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**MATHEMATICS**

**9709/02**

Paper 2

**For examination from 2017**

MARK SCHEME

Maximum Mark: 50

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**Specimen**

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This document consists of **8** printed pages.

**Mark Scheme Notes**

Marks are of the following three types:

- 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.
- 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  $\surd$  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.
  - Note: B2 or A2 means that the candidate can earn 2 or 0.  
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.

The following abbreviations may be used in a mark scheme or used on the scripts:

- 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  $\sqrt{\phantom{x}}$ " 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.

Question	Answer	Marks	Partial Marks	Guidance
<b>1</b>	Introduce logarithms and use power law twice	1	<b>M1*</b>	
	Obtain $(x + 3)\log 5 = (x - 1)\log 7$ or equivalent	1	<b>A1</b>	
	Solve linear equation for $x$	1	<b>DM1</b>	
	Obtain 20.1	1	<b>A1</b>	
		<b>4</b>		
<b>2</b>	Use quotient rule or, after adjustment, product rule	1	<b>M1*</b>	
	Obtain $\frac{3x - 15 - 3x - 1}{(x - 5)^2}$ or equivalent	1	<b>A1</b>	
	Equate first derivative to $-4$ and solve for $x$	1	<b>DM1</b>	
	Obtain $x$ -coordinates 3 and 7 or one correct pair of coordinates	1	<b>A1</b>	
	Obtain $y$ -coordinates $-5$ and $11$ respectively or other correct pair of coordinates	1	<b>A1</b>	
		<b>5</b>		
<b>3(i)</b>	State or imply $R = 17$	1	<b>B1</b>	
	Use appropriate formula to find $\alpha$	1	<b>M1</b>	
	Obtain 61.93	1	<b>A1</b>	
		<b>3</b>		

Question	Answer	Marks	Partial Marks	Guidance
3(ii)	Attempt to find at least one value of $\theta + \alpha$	1	M1	
	Obtain one correct value of $\theta$ (97.4 or 318.7)	1	A1	
	Carry out correct method to find second answer	1	M1	
	Obtain second correct value and no others between 0 and 360	1	A1	
			4	
4(i)	Make a recognisable sketch of $y = \ln x$	1	B1	
	Draw straight line with negative gradient crossing positive y-axis and justify one real root	1	B1	
			2	
4(ii)	Consider sign of $\ln x + \frac{1}{2}x - 4$ at 4.5 and 5.0 or equivalent	1	M1	
	Complete the argument correctly with appropriate calculations	1	A1	
			2	
4(iii)	Use the iterative formula correctly at least once	1	M1	
	Obtain final answer 4.84	1	A1	
	Show sufficient iterations to justify accuracy to 2 d.p. or show sign change	1		
	in interval (4.835, 4.845)	1	A1	
			3	

Question	Answer	Marks	Partial Marks	Guidance
<b>5(a)</b>	Use $\tan^2 x = \sec^2 x - 1$	1	<b>B1</b>	
	Obtain integral of form $p \tan x + qx + r \cos 2x$	1	<b>M1</b>	
	Obtain $\tan x - x - \frac{1}{2} \cos 2x + c$	1	<b>A1</b>	
		<b>3</b>		
<b>5(b)</b>	Obtain integral of form $ke^{-2x}$	1	<b>M1*</b>	
	Obtain $-\frac{3}{2}e^{1-2x}$	1	<b>A1</b>	
	Apply both limits the correct way round	1	<b>DM1</b>	
	Obtain $-\frac{3}{2}e^{-1} + \frac{3}{2}e$ or exact equivalent	1	<b>A1</b>	
		<b>4</b>		
<b>6(i)</b>	Carry out division at least as far as quotient $x^2 + kx$	1	<b>M1</b>	
	Obtain partial quotient $x^2 + 2x$	1	<b>A1</b>	
	Obtain quotient $x^2 + 2x + 1$ with no errors seen	1	<b>A1</b>	
	Obtain remainder $5x + 2$	1	<b>A1</b>	
		<b>4</b>		

Question	Answer	Marks	Partial Marks	Guidance
6(ii)	Either Carry out calculation involving $12x + 6$ and their remainder $ax + b$ Or Multiply $x^2 - x + 4$ by their three-term quadratic quotient	1	M1	
	Obtain $p = 7, q = 4$	1	A1	
		2		
6(iii)	Show that discriminant of $x^2 - x + 4$ is negative	1	B1	
	Form equation $(x^2 - x + 4)(x^2 + 2x + 1) = 0$ and attempt solution	1	M1	
	Show that $x^2 + 2x + 1 = 0$ gives one root $x = -1$	1	A1	
		3		
7(i)	Obtain $12 \sin t \cos t$ or equivalent for $\frac{dx}{dt}$	1	B1	
	Obtain $4 \cos 2t - 6 \sin 2t$ or equivalent for $\frac{dy}{dt}$	1	B1	
	Obtain expression for $\frac{dy}{dx}$ in terms of $t$	1	M1	
	Use $2 \sin t \cos t = \sin 2t$	1	A1	
	Confirm given answer $\frac{dy}{dx} = \frac{2}{3} \cot 2t - 1$ with no errors seen	1	A1	
		5		

Question	Answer	Marks	Partial Marks	Guidance
<b>7(ii)</b>	State or imply $\tan 2t = \frac{2}{3}$	1	<b>B1</b>	
	Obtain $t = 0.294$	1	<b>B1</b>	
	Obtain $t = 1.865$	1	<b>B1</b>	
		<b>3</b>		
<b>7(iii)</b>	Attempt solution of $2 \sin 2t + 3 \cos 2t = 0$ at least as far as $\tan 2t = \dots$	1	<b>M1</b>	
	Obtain $\tan 2t = -\frac{3}{2}$ or equivalent	1	<b>A1</b>	
	Substitute to obtain $-\frac{13}{9}$	1	<b>A1</b>	
		<b>3</b>		