UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 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.

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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	**(i)**	[WD = 65 × 76cos5°]	M1		For using WD = Tdcos α
		Work done is 4920 J	A1	**[2]**	
	(ii)	[P = 65 cos5° × 1.5]	M1		For using P = Tvcos α
		Rate of working is 97.1 W	A1ft	**[2]**	ft for the value of ans**(i)** × 1.5÷76 SR for candidates who assume without justification that the speed is constant (max 1/2) t = 76 ÷ 1.5 = 50.6…s rate = WD/t = 4960÷50.6.. = 97.1W B1
2			M1		For using 'loss of PE = gain in KE + WD against resistance'
		PE loss = ½ 8($8^2 - 3^2$) + 120 (= 340 J)	A1		
		[340 = 8gh]	DM1		For using PE = mgh
		Height is 4.25 m	A1	**[4]**	
					SR for candidates who assume without justification that the resistance to motion is constant, usually implicitly by using constant acceleration formulae (max 3/4) For using Newton's second law with 3 terms, $v^2 - u^2 = 2as$ and h = s sinα M1 For attempting to eliminate α, a and s from the equations (80sinα – 120/s = 8a 64 – 9 = 2as, h = s sinα) M1 80s sinα – 120 = 4(64 – 9) → 80h – 120 = 220 → h = 4.25 A1
3	**(i)**	[½ 5 × 50 + ½ 7(8 + 50) + 90 × 8]	M1		For using the area property for distance or s = ½ (u + v)t
		Distance is 1048 m	A1	**[2]**	AG
	(ii)		M1		For use of the gradient property for acceleration (deceleration)
		a = (8 – 50)/(12 – 5) or d = (50 – 8)/(12 – 5)	A1		
			M1		For using Newton's second law (3 terms)
		850 – F = 85a (or –85d)	A1		
		Upward force is 1360 N	A1	**[5]**	

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4	**(i)**	M1		For resolving forces in the **i** and **j** directions
	$F\cos\theta = 12\cos30°$ (= 10.932)	A1		
	$F\sin\theta = 10 - 12\sin30°$ (= 4)	A1		
		M1		For using $F^2 = X^2 + Y^2$ or $\tan\theta = Y/X$
	F = 11.1 or θ = 21.1 (accept 21.0)	A1		
	θ = 21.1 (accept 21.0) or F = 11.1	B1	**[6]**	
				SR for candidates who consistently have cos for sin and vice versa (max 4/6) M1 as above (resolving) A1 for $F\sin\theta = 12\sin30°$ and $F\cos\theta = 10 - 12\cos30°$ M1 as above F^2 = ... & $\tan\theta$ =.... A1 for F = 6.01 and θ = 93.7
	(ii) Magnitude is 12N	B1		
	Direction is 30° clockwise from +ve 'x' axis	B1	**[2]**	
	alternative for 4(i)			
	For triangle of forces with sides 12, F and 10 and at least one of the angles $(90° - \theta)$ or 60° or $(\theta + 30°)$	B1		
		M1		For use of cosine rule (with θ absent) or use of sine rule (with F absent) and use of $\sin(A \pm B) = \sin A\cos B \pm \sin B\cos A$
	$F^2 = 12^2 + 10^2 - 2 \times 12 \times 10\cos60°$ or $(12\cos30°)\sin\theta = (10 - 12\sin30°)\cos\theta$	A1		
	F = 11.1 or θ = 21.1 (accept 21.0)	A1		
		M1		For correct method for θ or F
	θ = 21.1 (accept 21.0) or F = 11.1	A1	**[6]**	
	second alternative for 4(i)			
	For using Lami's theorem with 12 N and 10 N	M1		
	$12/\sin(90 + \theta) = 10/\sin(150 - \theta)$	A1		
	$12/\cos\theta = 20 \div (\cos\theta + 3^{½}\sin\theta)$ $\rightarrow 12 \times 3^{½}\sin\theta = 8\cos\theta$ $\rightarrow \tan\theta = 2 \div (3 \times 3^{½})$ $\rightarrow \theta = 21.1$	A1		
	For using Lami's theorem with F N and (12 N or 10 N)	M1		
	$F/\sin120° = 12/\sin111.1°$ (or $10/\sin128.9°$)	A1		
	F = 11.1	A1	**[6]**	

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	Alternative for 4(ii)				
		For $X = 11.1\cos 21.1^o$ and $Y = 11.1\sin 21.1^o - 10$, $R^2 = X^2 + Y^2$ and $\tan\Phi = Y/X$	M1		
		Magnitude 12 N and direction 30^o clockwise from +ve x-axis	A1	**[2]**	
5	**(i)**		M1		For using $0 = u - gt$ to find times at maximum heights.
		Times to max. height are 1.2s and 0.7s	A1		
		Range of values is $0.7 < t < 1.2$	A1	**[3]**	
	(ii)		M1		For using $h = ut - \frac{1}{2}gt^2$ and attempting to solve $3h_A = 8h_B$ for t
		$36t - 1.5gt^2 = 56t - 4gt^2$	A1		
		$t = 8/g$	A1		
			M1		For using $v = u - gt$
		Velocities are $4ms^{-1}$ and $-1ms^{-1}$	A1	**[5]**	
	Alternative for part 5(ii)				
		For using $3h_P = 8h_Q \rightarrow 3(v_P^2 - 144) \div (-20) = 8(v_Q^2 - 49) \div (-20) \rightarrow 3v_P^2 - 8v_Q^2 = 40$	B1		
		For using $v_P = 12 - 10t$ and $v_Q = 7 - 10t$ $\rightarrow$ $v_P - v_Q = 5$	B1		
		For eliminating v_Q (or v_P) and solving for v_P (or v_Q).	M1		
		$v_P^2 - 16v_P + 48 = 0 \rightarrow v_P = 4$ (or 4, 12)	A1		
		Upward velocities are 4 ms^{-1} and -1 ms^{-1}	A1	**[5]**	
6	**(i)**		M1		For resolving forces on R vertically
		$2T\cos\alpha = 0.6g$	A1		Where α = ½ angle ARB
		Tension is 5N	A1	**[3]**	
	(ii)	$[F = T\sin\alpha]$	M1		For resolving forces on B horizontally
		Frictional component is 4N	A1		
		$[N = 0.4g + T\cos\alpha]$	M1		For resolving forces on B vertically
		Normal component is 7 N	A1	**[4]**	
	(iii)		M1		For using $\mu = F/N$
		Coefficient is 4/7 or 0.571	A1ft	**[2]**	ft conditional on both M1 marks scored in **(ii)**; ft F and/or N

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	Alternative for Q6(i)/(ii)				
	(i)	For finding the relevant angles and using Lami's theorem	M1		
		$6/\sin 106.26° = T/\sin 126.87°$	A1		
		Tension is 5N	A1	**[3]**	
	(ii)	$F/\sin 126.87° = 5/\sin 90°$	B1		
		Frictional component is 4N	B1		
		$(R - 4)/\sin 143.13° = 5/\sin 90°$	B1		
		Normal component is 7 N	B1	**[4]**	
7	**(i)**	[$1.3 = 0.9 + 0.004T$, $1.3^2 = 0.9^2 + 2 \times 0.004S$]	M1		For using $v = u + at$ or $v^2 = u^2 + 2as$
		Time is 100 s (or distance is 110 m)	A1		
		Distance is 110 m (or time is 100 s)	B1	**[3]**	
	(ii)	$\int kt^3\,dt = ¼\ kt^4$	B1		
		[$k(¼\ 100^4 - 0) = 110$]	M1		For using limits 0 to T and equating definite integral to S
		$k = 4.4 \times 10^{-6}$	A1		
		[$v_W = 0.9 + 0.004 \times 64.05$, $v_C = 4.4 \times 10^{-6} \times 64.05^3$]	M1		For attempting to find the speed of the walker and of the cyclist.
		Both are equal to 1.16 ms^{-1} correct to 3 sf.	A1	**[5]**	
	(iii)	Acceleration = $3kt^2$	B1		
		Acceleration at B is 0.132 ms^{-2}	B1	**[2]**	

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