CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2012 series

9709 MATHEMATICS

9709/42 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 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 October/November 2012 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 √ 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			M1		For using WD = Fdcos α
		WD = 45 × 25cos 14^o	A1		
		Work done is 1090 J (1.09 kJ)	A1	3	
2	**(i)**	[0.6 = 0 + 0.3a]	M1		For using v = 0 + at
		Acceleration is 2 ms^{-2}	A1	2	
	(ii)	[mg – T = 2m, T – (1 – m)g = 2(1 – m)]	M1		For applying Newton's 2nd law to A or to B
		[m = T/8 ➔ T – (10 – 1.25T) = 2 – 0.25T or T = 8m ➔ 8m – (10 – 10m) = 2 – 2m]	M1		For eliminating or evaluating m
		T + 1.25T + 0.25T = 10 + 2 or m = 0.6 and T = 8m	A1		
		m = 0.6 and tension is 4.8 N	A1	4	
		Alternative for part **(ii)**			
		[{m + (1 – m)} × 2 = {m – (1 – m)} × g]	M1		For using (m_A + m_B)a = (m_A – m_B)g
		m = 0.6	A1		
		[mg – T = 2m or T – (1 – m)g = 2(1 – m)]	M1		For applying Newton's 2nd law to A or to B, substituting for m and solving for T
		Tension is 4.8 N	A1		

3				For using $s = ut + \frac{1}{2}at^2$ for AB or AC
		M1		
	$55 = 5u + 12.5a$	A1		
	$(55 + 65) = 10\,u + 50a$ or $65 = 5v_B + 12.5a$ and $v_B = u + 5a$	A1		
		M1		For solving for a or u
	$a = 0.4$ (or $u = 10$)	A1		
	$u = 10$ (or $a = 0.4$)	A1ft	6	
	Alternative			
	$v_B = (55 + 65) \div (5 + 5)$	M1		For calculating the speed at B as the mean speed for the motion from A to C.
	$v_B = 12\text{ms}^{-1}$	A1		
	For calculating the speed at X, where X is the point where the car passes 2.5 s after passing through A, as $55 \div 5 = 11\text{ms}^{-1}$	B1		
	$[a = (12 – 11) \div 2.5]$	M1		For using $a = (v_B – v_X) \div 2.5$
	$a = 0.4$	A1		
	$u = v_X – a \times 2.5 = 11 – 0.4 \times 2.5 = 10$	B1		
4	**(i)** $[Y_1^2 = 68^2 – (–60)^2$, $Y_3^2 = 100^2 – 96^2$. $Y_1 = 68\sin 28.1^o$, $Y_3 = 100\sin 16.3^o]$	M1		For using $Y^2 = F^2 – X^2$ or for finding the angles (say α and β) between the forces of magnitudes 68 and 100, respectively, and the x-axis. Then find the two relevant magnitudes from $68\sin\alpha$ and $100\sin\beta$
	For correct magnitudes (32, 75, 28)	A1		Can be scored by implication if the final A1 is scored for the correct answer to part **(i)**
	Components are –32, 75 and –28	A1ft	3	
	(ii) $[R^2=(–60 + 0 + 96)^2 + (–32 + 75 – 28)^2]$	M1		For using $R^2 = X^2 + Y^2$
	Magnitude is 39 N	A1		
	$[\theta = \tan^{-1}\{(–32 + 75 – 28)\div(–60 + 0 + 96)\}]$	M1		For using $\theta = \tan^{-1}(Y/X)$
	Direction is 22.6^o (or 0.395rad^c) anticlockwise from +ve x-axis.	A1	4	Accept just ‘22.6 from x-axis’ or just ‘$\theta = 22.6$’

5	**(i)**	Acceleration for $t < 0.8$ is $4/0.8$	B1		
		$[5 = 10\sin\theta]$	M1		For using $a = g\sin\theta$
		$\theta = 30°$	A1	3	
		Alternative for part **(i)**			
	(i)	$[mgh = \frac{1}{2} m4^2$ and $s = \{(0 + 4) \div 2\} \times 0.8]$	M1		For using PE loss = KE gain and $s \div t = (u + v) \div 2$ (A to B)
		$\sin\theta = 0.8/1.6$	A1		
		$\theta = 30^o$	A1		
	(ii)	Acceleration for $0.8 < t < 4.8$ is			
		$-4/(4.8 - 0.8)$	B1		
		$[mg\sin 30^o - F = m(-1)]$	M1		For using Newton's second law
			M1		For using $\mu = F / R$
		$\mu = \dfrac{mg\sin 30^o + m}{mg\cos 30^o}$	A1ft		ft following a wrong answer for θ in part **(i)**
		Coefficient is 0.693	A1	5	Accept 0.69

6	**(i)**				For using DF = $30000/v$
		$[30000/v - 1000 - 1250g \times 30/500 = 1250a]$	M1		For using Newton's 2nd law
		$v_{bottom} = 30000/(1250 \times 4 + 1000 + 750)$ and $v_{top} = 30000/(1250 \times 0.2 + 1000 + 750)$	M1 A1		
		$[\frac{1}{2} 1250(15^2 - 4.44\ldots.^2)]$	M1		For using KE gain = $\frac{1}{2} m(v_{top}^2 - v_{bottom}^2)$
		Increase in KE is 128000 J (128 kJ)	A1	5	
		Alternative for part **(i)**			
	(i)	$[F - 1000 - 1250g \times 30/500 = 1250a]$	M1		For using Newton's second law to find the driving force at the bottom and the top
		$F_{bottom} = 1250 \times 4 + 1000 + 750 = 6750$ and $F_{top} = 1250 \times 0.2 + 1000 + 750 = 2000$	A1		
		$[v_{bottom} = 30000/6750$ and $v_{top} = 30000/2000]$	M1		For using DF = 30000/v to find v_{bottom} and v_{top}
		$[\frac{1}{2} 1250(15^2 - 4.44\ldots.^2)]$	M1		For using KE gain = $\frac{1}{2} m(v_{top}^2 - v_{bottom}^2)$
		Increase in KE is 128000 J (128 kJ)	A1		
	(ii)	PE gain = $1250g \times 30$ and			
		WD against resistance = 1000×500	B1		
		$[WD_{car} = 128000 + 375000 + 500000]$	M1		For using WD by car's engine = KE gain + PE gain + WD against resistance
		Work done is 1000 000 J (1000 kJ)	A1ft	3	ft incorrect answer in **(i)**
	Special Ruling applying to part **(i)** for candidates who omit the weight component in applying Newton's second law. (Max 3 out of 5)				
	(i)	$v_{bottom} = 30000/(1250 \times 4 + 1000)$ and $v_{top} = 30000/(1250 \times 0.2 + 1000)$	B1		
		$[\frac{1}{2} 1250(24^2 - 5^2)]$	M1		For using KE gain = $\frac{1}{2} m(v_{top}^2 - v_{bottom}^2)$
		Increase in KE is 344000 J (344 kJ)	A1		

7	**(i)**	$dv/dt = k(120t - 3t^2)$	B1		
		$[v(40) = k(60 \times 40^2 - 40^3) = 6.4]$	M1		For finding v_{max} as the value of v when $dv/dt = 0$ and $t \neq 0$ and equating with 6.4
		$k = 0.0002$	A1	3	AG
	(ii)	$t = 60$ at A	B1		
			M1		For integrating $v(t)$ to find $s(t)$
		$s(t) = 0.0002(20t^3 - t^4/4) \quad (+ C)$	A1		
		$[OA = 0.0002 \times (20 \times 60^3 - 60^4/4)]$	M1		For using limits 0 to 60 or evaluating $s(t)$ when $t = 60$ with $C = 0$ (which may be implied by its absence)
		Distance is 216 m	A1	5	
	(iii)	$[dv/dt = 0.0002(120 \times 60 - 3 \times 60^2)]$	M1		For evaluating dv/dt when $t = 60$
		Magnitude of acceleration is 0.72 ms^{-2}	A1	2	Accept $a = -0.72$ ms^{-2}
	(iv)	$[20t^3 - 0.25\,t^4 = 0,$ $v = 0.0002(60 \times 80^2 - 80^3)]$	M1		For attempting to solve $s(t) = 0$ for non-zero t and substituting into $v(t)$.
		Speed is 25.6 ms^{-1}	A1	2	