitution unless correct. -103 implies **M1**.
	Obtain gradient $-14e^2$	**A1**	
	Obtain equation $y = -14e^2x + 29e^2$ or equivalent of required form	**A1**	
		6	

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Question	Answer	Marks	Guidance
7(a)	Expand to obtain the form $k_1 \cos\theta \sin\theta + k_2 \cos^2\theta$	**M1**	
	Obtain $2\sqrt{3}\cos\theta\sin\theta + 2\cos^2\theta$ with exact coefficients	**A1**	
	Obtain $\sqrt{3}\sin 2\theta + \cos 2\theta + 1$	**A1 FT**	Following *their* expression in $\sin\theta$ and $\cos\theta$.
	State $R = 2$	**B1 FT**	Following *their* expression in $\sin 2\theta$ and $\cos 2\theta$.
	Use appropriate trigonometry to find value of α	**M1**	Must be of the form $a\sin 2\theta + b\cos 2\theta$.
	Conclude $2\cos(2\theta - 60) + 1$	**A1**	
		6	
7(b)	Attempt to express equation in form $\cos(4\phi - \alpha) = k$	***M1**	
	Use correct process to find one value of ϕ	**DM1**	
	Obtain $\cos(4\phi - 60) = \frac{1}{3}$ and hence 32.6	**A1**	Or greater accuracy 32.6321…
	Use correct process to find second value of ϕ	**DM1**	
	Obtain 87.4 and no others between 0 and 90	**A1**	Or greater accuracy 87.3678…
		5	

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