UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced/Advanced Subsidiary Level

MARK SCHEME for the May/June 2006 question paper

9709 MATHEMATICS

9709/05 Paper 5

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 initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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 minimum marks in these components needed for various grades were previously published with these mark schemes, but are now instead included in the Report on the Examination for this session.

- CIE will not enter into discussion or correspondence in connection with these mark schemes.

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

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	(i)	$mg = 2T\cos\alpha$ $0.064 \times 10 = 2T \times (0.08/0.325)$ (or $2T\cos 75.7°$) Tension is 1.3 N	M1 A1 A1	3	For resolving forces vertically
	(ii)	$1.3 = \lambda\,(0.025/0.3)$ (or $\lambda\,(0.05/0.6)$) $\lambda = 15.6$	M1 A1ft	2	For using $T = \lambda x/l$.

2	(i)	Distance is 9.5 cm	B1	1	
	(ii)	$\tan 31° = r/9.5$ Radius is 5.71 cm	M1 A1	2	For using the idea that the centre of mass is vertically above the lowest point of the base
	(iii)	$F = mg\sin 31°$ and $R = mg\cos 31°$ or $\mu = \tan\alpha$ when on the point of slipping (may be implied) $\mu \geq 0.601$	B1 B1	2	From $F \leq \mu R$ or $\mu \geq \tan\alpha$

3	(i)	$T\cos 35° = mg$ $T\sin 35° = m(L\sin 35°)\times 2.2^2$ $L = 2.52$	B1 M1 A1 A1	4	For using Newton's second law and $a = r\omega^2$
	(ii)	$v = 2.2(2.52\sin 35°)$ Speed is 3.18 ms^{-1}	M1 A1 ft	2	For using $v = \omega r$

4	(i)	$-0.4g - 0.1v = 0.4dv/dt$ $dv/dt = -0.25(v + 40)$	M1 A1	2	For using $a = dv/dt$ and applying Newton's second law
	(ii)	$\ln(v + 40) = -0.25t$ $(+C)$ For obtaining $C = \ln 56$ or for correct substitution of correct limits $t = 1.35$	M1 A1 A1 M1 A1	5	For separating variables and integrating For finding t when $v = 0$

5	(i)	Correct weights and moment distances of components $15\bar{x} = 9\times0.3 + 6\times0.1$ or $15\bar{x} = 9\times0.1 + 6\times0.4$ or $15\bar{x} = 27\times0.3 - 12\times0.4$ Distance is 0.22 m	M1 B1 A1 ft A1 4	For using $W\bar{x}$ = Sum (or difference) of moments of components 9N, 0.3m 6N,0.4m 27N,0.3m  6N,0.1m 9N,0.1m 12N,0.4m
	(ii)	$15\times0.22 = 11\times0.6\sin\theta$ $\theta = 30$	M1 A1 A1 3	For taking moments about B

6	(i)(a)	$0.052\times10d(12/13)$ PE loss is $0.48d$	M1 A1 2	For using PE loss = $mgd\sin\alpha$
	(i)(b)	$0.8\times(d-2)^2/4$ EE gain is $0.2(d-2)^2$	M1 A1 2	For using EE gain = $\lambda x^2/2L$
	(i)(c)	$F = 0.4\times0.052\times10\times(5/13)$ WD = $0.08d$	M1 A1 2	For using $F = \mu mg\cos\alpha$
	(ii)	$0.48d = 0.2(d-2)^2 + 0.08d$ → $d^2 - 6d + 4 = 0$ $d = 5.24$ (or $d = 3+\sqrt{5}$)	M1 A1 B1 3	For using PE loss = EE gain + WD From correct simplification For obtaining and selecting relevant correct root

7	(i)	$19.2 = V^2 \times (3/5) \times (4/5)/10$ $V = 20$	M1 A1 A1 3	For using $\frac{1}{2} R = V^2 \sin\theta \cos\theta / g$ or $0 = V\sin\theta - gt$ and $19.2 = Vt\cos\theta$
	(ii)	$5t^2 - 12t + 4 = 0$ $t = 2$ $x = 20 \times 2 \times (4/5)$ Horizontal distance is 32 m	M1 A1 M1 A1 4	For substituting for V and θ and solving $Vt\sin\theta - \frac{1}{2} gt^2 = 4$ $t = 0.4$ must be discarded (which may be implied by subsequent use of $t = 2$ only) For substituting for V, θ and t into $x = Vt\cos\theta$
				Alternatively: For substituting for V and θ into $x\tan\theta - gx^2/(2V^2\cos^2\theta) = 4$ and simplifying M1 $x^2 - 38.4x + 204.8 = 0$ A1 For solving the resultant quadratic and selecting the larger root M1 Horizontal distance is 32 m A1
	(iii)	Immediately before impact $(\dot{x}, \dot{y}) = (20\times 0.8, 20\times 0.6 - 10\times 2)$ Immediately after impact $(\dot{x}, \dot{y}) = (-8, -8)$ At ground $-8t - \frac{1}{2} 10t^2 = -4$ $\rightarrow 5t^2 + 8t - 4 = 0$ $t = 4\times 2 \div (12 + 8)$ Distance is 3.2m	B1 ft B1ft M1 A1 4	For obtaining appropriate quadratic equation or using $4 \div t = (V\sin\theta + 8) \div 2$ or using the idea that t takes the discarded value in (ii) [if the M mark is scored in this way the $\dot{y}$ component is not required for either of the B marks]