CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2013 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 2013 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 resolving forces parallel to the line of greatest slope
	Applying $T \cos \beta = W \sin \alpha$	A1		$T\ (24/25) = 5.1\ (8/17)$ or $T \cos 16.26 = 5.1 \sin 28.07$
	Tension is 2.5 N	A1	3	
First Alternative Marking Scheme				
		M1		For resolving forces vertically or horizontally
	Applying $R \cos \alpha + T \sin (\alpha + \beta) = W$ and $R \sin \alpha = T \cos (\alpha + \beta)$	A1		$R \cos 28.07 + T \sin 44.33 = 5.1$ and $R \sin 28.07 = T \cos 44.33$
	Tension is 2.5 N	A1	3	
Second Alternative Marking Scheme				
		M1		Using Triangle of forces
	Applying $T / \sin \alpha = 5.1 / \sin (90 + \beta)$	A1		$T / \sin 28.07 = 5.1 / \sin 106.26$
	Tension is 2.5 N	A1	3	

2		M1		For using $KE = \frac{1}{2} m v^2$ or $WD = F d \cos \alpha$
	Gain in KE = $\frac{1}{2}\ 25 \times 3^2$ or WD by pulling force = $220 \times 15 \cos \alpha$	A1		
	WD by pulling force = $220 \times 15 \cos \alpha$ or Gain in KE = $\frac{1}{2}\ 25 \times 3^2$	B1		
	[$3300 \cos \alpha = 112.5 + 3000$]	M1		For using WD by pulling force = KE gain + WD against resistance
	$\alpha = 19.4$	A1	5	

3 **(i)**		M1		For using F = P/v and Newton's 2nd law with a = 0
	$100/4 - 4k = 0 \rightarrow k = 6.25$	A1	2	AG
(ii)		M1		For using Newton's 2nd law with a = 0 uphill → 3 term equation
	$100/v - 70g \times 0.05 - 6.25v = 0$	A1		
	$[6.25v^2 + 35v - 100 = 0]$ or $[v^2 + 5.6v - 16 = 0]$	M1		For solving a 3-term quadratic for v
	Maximum speed is 2.08 ms^{-1}	A1	4	

4		M1		For resolving three forces parallel to the plane
	$0.6g \sin \alpha = F + P \cos \alpha$	A1		Value of α used or values of sin α and cos α used
		M1		For resolving three forces perpendicular to the plane
	$R = 0.6g \cos \alpha + P \sin \alpha$	A1		Value of α used or values of sin α and cos α used
		M1		For using F = μR
	$0.6g \sin \alpha - P \cos \alpha = 0.4 (0.6g \cos \alpha + P \sin \alpha)$	A1		Value of α used or values of sin α and cos α used
	$6(12/13) - P(5/13) = 2.4(5/13) + 0.4P(12/13)$	M1		For solving the resultant equation for P
	P = 6.12	A1	8	

Alternative Marking Scheme

		M1		For resolving three forces vertically
	$W = R\cos\alpha + F\sin\alpha$	A1		Value of α used or values of sin α and cos α used
		M1		For resolving three forces horizontally
	$P = R\sin\alpha - F\cos\alpha$	A1		Value of α used or values of sin α and cos α used
		M1		For using $F = \mu R$ in both equations
	$0.6g = R(5/13) + 0.4R(12/13)$ and $P = R(12/13) - 0.4R(5/13)$	A1		Value of α used or values of sin α and cos α used
	$78 = R(5 + 4.8)$ and $13P = R(12 - 2)$ $\rightarrow 13P = (78 \div 9.8) \times 10$	M1		For finding R and substituting into an expression for P
	$P = 6.12$	A1	8	

5 **(i)**	$[s = t^2/2 - 0.1t^3/3]$	M1*		For integrating to find s for $0 \leqslant t \leqslant 5$
	$[s_1 = 25/2 - 0.1 \times 125/3]$	DM1*		For obtaining s_1 by using limits 0 to 5 or having zero for constant of integration (can be implied) and substituting t = 5
	$s_1 = 8.33$	A1	3	
	(ii)		M1	For using $s = v(5) \times (45 - 5)$ for $5 \leqslant t \leqslant 45$
	$s_2 = 2.5 \times 40$	A1		
	$[s = 9t^2/2 - 0.1t^3/3 - 200t$ for $45 \leqslant t \leqslant 50]$	M1		For integrating to find s for $45 \leqslant t \leqslant 50$ and implying the use of limits 45 and 50 or equivalent via constant of integration
	$s_3 = [9(50)^2/2 - 0.1(50)^3/3 - 200(50)] - [9(45)^2/2 - 0.1(45)^3/3 - 200(45)]$	A1		For applying the limits at 45 and 50 correctly or equivalent via constant of integration
	$[= 8.33]$			

Alternative mark scheme for previous 2 marks				
	Recognising the symmetry of the velocity distribution due to the correspondence of the points (0,0) → (50,0) and (5,2.5) → (45,2.5)	(M1)		
	Complete the idea of symmetry with one further property and hence State $s_3 = s_1 = 8.33$	(A1)		Property is any one of a(0) = – a(50) a(5) = a(45) v(2.5) = v(47.5) oe
	Distance from O to A is 117m	A1		
	Average speed is 2.33 ms^{-1}	B1ft	6	ft answer for total distance

6 (i)		M1		For applying Newton's 2nd law to A or B
	T – 0.4g = 0.4a or 1.6g – T = 1.6a	A1		
	1.6g – T = 1.6a or T – 0.4g = 0.4a or 1.6g – 0.4g = (1.6 + 0.4)a	B1		
	T = 6.4	A1		
	Work done by tension is 7.68 J	B1ft	5	
Alternative mark scheme for 6 (i)				
		M1		For applying Newton's 2nd law to A or B
	T – 0.4g = 0.4a or 1.6g – T = 1.6a	A1		
	1.6g – T = 1.6a or T – 0.4g = 0.4a or 1.6g – 0.4g = (1.6 + 0.4)a	B1		
	WD by T = initial PE – final KE = 1.6 × g × 1.2 – ½ × 1.6 × 14.4	M1		For finding v^2 and applying Work/Energy equation to B
	WD by T = 19.2 – 11.52 = 7.68	A1	5	

6 (ii)	$[1.6 \times 10 \times 1.2 = ½\ 1.6\ v^2 + 7.68]$	M1		For using PE loss = KE gain + WD by T to find v^2
	$v^2 = 14.4$	A1		
	$14.4 = 2 \times 10 \times h$ $h = 0.72$ $H = 2 \times 1.2 + h$	M1		For using PCE for A's motion after B reaches the ground or $0 = u^2 - 2gh$ and $H = 2 \times 1.2 + h$
	Greatest height is 3.12 m	A1	4	
First Alternative Marking Scheme for 6 (ii)				
	$[v^2 = 2 \times 6 \times 1.2]$	M1		For using $v^2 = 2as$ to find v^2
	$v^2 = 14.4$	A1		
	$14.4 = 2 \times 10 \times h$ $h = 0.72$ $H = 2 \times 1.2 + h$	M1		For using PCE for A's motion after B reaches the ground or $0 = u^2 - 2gh$ and $H = 2 \times 1.2 + h$
	Greatest height is 3.12 m	A1	4	
Second Alternative Marking Scheme for 6 (ii)				
	WD by T = Increase in PE $7.68 = 0.4 \times g \times s$	M1		For applying WD by T to particle A's complete motion
	$s = 1.92$	A1		
	$H = 1.2 + s$	M1		For adding 1.2 to s
	$H = 1.2 + 1.92 = 3.12$ Height = 3.12 m	A1	4	

7	(i)	[s = ½ 5 × 0.4 + 19 × 0.4 + ½ 4 × 0.4]	M1		For using the area property for distance
		Distance = 9.4	A1	2	
	(ii)	Acceleration is 0.08 ms^{-2}	B1		
		Deceleration is 0.1ms^{-2}	B1	2	
	(iii)	[T – (800 + 100) g = (800 +100)a]	M1		For applying Newton's 2nd law to the elevator and box
		T – 900g = 900a	A1		
		T = 9072 N in 1st stage T = 9000 N in 2nd stage T = 8910 N in 3rd stage	A1	3	
	(iv)	[R – 100g = 100a]	M1		For applying Newton's 2nd law to the box
		R = 1008 N	A1		For obtaining the greatest value of the force on the box
		R = 990 N	A1	3	For obtaining the least value of the force on the box