CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Subsidiary and Advanced Level

MARK SCHEME for the October/November 2015 series

9709 MATHEMATICS

9709/11 Paper 1, 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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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 √ 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 √" 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.

1	$(a+x)^5 = a^5 + {}^5C_1 a^4 x + {}^5C_2 a^3 x^2 + \ldots$ soi	M1	Ignore subsequent terms
	$\left(-\frac{2}{a} \times (\textit{their}\ 5a^4) + (\textit{their}\ 10a^3)\right)(x^2)$	M1	
	0	A1 [3]	**AG**
2	$f(x) = x^3 - 7x\ (+c)$	B1	
	$5 = 27 - 21 + c$	M1	Sub $x = 3$, $y = 5$. Dep. on c present
	$c = -1 \rightarrow f(x) = x^3 - 7x - 1$	A1 [3]	
3	$4x^2 + x^2 = 1/2$ soi	B1	
	Solve as quadratic in x^2	M1	E.g. $(4x^2 - 1)(2x^2 + 1)$ or $x^2 =$ formula
	$x^2 = 1/4$	A1	Ignore other solution
	$x = \pm 1/2$	A1 [4]	
4 (i)	$4\cos^2\theta + 15\sin\theta = 0$	M1	Replace $\tan\theta$ by $\frac{\sin\theta}{\cos\theta}$ and multiply by $\sin\theta$ or equivalent
	$4(1 - s^2) + 15s = 0 \rightarrow 4\sin^2\theta - 15\sin\theta - 4 = 0$	M1A1 **[3]**	Use $c^2 = 1 - s^2$ and rearrange to **AG (www)**
(ii)	$\sin\theta = -1/4$	B1	
	$\theta = 194.5$ or 345.5	B1B1√ [3]	Ignore other solution Ft from 1st solution, SC B1 both angles in rads (3.39 and 6.03)
5 (i)	$\frac{dy}{dx} = -\frac{8}{x^2} + 2$ cao	B1B1	
	$\frac{d^2y}{dx^2} = \frac{16}{x^3}$ cao	B1 [3]	
(ii)	$-\frac{8}{x^2} + 2 = 0 \rightarrow 2x^2 - 8 = 0$	M1	Set = 0 and rearrange to quadratic form
	$x = \pm 2$	A1	
	$y = \pm 8$	A1	If A0A0 scored, SCA1 for just (2, 8)
	$\frac{d^2y}{dx^2} > 0$ when $x = 2$ hence MINIMUM	B1√	{ Ft for "correct" conclusion if $\frac{d^2y}{dx^2}$ incorrect or any valid method inc. a good sketch }
	$\frac{d^2y}{dx^2} < 0$ when $x = -2$ hence MAXIMUM	B1√ [5]	

6 **(i)**	$x^2 - x + 3 = 3x + a \rightarrow x^2 - 4x + (3 - a) = 0$	**B1** [1]	**AG**
(ii)	$5 + (3 - a) = 0 \rightarrow a = 8$ $x^2 - 4x - 5 = 0 \rightarrow x = 5$	**B1** **B1** [2]	Sub $x = -1$ into **(i)** **OR B2** for $x = 5$ www
(iii)	$16 - 4(3 - a) = 0$ (applying $b^2 - 4ac = 0$) $a = -1$ $(x - 2)^2 = 0 \rightarrow x = 2$ $y = 5$	**M1** **A1** **A1** **A1** [4]	**OR** $dy/dx = 2x - 1 \rightarrow 2x - 1 = 3$ $x = 2$ $y = 2^2 - 2 + 3 \rightarrow y = 5$ $5 = 6 + a \rightarrow a = -1$
7 **(i)**	$BC^2 = r^2 + r^2 = 2r^2 \rightarrow BC = r\sqrt{2}$	**B1** [1]	**AG**
(ii)	Area sector $BCFD = \frac{1}{4}\pi(r\sqrt{2})^2$ soi	**M1**	Expect $\frac{1}{2}\pi r^2$
	Area $\Delta\, BCAD = \frac{1}{2}(2r)r$	**M1**	Expect r^2 (could be embedded)
	Area segment $CFDA = \frac{1}{2}\pi r^2 - r^2$ .oe	**A1**	
	Area semi-circle $CADE = \frac{1}{2}\pi r^2$	**B1**	
	Shaded area $\frac{1}{2}\pi r^2 - \left(\frac{1}{2}\pi r^2 - r^2\right)$ or $\pi r^2 - \left(\frac{1}{2}\pi r^2 + \left(\frac{1}{2}\pi r^2 - r^2\right)\right)$	**DM1**	Depends on the area $\Delta\, BCD$
	$= r^2$	**A1** [6]	

8 (i)	$x^2 - 4x = 12$	**M1**	$4x - x^2 = 12$ scores M1A0
	$x = -2$ or 6	**A1**	
	3^{rd} term $= (-2)^2 + 12 = 16$ or $6^2 + 12 = 48$	**A1A1** [4]	SC1 for 16, 48 after $x = 2, -6$
(ii)	$r^2 = \frac{x^2}{4x}\left(= \frac{x}{4}\right)$ soi	**M1**	
	$\frac{4x}{1 - \frac{x}{4}} = 8$	**M1**	Accept use of unsimplified $\frac{x^2}{4x}$ or $\frac{4x}{x^2}$ or $\frac{4}{x}$
	$x = \frac{4}{3}$ or $r = \frac{1}{3}$	**A1**	
	3^{rd} term $= \frac{16}{27}$ (or 0.593)	**A1** [4]	
	ALT		
	$\frac{4x}{1-r} = 8 \rightarrow r = 1 - \frac{1}{2}x$ **or** $\frac{4x}{1-r} = 8 \rightarrow x = 2(1-r)$	**M1**	
	$x^2 = 4x\left(1 - \frac{1}{2}x\right)$ $\quad r = \frac{2(1-r)}{4}$	**M1**	
	$x = \frac{4}{3}$ $\quad r = \frac{1}{3}$	**A1**	
9 (i)	$-(1)(x-3)^2 + 4$	**B1B1B1** [3]	
(ii)	Smallest (m) is 3	**B1**√ [1]	Accept $m \geqslant 3$, $m = 3$. **Not** $x \geqslant 3$. Ft *their b*
(iii)	$(x-3)^2 = 4 - y$	**M1**	Or x/y transposed. Ft *their a, b, c*
	Correct order of operations	**M1**	
	$f^{-1}(x) = 3 + \sqrt{4-x}$ cao	**A1**	Accept $y =$ if clear
	Domain is $x \leqslant 0$	**B1** [4]	

10 **(i)**	PM = 2**i** – 10**k** + $\frac{1}{2}$(6**j** + 8**k**) oe PM = 2**i** + 3**j** – 6**k** $\div\sqrt{4+9+36}$ Unit vector = $\frac{1}{7}(2\mathbf{i}+3\mathbf{j}-6\mathbf{k})$	**M1** **A1** **M1** **A1** [4]	Any valid method
(ii)	AT = 6**j** + 8**k**, PT = a**i** + 6**j** – 2**k** soi (or TA and TP)	**B1**	Allow 1 vector reversed at this stage. (**AM** or **MT** could be used for **AT**)
	$(\cos ATP)=\frac{(6\mathbf{j}+8\mathbf{k}).(a\mathbf{i}+6\mathbf{j}-2\mathbf{k})}{\sqrt{36+64}\sqrt{a^2+36+4}}$ $=\frac{36-16}{\sqrt{36+64}\sqrt{a^2+36+4}}$	**M1**	
	$\frac{20}{10\sqrt{a^2+40}}$	**A1**√	Ft from their **AT** and **PT**
	$\frac{2}{\sqrt{a^2+40}}=\frac{2}{7}$ oe and attempt to solve	**M1**	
	$a=3$	**A1** [5]	Withheld if only 1 vector reversed
	ALT Alt (Cosine Rule) Vectors (AT, PT etc.)	**B1**	
	$\cos ATP=\frac{a^2+36+4+36+64-(100+a^2)}{2\sqrt{(a^2+40)}\sqrt{100}}$ then as above	**M1A1**	

11 (i)	$\frac{dy}{dx} = \left[\frac{1}{2}(1+4x)^{-1/2}\right] \times [4]$	**B1B1**	
	At $x = 6, \frac{dy}{dx} = \frac{2}{5}$	**B1**	
	Gradient of normal at $P = -\frac{1}{2}$	**B1**√	**OR** eqn of norm $y - 5 = their - \frac{5}{2}(x-6)$
	Gradient of $PQ = -\frac{5}{2}$ hence PQ is a normal, or $m_1 m_2 = -1$	**B1** [5]	When $y = 0, x = 8$ hence result
(ii)	Vol for curve $= (\pi)\int(1+4x)$ and attempt to integrate y^2	**M1**	
	$= (\pi)\left[x + 2x^2\right]$ ignore '+ c'	**A1**	
	$= (\pi)[6 + 72 - 0]$	**DM1**	Apply limits $0 \to 6$ (allow reversed if corrected later)
	$= 78(\pi)$	**A1**	
	Vol for line $= \frac{1}{3} \times (\pi) \times 5^2 \times 2$	**M1**	**OR** $(\pi)\left[\frac{\left(-\frac{5}{2}x + 20\right)^3}{3 \times -\frac{5}{2}}\right]_6^8$
	$= \frac{50}{3}(\pi)$	**A1**	
	Total Vol $= 78\pi + 50\pi/3 = 94\frac{2}{3}\pi$ (or $284\pi/3$)	**A1** [7]	