GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics A
Unit 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

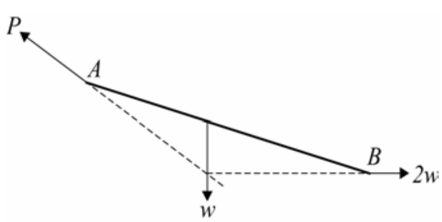
No method shown:

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)	$X = 2W$	B1		
	$Y = W$	B1	2	
(b)	Moments about A:			
	$Wa\sin\theta = 2W\,2a\cos\theta$	M1A1		
	$\theta = \tan^{-1}4$ ($\approx 76.0°$)	A1	3	
(c)	P must pass through the point of intersection of the lines of action of W and $2W$			
		B1		Lines of action of W, $2W$ clearly indicated.
		B1	2	Line of action of P clearly passing through the intersection of lines of action of W, $2W$.
	Total		**7**	
2(a)	2 revs per second $= 4\pi$ rad s^{-1}	A1		
	angular momentum $= 1.5 \times 4\pi$	M1		
	$= 6\pi$ (≈ 18.8 kg m^{2}s^{-1})	A1	3	Units not required
(b)	Angular momentum conserved:	M1		
	$6\pi = 8\omega$			
	$\omega = \dfrac{3\pi}{4}$ (≈ 2.36 rad s^{-1})	A1	2	
	Total		**5**	

MAM3 (Cont)

Q	Solution	Marks	Total	Comments
3(a)	$X = 4 + 3 + 3 + 2 = 12$			
	$Y = 3 + 4 + (-3) + 1 = 5$	B1		
		B1		
	$F = \sqrt{(12^2 + 5^2)}$	M1		Full credit if 5,12,13 seen
	$= 13$	A1	4	
(b)	Moments clockwise about O:			Or anticlockwise – must be consistent throughout
	$3 \times 2 + 3 \times 3 + 3 \times 4 - 1 \times 3 = 24$	M1A1		
	$-5d = 24$	M1		
	$d = -4.8$	A1	4	
(c)	L = 24 clockwise	A1FA1	2	ft on magnitude
	Total		**10**	
4(a)	$I = \frac{1}{2} \times 10m \times a^2$			
	$= 5ma^2$	A1	1	
(b)	(Taking tension in AB as T_1, in BC as T_2) accelerations of A and C are equal:			May be implied by later working for full credit
	$f_A = f_C = a\dot{\omega}$	B1		
	for B: $a(T_2 - T_1) = 5ma^2\dot{\omega}$	M1A1		
	for A: $T_1 = ma\dot{\omega}$	M1A1		M1 if <u>both</u> particles attempted
	for C: $2mg - T_2 = 2ma\dot{\omega}$	A1		
	$\therefore$ $2mg - 2ma\dot{\omega} - ma\dot{\omega} = 5ma\dot{\omega}$	M1		Clear attempt to eliminate T_1, T_2
	$2mg = 8ma\dot{\omega}$			
	$\dot{\omega} = \frac{g}{4a}$	A1	8	AG
	(Alternative solution considering energy changes) $2mgh = \frac{1}{2}mv^2 + \frac{1}{2}2mv^2 + \frac{1}{2}\mathrm{I}\dot{\theta}^2$	*(M1A2)*		– A1 each error
	but $v = a\dot{\theta}$, $h = a\theta$	*(B1)*		May be implied
	$\therefore$ $2mga\theta = \frac{3}{2}a^2\dot{\theta}^2 + \frac{5}{2}a^2\dot{\theta}^2$	*(M1)*		
	$g\theta = 2a\dot{\theta}^2$	*(A1)*		
	$\dot{\theta}^2 = \frac{g}{2a}\theta$	*(M1)*		May assume constant acceleration for full credit using:
	$2\dot{\theta}\ddot{\theta} = \frac{g}{2a}\dot{\theta}$			$\dot{\theta}^2 = \dot{\theta}_0^2 + 2\ddot{\theta}\theta$ $\dot{\theta}^2 = 2\ddot{\theta}\theta$ $g\theta = 2a.2\ddot{\theta}\theta$
	$\ddot{\theta} = \frac{g}{4a}$	*(A1)*	*(8)*	$\ddot{\theta} = \frac{g}{4a}$
	Total		**9**	

MAM3 (Cont)

Q	Solution	Marks	Total	Comments
5(a)	(Using tension in $AB = T_{AB}$, in $BC = T_{BC}$ and in $AC = T_{AC}$) Moments about A: $12 \times 2a\cos 60^\circ = Q \times \sqrt{3}\,a\cos 60^\circ$	M1A1		
	$Q = 8\sqrt{3}$	A1	3	
(b)(i)	Resolving along BA at B:	M1		Resolving in either direction
	$T_{AB} = Q\cos 30^\circ$ $= 8\sqrt{3} \times \dfrac{\sqrt{3}}{2}$	A1		
	$= 12$	A1		Alternative solution by resolving horizontally and vertically at B, then solving for T_{AB} T_{BC} full credit.
	Resolving along BC at B $T_{BC} = Q\sin 30^\circ$	A1		
	$= 8\sqrt{3} \times \dfrac{1}{2}$	A1		
	$= 4\sqrt{3}$	A1	6	
(ii)	T_{AB} is a tension	A1	1	Marks in b(ii), b(iii) only awarded if M1 awarded in b(i)
(iii)	T_{BC} is a tension	A1	1	
(c)	Resolving vertically at C: $12 = 4\sqrt{3} + T_{AC} \times \dfrac{\sqrt{3}}{2}$	M1		
	$T_{AC} = 4\sqrt{3}$	A1	2	Candidates may solve forces in a different order (e.g. T_{BC}, T_{AC}, T_{AB}, Q) and gain full credit.
	Total		**13**	

MAM3 (Cont)

Q	Solution	Marks	Total	Comments
6(a)	$I_G = \frac{1}{3}m(3a)^2 = 3ma^2$	M1		Parallel axes
	$I_B = 3ma^2 + ma^2$ $= 4ma^2$	A1	2	
(b)(i)	Rod turned through angle θ : P.E. lost = $mga\sin\theta$ K.E. gained = $\frac{1}{2}I\dot{\theta}^2$ $= 2ma^2\dot{\theta}^2$ hence, $2ma^2\dot{\theta}^2 = mga\sin\theta$	M1A1		
	$\dot{\theta}^2 = \frac{g\sin\theta}{2a}$ $\dot{\theta} = \sqrt{\frac{g\sin\theta}{2a}}$	A1	3	AG
(ii)	For the rod in motion: $I\ddot{\theta} = mga\cos\theta$	M1A1		Or by differentation of $\dot{\theta}^2$
	$4ma^2\ddot{\theta} = mga\cos\theta$ $\ddot{\theta} = \frac{g\cos\theta}{4a}$	A1	3	
(iii)	$mg\cos\theta - X = ma\ddot{\theta}$	M1A1		
	$X = mg\cos\theta - \frac{mag\cos\theta}{4a}$ $= \frac{3mg\cos\theta}{4}$	A1	3	
(c)	$Y - mg\sin\theta = ma\dot{\theta}^2$	M1		For M1 must be in context with attempted substitution
	$Y = mg\sin\theta + \frac{mag\sin\theta}{2a}$ $= \frac{3mg\sin\theta}{2}$	A1		
	At point of slipping $Y = \mu X$ $\frac{3mg\sin\theta}{2} = \mu\frac{3mg\cos\theta}{4}$	M1 A1		AG
	$\Rightarrow \quad \tan\theta = \frac{\mu}{2}$	A1	5	
	Total		**16**	
	Total		**60**	