UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2011 question paper

for the guidance of teachers

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 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.

Cambridge is publishing the mark schemes for the October/November 2011 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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	(i)	F = 720/12	B1		
		[F – R = 75 × 0.16]	M1		For use of Newton's second law
		R = 48	A1	3	
	(ii)	[720/v > 48]	M1		For using P/v – R = ma and a > 0 → P/v > R
		v < 15 i.e. speed is less than 15 ms^{-1}	A1	2	
2	(i)	F = 0.2 × 6g cos8	B1		
		[6g sin8 – F = 6a]	M1		For use of Newton's second law
		Deceleration is 0.589 ms^{-2}	A1	3	Accept a = –0.589
	(ii)		M1		For use of $0 = u^2 + 2as$
		Distance is 7.64 m	A1	2	
3			M1		For using $v = \int adt$
	v = (0.8/0.25) $t^{0.25}$ + (C)		A1		
	C = 1.8		B1		
			M1		For using $s = \int vdt$
	s = (3.2/1.25)$t^{1.25}$ + 1.8t + (K)		A1ft		ft only from an incorrect non-zero value of C
	Distance is 111 m		A1	6	
4	(i)	For triangle of forces with 60º shown correctly, or			
		C$\cos\phi$ = 4cos30 and C$\sin\phi$ =10 – 4sin30, or F = 4cos30 and R = 10 – 4sin30	B1		
		[$C^2 = 4^2 + 10^2 - 2 \times 4 \times 10\cos60$ or $C^2 = (4\cos30)^2 + (10 - 4\sin30)^2$]	M1		For using cosine rule or for using $C^2 = (C\cos\phi)^2 + (C\sin\phi)^2$ or $C^2 = F^2 + R^2$
		C = 8.72	A1	3	
	(ii)	[μ = 4cos30/(10 – 4sin30)]	M1		For using μ = F/R = C$\cos\phi$/C$\sin\phi$
		Coefficient is 0.433 (accept 0.43)	A1	2	
4	Alternative Method				
	(i)	For obtaining ϕ = 66.6º or			
		$\tan\phi = 4 \div \sqrt{3}$ from $4 \div \sin(90º + \phi) = 10 \div \sin(150º - \phi)$	B1		
		For using C N and (4 N or 10 N) in Lami's theorem to find C [C ÷ sin120º = (4 ÷ sin156.6º or 10÷sin83.4º)]	M1		
		C = 8.72	A1	3	
	(ii)	[$\mu = \sqrt{3} \div 4$ or μ = cos66.6º ÷ sin66.6º]	M1		For using μ = F/R = C$\cos\phi$ / C$\sin\phi$
		Coefficient is 0.433 (accept 0.43)	A1	2	

5	(i)		M1		For applying Newton's second law to A or to B
		$0.9g - T = 0.9a$ or $T - 0.6g = 0.6a$	A1		
		$T - 0.6g = 0.6a$ or $0.9g - T = 0.9a$ or $(0.9 - 0.6)g = (0.9 + 0.6)a$	B1		
		Acceleration is 2 ms^{-2} and tension is 7.2 N	A1	4	
	(ii)		M1		For using $0 = u - gt$
		$u = 3$	A1		
		$[3^2 = 2 \times 2\ h]$ $[½\ (0.9 + 0.6)3^2 = (0.9 - 0.6)gh]$	M1		For using $v^2 = 0^2 + 2ah$ with $v_{taut} = u_{slack}$ or for using KE gain = PE loss while the string is in tension
		Height is 2.25 m	A1	4	
6	(i)	KE loss = $½\ 16000(15^2 - 12^2)$	B1		
		PE gain = 16000g(AB/20)	B1		
			M1		For using WD by DF = PE gain + WD against resistance – KE loss
		1200 = 0.8g(AB) + 1.24(AB) – 648	A1		
		Distance AB is 200m	A1	5	
	(ii)	Distance BD is 300m	B1	1	
	(iii)	WD against resistance =			
		1240(BC) + 1860(300 – BC)	B1ft		ft distance BD
			M1		For using KE loss = PE gain + WD against res'ce – WD by DF
		$½\ 16000(12^2 - 7^2)$ = 2400000 + (558000 – 620BC) – 7200 × 300	A1		
		Distance BC is 61.3 m	A1	4	

Alternative for Q6 part **(iii)**.

For BC16000a = 7200 – 1240 – 8000 and for CD 16000a = 7200 – 1860 – 8000	B1
For using $v^2 = u^2 + 2as$ for both BC and CD	M1
$v_C^2 = 144 - 2 \times 0.1275(BC)$ and $49 = v_c^2 - 2 \times 0.16625(300 - BC)$	A1
For eliminating v_c^2 and obtaining BC = 61.3 m	A1

SR for candidates who assume that the acceleration is constant in part **(i)**, although there is no justification for the assumption (max. 3/5)

For appropriate use of Newton's second law and $v^2 = u^2 + 2as$ [1200000÷AB – 1240 – 160000/20 = 16000a and $a = (12^2 - 15^2)/2(AB)$]	M1
For eliminating a and attempting to solve for AB	M1
Distance AB is 200m	A1

7	(i)	(a)	[2 × ½ (1 + 9)400]	M1		For using area property for distance
			Approximation is 4000 m	A1	2	
		(b)		M1		For using the gradient property for acceleration
			Accelerations are 0.02 ms^{-2} and – 0.02 ms^{-2}	A1	2	Accept deceleration is 0.02 ms^{-2}
	(ii)	(a)		M1		For using a = dv/dt and attempting to solve a= 0.02 or a = –0.02.
			$0.04 - 0.0001t = \pm 0.02$	A1ft		
			Values of t are 200 and 600	A1	3	
		(b)	$v_1 - v = 0.02t + 1 - 0.04t + 0.00005t^2$	B1		
			$v_1 - v = [0.00005t^2 - 0.02t + 2 - 1]$ $= 0.00005(t^2 - 400t + 40000) - 1$ $= 0.00005(t - 200)^2 - 1$	B1	2	AG
		(c)	For using $(v_1 - v)_{min}$ occurs when			
			$t = 200 \rightarrow -1 \le v_1 - v$	B1		
			For using $(v_1 - v)_{max}$ occurs when t = 0 and when $t = 400 \rightarrow v_1 - v \le 1$	B1	2	