

MARK SCHEME for the October/November 2014 series

9709 MATHEMATICS

9709/32

Paper 3, maximum raw mark 75

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 will not enter into discussions about these mark schemes.

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			P. Mains
Page 2	Mark Scheme	Syllabus	P. Mar B
	Cambridge International A Level – October/November 2014	9709	32 31/10 15
Mark Scheme Notes			32 thscloud.com
Marks are of the following three types:			"

Mark Scheme Notes

- Μ 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.
- А 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).
- В Mark for a correct result or statement independent of method marks.
- 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 (or dep*) 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.
- The symbol $\sqrt{}$ 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 and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.
- B2 or A2 means that the candidate can earn 2 or 0. Note: B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the • scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking g equal to 9.8 or 9.81 instead of 10.

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The fo	ollowing abbreviations may be used in a mark scheme or used on the	scripts:	32 nscloud.com
AEF	Any Equivalent Form (of answer is equally acceptable)		m

- AEF Any Equivalent Form (of answer is equally acceptable)
- AG Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
- BOD Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)
- CAO Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)
- CWO Correct Working Only – often written by a 'fortuitous' answer
- ISW Ignore Subsequent Working
- MR Misread
- PA Premature Approximation (resulting in basically correct work that is insufficiently accurate)
- SOS See Other Solution (the candidate makes a better attempt at the same question)
- SR Special Ruling (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)

Penalties

- MR –1 A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through $\sqrt{2}$ " marks. MR is not applied when the candidate misreads his own figures - this is regarded as an error in accuracy. An MR -2 penalty may be applied in particular cases if agreed at the coordination meeting.
- PA –1 This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

Page 4	Mark Scheme	Syllabus	P	n Ma
	Cambridge International A Level – October/November 2014	9709	32	ATHS .
Obta	law of the logarithm of a power in a correct linear equation in any form, e.g. $x = (x - 2) \ln 3$ in answer $x = 22.281$		M1 A1 A1	In ansclot
(i)	State or imply ordinates 2, 1.1547, 1, 1.1547		B1	
	Use correct formula, or equivalent, with $h = \frac{1}{6}\pi$ and four ordinates		M1	
	Obtain answer 1.95		A1	[3]
	Make recognisable sketch of $y = \operatorname{cosec} x$ for the given interval Justify a statement that the estimate will be an overestimate		B1 B1	[2]
	titute $x = -\frac{1}{3}$, equate result to zero or divide by $3x + 1$ and equate the rem	ainder to zero		
and	bbtain a correct equation, e.g. $-\frac{1}{27}a + \frac{1}{9}b - \frac{1}{3} + 3 = 0$		B1	
	titute $x = 2$ and equate result to 21 or divide by $x - 2$ and equate constant re	emainder to 21	M1	
	in a correct equation, e.g. $8a + 4b + 5 = 21$		A1	
	e for a or for b in $a = 12$ and $b = -20$		M1 A1	[5]
	Use chain rule correctly at least once		M1	
	Obtain either $\frac{dx}{dt} = \frac{3\sin t}{\cos^4 t}$ or $\frac{dy}{dt} = 3\tan^2 t \sec^2 t$, or equivalent		A1	
	Use $\frac{dy}{dt} = \frac{dy}{dt} \div \frac{dx}{dt}$		M1	
	dx dt dt			LA I
	Obtain the given answer		A1	[4]
	State a correct equation for the tangent in any form		B1	
	Use Pythagoras		M1	[2]
	Obtain the given answer		A1	[3]
(i)	Substitute $z = 1 + i$ and obtain $w = \frac{1+2i}{1+i}$		B1	
	<i>EITHER</i> : Multiply numerator and denominator by the conjugate of the o	denominator,		
	or equivalent		M1	
	Simplify numerator to $3 + i$ or denominator to 2		A1	
	Obtain final answer $\frac{3}{2} + \frac{1}{2}i$, or equivalent		A1	
	<i>OR</i> : Obtain two equations in x and y , and solve for x or for y		M1	
	Obtain $x = \frac{3}{2}$ or $y = \frac{1}{2}$, or equivalent		A1	
			A1	[4]
	Obtain final answer $\frac{3}{2} + \frac{1}{2}i$, or equivalent		111	[4]

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(ii)	<i>EITHER</i> : Substitute $w = z$ and obtain a 3-term quadratic equation in z,	или, ту IS Р. 32 В1	
()	e.g. $iz^2 + z - i = 0$	B1	
	Solve a 3-term quadratic for z or substitute $z = x + iy$ and use a correct		
	method to solve for x and y	M1	
	<i>OR</i> : Substitute $w = x + iy$ and obtain two correct equations in x and y by equat real and imaginary parts	B1	
	Solve for x and y	M1	
	Obtain a correct solution in any form, e.g. $z = \frac{-1 \pm \sqrt{3} i}{2i}$	A 1	
	Obtain a correct solution in any form, e.g. $z = \frac{2i}{2i}$	A1	
	Obtain final answer $-\frac{\sqrt{3}}{2} + \frac{1}{2}i$	A 1	Γ <i>Α</i>
	Obtain linal answer $-\frac{1}{2}+\frac{1}{2}$	A1	[4]
	c 1		
(i)	Integrate and reach $bx \ln 2x - c \int x \cdot \frac{1}{x} dx$, or equivalent	M1*	
	Obtain $x \ln 2x - \int x \cdot \frac{1}{x} dx$, or equivalent	A1	
	Obtain integral $x \ln 2x - x$, or equivalent	A1	
		41(dep*)	
	Obtain a correct equation in any form, e.g. $a \ln 2a - a + 1 - \ln 2 = 1$ Obtain the given answer	A1 A1	[6
			1.
	Use the iterative formula correctly at least once	M1	
	Obtain final answer 1.94 Show sufficient iterations to 4 d.p. to justify 1.94 to 2d.p. or show that there is a sign	A1	
	change in the interval (1.935, 1.945).	A1	[3
(i)	Separate variables correctly and attempt to integrate at least one side	B1	
	Obtain term ln <i>R</i>	B1	
	Obtain $\ln x - 0.57x$	B1	
	Evaluate a constant or use limits $x = 0.5$, $R = 16.8$, in a solution containing terms of the $a \ln R$ and $b \ln x$	form M1	
	Obtain correct solution in any form	A1	
	Obtain a correct expression for R, e.g. $R = xe^{(3.80 - 0.57x)}$, $R = 44.7xe^{-0.57x}$ or		
	$R = 33.6xe^{(0.285 - 0.57x)}$	Δ 1	14
	$K = 55.0Xe^{-1}$	A1	[6]
(••)	Equate $\frac{dR}{dt}$ to zero and solve for x	MI	
(11)	Equate $\frac{dx}{dx}$ to zero and solve for x	M1	
	State or imply $x = 0.57^{-1}$, or equivalent, e.g. 1.75	A1	
	Obtain $R = 28.8$ (allow 28.9)	A1	[3
(i)	Use sin($A + B$) formula to express sin3 θ in terms of trig. functions of 2θ and θ	M1	
	Use correct double angle formulae and Pythagoras to express $\sin 3\theta$ in terms of $\sin \theta$	M1	
	Obtain a correct expression in terms of $\sin \theta$ in any form	A1	
	Obtain the given identity [SR: Give M1 for using correct formulae to express RHS in terms of $\sin\theta$ and $\cos2\theta$,	A1	[4
	then M1A1 for expressing in terms of $\sin\theta$ and $\sin3\theta$ only, or in terms		
	of $\cos A$, $\sin A$, $\cos 2A$ and $\sin 2A$ then A1 for obtaining the given identity 1		

of $\cos\theta$, $\sin\theta$, $\cos2\theta$ and $\sin2\theta$, then A1 for obtaining the given identity.]

Cambridge International A Level - October/November 2014970932(ii) Substitute for x and obtain the given answerB1[1](iii) Carry out a correct method to find a value of x Obtain answers 0.322, 0.799, -1.12 Solutions with more than 3 answers can only earn a maximum of A1 + A1.]A1 + A1 + A1[4](i) State or imply the form $\frac{A}{1-x} + \frac{B}{2-x} + \frac{C}{(2-x)^2}$ B1B1(i) State or imply the form $\frac{A}{1-x} + \frac{B}{2-x} + \frac{C}{(2-x)^2}$ B1(ii) State or imply the form $\frac{A}{1-x} + \frac{B}{2-x} + \frac{C}{(2-x)^2}$ B1(iii) State or imply the form $\frac{A}{1-x} + \frac{Dx + E}{(2-x)^2}$, where $A = 2, D = 1, E = 1$ is markedM1Obtain a second valueA1(j) Obtain a second valueA1(j) Use correct method to find the first two terms of the expansion of $(1-x)^{-1}, (2-x)^{-1}, (1-\frac{1}{2}x)^{-1}$ or $(1-\frac{1}{2}x)^{-2}$ (j) Use correct unsimplified expansions up to the term in x^2 of each partial fractionA1 $\sqrt{1 + A1} + A1\sqrt{1}$ Obtain final answer $\frac{9}{4} + \frac{5}{2} x + \frac{39}{16} x^2$, or equivalentA1[5][5][5][6] For the A,D,E form of partial fractions, give M1 A1 $\sqrt{1}$ A1 $\sqrt{1}$ for the expansions then, if $D \neq 0$, M1 for multiplying out fully and A1 for the final answer.][1] In the case of an attempt to expand $(x^2 - 8x + 9)(1 - x)^{-1}(2 - x)^{-2}$, give M1A1A1 for the expansions, M1 for multiplying out fully, and A1 for the final answer.]	<u>~9</u> ~ \	3	Mark Scheme	Syllabus		2 4
(ii) Carry out a correct method to find a value of x M1 Obtain answers 0.322, 0.799, -1.12 A1 + A1 + A1 [4] [Solutions with more than 3 answers can only earn a maximum of A1 + A1.] (i) State or imply the form $\frac{A}{1-x} + \frac{B}{2-x} + \frac{C}{(2-x)^2}$ B1 Use a correct method to determine a constant M1 Obtain on of $A = 2, B = -1, C = 3$ A1 Obtain a second value A1 [5] [The alternative form $\frac{A}{1-x} + \frac{Dx + E}{(2-x)^2}$, where $A = 2, D = 1, E = 1$ is marked B1M1A1A1A1 as above.] (ii) Use correct method to find the first two terms of the expansion of $(1-x)^{-1}, (2-x)^{-1}, (1-\frac{1}{x}x)^{-1}$ or $(1-\frac{1}{x}x)^{-2}$ M1 Obtain correct unsimplified expansions up to the term in x^2 of each partial fraction A1 / $x + \frac{Ax}{1-x} + \frac{B}{16}x^2$, or equivalent A1 [Symbolic binomial coefficients, e.g. $\binom{-1}{1}$ are not sufficient for M1. The \checkmark is on A,B,C .] [For the A,D,E form of partial fractions, give M1 A1 / A1 / \land for the expansions then, if $D \neq 0,$ M1 for multiplying out fully and A1 for the final answer.] [In the case of an attempt to expand $(x^2 - 8x + 9)(-x) (2 - x)^2$, give M1A1A1 for the expansions, M1 for multiplying out fully, and A1 for the final answer.] (i) <i>EITHER</i> : Find \overline{AP} (or \overline{PA}) for a point <i>P</i> on <i>I</i> with parameter λ , e.g. i - 17] + $4k + \lambda(-2i + j - 2k)$ B1 Calculate scalar product of \overline{AP} and a direction vector for <i>I</i> and equate to zero M1 Solve and obtain $\lambda = 3$ A1 Calculate scalar product of \overline{AP} and a direction vector for <i>I</i> , e.g. (-1+7j) - 4k B1 Calculate vector product of \overline{AP} and a direction vector for <i>I</i> , e.g. $(-1+7j - 4k) + \lambda(-2i + j - 2k)$ M1 Obtain the given answer is correctly A1 OR1: Calling (4, -9, 9) B, state \overline{BA} (or \overline{AB}) in component form, e.g. $-i + 17j - 4k$ B1 Calculate vector product of \overline{AP} and a direction vector for <i>I</i> , e.g. $(-i + 17j - 4k) \times (-2i + 1j - 2k)$ M1 Obtain the given answer eff. \overline{AP} and A incertion vector for <i>I</i> , e.g. $(-i + 17j - 4k) \times (-2i + 1j - 2k)$ M1 Obtain the given answ				9709	32	1ªth
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(ii) Carry out a correct method to find a value of x MI Obtain answers 0.322, 0.799, -1.12 AI + A1 + AI [4] [Solutions with more than 3 answers can only earn a maximum of A1 + A1.] (i) State or imply the form $\frac{A}{1-x} + \frac{B}{2-x} + \frac{C}{(2-x)^2}$ BI Use a correct method to determine a constant MI Obtain on cof $A = 2, B = -1, C = 3$ AI Obtain a second value AI [5] [The alternative form $\frac{A}{1-x} + \frac{Dx + F}{(2-x)^2}$, where $A = 2, D = 1, E = 1$ is marked BIM1A1A1A1 as above.] (ii) Use correct method to find the first two terms of the expansion of $(1-x)^1, (2-x)^2, (1-\frac{1}{2}x)^7$ or $(1-\frac{1}{2}x)^2$ MI Obtain a correct unsimplified expansions up to the term in x^2 of each partial fraction A1 $x^2 + \frac{3}{2}x + \frac{3}{2}y^2$, or equivalent A1 [Symbolic binomial coefficients, e.g. $\binom{-1}{1}$ are not sufficient for M1. The \checkmark is on A,B,C .] [For the A,D,E form of partial fractions, give M1 A1 \checkmark A1 \checkmark for the expansions then, if $D \neq 0,$ M1 for multiplying out fully and A1 for the final answer.] (i) <i>EITHER</i> : Find \overline{AP} (or \overline{PA}) for a point P on I with parameter λ , e.g. i - 17j + 4k + $\lambda(-2i + j - 2k)$ B1 Calculate scalar product of \overline{AP} and a direction vector for I and equate to zero M1 Solve and obtain $\lambda = 3$ A1 Obtain correct answipplete method for finding the length of AP M1 Obtain the given answer 15 correctly A1 OR1: Calling (4, -9, 9) B, state \overline{BA} (or \overline{AB}) in component form, e.g. $-i + 17j - 4k$ B1 Calculate vector product of \overline{AP} and a direction vector for I, e.g. $(-i + 17j - 4k) \times (-2i + j - 2k)$ M1 Obtain the given answer is correctly A1 Obtain the given answer is correctly A1 Obtain the given answer e.g. $-30i + 6j + 33k$ A1 Divide the modulus of the product by that of the direction vector for I, e.g. $(-i + 17j - 4k) \times (-2i + 1j - 2k)$ M1 Obtain correct answer, e.g. $-30i + 6j + 33k$ A1 Divide the modulus of the product by that of the direction vector M1 Obtain the given answer correctly A1 Obtain the given answer correctly A1 Obtain co	(ii)	Substitute	for x and obtain the given answer		B1	[1]
Use a correct method to determine a constant MI Obtain one of $A = 2, B = -1, C = 3$ A1 Obtain a second value A1 Obtain a second value A1 (5] [The alternative form $\frac{A}{1-x} + \frac{Dx + E}{(2-x)^2}$, where $A = 2, D = 1, E = 1$ is marked B1M1A1A1A1 as above.] (ii) Use correct method to find the first two terms of the expansion of $(1-x)^{-1}, (2-x)^{-1}, (1-\frac{1}{2}x)^{-1}$ or $(1-\frac{1}{2}x)^{-2}$ M1 Obtain correct nusimplified expansions up to the term in x^2 of each partial fraction A1x ² + A1x ² + A1x ² Obtain correct nusimplified expansions up to the term in x^2 of each partial fraction, e.g. $\binom{-1}{1}$ are not sufficient for M1. The \checkmark is on $A,B,C.$] [For the A,D,E form of partial fractions, give M1 A1 \checkmark A1 \checkmark for the expansions then, if $D \neq 0$, M1 for multiplying out fully and A1 for the final answer.] [In the case of an attempt to expand $(x^2 - 8x + 9)(1-x)^{-1}(2-x)^{-2}$, give M1A1A1 for the expansions, M1 for multiplying out fully, and A1 for the final answer.] (i) <i>ETITHER</i> : Find \overline{AP} (or \overline{PA}) for a point P on I with parameter λ , e.g. $i - 17j + 4k + \lambda(-2i + j - 2k)$ B1 Calculate scalar product of \overline{AP} and a direction vector for I and equate to zero M1 Solve and obtain $\lambda = 3$ A1 Calculate vector product of \overline{BA} and a direction vector for I, e.g. $(-i + 17j - 4k) \times (-2i + j - 2k)$ M1 Obtain the given answer 15 correctlyA1 OR1: Calling $(4, -9, 9)$, B, state \overline{BA} (or \overline{AB}) in component form, e.g. $-i + 17j - 4k$ B1 Calculate vector product of \overline{BA} and a direction vector for I, c.g. $(-i + 17j - 4k) \times (-2i + j - 2k)$ M1 Obtain the given answer correctlyA1 Obtain the given answer correctlyA1 Obtain the given answer correctlyA1 Obtain the given answer correctlyA1 Obtain correct answer, e.g. $-30i + 6j + 33k$ A1 Divide the modulus of the product by that of the direction vector M1 Obtain the given answer correctlyA1 Obtain the given answer correctlyA1 Obtain correct answer in any form, e.g. $\frac{27}{\sqrt{9}}$ A1	(iii)	Obtain ans	wers 0.322, 0.799, -1.12		M1	
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Obtain correct answer in any form, e.g. $\frac{27}{\sqrt{9}}$ A1		U112.				
			Use a scalar product to find the projection of <i>DA</i> (of <i>AD</i>) on <i>i</i>		1411	

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age 7	Mark Scheme	Syllabu	S P.	2 24
	Cambridge International A Level – October/November 20		32	aths
	Obtain the given answer correctly		4000 Minutes All All All Ml	-0/0
O	R3: State \overrightarrow{BA} (or \overrightarrow{AB}) in component form		B1	
	Use a scalar product to find the cosine of ABP		M1	
	Obtain correct answer in any form, e.g. $\frac{27}{\sqrt{9}.\sqrt{306}}$		A1	
	Use trig. to find the perpendicular		M1	
	Obtain the given answer correctly		A1	
O	R4: State \overrightarrow{BA} (or \overrightarrow{AB}) in component form		B1	
	Find a second point C on l and use the cosine rule in triangle	e ABC to find th	ne	
	cosine of angle A, B, or C, or use a vector product to find the	e area of ABC	M1	
	Obtain correct answer in any form		A1	
	Use trig. or area formula to find the perpendicular		M1	
	Obtain the given answer correctly		A1	
OI	R5: State correct AP (or PA) for a point P on l with parameter A	λ in any form	B1	
	Use correct method to express AP^2 (or AP) in terms of λ Obtain a correct expression in any form,		M1	
	e.g. $(1-2\lambda)^2 + (-17+\lambda)^2 + (4-2\lambda)^2$		A1	
	Carry out a method for finding its minimum (using calculus	, algebra		
	or Pythagoras)	-	M1	
	Obtain the given answer correctly		A1	[5]
(ii)	<i>EITHER</i> : Substitute coordinates of a general point of l in equation of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l is a statement of l in equation of l in equation of l is a statement of l in equation of l in equation of l in equation of	-	ner	
	equate constant terms or equate the coefficient of λ to zero equation in <i>a</i> and <i>b</i>	o, obtaining an	M1*	
	Obtain a correct equation, e.g. $4a - 9b - 27 + 1 = 0$		A1	
	Obtain a second correct equation, e.g. $-2a + b + 6 = 0$		A1	
	Solve for <i>a</i> or for <i>b</i>	Ν	11(dep*)	
	Obtain $a = 2$ and $b = -2$		Al	
OI		equation,		
	e.g. $4a - 9b = 26$	1	B1	
	<i>EITHER</i> : Find a second point on <i>l</i> and obtain an equation	n in <i>a</i> and <i>b</i>	M1*	
	Obtain a correct equation		A1	
	<i>OR</i> : Calculate scalar product of a direction vector for	or <i>l</i> and a vector		
	normal to the plane and equate to zero		M1*	
	Obtain a correct equation, e.g. $-2a + b + 6 = 0$	_	A1	
	Solve for <i>a</i> or for <i>b</i>	Ν	11(dep*)	
	Obtain $a = 2$ and $b = -2$		A1	[5]