UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2012 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.

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 using WD = Fdcos α
	$F \times 5\cos 60^o = 75$	A1		
	Magnitude of the force is 30 N	A1	[3]	
2	[$12 = 15\sin\alpha$]	M1		For resolving forces in the direction of the force of magnitude 12 N
	$\alpha = 53.1$	A1		
	[$F = 15\cos\alpha$]	M1		For resolving forces in the direction of the force of magnitude F N
	F = 9 N	A1	[4]	
2	ALTERNATIVE 1			
	[Fsin α = 12cos α and Fcos α + 12sin α = 15 ➔ sin α ÷ cos α = 12cos α ÷ 15 – 12sin α	M1		For resolving forces in the x and y directions and eliminating F from the resultant equations
	$15\sin\alpha - 12\sin^2\alpha = 12\cos^2\alpha$ ➔ $15\sin\alpha = 12$ ➔ $\alpha = 53.1$	A1		
		M1		For substituting into Fsin α = 12cos α or Fcos α +12sin α =15
	F = 9 N	A1	[4]	
2	ALTERNATIVE 2			
	[sin α =12/15]	M1		For using correct triangle of forces to find α
	$\alpha = 53.1$	A1		
	[$F^2 = 15^2 - 12^2$]	M1		For using correct triangle of forces to find F
	F = 9 N	A1	[4]	
2	ALTERNATIVE 3			
	[12 ÷ sin(180 – α) = 15 ÷ sin90 ➔12 = 15sin α]	M1		For using Lami's rule and sin $(180^o - \alpha) = \sin\alpha$
	$\alpha = 53.1$	A1		
	[F ÷ sin 143.1 = 15 ÷ sin90]	M1		For using Lami's rule and value of α to find F
	F = 9 N	A1	[4]	
SR (max 2/4) For candidates who have sin and cos interchanged.				
Allow B1 for α = 36.9 and allow B1 for F = 9 following correct work relative to the cos/sin interchange error.				

3	**(i)**		M1		For an attempt to find $v(t)$ using integration of $a(t)$
		$v = 1.2t^{5/3} + 2$	A1		
			DM1		For attempting to solve $v(t) = 3$ for $t^{5/3}$ or For confirming $v = 3$ by substituting $t^{5/3} = 5/6$ into the expression found for $v(t)$
		$t^{5/3} = 5/6$	A1	[4]	AG
	(ii)		M1		For integrating and using s(0) = 0 (may be implied by absence of +C) to find s(t)
		$s = 0.45t^{8/3} + 2t$	A1		
		Distance is 2.13 m	A1	[3]	
4	**(i)**		M1		For resolving forces horizontally
		Horizontal component is $T\cos 25^\circ$ (0.906T)	A1		
			M1		For resolving forces vertically
		Vertical component is $4g + T\sin 25^\circ$ (40 + 0.423T)	A1	[4]	
	(ii)		M1		For using F = 0.4R
		0.906T = 16 + 0.169T	A1ft		May be implied by correct answer for T
		T = 21.7 N	A1	[3]	
5	**(i)**	Tension in S_1 is 30 N	B1		
		Tension in S_2 is 50 N	B1	[2]	
	(ii)		M1		For applying Newton's second law to A or to B
		$3g - T - 1.6 = 3a$ (or $2g + T - 4 = 2a$)	A1		
		$2g + T - 4 = 2a$ (or $3g - T - 1.6 = 3a$) or $(3g + 2g) - (1.6 + 4) = (3 + 2)a$	B1		
		Acceleration is 8.88 ms^{-2}	B1		
		Tension is 1.76 N	A1	[5]	

SR (max. 1 / 2) for candidates who do not give numerical answers in (i).

Allow B1 for Tension in S_1 is 3g and Tension in S_2 is 5g

6	**(i)**	PE gain = 1250 × 10 x 400 × 0.125	B1		
		WD against resistance is 800 × 400 J	B1		
			M1		For using WD by car's engine = Gain in PE + WD against resistance
		WD by car's engine is 945 000 J (945 kJ)	A1	[4]	
	(ii)				For using P = Fv ➔ $\frac{v_2}{v_1} = \frac{P_2}{P_1} \times \frac{F_1}{F_2}$
		[v_2/6 = 5 × (1/3)]	M1		
		v_2 = 10	A1		
		KE gain = ½ 1250($10^2 - 6^2$)	B1ft		
		[WD by car's engine = 945 000 + 40 000]	M1		For using WD by car's engine = (Gain in PE + WD against resistance) + KE gain
		WD by car's engine is 985 000 J (985 kJ)	A1ft	[5]	ft incorrect ans**(i)**
		Alternative scheme for part (i)			
	(i)		M1		For using Newton's second law with a = 0
		DF = 1250g × 0.125 + 800	A1		
			M1		For using WD = DF × 400
		WD by car's engine is 945 00 J (945 kJ)	A1	[4]	

7	**(i)**	$[-0.12 = 0.15a]$	M1		For using Newton's 2nd law
		$a = -0.8$ ms^{-2}	A1		
		$[v = 3 - 0.8 \times 2]$	M1		For using $v = u + at$ to find speed of approach
		$v_{approach} = 1.4$	A1		
		$[\frac{1}{2}\ 0.15(1.4^2 - v_r^2)]$	M1		For using KE loss = $\frac{1}{2}$ m$(v_a^2 - v_r^2)$
		$v_{return} = -1$	A1		
			M1		For using $0 = v_{return} + a(t - 2)$
		$t = 3.25$ s when block comes to rest	A1		
					Alternative for the M1 A1 immediately above. $t_{YZ} = 1.25$ B1 $t = 3.25$s when block is at rest B1ft
		For correct sketch	B1ft	[9]	ft incorrect values of v and t (although v_{return} must be negative)
	(ii)	$[XY = \frac{1}{2}(3 + 1.4) \times 2,\ YZ = \frac{1}{2}\ 1.25 \times 1]$	M1		For using area property (or equivalent) to find distances XY and YZ
		s = 4.4 at Y and 3.775 at Z, stated or on graph	A1		(accept 3.77 or 3.78)
		Curve starts at origin, s increases, slope decreases (convex upwards) for $0 < t < 2$, value of s(2) shown	B1ft		ft incorrect value for s(2)
		Curve starts at (2, 4.4), s decreases, magnitude of slope decreases to zero at (3.25, 3.775)	B1ft	[4]	ft incorrect values of s and t