UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2009 question paper

for the guidance of teachers

9709 MATHEMATICS

9709/42 Paper 42, 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.

- CIE 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.

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)	[P = Wsin40°]	M1		For resolving forces parallel to the plane or for a correct triangle of forces or for resolving horizontally and vertically
		P = 7.71	A1	2	
	(ii)	[Pcos40° = Wsin40°]	M1		
		P = 10.1	A1	2	
2	(i)	Loss in PE is 2.7×10^6 J	B1	1	
	(ii)	WD is 2.1×10^6 J	B1ft	1	ft incorrect loss in PE
	(iii)	KE change = ½ 15000($16^2 - 14^2$)	B1		
		[WD = ½ 15000($16^2 - 14^2$) + 1600 × 2500]	M1		WD by DF = Gain in KE + WD by resistance
		WD is 4.45×10^6 J	A1	3	
					SR for candidates who use Newton's Law method instead of energy (max 1/3) a = ($16^2 - 14^2$)/(2 × 2500) = 0.012 DF = 1600 + 15000 × 0.012 = 1780 WD = 1780 × 2500 = 4.45×10^6 B1
3	(i)	[DF = 600 at max speed]	M1		For using DF = R at max. speed
		[DF = 24000/v]	M1		For using DF = P/v
		Speed cannot exceed 40 ms^{-1}	A1	3	AG
	(ii)	DF – R = ma]	M1		For using Newton's second law
		24000/15 – 600 = 1250a	A1		
		Acceleration is 0.8 ms^{-2}	A1	3	
4	(i)	[1.2 = mg cosα]	M1		For resolving forces normal to the plane
		Mass is 0.125 kg	A1	2	
	(ii)	[–mg sinα – F = ma]	M1		For using Newton's second law
		– 0.125 × 10 × 0.28 – 0.4 = 0.125a	A1ft		ft incorrect mass
		a = –6 ➔ deceleration is 6 ms^{-2}	A1	3	
	(iii)		M1		For comparing magnitudes of μR (0.4) and mg sinα (0.35)
		μR > mg sinα ➔ particle remains at rest	A1	2	

5	**(i)**		M1		For resolving forces vertically
		$12 + 15\sin30^\circ = R$	A1		
		$F = 15\cos30^\circ$	B1		
		$[\mu = 15\cos30^\circ/(12 + 15\sin30^\circ)]$	M1		For using $\mu = F/R$
		Coefficient is 0.666	A1	5	AG
	(ii)	$F = 0.666(12 - 15\sin30^\circ)$	B1		
			M1		For using Newton's second law
		$15\cos30^\circ - F = 1.2a$	A1		
		Acceleration is 8.33 ms^{-2}	A1	4	
6	**(i)**		M1		For applying Newton's second law to A or to B or for using $(M + m)a = (M - m)g$
		$T - 0.3g = 0.3a$ and $0.7g - T = 0.7a$ or $(0.7 + 0.3)a = (0.7 - 0.3)g$	A1		
		Acceleration is 4 ms^{-2}	A1	3	
	(ii)	$s_1 = 1.6^2/(2 \times 4)$	B1ft		ft acceleration
			M1		For using $0^2 = 1.6^2 - 2gs_2$
		Height is 0.448 m	A1	3	From $s_1 + s_2 = 0.32 + 0.128$
	(iii)	$t_1 = 1.6/4$	B1ft		ft acceleration (can be scored in **(ii)**)
			M1		For using $0 = 1.6 - gt_2$
		Time taken is 0.56 s	A1	3	From $t_1 + t_2 = 0.4 + 0.16$
	(Alternative for part (iii))				
			M1		For observing that the average speed is the same for each of the two phases and equal to $(0 + 1.6)/2$ ms^{-1}
		$\rightarrow t_1 + t_2 = (s_1 + s_2)/0.8$	A1		
		Time taken is 0.56 s	A1	3	[Similarly for finding $s_1 + s_2$ if ans**(iii)** is found before ans**(ii)**]
	(Alternatively for parts ii and iii using v–t graph)				
			M1		Use of gradient to find t_1 or t_2
		$t_1 = 1.6/4$ and $t_2 = 1.6/10$	A1		
		Time taken is 0.56s	A1		
			M1		For use of area to find s_1 or s_2 or $s_1 + s_2$
		$s_1 = 0.4 \times 1.6/2$ or $s_2 = 0.16 \times 1.6/2$ or $s_1 + s_2 = (0.4 + 0.16) \times 1.6/2$	A1		
		Height is 0.448m	A1	6	

7	(i)		M1		For using $v(t) = \dot{s}(t)$
		$v = 1.2t - 0.012t^2$	A1		
		$[a(50) = 1.2 - 0.024 \times 50]$	M1		For using $a(t) = \dot{v}(t)$ and evaluating a(50)
		$a = 0$	A1		AG
		$V = 30$	B1	5	
	(ii)	$s_1 = 0.6 \times 50^2 - 0.004 \times 50^3$ (= 1000)	B1		
		$\left[\frac{1000 + s_2}{50 + t_2} = 27.5\right]$	M1		For using 'average speed = total distance /total time'
		$[1000 + 30t_2 = 27.5(50 + t_2)]$	M1		For substituting $s_2 = Vt_2$ and attempting to solve for t_2
		$t_2 = 150$	A1		
		$t = 200$	A1	5	ft $50 + t_2$ (requires both M marks)
	(Alternative for part (ii))				
	$s_1 = 0.6 \times 50^2 - 0.004 \times 50^3$ (= 1000)		B1		
	$[(1000 + s_2)/t = 27.5]$		M1		For using 'average speed = total distance /total time' with $t_2 = t - 50$
	$(1000 + 30(t - 50))/t = 27.5$		A1ft		(ft V and s_1)
	$[27.5t = 1000 + 30(t - 50)]$		M1		For attempting to solve for t
	$t = 200$		A1	5	