

CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Level

MARK SCHEME for the May/June 2014 series

9709 MATHEMATICS

9709/51

Paper 5, maximum raw mark 50

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

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	GCE A LEVEL – May/June 2014	9709	51

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.

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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.
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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)
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ISW	Ignore Subsequent Working
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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.
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1	$-12\sin\theta = 12\sin\theta - 1.6g$ $\theta = 41.8^\circ$ OR $0 = 12\sin\theta \times 1.6 - \frac{1}{2} \times 10 \times 1.6^2$ $\theta = 41.8^\circ$ OR $0 = 12\sin\theta - 10 \times 0.8$ $\theta = 41.8^\circ$	M1 A1 M1 A1 M1 A1	2	$\sin\theta = (1.6g/2)12$ Uses $s = ut + \frac{1}{2}at^2$ Uses $v = u + at$ at the highest point
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2 (i)	$10\cos30 \times 1.2\sin\theta - 10\sin30 \times 1.2\cos\theta$ $= 6 \times 0.8\sin\theta$ $5.5923\sin\theta = 6\cos\theta$ $\theta = 47(.0)$ OR $10 \times 1.2\sin(\theta - 30) = 6 \times 0.8\sin\theta$ or $10 \times 1.2\cos(120 - \theta) = 6 \times 0.8\sin\theta$ $5.5923\sin\theta = 6\cos\theta$ $\theta = 47(.0)$	M1 A1 M1 A1 M1 A1 M1 A1	4	Creating a 3 term solvable equation in $\sin\theta$ and $\cos\theta$ Creating a 3 term solvable equation in $\sin\theta$ and $\cos\theta$
(ii)	$\mu = (10\cos30 - 6)/(10\sin30)$ $\mu = 0.532$	M1 A1	2	For using $F = \mu R$ with a reasonable attempt to find F and R

3 (i)	$0.4g = 16e/0.8$ $e = 0.2$	M1 A1	2	Uses $mg = 16e/0.8$
(ii)	EE at C = $16 \times 0.6^2 / (2 \times 0.8)$ $0.4u^2 / 2 + 16 \times 0.2^2 / (2 \times 0.8)$ $+ 0.4g(1.4 - 1.0) = 16 \times 0.6^2 / (2 \times 0.8)$ $u = 2.83 \text{ ms}^{-1}$	B1 M1 A1	3	KE/EE/PE balance attempted with 4 terms. $\sqrt{8}$ not allowed
(iii)	$16 \times 0.6^2 / (2 \times 0.8)$ $= 0.4v^2 / 2 + 0.4g(1.4 - 0.8)$ $v = 2.45 \text{ ms}^{-1}$	M1 A1	2	KE/EE/PE balance attempted with 3 terms.

4 (i)	$18^2 - (20\cos40)^2 = 20^2 - (20\cos40)^2$ $-2gh$ $h = 3.8 \text{ m}$ OR $m \times 20^2 / 2 - m \times 18^2 / 2 = mgh$ $h = 3.8 \text{ m}$	M1 A1 M1 A1	2	Uses vertical motion with $v^2 = u^2 - 2gs$ Uses energy equation
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(ii)	$V^2 = 18^2 - (20\cos 40)^2$ $V = 9.4483$ $9.4483 = -9.4483 + gt$ $t = 1.89 \text{ s}$ $x = 1.89 \times 20\cos 40$ $x = 29(.0) \text{ m}$ OR $3.8 = (20\sin 40)T - gT^2 / 2$ $T = 2.23(0), 0.34(1)$ $t = 2.23(0) - 0.34(1)$ $t = 1.89$	M1 A1 M1 A1 M1 A1 M1 A1 M1 A1	6	V is the vertical component of the velocity of P when P's speed is 18 M1 for using their V M1 scored if their time is used Uses $s = ut + \frac{1}{2}at^2$
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5 (i)	$OG(\text{arc}) = 1.8\sin(\pi/2)/(\pi/2)$ $OX(1.8 \times 2 + \pi \times 1.8) = 1.1459 \times \pi \times 1.8$ $OX = 0.7(00) \text{ m}$	B1 M1 A1	3	1.1459.. or $3.6/\pi$ 0.70017..
(ii)	$OY = 1.8\tan 22$ $OG(\text{lamina}) = 2 \times 1.8\sin(\pi/2)/(3\pi/2)$ $1.8\tan 22 \times (W + 27.5) =$ $0.7W + 0.763943 \times 27.5$ $W = 37(.3)\text{N}$	B1 B1 M1 A1 A1	5	C of M solid = 0.727247..m from O C of M lamina = 0.763943.. or $2.4/\pi$ $27.5 \left[4 \times 1.8 / (3\pi) - 0.727247 \right] =$ $W(0.727247 - 0.70017)$ Accept to 2sf as sensitive to rounding error

6 (i)	$0.6dv / dt = 0.6g - 3v$ $\int 1/(10 - 5v)dv = \int dt$ $-\frac{1}{5}\ln(10 - 5v) = t(+c)$ Finds c or uses limits twice $t = 0.738 \text{ s}$	B1 M1 A1 M1 A1	5	Newton's Second Law $0.6 \int 1/(0.6g - 3v)dv = \int dt$ $\frac{0.6}{-3}\ln(0.6g - 3v) = t(+c)$
(ii)	$0.6vdv / dx = -3v$ $\int 0.2dv = -\int dx$ $x = 0.39 \text{ m}$	B1 M1 A1	3	Newton's Second Law Integration with use of limits or finding c

7 (i)	$T = 42m(0.5 - 0.4) / 0.4$ $10m = Y + T \times (0.3 / 0.5)$ $Y = 3.7m$	B1 M1 A1 AG	3	$T = 10.5m$
(ii)	$m\omega^2 \times 0.4 = T \times (0.4 / 0.5)$ $\omega = 4.58 \text{ rads}^{-1}$	M1 A1	2	ft cv of T

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(iii)	$mv^2 / 0.4 = T \times (0.4 / 0.5) \pm 2m$ $v = 2.04 \text{ ms}^{-1}$ or $v = 1.6 \text{ ms}^{-1}$	M1 A1 A1	3	Either case
(iv)	$Y = 10m$ $10m = mv^2 / 0.4$ $v = 2 \text{ ms}^{-1}$	B1 M1 A1	3	Fresh value of Y not Y(i) Reject or ignore –2

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(iv)	$Y = 10m$ $10m = mv^2 / 0.4$ $v = 2 \text{ ms}^{-1}$	B1 M1 A1	3	Fresh value of Y not Y(i) Reject or ignore –2

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1	$EE = 5 \times (2.4 - 1.5)^2 / (2 \times 15)$ $5 \times (2.4 - 1.5)^2 /$ $(2 \times 1.5) - 0.1g \times (2.4 - 1.5)$ $= 0.1v^2 / 2$ $v = 3 \text{ ms}^{-1}$	B1 M1 A1	[3]	EE/KE/PE conservation
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2	$12F = 24 \times (2 \times 12/3) \cos(10 + 100/2)$ $F = 8$	M1 A1 AG A1	[3]	Moments about vertex attempt
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3 (i)	$0.2a = 0.42$ $v = (2.1 \times 1) = 2.1$	M1 A1	[2]	Newton's Second Law and $v = u + at$
(ii)	$0.2dv/dt = 0.42 - 0.32t$ $[v]_{2.1}^v = [2.1t - 0.8t^2]_1^2$ $v = 1.8$	M1 M1 A1	[3]	Newton's Second Law with $a = dv/dt$
(iii)	$v = \int (0.42 - 0.32t + 0.06t^2) dt / 0.2$ $v = [0.42t - 0.16t^2 + 0.02t^3]_0^3 / 0.2 \text{ or}$ $[v]_{1.8}^v = [0.42t - 1.16t^2 + 0.02t^3]_2^3 / 0.2$ $v = 1.8, \text{ so no change}$	M1 M1 A1	[3]	For attempt to integrate and correct limits seen

4 (i)	$T \cos 60 = 0.2g$ $T = 4N$ $T \sin 60 = 0.2v^2 / (2.4 \sin 60)$ $v = 6 \text{ ms}^{-1}$	M1 A1 M1 A1	[4]	Resolve vertically for P Newton's Second Law with $a = v^2/r$
(ii)	$T \sin \theta = 0.2 \times 4^2 \times 1.2 \sin \theta$ $T = 3.84$ $3.84 \cos \theta = 0.2g$ $\theta = 58.6^\circ$	M1 A1 M1 A1	[4]	Newton's Second Law with $a = \omega^2 r$ Resolve vertically with new tension

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7 (i)	$OG \text{ (handle)} = 0.3 \sin(\pi/2)/(\pi/2)$ $(8+14)d = 14 \times 0.15 - 8 \times 0.6/\pi$ $d = 0.026(0)\text{m}$	B1 M1 A1	[3]	$0.6/\pi, 0.19098\dots$
(ii)	$(8=14)x = 8 \times 0.191$ $x = 0.0694545\dots$ $(8+14)y = 14 \times 0.15$ $y = 0.0954545\dots$ Distance = 0.118	M1 A1 M1 A1 A1	[5]	Horizontal distance from bowl axis Vertical distance from bowl rim $\text{Distance}^2 = 0.06945^2 + 0.095454^2$
(iii)	$\tan \theta = 0.0694545/0.0954545$ or $\sin \theta = 0.0694545/0.118$ or $\cos \theta = 0.094545/0.118$ $\theta = 36(.0)^\circ$	M1 A1	[2]	Any trig ratio correctly using the two answers in (ii) Accept 36.1, 35.9

Alternative for 7(ii), 7(iii) (diagram below)

7 (ii)	$\tan H = 0.15/0.19098$ $HG = \frac{14}{22} \times \sqrt{(0.15^2 + 0.19098^2)}$ $OG^2 = 0.19098^2 + 0.15454^2 -$ $2 \times 0.19098 \times 0.15454 \cos 38.147$ Distance = 0.118	M1 A1 M1 A1 A1	[5]	$H = 38.147^\circ$ 0.15454 m Cosine rule on triangle OHG
(iii)	$\sin HOG = 0.15454 \sin 38.147 / 0.118$ Angle (= $90 - HOG$) = 35.9	M1 A1	[2]	54.06° Accept 36(.0), 36.1

