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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6300
Specification A

MAM3 Mechanics 3

Mark Scheme

2005 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Key to Mark Scheme

M	mark is for	method
m	mark is dependent on one or more M marks and is for	method
A	mark is dependent on M or m marks and is for	accuracy
B	mark is independent of M or m marks and is for	accuracy
E	mark is for	explanation
√or ft or F		follow through from previous incorrect result
CAO		correct answer only
AWFW		anything which falls within
AWRT		anything which rounds to
AG		answer given
SC		special case
OE		or equivalent
A2,1		2 or 1 (or 0) accuracy marks
–*x* EE		deduct *x* marks for each error
NMS		no method shown
PI		possibly implied
SCA		substantially correct approach
c		candidate
sf		significant figure(s)
dp		decimal place(s)

Abbreviations used in Marking

MC – *x*	deducted *x* marks for mis-copy
MR – *x*	deducted *x* marks for mis-read
ISW	ignored subsequent working
BOD	given benefit of doubt
WR	work replaced by candidate
FB	formulae book

Application of Mark Scheme

No method shown:	
Correct answer without working	mark as in scheme
Incorrect answer without working	zero marks unless specified otherwise
More than one method / choice of solution:	
2 or more complete attempts, neither/none crossed out	mark both/all fully and award the mean mark rounded down
1 complete and 1 partial attempt, neither crossed out	award credit for the complete solution only
Crossed out work	do not mark unless it has not been replaced
Alternative solution using a correct or partially correct method	award method and accuracy marks as appropriate

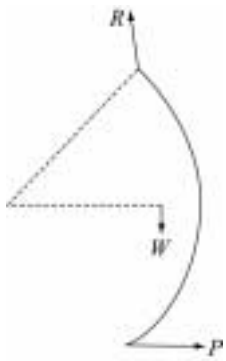
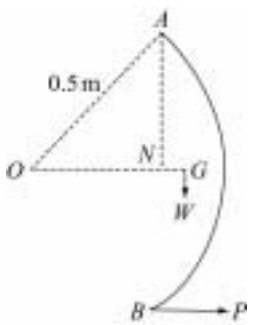
MAM3

Q	Solution	Marks	Total	Comments
1(a)	Momentum = Iω			
	$= 1.4 \times 3$	M1		
	$= 4.2$	A1	2	
(b)	$4.2 = I' \times 2.5$	M1		
	$I' = 1.68$ kg m²	A1	2	units not required
	Total		**4**	
2(a)		B2,1,0	2	–1 for each error T, R acceptable as components
(b)	Moments about A:			
	$T \times 0.8\sin\theta = 50g \times 1 + 40g \times 2$	M1A2		A2, 1, 0 (–1 each error)
	$T = \dfrac{130g}{0.8\sin\theta}$			
	$T < 2000$	M1		inequality used
	$\dfrac{130g}{0.8\sin\theta} < 2000$	M1		OE
	$\theta > 52.8^\circ$	A1F	6	ft one error in T dependent on **both** immediately preceding M1 marks
	Total		**8**	

MAM3 (cont)

Q	Solution	Marks	Totals	Comments
3(a)	$\begin{pmatrix} 2 \\ -8 \end{pmatrix} + \begin{pmatrix} a \\ b \end{pmatrix} + \begin{pmatrix} -3 \\ -4 \end{pmatrix} = \begin{pmatrix} 3 \\ -6 \end{pmatrix}$	M1		
	$\begin{pmatrix} a-1 \\ b-12 \end{pmatrix} = \begin{pmatrix} 3 \\ -6 \end{pmatrix}$			
	$\begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} 4 \\ 6 \end{pmatrix}$	A1 A1	3	
(b)(i)	Moments about O:	M1		may assume clockwise positive must be consistent
	$6\times3-4\times2-3\times2-4\times4=-12$	A1		at least 2 correct LHS terms
		A1		correct RHS
	magnitude = 12	A1	4	must state magnitude for this mark (even if taken "clockwise positive")
(ii)	Clockwise	A1	1	A0 if no M1 scored in (b)(i)
(c)	$-3d=-12$	M1		
	$d=4$	A1	2	
	Total		**10**	

MAM3 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)		B1	1	
(ii)		B1	1	*R* must pass through the intersection of lines of action of *P* and *W*
(b)				
	$NG = OG - ON$	M1		
	$= \dfrac{0.5\sin\frac{\pi}{3}}{\frac{\pi}{3}} - 0.5\cos\dfrac{\pi}{3}$	M1		
	$= 0.163\ \ (0.1634967)$	A1	3	AG
(c)	Moments about A:			
	$0.03gNG = 2\times 0.5\sin\dfrac{\pi}{3}\times P$	M1A1		
	$P = 0.0555\text{N}$	A1F	3	
	Total		**8**	

MAM3 (cont)

Q	Solution	Marks	Total	Comments
5(a)	M of I of elementary disc about diameter $= \frac{mr^2}{4}$			
	$= \frac{\pi r^4 \delta x}{4}$	B1		
	Parallel axes $I_O = I_G + mx^2$	M1		
	$= \frac{\pi r^4}{4}\delta x + \pi r^2 x^2 \delta x$	A1		
	$I = \int_0^l \frac{\pi r^4}{4} dx + \int_0^l \pi r^2 x^2 dx$	M1		integration of **both** parts
	$= \frac{\pi r^4 l}{4} + \frac{\pi r^2 l^3}{3}$	A1		
	But $M = \pi r^2 l$	m1		
	$\Rightarrow I = \frac{Mr^2}{4} + \frac{Ml^2}{3}$			
	$= M\left(\frac{r^2}{4} + \frac{l^2}{3}\right)$	A1	7	AG
(b)(i)	$I = M \times \left(\frac{a^2}{4} + \frac{(3a)^2}{3}\right) = \frac{13Ma^2}{4}$	B1	1	AG
(ii)	P.E lost. $= Mg.\frac{3a}{2}(1-\cos\theta)$	M1		for attempts at **both** energies
	K.E. gained $= \frac{1}{2} I\dot{\theta}^2$			
	$= \frac{1}{2}\ \frac{13Ma^2\dot{\theta}^2}{4}$	A1		for at least one energy correct
	$\frac{13Ma^2\dot{\theta}^2}{8} = \frac{3Mga}{2}(1-\cos\theta)$	M1		equating
	$\dot{\theta}^2 = \frac{12g}{13a}(1-\cos\theta)$	A1	4	
	Total		**12**	

MAM3 (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$T_1 - mg = mr\ddot{\theta}$	M1A1		M1 only if different tensions seen
	$2mg - T_2 = 2mr\ddot{\theta}$	A1	3	
(ii)	$T_2 r - T_1 r - G = I\ddot{\theta} = \frac{3mr^2}{2}\ddot{\theta}$	M1A2	3	–1 each error
(iii)	$\left(2mg - 2mr\ddot{\theta}\right)r - \left(mg + mr\ddot{\theta}\right)r - G = \frac{3mr^2}{2}\ddot{\theta}$	M1A2		substitution/valid attempt to solve –1 each error
	$mgr - G = \frac{3mr^2}{2}\ddot{\theta} + 3mr^2\ddot{\theta}$			
	$= \frac{9mr^2}{2}\ddot{\theta}$	A1		for significant progress
	$\ddot{\theta} = \frac{2(mgr - G)}{9mr^2}$	A1	5	AG
(b)(i)	Disc turns through α (constant acceleration) when cord detached			
	$\dot{\theta}^2 = 2 \times \frac{2(mgr - G)}{9mr^2}\alpha$	M1		
	$= \frac{4(mgr - G)}{9mr^2}\alpha$	A1	2	AG
(ii)	Cord detached			
	$G = -\frac{3mr^2}{2}\ddot{\theta}_2$	M1		full credit given for correct solution using method outside specification
	$\ddot{\theta}_2 = -\frac{2G}{3mr^2}$	A1		
	$0 = \frac{4(mgr - G)}{9mr^2}\alpha - 2 \times \frac{2G}{3mr^2}\beta$	M1A1		Use of "$v^2 = u^2 + 2as$"
	$\frac{4(mgr - G)}{3}\alpha = 4G\beta$			
	$G = \frac{mgr\alpha}{\alpha + 3\beta}$	A1	5	
	Total		**18**	
	TOTAL		**60**	