UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9709 MATHEMATICS

9709/43 Paper 4, 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 must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with 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.

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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.

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1			M1		For using WD = Fdcos α
		WD = $6 \times (0.5 \times 8)\cos 24^o$	A1		
		Work done is 21.9 J	A1	[3]	
2	**(i)**		M1		For resolving forces horizontally or vertically
		$T\cos\theta + T\sin\theta = 11.2$ (or $-T\cos\theta + T\sin\theta = 0.16g$)	A1		
		$-T\cos\theta + T\sin\theta = 0.16g$ (or $T\cos\theta + T\sin\theta = 11.2$)	A1	[3]	
	(ii)	[$T\cos\theta = 4.8$ and $T\sin\theta = 6.4$ and $T^2 = 4.8^2 + 6.4^2$ or $\tan\theta = 6.4/4.8$] [$4T^2(\cos^2\theta + \sin^2\theta) = (11.2 - 1.6)^2 + (11.2 + 1.6)^2$ or $2T\sin\theta \div 2T\cos\theta = (11.2 + 1.6) \div (11.2 - 1.6)$ or $(T\cos\theta + T\sin\theta) \div (-T\cos\theta + T\sin\theta) = 11.2 \div 1.6$]	M1		For finding $T\cos\theta$ and $T\sin\theta$ and hence finding T or θ, OR for finding the value of $4T^2(\cos^2\theta + \sin^2\theta)$ or of $2T\sin\theta \div 2T\cos\theta$ or of $(T\cos\theta + T\sin\theta) \div (-T\cos\theta + T\sin\theta)$
		$T = 8$ (or $\theta = 53.1$)	A1		
		$\theta = 53.1$ or $T = 8$	A1	[3]	
3	**(i)**		M1		For using $s = \int v\,dt$
		$s = 0.027(10t^3/3 - t^4/4)$ (+C)	A1		
		$s = 0.027[10\,000/3 - 10000/4]$	DM1		For finding the value of t at A and using limits or equivalent
		Distance is 22.5 m	A1	[4]	
	(ii)	[$0.027(20t - 3t^2) = 0 \rightarrow t = 20/3$]]	M1		For using $dv/dt = 0$
		$v_{max} = 0.027(4000/9 - 8000/27)$	A1ft		ft incorrect t in $0.027(10t^2 - t^3)$
		Maximum speed is 4 ms^{-1}	A1	[3]	

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4	**(i)**	[When $4 < v < 6$, $a_{ave} = (6 - 4)/(0.5 - 0)$; when $19 < v < 21$ $a_{ave} = (21 - 19)/(24.5 - 16.3)$]	M1		For using $a \approx \frac{\Delta v}{\Delta t}$
		Average accelerations are $4\ ms^{-2}$ and $0.244\ ms^{-2}$	A1	[2]	
	(ii)	DF(5) = P/5 and DF(20) = P/20	B1		
		[DF – R = ma]	M1		For using Newton's 2nd law
		P/5 – R = 1230 × 4 and P/20 – R = 1230 × 0.244	A1ft		ft incorrect average a values
		P = 30800 (or R = 1240)	B1		
		R = 1240 (or P = 30800)	B1ft	[5]	ft P/5 – 1230a_1 or P/20 – 1230a_2 or 5(1230a_1 + R) or 20(1230a_2 + R)
5	**(i)**	WD against resistance = 800 × 500	B1		
		[2 800 000 = PE gain + 400 000]	M1		For using WD by the driving force = PE gain + WD against resistance
		[2 400 000 = 16000g × 500sin α]	M1		For using PE gain = mgLsin α
		α = 1.7	A1	[4]	
	(ii)	[KE gain = 2 400 000 + 2 400 000 – 800 000]	M1		For using KE gain = WD by the driving force + PE loss – WD against resistance
		4000 000 J	A1ft		ft PE gain
		[½ 16000($v^2 - 20^2$) = 4 000 000]	M1		For KE gain = ½ m($v^2 - 20^2$) and attempting to solve for v
		Speed is $30\ ms^{-1}$	A1	[4]	

SR (max 2/4) for candidates who assume constant driving force and constant resistance without justification

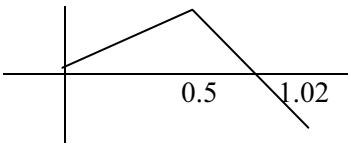
Uses Newton's Second Law and $v^2 = u^2 + 2as$ [4800 + 16000gsin α – 1600 = 16000a, $v^2 = 20^2 + 2a \times 500$)] M1

Speed is $30\ ms^{-1}$ A1

Alternative Method for Part (i)

(i)	Driving force = 2800 000 ÷ 500	B1		
	[DF – mgsinα – R = m × 0] For using Newton's second law	M1		
	[16000 × 10sinα = 5600 – 800] For solving the resultant equation for α	DM1		
	α = 1.7	A1	[4]	

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6	**(i)**		M1		For resolving forces parallel to the plane
		$F = 5.9 - 6.1 \sin\alpha$	A1		
		$R = 6.1\cos\alpha$	B1		
		$[5.9 - 6.1 \sin\alpha \leq \mu (6.1\cos\alpha)]$	M1		For using $F \leq \mu R$
		$\mu > \frac{4}{5}$	A1	[5]	AG
	(ii)	$[6.1 \times (11/61) + 5.9 - \mu 6.1 \times (60/61) > 0]$	M1		For using $F = \mu R$ and 'net downward force > 0'
		$\mu < \frac{7}{6}$	A1	[2]	AG
	(iii)	$[6.1 \times (11/61) + 5.9 - \mu\, 6.1 \times (60/61) = 0.61 \times 1.7]$	M1		For using Newton's 2nd law and $F = \mu R$
		$\mu = 0.994$	A1	[2]	
7	**(i)**				For using Newton's second law
		$[T - 0.12g = 0.12a$ & $0.38g - T = 0.38a$; $a = \frac{0.38 - 0.12}{0.38 + 0.12} g]$	M1		for A and B or for using $a = \frac{M - m}{M + m} g$
		Acceleration is 5.2 ms^{-2}	A1	[2]	
	(ii)	$[v^2 = 2 \times 5.2 \times 0.65;\ 0.65 = \frac{1}{2}\, 5.2 T_B^2]$	M1		For using $v^2 = 2ah$ or $s = \frac{1}{2}\, at^2$
		Speed of B is 2.6ms^{-1} or $T_B = 0.5$	A1ft		ft incorrect a
		$T_B = 0.5$ or Speed of B is 2.6ms^{-1}	B1	[3]	
	(iii)	$[-2.6 = 2.6 - 10(T - 0.5)]$	M1		For using $-V = V - g(T - T_B)$ or equivalent
		$T = 1.02$	A1ft		ft incorrect V and/or T_B
		Correct graph for $0 < t < 1.02$ ft incorrect values of V, T and T_B	B1ft	[3]	
	(iv)	$[0.65 + 0.5(1.02 - 0.5)2.6]$	M1		For using 'total distance $= \frac{1}{2}(VT_B) + 2 \times \frac{1}{2} \frac{T_A - T_B}{2} V$
		Total distance is 1.326 m (accept 1.33)	A1	[2]	

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