MARK SCHEME for the October/November 2006 question paper

9709 MATHEMATICS

9709/04   Paper 4, maximum raw mark 50

This mark scheme is published as an aid to teachers and students, 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.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

The grade thresholds for various grades are published in the report on the examination for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses.

CIE is publishing the mark schemes for the October/November 2006 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.

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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 $\sqrt{}$" 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)	[WD = 30x20cos10°]	M1		For using WD = Fd cos β
		Work done is 591J	A1	2	
	(ii)	[PE gain = 8x10x20sin15°]	M1		For using PE = mgh and
					$h = d\sin\alpha$
		PE gain is 414J	A1	2	
	(iii)	Work done is 177J	B1ft	1	ft (ans(i) – ans(ii))

2	(i)	[F + 5cos30° = 0.6g]	M1		For resolving forces vertically (3 terms needed)
		Frictional force is 1.67 N	A1	2	
	(ii)	R – 5sin30° [= 2.5]	B1		Can be scored in (i)
			M1		For using 1.67 = μ R
		Coefficient is 0.668	A1	3	

3		F = 420/5 [= 84]	B1		
			M1		For using Newton's second law in (i)
	(i)	Acceleration is 1.12ms⁻²	A1ft		From F = 75a
	(ii)	[420/5 – 750sin 1.5° = 75a or $a = 1.12 - g\sin1.5°$]	M1		For including weight component in N2 equation or for a(ii) = a(i) – wt. comp./m
		Acceleration is 0.858ms⁻²	A1ft	5	ft ans(i) – 0.262

4	(i)	a(t) = 1.25 – 0.1t	B1		May be scored in (ii)
		Initial acceleration is 1.25ms⁻²	B1	2	Must follow an attempt to differentiate
	(ii)	[t = 12]	M1		For attempting to solve dv/dt = 0.05
			M1		For attempting to integrate v(t)
		1.25t²/2 – 0.05t³/3 (+C)	A1		
		[1.25x12²/2 – 0.05x12³/3 = 90 – 28.8]	DM1		For using appropriate limits (0 to 12) or equivalent
		Displacement is 61.2m	A1	5	

5	(i)	Loss of PE = mgx2.45	B1		
		[½ mv² = 24.5m]	M1		For using KE gain = PE loss
		Greatest speed is 7ms⁻¹	A1	3	
	(ii)	KE = 0.5g(2.45 – 1.2) or KE – ½ 0.5x7² – 0.5gx1.2	B1ft		
		Kinetic energy is 6.25J	B1	2	
					SR(max 1 mark out of 2) For use of v² = 2x10(2.45 – 1.2) to obtain v = 5 and then KE = ½ 0.5x5² = 6.25 B1
	(iii)	[½ 0.5v² = 6.25]	M1		For using KE found in (ii)=½mv² or ½ m7² – 1.2mg = ½ mv²
		Least value is 5	A1	2	

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6	(i)		M1		For using
					$\lvert X\rvert = \sqrt{X_1^2 + X_2^2}$ for P or R
	P = 10		A1		From $P^2 = (-2.8)^2 + 9.6^2$
	R = 26.9		A1ft	3	From $R^2 = 10^2 + 25^2$ or
					$R^2 = 21.2^2 + 16.6^2$
	(ii)		M1		For using $\tan\alpha = 9.6/(\pm 2.8)$ or
					equivalent; may be scored in (i)
	$\alpha = 73.7$		A1		From c.w.o.; may be scored in (i)
	(a) 24N		A1ft		ft $25\cos(90 - \alpha)^\circ$ for $\alpha > 0$
	(b) 7N		A1ft	4	ft $25\sin(90 - \alpha)^\circ$ for $\alpha > 0$
	(iii)		M1		For using $\cos\theta = X/R$, $\sin\theta = Y/R$ or $\tan\theta = Y/X$, finding X or Y or X and Y as necessary
	$\cos\theta = (24 - 2.8)26.9\ldots$ or		A1ft		
	$\sin\theta = (7 + 9.6)/26.9\ldots$ or				
	$\tan\theta = (7 + 9.6)/(24 - 2.8)$				Alternative for the above 2 marks: For using
					$\theta = \tan^{-1}(Y/X) + \tan^{-1}(P/25)$ M1
					$\theta = \tan^{-1}(7/24) + \tan^{-1}(10/25)$
					A1ft
	$\theta = 38.1$		A1	3	

7	(i)	$R = mg\cos21° = 9.336m$	B1	
			M1	For using $0 = 10 + at$
		$a = -5$	A1	
		$[-mg\sin21° - F = -5m]$	M1	For using Newton's second law
				Alternative for the above 3 marks: For using WD by frictional force = KE at P − PE at highest point M1 $WD = ½ m10^2 - mgs \sin 21°$ A1 $s = 10$ (mark available in (ii) may be given here) For WD = Fs to find F DM1
		$F = 1.416m$	A1 5	
	(ii)	Coefficient is 0.152	B1 1	
	(iii)	$s = 10$	B1	From $s = (u + v)/2$ (upwards) or equivalent; may already have been scored for appropriate work in part (i)
			M1	For using Newton's second law
		$mg\sin21° - 1.416m = ma$ $[a = 2.167...]$	A1	
		$[v^2 = 2(g\sin21° - 1.416)10]$	M1	For using $v^2 = 2as$
				Alternative for the above 3 marks For using WD by frictional force (up and down) = 2Fs M1 $WD = 2(1.416m)10$ A1 For using KE at P(down) = KE at P(initial) − WD by frictional force (up and down) M1 $[½ mv^2 = ½ m10^2 - 28.32m]$ Second alternative for the above 3 marks WD by frictional force (down) = 1.416mx10 B1 PE loss (down) = mg(10sin21°) B1 For using KE at P(down) = PE loss − WD by frictional force (down) M1 $[½ mv^2 = mg(10\sin21°) -14.16m]$
		Speed is 6.58 ms^{-1}	A1 5	