GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics A
(MAM3)

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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 ..... method and 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 booklet

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)	Mass of element ring $= 2\pi\rho x\delta x$	M1		
	M of I of element $= 2\pi\rho x.x^2\delta x$			
	$= 2\pi\rho x^3\delta x$	M1		
	$2\pi\rho\int_0^r x^3\mathrm{d}x = 2\pi\rho\left[\frac{x^4}{4}\right]_0^r$	M1		
	$= \frac{\pi\rho r^4}{2}$	A1		
	but $m = \pi\rho r^2$			
	$I = \frac{mr^2}{2}$	A1	5	
(b)	$I = \frac{1}{2}M\times 0.5^2$			
	$= \frac{M}{8}$	B1	1	
(c)(i)	P.E. lost $= 5\times 9.8\times 4$	B1	1	Units not required
	$= 196\mathrm{J}$			
(ii)	$\omega = \frac{v}{r} = \frac{8}{0.5} = 16$	B1	1	
(iii)	K.E. $= \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$			
	$= \frac{1}{2}\frac{M}{8}\times 16^2 + = \frac{1}{2}\times 5\times 8^2$	M1A1F		Both elements present for M1
	$= 16M + 160$	A1F		
	$\therefore\ 196 = 16M + 160$	M1		
	$M = 2.25\,\mathrm{kg}$	A1F	5	Ft from error in c(ii)
	Total		**13**	

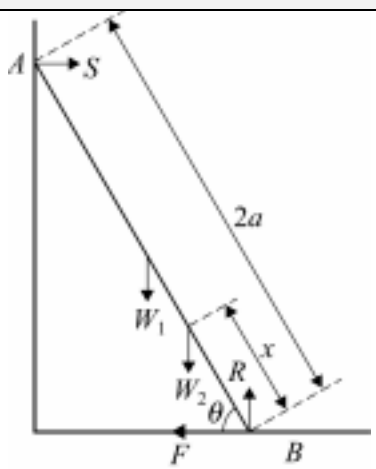
MAM3 (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	Distance $= 4 + \frac{1}{3} \times 6 = 6$	M1A1	2	
(ii)	Shape Mass Dist from AB Mass × Dist $ABEC'$ 24ρ 2 48ρ $C'ED$ 36ρ 6 216ρ $ABED$ 60ρ $\bar{X}$ $60\rho X$ $\therefore 60\rho\bar{X} = 264\rho$ $\bar{X} = 4.4$	M1 A1	 2	 no penalty if ρ omitted CAO; AG
(iii)	Shape Mass Dist from AD Mass×Dist $ABEC'$ 24ρ 3 72ρ $C'ED$ 36ρ 2 72ρ $ABED$ 60ρ $\bar{Y}$ $60\rho Y$ $\therefore 60\rho\bar{Y} = 144\rho$ $\bar{Y} = 2.4$	M1 A1	 2	
(b)	Moments about B: $K = 0.044 \times 2 = 0.088$	M1A1	2	M1A0 for 8.8
	Total		**8**	
3(a)	$X\mathbf{i} + Y\mathbf{j} = 4\mathbf{i} + 5\mathbf{j} + 2\mathbf{i} - \mathbf{j} - 3\mathbf{i} + 2\mathbf{j}$ $= 3\mathbf{i} + 6\mathbf{j}$	 A1	 1	
(b)(i)	Moments about O $= 5\times1 - 4\times2 + 2\times1 - 1\times3 + 3\times1 - 2\times2$ $= -5$ magnitude $= 5$	M1 A2,1,0 A1	 4	 –1 each error
(ii)	Clockwise	A1F	1	ft consistent with (b)(i)
(c)	$3d = 5$ $d = \frac{5}{3}(1.67)$	M1A1F A1F	 3	May assume clockwise + ve. Must be consistent ft on (b)
	Total		**9**	

MAM3 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$I_G = \frac{m}{3}\left(\left(\frac{a}{2}\right)^2 + a^2\right)$			
	$= \frac{5ma^2}{12}$	B1	1	
(ii)	$I_O = I_G + ma^2$	M1		Parallel axes
	$= \frac{5ma^2}{12} + ma^2$			
	$= \frac{17ma^2}{12}$	A1	2	
(b)(i)	P.E. lost $= mga\sin\theta$	B1		
	K.E. gained $= \frac{1}{2}I\dot{\theta}^2$			
	$= \frac{17ma^2}{24}\dot{\theta}^2$	B1		
	$\therefore \frac{17ma^2}{24}\dot{\theta}^2 = mga\sin\theta$	M1		
	$\dot{\theta}^2 = \frac{24g\sin\theta}{17a}$	A1	4	AG
(ii)	$2\dot{\theta}\ddot{\theta} = \frac{24}{17a}\cos\theta\dot{\theta}$	M1		Attempt to differentiate
	$\ddot{\theta} = \frac{12g}{17a}\cos\theta$	A1	2	
(c)(i)	$Y - mg\sin\theta = ma\dot{\theta}^2$	M1A1		
	$Y = mg\sin\theta + ma\frac{24g\sin\theta}{17a}$			
	$= \frac{41mg\sin\theta}{17}$	A1	3	
(ii)	$mg\cos\theta - X = ma\ddot{\theta}$	M1A1		
	$X = mg\cos\theta - ma\frac{12g\cos\theta}{17a}$			
	$= \frac{5mg\cos\theta}{17}$	A1	3	

MAM3 (cont)

Q	Solution	Marks	Total	Comments
4(d)	When total reaction is at 45° to GO $X = Y$ $\frac{5mg\cos\theta}{17} = \frac{41mg\sin\theta}{17}$ $\tan\theta = \frac{5}{41}$ $\theta = 7^\circ\left(6.953^\circ\right)$	M1 A1F	 2	 0.121 radians accepted. A1F awarded only if M1 awarded in both c(i) and c(ii)
	Total		**17**	
5(a)		A2,1,0	2	–1 each error. F and R may be combined as a single reaction force for full credit. -1 for vertical force shown at A unless explained that this equals zero
(b)	Moments about B $S.2a\sin\theta = W_1 a\cos\theta + W_2 x\cos\theta$ $S = \frac{1}{6}\left(W_1 + W_2\frac{x}{a}\right)$	M1A1 m1A1	 4	 (use of $\tan\theta = 3$)
(c)	$R = W_1 + W_2$ $F = S$ $F \le \mu R$ $\frac{1}{6}\left(W_1 + W_2\frac{x}{a}\right) \le (W_1 + W_2)$ $x \le \frac{a(4W_1 + 9W_2)}{5W_2}$	B1 B1 M1 A1	 4	 CAO; AG
(d)	For the ladder to remain in equilibrium with the man at the top $2a \le \frac{a(4W_1 + 9W_2)}{5W_2}$ $10W_2 \le 4W_1 + 9W_2$ $W_2 \le 4W_1$	 M1 A1 A1	 3	
	Total		**13**	
	Total		**60**	