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

9709/41 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.

- 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	[$15000 = 750v_A$, $15000 = 500v_B$]	M1		For using P = Fv
	Speeds are 20ms^{-1} and 30ms^{-1}	A1		
	[KE gain = ½ $1000(30^2 - 20^2)$]	M1		For using KE = ½ mv^2
	Increase is 250 000J (or 250kJ)	A1ft	4	ft $500(v_B{}^2 - v_A{}^2)$
2	**(i)** [mgh = ½ $m6^2$]	M1		For using PE loss = KE gain
	Height is 1.8m	A1	2	
	(ii) ½ mv^2 = mg(1.8 + 0.65) or ½ mv^2 – ½ $m6^2$ = mg × 0.65	B1ft		
	Maximum speed is 7ms^{-1}	B1	2	
3		M1		For resolving forces parallel to or perpendicular to:– the force of magnitude QN, or the resultant
	Q – Pcos60° = 12cos80° and Psin60° = 12sin80° Qcos80° + Pcos40° = 12 and Psin40° = Qsin80°	A1		
	[Q – 12sin80°cos60°/sin60° = 12cos80° Qcos80° + Qsin80°cos40°/sin40° = 12]	M1		For eliminating P
	Q = 8.91	A1	4	
	(First alternative)	M2		For resolving forces perp. to P
	Qcos30° = 12cos50°	A1		
	Q = 8.91	A1	4	
	(Second alternative)	M1		For triangle of forces with sides P, Q and 12, and values of any 2 angles shown or implied (Note P, Q and –R are in equil.)
	Angles opposite Q and 12 are 40° and 60° respectively	A1		
	Q/sin40° = 12/sin60°	M1		For using the sine rule
	Q = 8.91	A1	4	
	(Third alternative)	M1		For force diagram showing P, Q and –R, and values of any 2 angles at 'O' shown.
	Angle between P and Q is 120° and between P and –R is 140°	A1		
	[Q/sin140° = 12/sin120°]	M1		For using Lami's theorem
	Q = 8.91	A1	4	

4	(i)	For angle between AP and vertical = 36.9° (or $\sin^{-1}0.6$) or for angle between PS and vertical = 53.1° (or $\sin^{-1}0.8$)	B1		May be implied
		$[T_{PS} + (T_{PA}\cos 90^o) = 5\sin 36.9^o]$	M1		For resolving forces on P in the direction of PS (2 non–zero terms required)
		. . . .			. . . .
		(First alternative) For the angle between PA and the horizontal through P is 53.1° and the angle between PS and the horizontal through P is 36.9°	B1		May be implied
		$[0.6T_{PA} = 0.8T_{PS}$ and $0.8T_{PA} + 0.6T_{PS} = 5 \rightarrow \{0.8(0.8/0.6) + 0.6\}T_{PS} = 5]$	M1		For resolving forces on P vertically and horizontally and eliminating T_{PA}
		. . . .			. . . .
		(Second alternative) For Δ of forces with sides T_{PA}, T_{PS} and 5, with angles opposite T_{PS} and 5 shown as 36.9° and 90°	B1		May be implied
		$[T_{PS} = 5\sin 36.9^o]$	M1		For using trig. in Δ
		. . . .			. . . .
		(Third alternative) For force diag. showing T_{PA}, T_{PS} and 5, with angles between T_{PS} and T_{PA}, and between 5 and T_{PA} being shown as 90° and 143.1°	B1		May be implied
		$[T_{PS}/\sin 143.1^o = 5/\sin 90^o]$	M1		For using Lami's rule
		. . . .			. . . .
		Tension is 3N	A1	3	Accept 3.00
	(ii)	$[F = T\cos(\sin^{-1}0.6)]$	M1		For resolving forces on S horizontally
		Frictional force is 2.4N	A1	2	Accept 2.40
	(iii)	R = 2.4/0.75	B1ft		
		$[W + T\sin(\sin^{-1}0.6) = R]$	M1		For resolving forces on S vertically
		W = 1.4	A1ft	3	ft W = 7T/15 or W = 4F/3 – 1.8
5	(i)		M1		For using Newton's second law
		$-F - 0.6g\sin 18^o = 0.6(-4)$	A1		
		Frictional component is 0.546N	A1		
		$[R = 0.6g\cos 18^o]$	M1		For resolving forces normal to the plane
		Normal component is 5.71N	A1		
		Coefficient is 0.096	B1ft	6	
	(ii)	$0.6g\sin 18^o - 0.546 = 0.6a$ or $2(0.6g\sin 18^o) = 0.6(a + 4)$	B1ft		
		a = 2.18	B1	2	
			SR For candidates who use 'a' for the upwards acceleration , instead of as defined in the question. $-0.6g\sin 18^o + 0.546 = 0.6a \rightarrow a = -2.18$ B1 a = 2.18 accompanied by satisfactory explanation for dropping the minus sign. B1			

6	**(i)**	$0.55g – T = 0.55a$ and $T – 0.45g = 0.45a$ or $a = [(0.55 – 0.45)/(0.55+ 0.45)]g$	M1		For using Newton's second law to P or Q, or for using $a = \frac{M - m}{M + m}g$
			A1		
		Acceleration is $1ms^{–2}$	A1	3	
	(ii) (a)		M1		For using $s = 5 – ½ a2^2$ for P or $s = 5 + ½ a2^2$ for Q
		Height of P is 3m and height of Q is 7m	A1ft	2	ft $5 – 2a$ and $5 + 2a$
	(b)	Speed is $2ms^{–1}$	B1ft	1	ft 2a
	(iii)	$[3 = 2t_P + 5t_P^2,\ 7 = –2t_Q + 5t_Q^2]$	M1		For using $s = ut + ½ gt^2$ for P or for Q (NB a = g)
		$t_P = 0.6$	A1		
		$t_Q = 1.4$	A1		Accept $t_Q = 0.2 + 1.2$ following consideration of upward and downward motion under gravity of Q separately
		Q is 0.8s later than P	A1	4	AG
7	**(i)**	Speed is $6ms^{–1}$	B1		
		$a = 0.6$	B1ft	2	ft v/10
	(ii)		M1		For differentiating v(t)
		$a(t) = –1600/t^3$ (second stage)	A1		
		$[0.6 = 1600/t^3 \rightarrow t^3 = (1600/0.6)]$	M1		For attempting to solve $a(t) = –0.6$
		$t = 13.9$	A1	4	
					SR in parts **(i)** and **(ii)** (treated as a single entity) for candidates who assume there is necessarily continuity of acceleration at t = 10 (max 5/6) Speed is $6ms^{–1}$ B1 For differentiating v(t) M1 $a(t) = –1600/t^3$ A1 $a = a(10) = –1.6$ B1 For $t = \sqrt[3]{\frac{-1600}{1.6}}$ B1
	(iii)	$s_1 = 30m$	B1		
			M1		For integrating v(t)
		$s = (800t^{–1})/(–1) – 2t\ \ (+ C)$	A1		
			M1		For using limits 10, 20 or for using $s(10) = s_1$ to find c (= 130) and evaluating s(20).
		$s_2 = (–40 – 40) – (–80 – 20)$ or $s = –40 – 40 + 130$	A1		Any correct form
		Displacement from A is 50m	A1	6	