ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme January 2004

GCE

Mathematics A

Unit MAM3

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 mark 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		Perhaps implied
c		Candidate

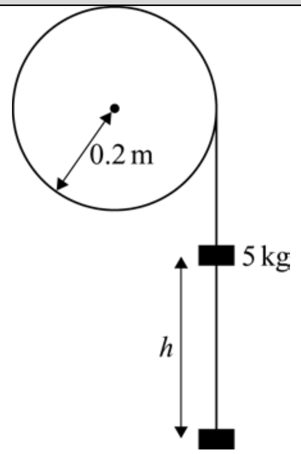
Abbreviations used in marking

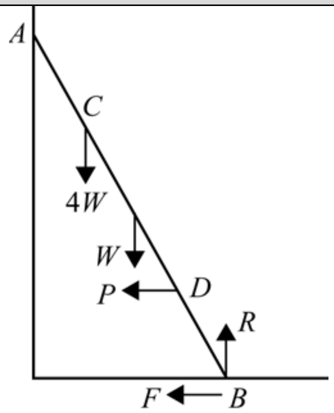
MC – x	deducted x marks for miscopy
MR – x	deducted x marks for misread
ISW	ignored subsequent working
BOD	gave benefit of doubt
WR	work replaced by candidate

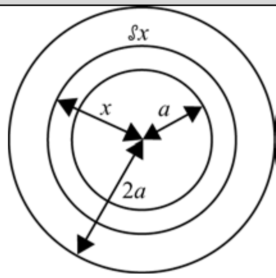
Application of mark scheme

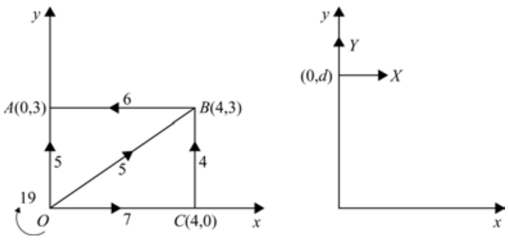
Correct answer without working	mark as in scheme
Incorrect answer without working	zero marks unless specified otherwise

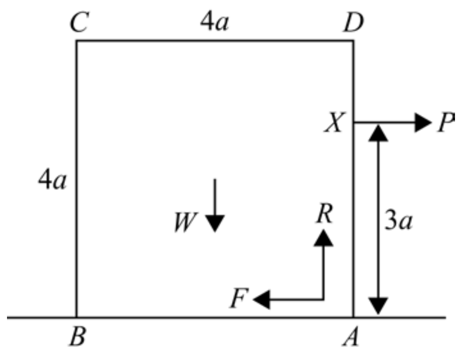
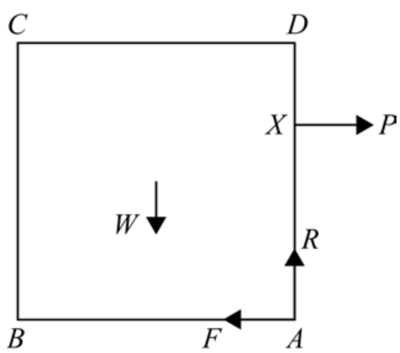
Award method and accuracy marks as appropriate to an alternative solution using a correct method or partially correct method.

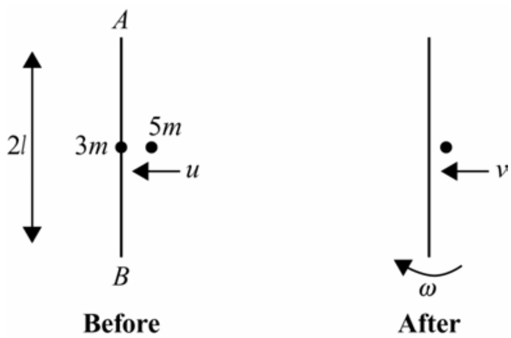
Q	Solution	Marks	Total	Comments
1				
(a)	$h = 2\pi r = 2\pi \times 0.2$ $\approx 1.26\,\text{m}$	M1 A1	2	Allow 0.4π
(b)	Change in PE of mass $= -mgh$ $= -5 \times g \times 0.4\pi$ $= -2\pi g$	M1 A1		For PE + KE of mass For either of PE/KE results
	Change in KE of mass $= \frac{1}{2} m v^2$ $= \frac{1}{2} \times 5 \times (a\omega)^2$ $= \frac{1}{2} \times 5 \times (0.2)^2\, \omega^2$ $= 0.1\omega^2$			
	Change in KE of wheel $= \frac{1}{2} I\omega^2$ $= \frac{1}{2} \times 10 \times \omega^2$ $= 5\omega^2$	A1		
	$\therefore\ 5\omega^2 + 0.1\omega^2 = 2\pi g$	M1AF		(1 error only)
	$\omega^2 = \dfrac{2\pi g}{5.1}$ => $\omega = 3.47\ \text{rad s}^{-1}$	A1F	6	
		Total	**8**	

Q	Solution	Marks	Total	Comments
2				
(a)	Resolving ↕ $R = 5W$	B1		
	Ladder in limiting equilibrium $F = \mu R$	M1		
	$= \frac{11}{40} \times 5W$			
	$= \frac{5W}{4}$	A1	3	AG
(b)	Moments about A (or other appropriate point)	M1		
	$4Wa\cos\theta + W \times 2a\cos\theta + P \times 3a\sin\theta + F \times 4a\sin\theta = R \times 4a\cos\theta$	A3,2,1		(-1 per error)
	$\Rightarrow 6W\cos\theta + 3P\sin\theta + \frac{5W}{4} \times 4\sin\theta = 5W \times 4\cos\theta$			
	$\Rightarrow 3P \times \frac{12}{13} + 5W \times \frac{12}{13} = 14W \times \frac{5}{13}$	A1		use of $\sin\theta = \frac{12}{13}$ etc
	$\Rightarrow 36P + 60W = 70W$			
	$\Rightarrow 36P = 10W$			
	$\Rightarrow P = \frac{5W}{18}$	A1F	6	
		Total	**9**	

Q	Solution	Marks	Total	Comments
3				
(a)	Mass of elementary ring $= 2\pi\rho x\delta x$	M1		
	M.I. of element$= 2\pi\rho x.x^2\delta x$	M1		
	$= 2\pi\rho x^2\delta x$			
	$\therefore 2\pi\rho\int_a^{2a} x^3 \mathrm{d}x = 2\pi\rho\left[\frac{x^4}{4}\right]_a^{2a}$	M1		
	$= \frac{2\pi\rho}{4}\left[16a^4 - a^4\right]$	A1		
	$= \frac{30\pi\rho a^4}{4}$			
	but $M = 3\pi\rho a^2$	M1A1		
	$\Rightarrow \quad \mathrm{I} = \frac{10Ma^2}{4} = \frac{5Ma^2}{2}$	A1	7	
(b)	$\perp$ axes $I_z = I_x + I_y$	M1		
	$\Rightarrow \frac{5Ma^2}{2} = 2I_D$	A1		
	$\Rightarrow I_D = \frac{5Ma^2}{4}$	A1	3	
		Total	**10**	

Q	Solution	Marks	Total	Comments
4				
(a)	$X = 7 - 6 + 5\cos\theta$	M1A1		Correct at this stage
	$= 1 + 5 \times \frac{4}{5}$			
	$= 5$			
	$Y = 4 + 5 + 5\sin\theta$	M1		
	$= 9 + 5 \times \frac{3}{5}$			
	$= 12$	A1		(both X and Y correct)
	$\therefore$ Resultant $= \sqrt{5^2 + 12^2}$			
	$= 13$	A1	5	CAO
(b)(i)	$Xd = -4 \times 4 - 6 \times 3 + 19$	M1A1		(for Xd)
	$5d = -15$	A1		1st 2 terms RHS
	$d = -3$	A1		(+ 19)
	$\therefore$ line cuts axis at $(0, -3)$	A1	5	CAO
				[candidate may use "anticlockwise + ve" convention for full marks]
(ii)	Gradient line of action $+ \frac{Y}{X} = \frac{12}{5}$	M1A1F		} ft from (a)
	$\therefore y = \frac{12}{5}x - 3$	A1F	3	
	(or any acceptable equivalent			
	e.g $5y = 12x - 15$ etc)			
	Total		**13**	

Q	Solution	Marks	Total	Comments
5				
(a)	Block sliding $\therefore P > F$	M1		
	$R = W$	B1		
	$F = \mu R$ hence $P > \mu W$	A1	3	
(b)(i)		A1	1	forces
(ii)	$P \times 3a \geq W \times 2a$	M1		
	$\Rightarrow P \geq \frac{2W}{3}$ allow = for A1	A1	2	
(c)	If $\mu = 0.6$, slides when $P > 0.6W$, if not toppled previously	B1		
	If $\mu = 0.667$, topples when $P > 0.667W$ if not started to slide	B1	3	
	$\therefore$ slides first	B1		
	Total		**9**	

Q	Solution	Marks	Total	Comments
6				
(a)	$\mathrm{I} = \frac{4}{3} \times 3m \times l^2$			
	$= 4ml^2$	A1	1	AG
(b)(i)	Collision elastic, so			
	$l\omega - v = -(0 - u)$	M1		
	$\Rightarrow l\omega = u + s$	A1	2	AG
(ii)	Angular momentum before:	M1		
	Rod $= 0$			(Angular momentum attempted)
	Particle $= 5m \times ul = 5mul$	A1		
	$\therefore$ Total $= 5mul$			
	after:			
	Rod $= I\omega = 4ml^2\omega$			
	Particle $= 5mvl$			
	$\therefore$ Total $= 4ml^2\omega + 5mvl$	A1		
	Momentum conserved			
	$\therefore 5mul = 4ml^2\omega + 5mvl$			
	$\Rightarrow 5u = 4l\omega + 5v$	A1		
	$\therefore 5u = 4(u+v) + 5v$			
	$5u = 4u + 9v$	M1		Solving equations
	$\Rightarrow v = \frac{u}{9}$	A1	6	CAO (AG)
(iii)	Particle moving in same direction initially	A1	1	
(c)	$l\omega = u + \frac{u}{9}$			
	$= \frac{10u}{9}$			
	$\Rightarrow \omega = \frac{10u}{9l}$	A1	1	
		Total	**11**	
		Total	**60**	