

Cambridge International AS & A Level

MATHEMATICS**9709/11**

Paper 1 Pure Mathematics 1

May/June 2025**MARK SCHEME**Maximum Mark: 75

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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This document consists of **24** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

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- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

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Mathematics-Specific Marking Principles

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- 2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
- 3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
- 4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
- 5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.
- 6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Annotations guidance for centres

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We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Independent accuracy mark awarded zero
	Independent accuracy mark awarded one
	Independent accuracy mark awarded two
	Benefit of the doubt
	Blank Page
	Incorrect
Dep	Used to indicate DM0 or DM1

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
	Follow through
	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Judgement
	Judgement
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Misread
	Omission or Other solution
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
	Judgment made by the PE
	Premature approximation
	Special case
	Indicates that work/page has been seen

Annotation	Meaning
	Error in number of significant figures
	Correct
	Transcription error
	Correct answer from incorrect working

PUBLISHED**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.

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	$6\sin^2 \theta - \sin \theta - 2 [= 0] \Rightarrow [(2\sin \theta + 1)(3\sin \theta - 2) = 0]$	M1	For expressing as a 3-term quadratic. Terms need not all be on the same side.
	$\sin \theta = -\frac{1}{2}$ or $\sin \theta = \frac{2}{3}$	A1	For both. Allow AWRT 0.667.
	$\theta = -150^\circ, -30^\circ, 41.8^\circ, 138.2^\circ$	A1 A1	AWRT A1 for any correct angle from a correct value of $\sin \theta$, A1 for all 4 and no others in the interval $-180^\circ < \theta < 180^\circ$. SC B1 for $\frac{-5\pi}{6}, \frac{-\pi}{6}, 0.730^\circ, 2.41^\circ$ if use of radians is clear.
		4	

Question	Answer	Marks	Guidance
2(a)	$[\text{Gradient of tangent}] = 4(2 \times 4 - 5)^3 - 9 \times 4^{\frac{1}{2}} [= 90]$	M1	Substitute $x = 4$ into $\frac{dy}{dx}$. $\frac{-11}{2} = 4(2 \times 4 - 5)^3 - 9 \times 4^{\frac{1}{2}}$ is M0 unless they reach $-\frac{1}{90}$.
	$[\text{Gradient of normal}] = -\frac{1}{90}$	A1	AWRT -0.0111 .
		2	
2(b)	$[y] = \left\{ \frac{1}{2}(2x - 5)^4 \right\} \left\{ -6x^{\frac{3}{2}} \right\} [+c]$	B1 B1	Accept unsimplified.
	$-\frac{11}{2} = \frac{1}{2} \times (2 \times 4 - 5)^4 - 6 \times 4^{\frac{3}{2}} + c$	M1	Sub $x = 4, y = -\frac{11}{2}$ into an integrated expression and attempt to find c .
	$y = \frac{1}{2}(2x - 5)^4 - 6x^{\frac{3}{2}} + 2$	A1	Condone $c = 2$ as final answer if 'y = ...' seen previously. Fractions must be simplified. Accept $f(x)$ in place of y .
		4	

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Question	Answer	Marks	Guidance
3(a)	$ar^2 = 18, a + ar + ar^2 = 26$ or $a + ar + 18 = 26$	B1	For first and second, or first and third equations.
	$\frac{18}{r^2} + \frac{18}{r} + 18 = 26 \Rightarrow 8r^2 - 18r - 18 [= 0] \Rightarrow [(4r + 3)(r - 3) = 0]$	M1	For expressing as a 3-term quadratic from two expressions with sign errors only. Terms need not all be on one side.
	$r = -\frac{3}{4}$ [or $r = 3$]	A1	CAO Allow -0.75 .
	$a = 32$	A1	CAO Ignore $a = 2$. May not find a , but instead use expression for a in terms of r (e.g. $a = \frac{18}{r^2}$) and then find a in part (b).
	Tenth term = -2.40	A1	AWRT. Ignore other values.
	Alternative Method for first three marks in Question 3(a)		
	$ar^2 = 18, 26 = \frac{a(1-r^3)}{1-r}$	B1	
	$26 = \frac{\frac{18}{r^2}(1-r^3)}{1-r} \Rightarrow 8r^3 - 26r^2 + 18 [= 0]$	M1	Expressing as a 3-term cubic from two expressions with sign errors only. Terms need not all be on one side
	$r = -\frac{3}{4}$ [or $r = 3, 1$]	A1	CAO Accept -0.75 .
		5	Note: SC B1 B1 B1 is possible following B1 M0 if no method is shown for finding $r = -\frac{3}{4}$ [or $r = 3$].

Question	Answer	Marks	Guidance
3(b)	$S_{\infty} = \frac{32}{1 - \left(-\frac{3}{4}\right)}$	M1	FT on values of a and r , provided $-1 < r < 1$.
	$\frac{128}{7}$	A1 FT	FT on values of a and r , provided $-1 < r < 0$. Condone extra answers.
		2	

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Question	Answer	Marks	Guidance
4	Attempt to integrate $(x-16) - \left(5x^{\frac{3}{2}} - 20x\right) \left[= -5x^{\frac{3}{2}} + 21x - 16 \right]$	*M1	Attempt to integrate both terms and subtract areas. Accept subtraction either way round.
	$\left\{ \frac{1}{2}x^2 - 16x \right\} [-] \left\{ \left(2x^{\frac{5}{2}} - 10x^2 \right) \right\} \left[= -2x^{\frac{5}{2}} + \frac{21}{2}x^2 - 16x \right]$	B1 B1	B1 for each integral. B2,1, 0 for $-2x^{\frac{5}{2}} + \frac{21}{2}x^2 - 16x$.
	Use of limits 1 and 16	DM1	Limits either way round. Minimum $-7.5 - 384$. E.g. $\left(\left(\frac{1}{2} - 16 \right) - (2 - 10) \right) - ((128 - 256) - (2048 - 2560))$ $= (15.5 + 8) - (-128 + 512)$ $= -7.5 - 384 = -391.5$ Or $(-2 + 10.5 - 16) - (-2048 + 2688 - 256)$ $= -7.5 - 384 = -391.5$ Or $-504 + \frac{225}{2} = -391.5$
	391.5 or $\frac{783}{2}$	A1	CAO SC B1 for correct answer if M1 B1 B1 DM0 scored.

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Question	Answer	Marks	Guidance
	Alternative Method for Question 4		
	Height of triangle = 15	B1	
	Area of triangle = $\frac{1}{2} \times 15 \times \text{their height} = 112.5$	M1	
	Integrates $\pm \left(5x^{\frac{3}{2}} - 20x \right)$ to $\pm \left(2x^{\frac{5}{2}} - 10x^2 \right)$	B1	
	Use of limits 1 and 16 on their integral and subtracts area of triangle	DM1	Limits either way round.
	391.5	A1	CAO SC B1 for correct answer if M1 B1 B1 DM0 scored.
		5	

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Question	Answer	Marks	Guidance
5(a)(i)	$32 - 80px + 80p^2x^2$	B2,1,0	B2 for all correct. B1 for any two correct. May be in a list. Ignore terms with higher powers.
		2	
5(a)(ii)	$1 - 2x + \frac{3}{2}x^2$	B2,1,0	OE B2 for all correct. B1 for any two correct. May be in a list. Ignore terms with higher powers.
		2	
5(b)	Coefficient of $x^2 = 32 \times \frac{3}{2} + (-2 \times -80p) + 80p^2$	*M1	3 terms FT <i>their</i> values.
	$48 + 160p + 80p^2 = 93 \Rightarrow 5(4p + 9)(4p - 1)[= 0]$	DM1	Set <i>their</i> 3-term coefficient to 93 and attempt to solve by factorising or other accepted method for solving their 3-term quadratic.
	$p = -\frac{9}{4}$ and $p = \frac{1}{4}$	A1	SC B1 following M0 if method for solving quadratic is not shown.
		3	

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Question	Answer	Marks	Guidance
6(a)	$2x^2 - 2x(11x + 3) + 2 [= 0]$	*M1	Substitutes $k = 2, p = 11$ and eliminates y or x . Note: $\frac{2x^2 + 2}{2x} = 11x + 3$.
	$-20x^2 - 6x + 2 [= 0] \Rightarrow [(5x - 1)(2x + 1) = 0]$	DM1	Simplifies to a 3-term quadratic. Terms need not all be on one side.
	Coordinates $\left(-\frac{1}{2}, -\frac{5}{2}\right), \left(\frac{1}{5}, \frac{26}{5}\right)$	A1 A1	A1 for either both x -values correct or for both coordinates of one point correct. Need not be written as coordinates. Fractions must be simplified.
		4	

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Question	Answer	Marks	Guidance
6(b)	$2x^2 - kx(4x + 3) + 2 = 0 \Rightarrow (2 - 4k)x^2 - 3kx + 2 [= 0]$	*M1	Substitute and reduce to 3-term quadratic. Terms need not all be on one side. Allow $2x^2 - 4kx^2 - 3kx + 2 [= 0]$.
	$(2 - 4k)x^2 - 3kx + 2 [= 0]$	A1	Correct quadratic. All terms to one side. Allow $2x^2 - 4kx^2 - 3kx + 2 [= 0]$.
	$b^2 - 4ac = 9k^2 - 4 \times (2 - 4k) \times 2$	DM1	Use of $b^2 - 4ac$. Must be correct for <i>their</i> a , b , c . a term must have two components.
	$9k^2 + 32k - 16 [< 0] \Rightarrow (k + 4)(9k - 4) [< 0]$	M1	Attempt to solve a 3-term quadratic in k by factorising or other accepted method for solving their 3-term quadratic.
	$-4 < k < \frac{4}{9}$	A1	SC B1 following M0 if no method shown for solving quadratic. A0 for correct answer following incorrect quadratic. Must be k . Allow other correct notation.
		5	

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Question	Answer	Marks	Guidance
7(a)	$\left[\frac{dy}{dx} = \right] 8x - \frac{18}{x^3}$	B1	OE Accept unsimplified.
	At $x = 2, \frac{dy}{dx} = \frac{55}{4}$	M1	OE For evaluating <i>their</i> $\frac{dy}{dx}$ or $\frac{dx}{dy}$.
	$\frac{dy}{dx} = \frac{dy}{dt} \times \frac{dt}{dx} \Rightarrow \frac{55}{4} = -5 \times \frac{dt}{dx}$	M1	For correct use of chain rule with ± 5 and <i>their</i> $\frac{dy}{dx}$ (may be algebraic). Condone missing brackets.
	$\left[\frac{dx}{dt} = \right] -\frac{4}{11}$	A1	Or decreasing at a rate of $\frac{4}{11}$. AWRT -0.364 .
		4	

Question	Answer	Marks	Guidance
7(b)	$8x - \frac{18}{x^3} = 0 \left[\Rightarrow x^4 = \frac{9}{4} \right]$	M1	Equating <i>their</i> 2-term $\frac{dy}{dx}$ to zero.
	$x = \pm \sqrt{\frac{3}{2}} \text{ or } \pm \frac{\sqrt{6}}{2}$	A1	AWRT ± 1.22 .
	$y = 4$ (for both)	A1	A0 A1 if one point correct. AWRT 4.00.
	$\left[\frac{d^2y}{dx^2} \right] = 8 + \frac{54}{x^4}$	M1	For differentiation. At least one correct term needed.
	So both are minima	A1	No need for reason. WWW on x -values.
		5	

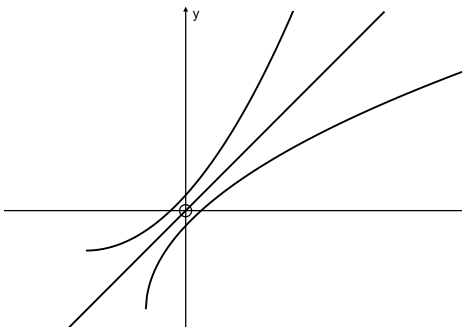
Question	Answer	Marks	Guidance
8	Centre of circle is $(3, -5)$	B1	Seen or implied.
	$x = -2 \Rightarrow y^2 + 10y - 11 = 0 \quad [\Rightarrow (y - 1)(y + 11) = 0]$ or $(y + 5)^2 = 36$.	M1	3-term quadratic. Terms need not all be on one side. $(3, -5)$ must be correct if it is used.
	$y = 1$ and $y = -11$	A1	No method needed for solving quadratic.
	Gradient of line PC is $\frac{-5-1}{3-(-2)} \left[= \frac{-6}{5} \right]$ or gradient of line QC is $\frac{-5+11}{3-(-2)} \left[= \frac{6}{5} \right]$	M1	At least one correct.
	Gradient of tangent at P is $\frac{5}{6}$ or gradient of tangent at Q is $-\frac{5}{6}$	A1	At least one correct.
	Equation of tangent is $y - 1 = \frac{5}{6}(x + 2)$. Crosses $y = -5$ at $x = -\frac{46}{5}$, so distance = $\frac{36}{5}$ or equations of two tangents are $y - 1 = \frac{5}{6}(x + 2)$ and $y + 11 = -\frac{5}{6}(x + 2)$ and these meet when $x = -\frac{46}{5}$ so distance = $\frac{36}{5}$	M1	Distance from point of intersection to line $x = -2$ is $6 \times \frac{6}{5} \left[= \frac{36}{5} \right]$. Note $y = \frac{5}{6}x + \frac{8}{3}$ and $y = -\frac{5}{6}x - \frac{38}{3}$.
	Area = $\frac{1}{2} \times 12 \times \text{their } \frac{36}{5}$	M1	Condone use of $\frac{46}{5}$.
8	$\frac{432}{10}$ or $\frac{216}{5}$ or 43.2	A1	
		8	

Question	Answer	Marks	Guidance
9(a)	$\frac{1}{2}r^2\alpha = 8\alpha \Rightarrow r = 4$	B1	
	$\frac{1}{2}r^2 \sin \alpha = 4 \Rightarrow \alpha = \frac{\pi}{6}$	B1	
	Area of segment = $\frac{1}{2} \times 4^2 \times \frac{\pi}{6} - 4$	M1	Using <i>their</i> r and <i>their</i> α . Condone $4 - \frac{1}{2} \times 4^2 \times \frac{\pi}{6}$. Allow use of $8 \times \text{their } \alpha - 4$
	$= \frac{4}{3}\pi - 4$	A1	Fraction must be simplified. Allow $\frac{4\pi - 12}{3}$.
		4	
9(b)	$r^2 + r^2 - 2r^2 \cos \alpha = \frac{1}{2}r^2 \Rightarrow 2 \cos \alpha = \frac{3}{2}$	*M1	Or $\alpha = 2 \sin^{-1}\left(\frac{\sqrt{2}}{4}\right)$ or $2 \sin^{-1}\left(\frac{1}{2\sqrt{2}}\right)$ Using $\alpha = \frac{\pi}{6}$ or $r = 4$ implies 0/4.
	$\alpha = 0.723 [0.72273...] \Rightarrow \frac{1}{2}r^2 \sin(\text{their } 0.723) [= 4]$	DM1	Or $\alpha = 41.4 \Rightarrow \frac{1}{2}r^2 \sin(\text{their } 41.4) [= 4]$
	$r = 3.48 [3.4777...]$	A1	Accept $r^2 = 12.1$ AWRT.
	Area of segment = $\frac{1}{2} \times 3.48^2 \times 0.723 - 4 = 0.371 [0.37068...]$	A1	Or $\frac{1}{2} \times 3.48^2 \times \frac{\pi}{180} \times 41.4 - 4 = 0.371$ AWRT.
		4	

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Question	Answer	Marks	Guidance
10(a)	{Stretch} {factor 3} {parallel to y -axis/in y -direction/vertically}	B2,1,0	
	Translation $\begin{pmatrix} -2 \\ -5 \end{pmatrix}$	B2,1,0	
		B1	Transformations correct and in the correct order.
	Alternative solution for Question 10(a)		
	Translation $\begin{pmatrix} -2 \\ 5 \\ -\frac{5}{3} \end{pmatrix}$	B2,1,0	
	{Stretch} {factor 3} {parallel to y -axis/in y -direction/vertically}	B2,1,0	
		B1	Transformations correct and in the correct order.
		5	The translation parallel to the x -axis can be made anywhere in the sequence. Note: If 3 or more transformations are given then maximum 2/5 for any correct one.

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Question	Answer	Marks	Guidance
10(b)		B1	For line or curve in correct quadrants only.
		B1	Must not pass through (0, 0). Fully correct including the line $y = x$. No label needed. Approximate reflection of $y = f(x)$. Curve must not come back on itself.
		2	
10(c)	$y = 3\sqrt{x+2} - 5 \Rightarrow \frac{y+5}{3} = \sqrt{x+2}$	M1	Allow x/y swap.
	$[g^{-1}(x)] = \left(\frac{x+5}{3}\right)^2 - 2$	A1	Must be in terms of x . Not ' $x = \dots$ '.
		2	
10(d)	[Range of g^{-1} is $g^{-1}(x) \geq -2$	B1 FT	Following <i>their</i> $g^{-1}(x) = \left(\frac{x+a}{b}\right)^2 - c$ where a , b , c are non-zero. Not $x \geq -2$. Not > -2 . Accept other notations, e.g. $[-2, \infty]$.
		1	

Question	Answer	Marks	Guidance
10(e)	$[g^{-1}h(4) = g^{-1}(2)] = \frac{31}{9}$	B1	AWRT 3.44.
		1	
10(f)	hg^{-1} is impossible since the range of g^{-1} is $x \geq -2$ is not within the domain of h , which is $x \geq 0$	B1	Minimum acceptable: ‘The range of g^{-1} is not within the domain of h ’.
		1	

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The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Independent accuracy mark awarded zero
	Independent accuracy mark awarded one
	Independent accuracy mark awarded two
	Benefit of the doubt
	Blank Page
	Incorrect
Dep	Used to indicate DM0 or DM1

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
	Follow through
	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Judgement
	Judgement
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Misread
	Omission or Other solution
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
	Judgment made by the PE
	Premature approximation
	Special case
	Indicates that work/page has been seen

Annotation	Meaning
SF	Error in number of significant figures
	Correct
TE	Transcription error
XP	Correct answer from incorrect working

PUBLISHED**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.

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	{Stretch} {factor 2} {'parallel to y -axis' or 'in y -direction' or 'vertically'}	B2,1,0	B2 for 3 correct components. B1 for 2.
	{Translation} $\begin{pmatrix} \{0\} \\ \{-14\} \end{pmatrix}$ or $\{-14\}$ {'parallel to the y -axis' or 'in the y -direction' or 'vertically'.}	B2,1,0	B2 for 3 correct components. B1 for 2.
	Alternative Method for Question 1		
	{Translation by} $\begin{pmatrix} \{0\} \\ \{-7\} \end{pmatrix}$ or $\{-7\}$ {'parallel to the y -axis' or 'in the y -direction' or 'vertically'}	B2,1,0	B2 for 3 correct components. B1 for 2.
	{Stretch} {factor 2} {'parallel to y -axis' or 'in y -direction' or 'vertically'}	B2,1,0	B2 for 3 correct components. B1 for 2.
		4	

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Question	Answer	Marks	Guidance
2	$2\left(\frac{-y-4}{2}\right)y + 5y^2 = 24$ or $2\left(\frac{24-5y^2}{2y}\right) + y + 4 [=0]$ or $2x(-4-2x) + 5(-4-2x)^2 = 24$	*M1	OE For eliminating x or y . Condone sign errors in the rearrangements.
	$4y^2 - 4y = 24$ or $16x^2 + 72x + 56 [=0]$	DM1	OE For simplifying to a 3-term quadratic; terms do not all have to be on the same side. Condone sign errors in the expansions or in the collecting of terms.
	$\Rightarrow y = -2, y = 3$ or $x = -1, x = -\frac{7}{2}$	B1	OE Not for a correct (x, y) pair. Allow from a correct quadratic (ignore any working seen).
	$(-1, -2), \left(-\frac{7}{2}, 3\right)$	B1	OE Allow from a correct quadratic (ignore any working seen). Condone $x = -1$ and $y = -2$ and $x = -\frac{7}{2}$ and $y = 3$.
		4	

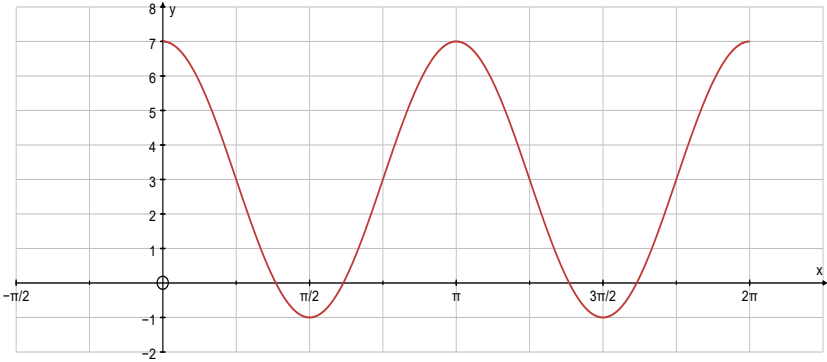
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Question	Answer	Marks	Guidance
3	$\binom{5}{3}$ or $\binom{5}{2}$ or $10 \times (px^2)^{5-3} \times \left(\frac{4}{p}x\right)^3$	B1	May be seen in a list. Allow with or without x 's. Condone missing brackets only if recovered later.
	$10p^2 \times \frac{64}{p^3}$	B1	This term must now be identified if given as part of a list. Allow with or without x 's.
	$\frac{\text{Their integer } k}{p} [x^7] = 1280[x^7]$	M1	Condone e.g. $\frac{640x^7}{p} = 1280$ if x^7 then disappears in subsequent work. Must be from $a \times (px^2)^{5-3} \times \left(\frac{4}{p}x\right)^3$.
	$p = \frac{1}{2}$	A1	OE SC B1 for $\binom{5}{4}$ or $\binom{5}{1}$ or $5 \times (px^2)^{5-1} \times \left(\frac{4}{px}\right)^1 \Rightarrow p = 4$.
		4	

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Question	Answer	Marks	Guidance
4(a)	$\left[\frac{dy}{dx}\right] = \frac{3}{2}ax^{\frac{1}{2}} - 12$	*M1	For attempt at differentiation; at least one correct term needed. Condone poor notation throughout.
	$\left[\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} = \right] \left(\frac{3}{2}a \times 9^{\frac{1}{2}} - 12 \right) \times 5$	DM1	For correct use of chain rule with 5, $x=9$ and <i>their</i> $\frac{dy}{dx}$. Condone missing brackets and allow errors in their working.
	$\left[\frac{dy}{dt} = \right] 5\left(\frac{9}{2}a - 12\right)$ or $\frac{45}{2}a - 60$ or $22.5a - 60$ or $\frac{45a - 120}{2}$ or $\frac{15}{2}(3a - 8)$	A1	OE simplified form.
		3	
4(b)	$\frac{3}{2}a \times \left(\frac{1}{4}\right)^{\frac{1}{2}} - 12 = 0$	M1	For setting <i>their</i> 2 term $\frac{dy}{dx}$ with at least one term correct = 0 and substituting $x = 0.25$. Condone missing brackets. Allow a restart for $\frac{dy}{dx}$ if 2 terms seen and at least one term correct.
	$\Rightarrow a = 16$	A1	
		2	

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Question	Answer	Marks	Guidance
5(a)	[Greatest] 7, [least] -1	B1B1	B2 for answers of -1 and 7 only. B1 for one correct value. Ignore incorrect identification/inequality.
		2	
5(b)		B2,1,0	Ignore any graph outside domain $(0, 2\pi)$. B1 for two complete cycles, one from 0 to approximately π and the other finishing at approximately 2π. Starting at <i>their</i> greatest value and initially decreasing. Condone straight lines and minimum above the x-axis or joining points with straight lines. B2 for correct curve; condone any incorrect x-axis intercepts. Graph must start to level off at both 0 and 2π. Ignore any y-labels, but the curve should be more above the x-axis than below.
		2	
5(c)	3 [solutions]	B1	Ignore any graphs drawn
		1	

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Question	Answer	Marks	Guidance
6	$6 - 3x = 3 \Rightarrow x\text{-coordinate of point of intersection} = 1$	B1	
	$\left[\frac{18}{5} (5x + 4)^{\frac{1}{2}} \right]_0^1$	B1 B1	B1 for $k(5x + 4)^{\frac{1}{2}}$
	$\text{Area} = \frac{18}{5} \times 3 - \frac{18}{5} \times 2 \left[= \frac{18}{5} \right]$	M1	
	Line crosses x -axis at $x = 2$, so triangle area $= \frac{1}{2} \times 3 \times 1$	M1	
	Total area $= \frac{51}{10}$	A1	
		6	

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Question	Answer	Marks	Guidance
7(a)	For appropriate use of $\tan \theta = \frac{\sin \theta}{\cos \theta}$ or $\tan \theta \cos \theta = \sin \theta$ at least once	M1	The first two marks can be applied in the reverse order but as soon as an error occurs, no further marks are awarded. Candidates can work from LHS to RHS or RHS to LHS for full marks. If they work on both sides simultaneously, maximum of M1M1 only if a common correct expression is reached. Condone missing brackets. If the numerator and denominator are worked on separately, they need to be brought together for the second mark.
	For appropriate use of $\sin^2 \theta + \cos^2 \theta = 1$ or $1 + \tan^2 \theta = \sec^2 \theta$	M1	
	Fully correct proof	A1	WWW Condone missing brackets if recovered.
		3	
7(b)	$\frac{\tan \theta + 7}{\tan^2 \theta - 3} = \frac{5}{\tan \theta} \Rightarrow \tan \theta (\tan \theta + 7) = 5(\tan^2 \theta - 3)$	*B1	OE Using part (a) and eliminating fractions.
	$\Rightarrow 4 \tan^2 \theta - 7 \tan \theta - 15 = 0 \Rightarrow (4 \tan \theta + 5)(\tan \theta - 3) = 0$	DM1	Factorising or other accepted method for solving <i>their</i> 3-term quadratic in $\tan \theta$. Condone errors made in forming 3-term quadratic.
	$\tan \theta = -1.25$ and $\tan \theta = 3$	B1	OE Independent of factorisation of the quadratic. And no extra solutions. Allow e.g. $x = \dots$ provided $x = \tan \theta$ is seen. Can be implied by a correct final answer.
	$\theta = 71.6^\circ$ and $\theta = 128.7^\circ$	B1	AWRT No others in range $0 \leq \theta \leq 180^\circ$. Ignore any answers outside this range. Maximum 3/4 if incorrect factorisation or formula.
		4	

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Question	Answer	Marks	Guidance
8(a)	(2, -2)	B1	Condone $x = 2$ and $y = -2$ if seen together.
	(12, -2)	B1	Condone $x = 12$ and $y = -2$ if seen together.
	(7, -4)	B1	
		3	If B0 B0 for the first two marks, then SC B1 available for $x = 2$ and $x = 12$.
8(b)	$\tan\left(\frac{1}{2}\theta\right) = \frac{5}{2} \left[\Rightarrow \theta = 2 \tan^{-1} \frac{5}{2} \right]$ or $\sin\left(\frac{\theta}{2}\right) = \frac{5}{\sqrt{29}}$ or $\cos\left(\frac{\theta}{2}\right) = \frac{2}{\sqrt{29}}$ or $\theta = \pi - 2 \times \tan^{-1} \frac{2}{5}$ or $\pi - 2 \times 0.381$ or $10^2 = 29 + 29 - 2 \times \sqrt{29} \times \sqrt{29} \cos \theta \left[\Rightarrow \cos \theta = \frac{29 + 29 - 100}{2 \times \sqrt{29} \times \sqrt{29}} = \frac{-21}{29} \right]$	M1	Or other correct method for an isosceles triangle using their A and B of the form $(\quad, -2)$ and C of the form $(\quad, -d)$, where $-d < -2$. Note: $\tan \theta = \frac{5}{2} \Rightarrow 0/2$ unless θ is then doubled. Using $r = 29$ scores 0/2.
	$[\theta =] 2.38$	A1	AWRT Final answer of 136.4° scores max 1/2. Ignore degree symbol if present.
	Alternative Method for Question 8(b)		
	$\tan \theta = \frac{\frac{-2}{5} - \frac{2}{5}}{1 + \frac{-2}{5} \times \frac{2}{5}} \left[= -\frac{20}{21} \right]$	M1	Use of $\tan \theta = \frac{m_2 - m_1}{1 + m_2 m_1}$, where m_1 and m_2 are the gradients of <i>their</i> AC and BC , where A , B and C are of the required form.
	$[\theta =] 2.38$	A1	AWRT Ignore degree symbol if present.
		2	

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Question	Answer	Marks	Guidance
8(c)	[Length $AC = \text{Length } BC = \sqrt{5^2 + 2^2}] = \sqrt{29} [=5.385\dots]$	B1	Sight of $\sqrt{29}$. SOI. Condone 5.4. Could be found in parts (a) or (b) , but do not award unless it is seen in part (c) .
	[Area of large sector =] $\frac{1}{2} \times \sqrt{29} \times \sqrt{29} \times (2\pi - \text{their } \theta) [=56.587\dots]$ or [Area of small sector =] $\frac{1}{2} \times \sqrt{29} \times \sqrt{29} \times \text{their } \theta [=34.518\dots]$	M1	Use of correct sector formula with <i>their</i> identified radius (e.g. 29) and <i>their</i> $(2\pi - \theta)$ or <i>their</i> θ . May be embedded as part of the segment formula.
	Area of triangle = $\frac{1}{2} \times \sqrt{29} \times \sqrt{29} \times \sin \theta$ or $\frac{1}{2} \times 10 \times 2 [=10]$	M1	Use of correct triangle formula with <i>their</i> identified radius (e.g. 29) and <i>their</i> θ . May be embedded as part of the segment formula.
	[Segment area =] 66.6	A1	AWRT [Area of circle – smaller segment = $\pi \times 29 - 34.52 + 10$]
		4	

Question	Answer	Marks	Guidance
9(a)	$\left[\frac{dy}{dx} = \right] \frac{-24x^{-2}}{-2} \left[= \frac{12}{x^2} \right] [+c]$	B1	May be unsimplified.
	$\frac{12}{(-2)^2} + c = 0 [\Rightarrow c = -3]$	M1	Substituting $x = -2$ into <i>their</i> $\frac{dy}{dx}$ of the form $kx^{-2} + c$, and setting = 0. Condone missing bracket.
	$\left[\frac{dy}{dx} = \right] \frac{12}{x^2} - 3$ or $12x^{-2} - 3$	A1	$\frac{-24}{-2}$ must be simplified to 12, but accept $c = -3$ as the final answer.
		3	

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Question	Answer	Marks	Guidance
9(b)	$\left[\frac{12}{x^2} - 3 = 0 \Rightarrow x^2 = 4 \Rightarrow x = \pm 2 \Rightarrow \right] x = 2$	B1	May be done by inspection or calculator, but must be WWW. Condone ± 2 .
	$\left[\frac{d^2y}{dx^2} = \right] -\frac{24}{(2)^3}$ or -3 or $< 0 \Rightarrow$ maximum	B1	WWW. Or other valid method. Ignore any working for $x = -2$.
		2	
9(c)	$[y =] -12x^{-1} + \text{their } cx \left[= -\frac{12}{x} - 3x \right] [+d]$	B1FT	May be unsimplified. FT <i>their</i> nonzero c .
	$19 = -\frac{12}{-2} - 3 \times (-2) + d \quad [\Rightarrow d = 7]$	M1	Substituting $(-2, 19)$ into their integrated expression (defined by having at least one correct power) and including $+d$.
	$y = -\frac{12}{x} - 3x + 7$	A1	Accept $d = 7$ as final answer if $y = \dots$ seen previously. Allow ' $f(x) =$ ' in place of ' $y =$ '.
		3	

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Question	Answer	Marks	Guidance
9(d)	$\frac{12}{x^2} - 3 = -\frac{9}{4} \Rightarrow \frac{12}{x^2} = \frac{3}{4} \Rightarrow x = \dots \left[\Rightarrow x^2 = 16 \Rightarrow x = 4, y = -8 \right]$	*M1	Setting <i>their</i> $\frac{dy}{dx}$ of the form $kx^{-2} + c = -\frac{9}{4}$, and correctly solving for x from their equation where $x^2 > 0$.
	Gradient of normal = $\frac{4}{9}$	B1	
	$\frac{y+8}{(x-4)} = \frac{4}{9}$	DM1	For using <i>their</i> stated positive x and <i>their</i> stated y and a changed gradient to correctly form a line equation; condone $-\frac{4}{9}$ or $\frac{9}{4}$.
	$4x - 9y - 88 = 0$	A1	OE in correct form.
		4	

Question	Answer	Marks	Guidance
10(a)(i)	$8k - k^2 = k^2 - 4k$ or $2k^2 = 4k + 8k$ or $4k + 2(k^2 - 4k) = 8k$	M1	OE Forming an equation in k only, clearly using the first 3 terms of an AP.
	$[2k(k-6) = 0 \Rightarrow] k = 6$ [or $k = 0$]	A1	Condone extra 'solution' $k = 0$. Note: can be done by inspection or with no working. 2 / 2
		2	

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Question	Answer	Marks	Guidance
10(a)(ii)	$d [= 8k - k^2 \text{ or } 2k \text{ or } k^2 - 4k] = 12 \text{ and } a [= 4k] = 24$	*M1	Using a correct method to find a and d from <i>their</i> k . SOI. May have been found in (a)(i) but must be used in (ii) .
	$S_{20} = \frac{20}{2}(2 \times 24 + 19 \times 12) \text{ or } = \frac{20}{2}(24 + 252)$	DM1	Use of correct sum formula with $n = 20$ and <i>their</i> a and d .
	$S_{20} = 2760$	A1	
		3	
10(b)	$ar^3 = 36 \text{ and } ar^5 = 6$ or $r^2 = \frac{1}{6}$	B1	SOI WWW
	$r = \sqrt{\frac{6}{36}} \left[= \frac{1}{\sqrt{6}} \text{ or } \frac{\sqrt{6}}{6} \right]$	*M1	Using a correct method to find r . Condone $\pm$.
	$a = \frac{36}{\left(\frac{1}{\sqrt{6}}\right)^3} \left[= 36 \times \sqrt{6}^3, 216\sqrt{6} \text{ or } \frac{1296}{\sqrt{6}} \right]$	*M1	Using a correct method to find a . Condone $\pm$.
	$S_{\infty} = \frac{216\sqrt{6}}{1 - \frac{1}{\sqrt{6}}}$	DM1	Using the correct formula with <i>their</i> a and <i>their</i> $ r < 1$.
	$[S_{\infty} =] \frac{1296}{\sqrt{6} - 1} \text{ or } \frac{7776}{\sqrt{216} - 6}$	A1	OE in the required form. $r = 0.408 \Rightarrow a = 529 \Rightarrow S_{\infty} = 894$ scores 4/5.
		5	

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Question	Answer	Marks	Guidance
11(a)	$\{(x+2)^2\}\{-2\}$	B1B1	B1 for each correct $\{ \}$. Allow $a = 2$, $b = -2$. If contradictory, give preference to the expression.
		2	
11(b)(i)	$y = (x+2)^2 - 2 \Rightarrow y+2 = (x+2)^2$	*M1	Equating y or $f^{-1}(x)$ or f^{-1} or $f(x)$ to <i>their</i> completed square form and first step. x and y may be interchanged at this stage. Condone $\pm$ errors.
	$x = [\pm]\sqrt{y+2} - 2$	DM1	Condone $\pm$ errors during simplification.
	$[f^{-1}(x) =] - \sqrt{x+2} - 2$	A1	Do not condone $x =$ or $f(x) =$.
		3	

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Question	Answer	Marks	Guidance
11(b)(ii)	$[gf(x)=] - \{their \text{ completed square form} \} - 4 \text{ or } -(x^2 + 4x + 2) - 4$	*M1	Using $fg(x) = \{(-x - 4) + 2\}^2 - 2$ scores 0/4.
	$[gf(x)=] - (x + 2)^2 - 2$	A1	
	$x = [\pm] \sqrt{-y - 2} - 2$	DM1	Finding x from <i>their</i> completed square form, which must contain a $-(x + k)^2$ term. Condone $\pm$ errors only during simplification. $x = -\sqrt{y + 2} - 2$ is DM0 (Square rooting then $\div$ or $\times -1$) x and y may be interchanged at this stage.
	$[(gf)^{-1}(x)=] - \sqrt{-x - 2} - 2$	A1	Do not condone $x =$.
	Alternative Method for Question 11(b)(ii)		
	$(gf)^{-1} = f^{-1}g^{-1}$	*M1	SOI Allow with <i>their</i> f^{-1} and <i>their</i> g^{-1} . Using $g^{-1}f^{-1}(x)$ scores 0/4.
	$g^{-1}(x) = -x - 4$	A1	
	$(gf)^{-1}(x) = -\sqrt{-x - 4 + 2} - 2$	DM1	Allow with <i>their</i> f^{-1} and <i>their</i> g^{-1} .
	$[(gf)^{-1}(x)=] - \sqrt{-x - 2} - 2$	A1	Do not condone $x =$
		4	

Cambridge International AS & A Level

MATHEMATICS**9709/13**

Paper 1 Pure Mathematics 1

May/June 2025**MARK SCHEME**Maximum Mark: 75

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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 **27** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics-Specific Marking Principles

- 1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
- 2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
- 3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
- 4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
- 5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.
- 6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Annotations guidance for centres

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	Transcription error
	Correct answer from incorrect working

PUBLISHED**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.

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	$2 + (12)(-2)x^{-3}$	B1	Correct differential but can be unsimplified.
	$2 + (12)(-2)(-2)^{-3} [= 5]$	*M1	Substitute $x = -2$ into <i>their</i> differential, which must contain x^{-3} .
	Either $(\text{their } 5) = \frac{y - (-1)}{x - (-2)}$ or $-1 = (\text{their } 5) \times (-2) + c \Rightarrow c =$	DM1	Attempt to find equation of tangent through $(-2, -1)$ with their numerical gradient obtained as described above.
	$y = 5x + 9$	A1	
		4	

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Question	Answer	Marks	Guidance
2	$r = \frac{8 \sin^3 \theta}{4 \sin^2 \theta} [= 2 \sin \theta]$	B1	A correct unsimplified expression for r , this may only be seen in a correct S_{∞}
	$\frac{4 \sin^2 \theta}{1 - 2 \sin \theta} = \frac{1}{2}$	*M1	OE Correct S_{∞} with <i>their</i> expression for r .
	Or		
	$r = \frac{8 \sin^3 \theta}{4 \sin^2 \theta}$ and $\frac{4 \sin^2 \theta}{1 - r} = \frac{1}{2}$	B1	
	$1 - 8 \sin^2 \theta = \frac{8 \sin^3 \theta}{4 \sin^2 \theta}$	*M1	
	Then		
	Expect $8 \sin^2 \theta + 2 \sin \theta - 1 [= 0]$	DM1	OE and attempt to solve. Attempt to solve a three-term quadratic to find at least one value of $\sin \theta$. This can be implied by a final answer of $\theta = 0.253^{\circ}$ AWRT
	$[\theta =] \sin^{-1} \frac{1}{4}, 0.25$	A1	OE Clearly identify one answer only. Accept $\sin \theta = \frac{1}{4} \Rightarrow k = \frac{1}{4}$ etc.
		4	

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Question	Answer	Marks	Guidance
3	$\left(\frac{1}{-1 \times 4}\right)a(4x-3)^{-1} + 2x$	B1	OE Do not accept $(-2+1)$ as equivalent to -1 .
	Apply correct limits, $x = 3$ & 1 , to <i>their</i> integral	*M1	<i>Their</i> integral must contain $(4x-3)^{-1}$. Condone using $x = 1$ and 3 .
	$\frac{-a}{36} + 6 - \left(\frac{-a}{4} + 2\right) = 12 \Rightarrow \left[\frac{8a}{36} + 4 = 12\right]$	DM1	OE Equate <i>their</i> linear unsimplified expression in a to 12 .
	$a = 36$	A1	
		4	

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Question	Answer	Marks	Guidance
4(a)	$\{32[x^0]\}\{-120x\}\{+180x^2\}$	B1B1B1	Coefficients must be simplified. Ignore further terms in the expansion. SC B3: $2^5\left(1 - \frac{15}{4}x + \frac{45}{8}x^2 \dots\right)$ can be awarded full marks, ISW.
		3	
4(b)	$x = 0.01$ or $\frac{1}{100}$	B1	Identify 0.01 as the only value to substitute, condone any method.
	$(\textit{Their } 32 - 120x + 180x^2)$ with $x = (\textit{their } 0.01)$	M1	Clear use of <i>their</i> x -value from <i>their</i> solution of $2 - \frac{3}{2}x = 1.985$ and <i>their</i> answer to (a). Expect $32 - 120(0.01) + 180(0.01)^2 = 32 - 1.2 + 0.018$. Condone substitution into further terms in the expansion.
	30.8[18]	A1	Correct answer to at least 3sf coming from substitution into three or more terms. 'Correct' answers without appropriate working get A0.
		3	

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Question	Answer	Marks	Guidance
5	Replace $\tan \theta$ with $\frac{\sin \theta}{\cos \theta}$	M1	
	Replace $\sin^2 \theta$ with $1 - \cos^2 \theta$ leading to a 3-term quadratic	*M1	To obtain a 3-term quadratic in $\cos \theta$. Accept a cubic that has a common factor of $\cos \theta$. Condone +/- sign errors during simplification.
	$9 \cos^2 \theta + \cos \theta - 4 \quad [= 0]$	A1	OE
	Attempt to solve (<i>their</i> quadratic in $\cos \theta$) using a valid method	DM1	Only available for solution of a three-term quadratic. Correct values of $\cos \theta$ are 0.6134 and -0.7245 .
	Any two of ± 52.2 , ± 136.4	A1	AWRT as final answers. Any two correct answers between -180° and 180° as <i>their</i> final answers.
	All four values	A1	Condone other answers outside the range but no others between -180° and 180° . SC after M1 *M1 A1 DM0, correct answers can score B1 B1.
		6	

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Question	Answer	Marks	Guidance
6	$a + 2(N - 1) = 55$	B1	SOI
	$\frac{1}{2} \times 3N(2a + 2(3N - 1)) = 5760$	B1	SOI
	Eliminate either a or N	M1	Using a valid substitution, expect either $a = 57 - 2N$ or $N = \frac{(57 - a)}{2}$. Condone +/- sign errors in <i>their</i> substitution or during simplification.
	$N^2 + 56N - 1920$ or $a^2 - 226a + 1953 [= 0]$	A1	All terms need not be collected on one side.
	$N = 24, a = 9$	A1 A1	Ignore presence of extra solutions for N and a .
		6	

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Question	Answer	Marks	Guidance
7(a)	$3x^2 + 10x - 8 < 0$ or $3\left(x + \frac{5}{3}\right)^2 - \frac{49}{3} < 0$	*B1	OE Condone = or ≤ 0 , but use of $>$ or $\geq$ can only score B0B1B0. If there is no $<$, $=$ or ≤ 0 , then a correct final answer implies < 0 here.
	-4 and $\frac{2}{3}$	B1	
	$-4 < x < \frac{2}{3}$	DB1 FT	OE Use of $\leq$ sign(s) gets DB0. Condone $x > -4$, $x < \frac{2}{3}$, $x > -4$ and $x < \frac{2}{3}$ but not $x > -4$ or $x < \frac{2}{3}$. FT on <i>their</i> critical values.
		3	
7(b)	Identify $x = -4$ as the x -value of the maximum point.	B1 FT	SOI FT on <i>their</i> lower critical value from part (a).
	$[y =] \frac{3}{3}x^3 + \frac{10}{2}x^2 - 8x [+c]$	B1	Correct integration of the three terms given. Condone $f(x) =$.
	Use of $y = 27$, $x = \text{their}\left(-4 \text{ or } \frac{2}{3}\right)$ in <i>their</i> integral.	M1	<i>Their</i> integral must be a cubic, <i>their</i> $\left(-4 \text{ or } \frac{2}{3}\right)$ must come from (a) or a restart.
	$c = -21 \Rightarrow y = x^3 + 5x^2 - 8x - 21$	A1	Do not ISW if they continue to find a straight line. Condone omission of final statement if y or $f(x) = x^3 + 5x^2 - 8x + c$ has been seen earlier.
		4	

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Question	Answer	Marks	Guidance
8(a)	$\frac{1}{2}\pi - 2\left(\tan^{-1}\frac{4}{12} \text{ or } \sin^{-1}\frac{4}{\sqrt{160}} \text{ or } \cos^{-1}\frac{12}{\sqrt{160}}\right)$ Or $2\sin^{-1}\left[\frac{\frac{1}{2}EF}{AE} = \frac{\sqrt{32}}{\sqrt{160}} = \frac{\sqrt{2}}{\sqrt{10}}\right] \text{ or other valid method.}$	M1	Attempt a complete valid method for finding angle EAF. $\sqrt{160}$ may be replaced by 12.65 AWRT and $\sqrt{32}$ by 5.657 AWRT. Working in degrees should give $E\hat{A}F = 53.13^\circ$ which converts to the correct value in radians.
	$[E\hat{A}F = 0.927295\dots] = 0.9273$	A1	AG If decimals are used, at least one of 0.32175..., 0.6435 or 0.92729.. must be seen in the first method and 5.6569 and 12.649 or 0.46364 seen in the second method for the correct level of accuracy. Note: $E\hat{A}F = 53.14^\circ$ does not convert to the correct answer, so A0.
	Alternative Method for Question 8(a)		
	$12^2 - (24 + 24 + 32) = \frac{1}{2}(their AE \times their AF) \sin E\hat{A}F$ $\sin E\hat{A}F = \frac{2\{12^2 - (24 + 24 + 32)\}}{(their AE \times their AF)}$ $E\hat{A}F = \sin^{-1} \frac{2\{12^2 - (24 + 24 + 32)\}}{(their AE \times their AF)}$	M1	Attempt a complete valid method for finding angle EAF. Area of ABCD – (Area Δs ADF, ABE & CEF) = Area ΔAEF. $E\hat{A}F = \sin^{-1}\left(their \frac{4}{5}\right)$. Using the cosine rule should lead to $\cos^{-1}\frac{3}{5}$.
	$\left[E\hat{A}F = \sin^{-1}\frac{4}{5} = \right] \frac{\frac{1}{2}EF}{AE}$	A1	AG
		2	

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Question	Answer	Marks	Guidance
8(b)	$[AE \text{ or } AF =] \sqrt{160} \text{ or } \frac{4}{\sin \hat{EAB}}$	B1	OE Expect AWRT 12.65.
	$[r\theta =] (their\ 12.65) \times 0.9273$	M1	Use of $r\theta$ with $(their\ \sqrt{160})$. Note: using $r = 12$ scores M0.
	$[11.729... + 8 + 8 =] 27.7$ AWRT	A1	
		3	
8(c)	$\frac{1}{2}(their\ 12.65)^2 \times 0.9273 [= 74.184]$	M1	Use $\frac{1}{2}r^2\theta$ for area of sector with $(their\ 12.65)$. Note: using $r = 12$ scores M0.
	$144 - 24 - 24 - \left\{ \frac{1}{2}(their\ 12.65)^2 \times 0.9273 \right\}$	M1	Attempt a complete method for finding area of shaded region. Condone use of $r = 12$.
	[Area =] 21.8	A1	AWRT
	Alternative Method for Question 8(c)		
	$\frac{1}{2}(their\ 12.65)^2 (0.9273 - \sin 0.9273) [= 10.183]$	M1	Area of the segment with $(their\ 12.65)$. Note: using $r = 12$ scores M0.
	$32 - \frac{1}{2}(their\ 12.65)^2 (0.9273 - \sin 0.9273)$	M1	Attempt a complete method for finding area of shaded region, condone use of $r = 12$.
	[Area =] 21.8	A1	AWRT
		3	

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Question	Answer	Marks	Guidance
9(a)	Gradient of $PR = \frac{k-5}{2+13}$ or gradient of $RQ = \frac{k-1}{2-5}$	B1	Obtain at least one relevant gradient.
	$(\text{their gradient of } PR) \times (\text{their gradient of } RQ) = -1$ and attempt to simplify	M1	Clear of fractions and expand brackets. Expect $k^2 - 6k + 5 = 45$ OE. Condone +/-sign errors during simplification.
	$k^2 - 6k - 40 [= 0]$	A1	OE
	$k = 10, k = -4$	A1	
	Alternative Method for Question 9(a)		
	$PR^2 = (k-5)^2 + (2+13)^2$ or $RQ^2 = (k-1)^2 + (2-5)^2$	B1	Obtain at least one of PR^2 and RQ^2 . These expressions may be seen under a square root sign.
	$(\text{their } PR^2) + (\text{their } RQ^2) = 18^2 + 4^2$ and attempt to simplify	M1	Expect $2k^2 - 12k + 260 = 340$ OE. Condone +/-sign errors.
	$2k^2 - 12k - 80 [= 0]$	A1	OE
	$k = 10, k = -4$	A1	

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Question	Answer	Marks	Guidance
9(a)	Alternative Method 2 for Question 9(a)		
	$x^2 + y^2 + 8x - 6y - 60 = 0$	B1	OE
	$2^2 + k^2 + 8 \times 2 - 6 \times k - 60 = 0$	M1	Substitution of $(2, k)$ into their circle equation.
	$k^2 - 6k - 40 [= 0]$	A1	OE
	$k = 10, k = -4$	A1	
		4	If none of the above marks are awarded, then SC B1 for using $k = 10$ to find the gradients of QR (-3) and PR ($\frac{1}{3}$) and showing that their product is -1 (or other similar verification), and then stating that this shows that 10 is a possible value for k .

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Question	Answer	Marks	Guidance
9(b)	[Centre is] $(-4, 3)$	B1	SOI
	Radius gradient = $\frac{(their\ 3) - 10}{(their\ -4) - 2} \left[= \frac{7}{6} \right]$	*M1	Attempt at finding the gradient of the radius using $(2, 10)$ and their centre, but not P, Q , the mid-point of PR or QR .
	Either $\frac{-1}{\left(\frac{their\ 7}{6} \right)} = \frac{y - 10}{x - 2}$ Or $10 = \frac{-1}{\left(\frac{their\ 7}{6} \right)} \times 2 + c \Rightarrow c = \dots$	DM1	OE Correct method to find the equation of the tangent using $\frac{-1}{their\ radius\ gradient}$ and $(2, 10)$.
	$y - 10 = -\frac{6}{7}(x - 2)$ or $y = \left(-\frac{6}{7} \right)x + \frac{82}{7}$	A1	OE Correct equation but not stated in the required form.
	$6x + 7y - 82 = 0$ or $82 - 6x - 7y = 0$	A1	All correct terms on one side, but condone them being in the wrong order.
	Alternative Method for Question 9(b)		
	$x^2 + y^2 + 8x - 6y - 60 = 0$	B1	OE Equation of the circle.
	$2x + 2y \frac{dy}{dx} + 8 - 6 \frac{dy}{dx} = 0$ Or $\frac{dy}{dx} = \frac{-2x - 8}{2} (85 - x^2 - 8x - 16)^{-\frac{1}{2}}$	*M1	Differentiate implicitly to arrive at an expression with two terms containing $\frac{dy}{dx}$. Or rearrange to make y the subject and differentiate to arrive at an expression of the form $f'(x) \times f(x)$.

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Question	Answer	Marks	Guidance
9(b)	$2(2) + 2(10) \frac{dy}{dx} + 8 - 6 \frac{dy}{dx} = 0$ Or $\frac{dy}{dx} = \frac{-2(2) - 8}{2} \left(85 - (2)^2 - 8(2) - 16 \right)^{-\frac{1}{2}}$	DM1	Substitute (2,10) into their implicit differential. Or substitute $x = 2$ into their expression for $\frac{dy}{dx}$.
	$y - 10 = -\frac{6}{7}(x - 2)$ or $y = -\frac{6}{7}x + \frac{82}{7}$	A1	OE Correct equation but not stated in the required form.
	$6x + 7y - 82 = 0$	A1	All correct terms on one side, but condone them being in the wrong order.
		5	

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Question	Answer	Marks	Guidance
10(a)	$-9 \times 2(2x-5)^{-2} + 2$	B1	Correct differential.
	$(\text{their } -18(2x-5)^{-2} + 2) = 0$ and rearrange to form a quadratic. $\left[(2x-5)^2 = 9 \text{ or } 8x^2 - 40x + 32 = 0 \right]$	M1	Equating a two term $\frac{dy}{dx}$ to 0 and dealing correctly with the negative power. Their two term $\frac{dy}{dx}$ must contain $(2x-5)^{-2}$.
	$(1, -6)$ and $(4, 6)$	A1, A1	A1 for two correct x -values or one correct point, second A1 for all correct.
		4	
10(b)	$-18 \times -2 \times 2(2x-5)^{-3} \left[= 72(2x-5)^{-3} \text{ or } \frac{144x-360}{(2x-5)^4} \right]$	B1 FT	Following through on <i>their</i> first derivative which must contain $(2x-5)^{-2}$.
	Use $(\text{their } x=1 \text{ and } x=4)$ in $(\text{their } 72(2x-5)^{-3})$ To determine the nature of both turning points.	M1	Substitute x -coordinate of each stationary point and determine their nature. Nature of the turning points must correctly follow from <i>their</i> values of $\frac{d^2y}{dx^2}$.
	For $x=1$, $\left[\frac{d^2y}{dx^2} = \right] -\frac{72}{27}$ or $< 0 \Rightarrow$ maximum For $x=4$, $\left[\frac{d^2y}{dx^2} = \right] \frac{72}{27}$ or $> 0 \Rightarrow$ minimum	A1	CWO
		3	

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Question	Answer	Marks	Guidance
10(c)(i)	(1, -13)	B1	
		1	
10(c)(ii)	$[y =] \frac{9}{2(x \pm 3) - 5} + 2(x \pm 3) - 5 \pm 7$	M1	Application of $\begin{pmatrix} -3 \\ 7 \end{pmatrix}$ to the original expression for C but condone $+/-$ sign errors.
	$[y =] - \left(\frac{9}{2(x \pm 3) - 5} + 2(x \pm 3) - 5 \pm 7 \right)$	M1	SC B1 for $[y =] - \left(\frac{9}{2x - 5} + 2x - 5 \right)$.
	$y = -\frac{9}{2x + 1} - 2x - 8$	A1	Answer must be in this format; the ' $y =$ ' can be implied by earlier inclusion.
		3	

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Question	Answer	Marks	Guidance
11(a)	$[f(x) =](x + 2a)^2 - 4a^2 + a$	B1	
	$(their(-4a^2 + a)) = -33$	M1	Condone $\geq$ or $>$.
	$4a^2 - a - 33 [= 0]$	B1	Condone $\leq$ or $<$.
	$-\frac{11}{4}, 3$	A1	OE Do not ISW if their final answer is given as a range or if one of the answers is rejected.
	Alternative Method for Question 11(a)		
	$x = -2a, y = -4a^2 + a$	B1	The co-ordinates of the minimum point (likely to be either from differentiation or completing the square).
	$(their - 4a^2 + a) = -33$	M1	Their y-coordinate equated to -33 . Condone $\geq$ or $>$.
	$-4a^2 + a + 33 [= 0]$	B1	OE Condone $\geq$ or $>$.
	$-\frac{11}{4}, 3$	A1	OE Do not ISW if their final answer is given as a range or if one of the answers is rejected.

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Question	Answer	Marks	Guidance
11(a)	Alternative Method 2 for Question 11(a)		
	$x^2 + 4ax + a + 33 [=0]$	B1	Condone $\geq$ or $>$.
	$(4a)^2 - 4[1](a + 33) [=0]$	M1	Condone $\geq$ or $>$.
	$16a^2 - 4a - 132 [=0]$	B1	OE Condone $\geq$ or $>$. Accept $4a^2 - a - 33$ or multiples thereof.
	$-\frac{11}{4}, 3$	A1	OE Do not ISW if their final answer is given as a range or if one of the answers is rejected.
		4	

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Question	Answer	Marks	Guidance
11(b)	$[g(x) =] \frac{1}{2}(x^3 + 4)$	B1	Expression for $g(x)$. SOI
	Either		
	$[g(0) =] \frac{1}{2}((0)^3 \pm 4) \quad [g(0) = 2]$	M1	Replacing x with 0 in <i>their</i> $g(x)$.
	$gg(0) = 6$	A1	
	$f(\text{their } 6) [=36 + 24a + a]$	M1	
	Or		
	$fg(x) = \left(\frac{x^3 + 4}{2}\right)^2 + 4a\left(\frac{x^3 + 4}{2}\right) + a$ or $gg(x) = \frac{\left(\frac{x^3 + 4}{2}\right)^3 + 4}{2} \quad \left[= \frac{(x^3 + 4)^3}{16} + 2 \right]$	M1	Either composite function using <i>their</i> $g(x)$.
	$fgg(x) = \left\{ \frac{(x^3 + 4)^3}{16} + 2 \right\}^2 + 4a \left\{ \frac{(x^3 + 4)^3}{16} + 2 \right\} + a$	A1	Complete algebraic expression for $fgg(x)$.
	$fgg(0) = \left\{ \frac{(0 + 4)^3}{16} + 2 \right\}^2 + 4a \left\{ \frac{(0 + 4)^3}{16} + 2 \right\} + a$	M1	Replacing x with 0 in <i>their</i> $fgg(x)$.

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Question	Answer	Marks	Guidance
11(b)	Then		
	$36 + 24a + a = 96$	A1	OE
	$[a =] \frac{12}{5}$	A1	OE
		6	

Cambridge International AS & A Level

MATHEMATICS**9709/15**

Paper 1 Pure Mathematics 1

May/June 2025**MARK SCHEME**Maximum Mark: 75

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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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 **24** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptions for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Mathematics-Specific Marking Principles

- 1 Unless a particular method has been specified in the question, full marks may be awarded for any correct method. However, if a calculation is required then no marks will be awarded for a scale drawing.
- 2 Unless specified in the question, non-integer answers may be given as fractions, decimals or in standard form. Ignore superfluous zeros, provided that the degree of accuracy is not affected.
- 3 Allow alternative conventions for notation if used consistently throughout the paper, e.g. commas being used as decimal points.
- 4 Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored (isw).
- 5 Where a candidate has misread a number or sign in the question and used that value consistently throughout, provided that number does not alter the difficulty or the method required, award all marks earned and deduct just 1 A or B mark for the misread.
- 6 Recovery within working is allowed, e.g. a notation error in the working where the following line of working makes the candidate's intent clear.

Annotations guidance for centres

Examiners use a system of annotations as a shorthand for communicating their marking decisions to one another. Examiners are trained during the standardisation process on how and when to use annotations. The purpose of annotations is to inform the standardisation and monitoring processes and guide the supervising examiners when they are checking the work of examiners within their team. The meaning of annotations and how they are used is specific to each component and is understood by all examiners who mark the component.

We publish annotations in our mark schemes to help centres understand the annotations they may see on copies of scripts. Note that there may not be a direct correlation between the number of annotations on a script and the mark awarded. Similarly, the use of an annotation may not be an indication of the quality of the response.

The annotations listed below were available to examiners marking this component in this series.

Annotations

Annotation	Meaning
	More information required
	Accuracy mark awarded zero
	Accuracy mark awarded one
	Independent accuracy mark awarded zero
	Independent accuracy mark awarded one
	Independent accuracy mark awarded two
	Benefit of the doubt
	Blank Page
	Incorrect
Dep	Used to indicate DM0 or DM1

Annotation	Meaning
DM1	Dependent on the previous M1 mark(s)
	Follow through
	Indicate working that is right or wrong
Highlighter	Highlight a key point in the working
	Ignore subsequent work
	Judgement
	Judgement
	Method mark awarded zero
	Method mark awarded one
	Method mark awarded two
	Misread
	Omission or Other solution
Off-page comment	Allows comments to be entered at the bottom of the RM marking window and then displayed when the associated question item is navigated to.
On-page comment	Allows comments to be entered in speech bubbles on the candidate response.
	Judgment made by the PE
	Premature approximation
	Special case
	Indicates that work/page has been seen

Annotation	Meaning
SF	Error in number of significant figures
	Correct
TE	Transcription error
XP	Correct answer from incorrect working

PUBLISHED**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.

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	$[y =] \left\{ \frac{12}{3 \times 2} (2x - 5)^3 \right\} \left\{ + \frac{8}{2} x^2 \right\} [+c]$	B1 B1	OE Terms may be unsimplified. May see $[y =] \{16x^3\} \{-116x^2\} \{+300x\} [+c]$.
	$4 = 2 \times (2 \times 2 - 5)^3 + 4 \times 2^2 + c [\Rightarrow c = -10]$	M1	Sub (2, 4) correctly into <i>their</i> integrated expression with a '+ c'.
	y or f or $f(x) = 2(2x - 5)^3 + 4x^2 - 10$	A1	May see $y = 16x^3 - 116x^2 + 300x - 260$. ' $y =$ ' or ' $f(x) =$ ' or ' $f =$ ' can be implied if seen in working.
		4	

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Question	Answer	Marks	Guidance
2	x^2 coeff = $10 \times 3^3 \times a^2$ and $6 \times 6^2 \times (-1)^2$ allow correct terms with x^2	B1	Expect $270a^2$ and 216. Terms may be seen separately. Allow if seen in an expansion. Combinations must be evaluated.
	x coeff = $5 \times 3^4 \times a$ and $4 \times 6^3 \times (-1)$ allow correct terms with x	B1	Expect $405a$ and -864 . Terms may be seen separately. Allow if seen in an expansion. Combinations must be evaluated.
	$270a^2 + 216 = 6(405a - 864)$	M1	OE For forming a correct quadratic equation using <i>their</i> 4 terms only.
	$45a^2 - 405a + 900 = 0 \Rightarrow 45(a - 4)(a - 5) = 0$	DM1	For evidence of a correct method of solving. If quadratic formula used a full substitution must be seen.
	$a = 4$ or $a = 5$	A1	Only dependent on the first M1.
		5	

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Question	Answer	Marks	Guidance
3(a)	$4\left(x - \frac{1}{2}\right)^2 [-2 = 0] \text{ or } (2x - 1)^2 [-2 = 0] \text{ or } \left(x - \frac{1}{2}\right)^2 \left[-\frac{1}{2} = 0\right]$	M1	OE Must deal with the coefficient of x^2 and x correctly to produce an $(ax + b)^2$ term.
	$x = \frac{1}{2} \pm \sqrt{\frac{1}{2}}$	A1	OE, e.g. $x = \frac{1}{2}(1 \pm \sqrt{2})$. SC B1 only for correct solutions from another method.
		2	
3(b)	$\tan \theta = \frac{1}{2}(1 \pm \sqrt{2})$	M1	Setting $\tan \theta = \text{their } x$ for at least one value of <i>their</i> x . May restart and solve the quadratic in $\tan \theta$.
	$[\theta =] 50.4, 168.3 \text{ AWRT and no other answers in the range } 0 < \theta < 180$	A1 A1	SC A1 only for AWRT 0.879 and 2.94 radians. SC M0 B1 B1 for answers only. SC M0 B1(only) for both answers only in radians.
		3	

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Question	Answer	Marks	Guidance
4	Intersects x -axis when $x^4 = 1 \Rightarrow x = 1$	B1	WWW May be seen without working. May be seen as a limit in the integration. Allow ± 1 if $x = 1$ is seen as the lower limit in the integration.
	$V = [\pi] \int y^2 dx = [\pi] \int \left(x^2 - \frac{1}{x^2}\right)^2 dx = [\pi] \int \left(x^4 - 2 + \frac{1}{x^4}\right) dx$ with attempt at integration	*M1	With some attempt at squaring (accept $x^4 \pm \frac{1}{x^4}$ as evidence).
	$\frac{1}{5}x^5 - 2x - \frac{1}{3x^3}$	A1	
	$[\pi] \left\{ \left(\frac{1}{5} \times 2^5 - 2 \times 2 - \frac{1}{3 \times 2^3} \right) - \left(\frac{1}{5} - 2 - \frac{1}{3} \right) \right\}$	DM1	Use of limits, $x = 2$ and <i>their</i> $x = 1$, min evidence if correct answer: $\frac{283}{120} + \frac{32}{15}$. If answer incorrect, substitution of limits must be clear. DM0 for use of the limit $x = 0$.
	$\pi \times 4.49... = 14.11$	A1	AWRT, WWW Allow $\frac{539}{120}\pi$ or 14.1, dependent on the first M1 and A1.
		5	

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Question	Answer	Marks	Guidance
5(a)	Angle $CAD = \frac{\pi}{3}$ or 60° , $CD = \sqrt{75}$ or $5\sqrt{3}$	B1	OE For either $\hat{CAD}$ or CD . Allow $\hat{CAD} = 1.05$, $CD = 8.7$ or 8.66 .
	[Perimeter =] $\left\{10 \times \frac{\pi}{3}\right\}\{+\sqrt{75} + 5\}$ or $\left\{\frac{60}{360} \times 2\pi(10)\right\}\{+\sqrt{75} + 5\}$	B1 B1	OE B1 for the two sides and B1 for arc length (allow 10.5).
	= 24.1 cm	B1	
		4	
5(b)	Area = $\frac{1}{2} \times 10^2 \times \frac{\pi}{3} - \frac{1}{2} \times 5 \times \sqrt{75}$ or $\frac{60}{360} \times \pi \times 10^2 - \frac{1}{2} \times 5 \times \sqrt{75}$	M1	OE Use of sector area formula minus triangle area formulae, with <i>their</i> angle CAD and <i>their</i> side CD .
	= 30.7 cm ²	A1	
		2	

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Question	Answer	Marks	Guidance
6(a)	Eleventh birthday: Father $10+10\times 5 [= 60]$	M1	For correct use of AP formula OE.
	Mother $10\times 1.2^{10} [= 61.9(2)]$	M1	For correct use of GP formula OE.
	60 and 61.9	A1	Both answers. Accept 2 sf answers.
		3	
6(b)	Father $\frac{18}{2}(2\times 10+17\times 5) = 945$	M1A1	A1 may be implied by a correct final answer.
	Mother $\frac{10(1-1.2^{18})}{(1-1.2)} = 1281.17$	M1A1	A1 may be implied by a correct final answer.
	Total = 2226.17	A1	Accept 3 or more sf answers. Ignore $S_{17} (= 1909.3)$ as an extra answer.
		5	

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Question	Answer	Marks	Guidance
7(a)	$\frac{7-p}{3-6} = -\frac{2}{3}$ or use of straight line equations with $m = -\frac{2}{3}$, $(x, y) = (3, 7)$ with $(6, p)$ substituted.	M1	OE Expect $y - 7 = \left(-\frac{2}{3}\right)(x - 3)$ with $(6, p)$ substituted or $y = \frac{-2}{3}x + 9$ with $(6, p)$ substituted.
	$p = 5$	A1	
		2	
7(b)	$(\{4\}, \{their\ 2p-7\})$	B1	WWW
		B1FT	Extra solutions lose both marks.
		2	
7(c)	Mid-point AB is $(4.5, 6)$	B1	
	Gradient of perp bisector $\left[\begin{array}{c} -1 \\ -\frac{2}{3} \end{array} \right] = \frac{3}{2}$	B1	
	Equation $y - 6 = \frac{3}{2}(x - 4.5)$	M1	OE. Must be using <i>their</i> mid-point and <i>their</i> perpendicular gradient.
	Crosses axes at $(0, -0.75), (0.5, 0)$	DM1	Correct use of <i>their</i> perpendicular bisector equation to find the x - and y -intercept.
	Area = 0.1875 (accept 3 sf accuracy)	A1	OE, e.g. $\frac{3}{16}$. Last 2 marks can be gained by integrating the line equation between zero and 0.5.
		5	

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Question	Answer	Marks	Guidance
8(a)	$9 = 1 + a + b + 5$	B1	
	$\frac{dy}{dx} = 3x^2 + 2ax + b$	B1	
	Gradient = 0 at (1, 9) so $0 = 3 + 2a + b$	M1	Setting <i>their</i> $\frac{dy}{dx}$ to zero and substituting $x = 1$.
	Attempt to solve <i>their</i> linear equations simultaneously	DM1	Can be implied by their answers.
	$a = -6, b = 9$	A1	WWW
		5	
8(b)	$\frac{dy}{dx} = 3x^2 - 12x + 9 = 0$	M1	Setting <i>their</i> $\frac{dy}{dx}$ to zero.
	Solution [leading to $x = 1$ or $x = 3$]	DM1	Solving <i>their</i> 3-term quadratic
	(3, 5) or $x = 3, y = 5$	A1	WWW Ignore (1, 9) if given as a second answer. Only dependent on the first M1.
		3	

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Question	Answer	Marks	Guidance
8(c)	At $x = 5$, $\frac{dy}{dx} = 3 \times 5^2 - 12 \times 5 + 9$	M1	Substituting $x = 5$ into <i>their</i> $\frac{dy}{dx}$. May be implied.
	$6 = \text{their } 24 \times \frac{dx}{dt}$ or $\text{their } 24 = 6 \times \frac{dt}{dx}$	M1	OE Use of chain rule SOI $\left(\frac{dy}{dt} = \frac{dy}{dx} \times \frac{dx}{dt} \right)$. Linking correctly $\frac{dx}{dt}$ (or $\frac{dt}{dx}$), <i>their</i> 24 and 6.
	$\frac{dx}{dt} = \frac{1}{4}$	A1	OE
		3	

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Question	Answer	Marks	Guidance
9(a)	{Stretch} {factor 3} {in y-direction}	B2,1,0	If 2 or more stretches or extra transformations, give B0 for stretches.
	{Translation or shift} $\begin{pmatrix} \{\pi\} \\ \{2\} \end{pmatrix}$	B2,1,0	Translation may be split to $\begin{pmatrix} \pi \\ 0 \end{pmatrix}$ before the stretch and $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$ after the stretch. If both vectors correct but ‘translation’/’shift’ not stated, then B1 only for the translations.
	Alternative Method for Question 9(a)		
	{Translation or shift} $\begin{pmatrix} \{\pi\} \\ \left\{\frac{2}{3}\right\} \end{pmatrix}$ or $\begin{pmatrix} \pi \\ 0 \end{pmatrix}$ and $\begin{pmatrix} 0 \\ \frac{2}{3} \end{pmatrix}$	B2,1,0	If two or more stretches or any extra incorrect transformation is given, then B0 for the stretches. If order incorrect, maximum of 3/4.
	followed by {stretch} {factor 3} {in y direction}	B2,1,0	
		4	

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Question	Answer	Marks	Guidance
9(b)		B1†	Graph of $f(x)$ with correct domain.
		B1†	For $g(x)$ being a decreasing function in the domain π to 2π .
		B1	Domain π to 2π for $g(x)$.
		B1	Range for g approximately correct (should be from 5 to -1).
		4	†Sketches must be curves and have zero gradient at the ends of the given domains.
9(c)	$[g^{-1}] f\left(\frac{\pi}{3}\right) = [g^{-1}]\left(\frac{1}{2}\right)$	B1	May be implied by correct substitution later.
	$[g^{-1}(x) \text{ or } y =] \cos^{-1}\left(\frac{x-2}{3}\right) + \pi \text{ or } [x =] \cos^{-1}\left(\frac{y-2}{3}\right) + \pi$	M1	Finding inverse of g . Allow one sign error. Alt: $3 \cos(x - \pi) + 2 = \frac{1}{2}$
	$[g^{-1}\left(\frac{1}{2}\right) =] \cos^{-1}\left(\frac{\frac{1}{2}-2}{3}\right) + \pi$	DM1	Substituting <i>their</i> $x = \frac{1}{2}$ into <i>their</i> expression for $g^{-1}(x)$. Alt: Use of arccos for $\cos(x - \pi) = -\frac{1}{2} \Rightarrow x - \pi = \frac{2\pi}{3}$
	$[g^{-1}(x) =] \frac{2\pi}{3} + \pi = \frac{5\pi}{3} \text{ or } 5.24 \text{ AWRT}$	A1	
		4	

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Question	Answer	Marks	Guidance
9(d)	The domain of f does not include the whole of the range of g	B1	OE, but must mention range of g and domain of f.
	Alternative Method for Question 9(d)		
	Show clearly that a particular value or set of values in the domain of g gives a value of $g(x)$ which is outside the domain of f	B1	Value of x for substitution into $g(x)$ must be in the ranges: $\pi \leq x < 4.322$ or $5.447 < x \leq 2\pi$.
		1	

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Question	Answer	Marks	Guidance
10(a)	Centre is $(-2, 4)$	B1	
	Gradient of perpendicular $= \frac{8-4}{2-(-2)} [= 1]$	M1	OE, e.g. using equation of the radius.
	Equation of tangent is $y - 8 = -1(x - 2)$	M1	Using a correct point and <i>their</i> tangent gradient from an attempt to find $\frac{dy}{dx}$, or the negative reciprocal of <i>their</i> perpendicular gradient.
	$x + y - 10 = 0$ or $-x - y + 10 = 0$	A1	CAO – this form is required. Answer without working, allow maximum of 2/4.
	Alternative Method for Question 10(a)		
	$y = [\pm](28 - x^2 - 4x)^{\frac{1}{2}} + 4$ or $y = [\pm](32 - (x + 2)^2)^{\frac{1}{2}} + 4$	B1	OE; a correct expression for y .
	$\frac{dy}{dx} = [\pm]\frac{1}{2}(28 - x^2 - 4x)^{-\frac{1}{2}}(-2x - 4) [= -1 \text{ at } x = 2]$	M1	OE Differentiating y with no more than one sign error.
	Equation of tangent is $y - 8 = -1(x - 2)$	M1	Using a correct point and <i>their</i> tangent gradient from an attempt to find $\frac{dy}{dx}$, or the negative reciprocal of <i>their</i> perpendicular gradient.
	$x + y - 10 = 0$ or $-x - y + 10 = 0$	A1	CAO – this form is required. Answer without working, allow maximum of 2/4.

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Question	Answer	Marks	Guidance
	Alternative Method 2 for Question 10(a)		
	$2x + 2y \frac{dy}{dx} + 4 - 8 \frac{dy}{dx} = 0$	B1	Differentiating implicitly.
	$\frac{dy}{dx} = \frac{(2x+4)}{(8-2y)} \quad [= -1 \text{ at } (2, 8)]$	M1	Rearranging to make $\frac{dy}{dx}$ the subject, May substitute (2, 8) and then rearrange to find $\frac{dy}{dx}$.
	Equation of tangent is $y - 8 = -1(x - 2)$	M1	Using a correct point and <i>their</i> tangent gradient from an attempt to find $\frac{dy}{dx}$, or the negative reciprocal of <i>their</i> perpendicular gradient.
	$x + y - 10 = 0$ or $-x - y + 10 = 0$	A1	CAO – this form is required. Answer without working, allow maximum of 2/4.
		4	

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Question	Answer	Marks	Guidance
10(b)	$(k-3y)^2 + y^2 + 4(k-3y) - 8y - 12 = 0$ or $(k-3y+2)^2 + (y-4)^2 = 32$	M1*	Sub $x = k - 3y$ or $y = \frac{k-x}{3}$ into circle equation. $y = \frac{k-x}{3}$ gives: $\frac{(k-x)^2}{9} - 8\frac{k-x}{3} + x^2 + 4x - 12 = 0$ or $(x+2)^2 + \left(\frac{k-x}{3} - 4\right)^2 = 32.$
	$9y^2 - 6ky - 20y + y^2 + k^2 + 4k - 12 = 0$	DM1	OE All squared brackets expanded to give a quadratic equation in y (or x , which gives: $9x^2 + 60x - 2kx + k^2 + x^2 - 24k - 108 = 0$ or $\frac{x^2 + k^2 - 2kx}{9} - \frac{8k - 8x}{3} + 16 + x^2 + 4x + 4 = 32.$)
	$b^2 - 4ac = (6k + 20)^2 - 4 \times 10 \times (k^2 + 4k - 12)$	M1**	OE Factorising out y (or x) from <i>their</i> quadratic (this is the quadratic where the previous DM1 or possibly DM0 was awarded) to identify ' b ' and then finding the discriminant. From equation in x , this is: $(60 - 2k)^2 - (4)(10)(k^2 - 24k - 108).$
	$-4k^2 + 80k + 880 < 0$	DM1	OE Simplify the discriminant and setting it to less than zero. From eliminating y this is: $-36k^2 + 720k + 7920 < 0$ Only dependent on the previous M1.
	$k^2 - 20k - 220 > 0$	A1	AG WWW

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Question	Answer	Marks	Guidance
10(b)	Alternative Method for Question 10(b)		
	Centre of circle $(-2, 4)$ and radius of circle is $\sqrt{32}$	B1	
	Distance of $x + 3y - k$ from $(-2, 4) = \frac{1(-2) + 3(4) - k}{\sqrt{1^2 + 3^2}}$	M1*	Correct use of ‘distance of a line from a point formula’ with <i>their</i> centre coordinates.
	Setting $\frac{1(-2) + 3(4) - k}{\sqrt{1^2 + 3^2}} > \sqrt{32}$	DM1	Setting distance to be greater than <i>their</i> radius.
	Squaring both sides	DM1	Removing the square roots.
	Rearranging to $k^2 - 20k - 220 > 0$	A1	AG
		5	