CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2014 series

9709 MATHEMATICS

9709/43 Paper 4 (Mechanics 1), 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.

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.

Cambridge is publishing the mark schemes for the May/June 2014 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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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 $\sqrt{}$ 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.

- 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 (i)	[N + component of X = Weight of B]	M1		For resolving forces acting on the block vertically (3 terms required)
	Normal component is (70 – Xcos15°) N	A1	[2]	
(ii)	F = Xsin15°	B1		
	[Xsin15° = 0.4(70 – Xcos15°)]	M1		For using F = μR
	Value of X is 43.4	A1	[3]	
2		M1		For using Newton's 2nd law
	DF – 600 – 1250 × 0.02g = 1250 × 0.5	A1		
		M1		For using DF = 23000/v
	v = 23000 ÷ (625 + 600 + 250)	A1ft		ft error in one term for DF above (1st A mark)
	Speed of car is 15.6 ms^{-1}	A1	[5]	
	Alternative Method			
		M1		For using WD by driving force = KE gain + PE gain + WD against resistance
	WD = 1250 × 0.5s + 1250g × 0.02s + 600s	A1		
		M1		For using WD by driving force = DF × s and DF=23000/v
	v = 23000 ÷ (625 + 600 + 250)	A1ft		ft error in one term for WD above (1st A mark)
	Speed of car is 15.6 ms^{-1}	A1	[5]	
3		M1		For resolving forces acting on *P* horizontally.
	$0.8T_1 + 12T_2/13 = 2.24$	A1		
		M1		For resolving forces acting on *P* vertically.
	$0.6T_1 – 5T_2/13 = 1.4$	A1		
		M1		For solving for T_1 and T_2
	$T_1 = 2.5$ <u>and</u> $T_2 = 0.26$	A1	[6]	
				SR for using Lami's Rule for T_1, T_2 and 2.24 N (weight missing) (max 3/6) $T_1/\sin157.38 = 2.24/\sin59.49$ B1 $T_2/\sin143.13 = 2.24/\sin59.49$ B1 $T_1 = 1(.00)$ and $T_2 = 1.56$ B1

4 (i)	PE loss = $0.4g \times 5$ J = 20 J	B1		
	Initial $KE_{up} = 0.4g \times 5 - 12.8 = 7.2$ J	B1		
	$[0.4gh = 2g - 12.8]$	M1		Uses PE gain = KE loss to form equation in h
	Height reached is 1.8 m	A1	[4]	AG
(ii)	$5 = 0 + \frac{1}{2} gt_{down}^2 \quad (t_{down} = 1)$	B1		
	$0 = 6 - gt_{up}$ or $1.8 = \frac{1}{2} gt_{up}^2 \ (t_{up} = 0.6)$	B1		
	Total time is 1.6 s	B1	[3]	
	First Alternative for part (i)			
	$v^2 = 2 \times 10 \times 5 \rightarrow \quad (v = 10)$	B1		
	KE loss = $\frac{1}{2}\ 0.4(10^2 - v_{up}^2) = 12.8$	B1		
	$[v_{up} = 60, \quad 0 = 6^2 - 2gh]$	M1		Uses $v^2 = u^2 - 2gs$ to form equation in h
	Height reached is 1.8 m	A1	[4]	AG
	Second Alternative for part (i)			
	$0.4gh = 12.8$	M1		Uses PE gain = KE loss
	h = 3.2 m	A1		
	[Height reached = $5 - 12.8/0.4g$]	M1		Uses height reached = 5 – 'height not reached'
	Height reached is 1.8 m	A1	[4]	AG
	Third Alternative for part (i)			
	$\frac{1}{2} \times 0.4v^2 = 12.8 \quad (v=8)$ and $[8^2 = 0^2 + 2gh]$	M1		Uses KE loss = 12.8 and $v^2=u^2+2gs$
	h = 3.2 m	A1		
	[Height reached = 5 – 3.2]	M1		Uses height reached = 5 – 'height not reached'
	Height reached is 1.8 m	A1	[4]	AG

5 (i)		M1		For using WD by driving force = Gain in PE + WD against resistance
	WD against resistance $= 4500 \times 1200 - 16000g \times 18$	A1		
	WD against resistance $= 2.52 \times 10^6$ J	A1	[3]	
	Alternative Method for part (i)			
	$[R + 16000g \times 18/1200 = 4500]$	M1		For resolving along the plane
	$[WD=(4500 - 16000g \times 18/1200) \times 1200]$	M1		For using WD against resistance = Rs
	WD against resistance $= 2.52 \times 10^6$ J	A1	[3]	
(ii)	KE gain $= \frac{1}{2}\ 16000(21^2 - 9^2)$ J	B1		
		M1		For using F = (KE gain + 2000 × 2400) ÷ 2400
	$F = 7680000 \div 2400 = 3200$	A1	[3]	
				SR (max 1/3) for using $v^2=u^2+2as$ and Newton's 2nd law $21^2 - 9^2 = 2a \times 2400$, $a = 0.075$ $F - 2000 = 16000 \times 0.075$ $F = 3200$ B1
(iii)	$[P_A = (3200 + 1280) \times 9$ and $P_B = (3200 - 1280) \times 21]$	M1		For using $P = Fv$ to find P_A and P_B
	$P_A = P_B = 40320$ W	A1	[2]	
6 (i)	Velocity immediately before is $1.2\,\text{ms}^{-1}$	B1		
	Velocity immediately after is $-1\ \text{ms}^{-1}$	B1	[2]	
(ii)		M1		For using distance OW = $\int v\,dt$ with limits 0 to 60 (W is wall) or For using distance WA = $-\int v\,dt$ with limits 60 to 100
	Distance OW $= 0.025 \times 60^2 - 0.0005 \times 60^3 \div 3$	A1		
	Distance WA $= -[(0.0125 \times 100^2 - 2.5 \times 100) - (0.0125 \times 60^2 - 2.5 \times 60]$	A1		
	Distance is $54 + 20 = 74$ m	A1	[4]	

(iii)	[$dv/dt = 0.05 - 0.001t = 0$ or $0.0005t(100 - t) = 0 \rightarrow t = 0$ or 100]	M1		For using v_{max} occurs when $dv/dt = 0$ or when t = the midpoint of the roots of the quadratic equation v = 0.
	Maximum speed ($= 0.05 \times 50 - 0.0005 \times 50^2$) is $1.25\,ms^{-1}$	A1		
	Plausible quadratic curve starting at (0,0), with max. at (50, 1.25) and terminating at (60, 1.2)	B1		
	Straight line segment from (60,–1) to (100,0)	B1	[4]	
7 (i)		M1		For applying Newton's 2nd law to P or to Q
	For $T - (40 \div 160) \times 0.76g = 0.76a$ <u>or</u> $0.49g - T = 0.49a$	A1		
	For $0.49g - T = 0.49a$ <u>or</u> $T - (40 \div 160) \times 0.76g = 0.76a$ <u>or</u> $0.49g - (400 \div 160) \times 0.76g = (0.49 + 0.76)a$	B1		
	Acceleration is $2.4\,ms^{-2}$ and tension is 3.72 N (3.724 exact)	A1	[4]	
(ii)	[$v^2 = 2 \times 2.4 \times 0.3$]	M1		For using $v^2 = 0 + 2as$
	Speed is $1.20\,ms^{-1}$	A1ft	[2]	ft a from (i) ($a \neq \pm g$)
(iii)		M1		For using $v^2 = u^2 + 2as$ with v = 0 and $a = -(40 \div 160)g$
	Distance while Q is on the ground $= (2 \times 2.4 \times 0.3) \div 2(40g \div 160)$ (= 0.288 m)	A1ft		ft a from (i) and/or s = 30
	Distance travelled is 0.588 m	A1	[3]	