UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9709 MATHEMATICS

9709/41 Paper 41, 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.

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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	DF = 35000/16	B1		
		M1		For using Newton's second law
	DF – 1150g sin1.2° – 975 = 1150a	A1		
	Acceleration is 0.845 ms^{-2}	A1		
			[4]	
2	**(i)** Acceleration is 0.09 ms^{-2}	B1		
			[1]	
	(ii) [D = ½ (8 + 4)0.18 or D = (0 + ½ 0.09 × 2^2) + (0.18 × 4 + ½ 0 × 4^2) + (0.18 × 2 – ½ 0.09 × 2^2)]	M1		For using the idea that area represents distance or for repeated use of $s = ut + \frac{1}{2}at^2$
	Distance is 1.08 m	A1		
			[2]	
	(iii) [½ 3V = 1.08]	M1		For using area of triangle = area of trapezium
	Greatest speed is 0.72 ms^{-1}	A1		
			[2]	
				SR (max 1 out of 2) for candidates who assume (implicitly) that speed is greatest at a specific time (t = 11 or t = 9.5) 0.72 ms^{-1} B1 from ½ (0 + V) × 3 = 1.08 or from ½ (0 + V) × 1.5 = ½ 1.08
3	**(i)** [R + 7sin45° = 0.8g]	M1		For resolving forces vertically (needs 3 terms)
	Normal component is 3.05 N	A1		AG
			[2]	
	(ii) F = 7cos45°	B1		
		M1		For using μ = F/3.05
	Coefficient is 1.62	A1		
			[3]	
4		M1		For resolving forces in the *x*-direction or in the *y*-direction
	X = 160 + 250cos α	A1		
	Y = 370 – 250sin α	A1		
		M1		For using $R^2 = X^2 + Y^2$
	Magnitude is 500 N	A1ft		ft 264 N for consistent sin/cos mix
		M1		For using tan θ = Y/X
	Required angle is 36.9° (or 0.644 rads)	A1ft		ft 29.5° for consistent sin/cos mix
			[7]	

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Alternative for **4**			M1	For finding the resultant in magnitude and direction of **two** forces and obtaining a triangle enabling the calculation of the resultant of the **three** forces
	Triangle has sides 403, 250 and R		A1	or equivalent for different choice of two forces*
	Triangle has angle opposite R equal to 97.1°		A1	As *
	[$R^2 = 403^2 + 250^2 – 2 \times 403 \times 250\cos 97.1°$]		M1	For using cosine rule to find R
	Magnitude is 500 N		A1	
	[$\sin(66.6° – z) \div 250 = \sin 97.1° \div R$]		M1	For using sine rule to find z
	Required angle is 36.9°		A1	
5	**(i)**		M1	For using KE loss = PE gain or $0^2 = u^2 – 2(g \sin\alpha)(0.45/\sin\alpha)$
		½ (m)u^2 = (m)g(0.45)	A1	
		Speed is 3 ms^{-1}	A1	
			[3]	
	(ii)	[PE gain = ½ 0.3 × 3^2 – 0.39]	M1	For using PE gain = KE lost – WD
		PE gain is 0.96 J	A1ft	ft incorrect u
		[0.3gh = 0.96]	DM1	For using PE = mgh; dependent on the given WD being reflected in the value for PE used
		R is 0.32 m higher than the level of P	A1	
			[4]	
6	**(i)**		M1	For applying Newton's second law to *A* or to *B* or using (M + m)a = Mg – F
		0.45a = 0.45g – T and 0.2a = T – F or (0.45 + 0.2)a = 0.45g – F	A1	
		F = 0.3 × 0.2g	B1	
			M1	For substituting for F and solving for a
		Acceleration is 6 ms^{-2}	A1	
		[$v^2 = 2 \times 6 \times [2 – (2.8 – 2.1)]$]	M1	For using $v^2 = (0^2) + 2as$ (s must be less than 2)
		Speed is 3.95 ms^{-1}	A1	AG
			[7]	
	(ii)	$0.2a_2 = –0.06g$	B1ft	ft incorrect F
			M1	For using $v^2 = 3.95^2 +$ $2a_2$[2.1 – distance moved by B]
		$v^2 = 15.6 + 2(–3)(0.8)$	A1	
		Speed is 3.29 ms^{-1}	A1	
			[4]	
Alternative for **6(ii)**				
	WD against friction = 0.06g × [2.1 – (2 – 0.7)]		B1	
			M1	For using KE loss = WD against friction
	½ 0.2 × 3.95^2 – ½ 0.2v^2 = 0.48		A1	
	Speed is 3.29 ms^{-1}		A1	

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7	**(i)**		M1	For integrating v_1 to find s_1
		$\int_0^{15} v_1 dt = 225$ ➔	A1	
		$A[(15^2/2 - 0.05 \times 15^3/3) - (0 - 0)] = 225$		
		$A = 4$	A1	
		$[4(15 - 0.05 \times 15^2) = B/15^2]$	M1	For using $v_1(15) = v_2(15)$
		$B = 3375$	A1	AG
			[5]	
	(ii)	$s_2(t) = Bt^{-1}/(-1)$ (+ C)	B1	
		$[-3375/15 + C = 225]$	M1	For using $s_2(15) = 225$ to find C
		Distance travelled is $[450 - 3375/t]$ m (for $t \geqslant 15$)	A1	
			[3]	
	(iii)	$[450 - 3375/t = 315]$	M1	For attempting to solve $s_2(t) = 315$
		$[v = 3375/25^2]$	M1	For substituting into $v = 3375/t^2$
		Speed is $5.4\,\text{ms}^{-1}$	A1	
			[3]	
Alternative for **7(ii)**				
		$s = \int_{15}^{t} 3375t^{-2} dt = -3375(\frac{1}{t} - \frac{1}{15})$	B1	
		$= 225 - 3375/t$		
		Distance travelled $= 225 + (225 - 3375/t)$	M1	
		Distance travelled is $[450 - 3375/t]$ m (for $t \geqslant 15$)	A1	

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