GCE 2004
June Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics A
Unit MAM2/W

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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

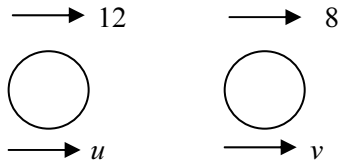
Crossed out work — do not mark unless it has not been replaced

Alternative solution using a correct or partially correct method — award method and accuracy marks as appropriate

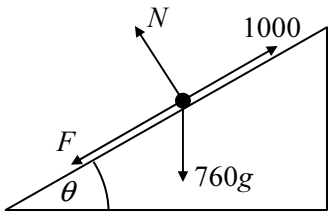
MAM2/W

Q	Solution	Marks	Total	Comments
1(a)	$\sum mx \quad \sum m\bar{x}$			
	$2\,(1) + m\,(7) = (2 + m)\,5$	M1 A1		mx correct for one term Fully correct equation
	$\therefore m = 4$	A1	3	$m = 4$ obtained correctly; AG
				Alternative: moments about $x = 5$
				(a) $2(4) = m\,(2)$ M1A1
				$m = 4$ A1 (3)
(b)	$\sum my \quad \sum m\bar{y}$	M1		my correct for one term (m need not be substituted)
	$2\,(8) + 4\,(11) = 6\ \bar{y}$	A1		Fully correct equation
	$\bar{y} = 10$	A1	3	$\bar{y}$ correctly obtained from their equation (allow one slip)
				Alternative : moments about $y = \bar{y}$
				(b) $2\left(\bar{y} - 8\right) = 4\left(11 - \bar{y}\right)$ M1A1
				$\bar{y} = 10$ A1 (3)
	Total		**6**	

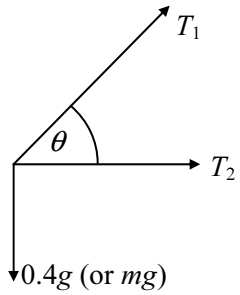
MAM2/W (Cont)

Q	Solution	Marks	Total	Comments
2				
	Cons of momentum,			
	$12\,(800) + 8\,(1000) = 800\,u + 1000\,v$	M1		Attempt at cons of mom – 2 terms correct
		A1		Fully correct – accept if 10 used
	$88 = 4u + 5v \quad -$ (1)			
	Restitution law,			
	$v - u = \frac{1}{8}(12 - 8)$	M1		Attempt at restitution equation
		A1		Fully correct – accept if 10 used
	$v - u = \frac{1}{2} \quad -$ (2)			
	4 × (2) + (1) gives $9v = 90$	M1		Solving a pair of simultaneous eqns
	$v = 10\ \text{ms}^{-1}$	A1		
	$\therefore \quad u = 9.5\ \text{ms}^{-1}$	B1	7	AG; $v = 10$ correctly obtained from pair of eqns
	Total		**7**	

MAM2/W(Cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	Change in KE = $\frac{1}{2}(760)(25^2 - 10^2)$	M1		PE or KE seen
	Change in PE = $760g(200)\left(\frac{1}{10}\right)$	A1		Correct sub for KE
		A1		Correct sub for PE
	Total change = 199 500 – 148 960 = 50 540	A1√	4	ft their values (Must include KE & PE)
(ii)	Work done = change in energy			
	$200F = 50540$	M1		Attempt at work done = change in energy
	$F = 252.7$	A1	2	Should really be seen to 1dp first.
	$\approx$ 253 N			AG
(b)(i)		B1	1	Four forces shown
(ii)	Max speed $\Rightarrow$ $a = 0$	B1		$mg\sin\theta$ seen anywhere
	$F + 760g\sin\theta - 1000 = 0$	M1 A1		Attempt at F = *ma* a=0
	$F = 1000 - 760(9.8)\left(\frac{1}{10}\right)$			
	= 255.2 N	A1	4	255 (…) obtained
	Total		**11**	

MAM2/W (Cont)

Q	Solution	Marks	Total	Comments
4(a)		B1	1	Three forces evident; T_1, T_2 clear – on diagram or in calculations
(b)	Vertically $T_1 \sin\theta = 0.4g$	M1 A1		Resolve vertically – component evident $T\sin\theta = mg$ seen
	$T_1\left(\frac{4}{5}\right) = 0.4g$			
	$T_1 = 0.5g = 4.9\text{N}$	A1	3	AG obtained
(c)	$T_2 = 0.1k$	B1	1	
(d)	$a = r\omega^2 = 0.3\times 5^2$	B1		Calculation of a seen
	Force $= T_2 + T_1\cos\theta$	M1		(Both terms of horizontal resultant force attempted)
	$= 0.1k + 4.9\times\frac{3}{5}$	A1		Previous expression /result substituted
	$F = ma$	m1		Their 'a' and 'F' (Dependent on first M1)
	$k = 0.6$	A1	5	AG
(e)	EPE $= \frac{kx^2}{2} = \frac{0.6\ (0.1)^2}{2}$	M1		$\frac{kx^2}{2}$ seen and attempt to use
	$= 0.003\,\text{J}$	A1	2	
	Total		**12**	

MAM2/W (Cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	$\mathbf{v} = \begin{pmatrix} 1+4\sin 2t \\ 4\cos 2t \end{pmatrix}$			
	$\mathbf{a} = \begin{pmatrix} 8\cos 2t \\ -8\sin 2t \end{pmatrix}$	M1 A1		Differentiation Both correct
	$\mathbf{F} = m\mathbf{a} \Rightarrow \mathbf{F} = \begin{pmatrix} 12\cos 2t \\ -12\sin 2t \end{pmatrix}$	B1√	3	Use of $\mathbf{F} = m\mathbf{a}$ Accept unsimplified
(ii)	$\lvert\mathbf{F}\rvert = \sqrt{12^2\cos^2 2t + 12^2\sin^2 2t} = 12$	M1		
	since $\cos^2 2t + \sin^2 2t \equiv 1$	A1	2	
(b)	$\mathbf{F}.\mathbf{v} = \begin{pmatrix} 12\cos 2t \\ -12\sin 2t \end{pmatrix} \bullet \begin{pmatrix} 1+4\sin 2t \\ 4\cos 2t \end{pmatrix}$	M1		**Alternative to part (b)** W.D = increase in KE $= \frac{1}{2}(1.5)(\mathbf{v}_2^2 - \mathbf{v}_1^2)$ M1A1 $\mathbf{v}_2^2 = 5^2$ A1 $\mathbf{v}_1^2 = 1^2 + 4^2$ M1A1
	$= 12\cos 2t + 48\cos 2t \sin 2t - 48\sin 2t \cos 2t$	A1√		W.D = 6 J c.a.o A1
	$= 12\cos 2t$	A1√		Their F
	Work done $= \int_0^{\frac{\pi}{4}} 12\cos 2t \, dt$	M1		
	$= [6\sin 2t]_0^{\frac{\pi}{4}}$	A1√		Correct integration from their expression
	$= 6$ (Joules)	A1	6	Correct answer only
	Total		**11**	

MAM2/W (Cont)

Q	Solution	Marks	Total	Comments
6(a)	Use of PE = KE	M1		
	$mg\,(5a) = \frac{1}{2}mv^2$			
	$v = \sqrt{10ga}$	A1	2	or $\sqrt{2g}\,\sqrt{5a}$
				Alternative for 6(a)
				Use of $v^2 = u^2 + 2as$ M1
				$v^2 = 0^2 + 2g\,(5a)$ A1
				$v = \sqrt{10ga}$
(b)(i)	Use of energy			
	$mg5a = \frac{1}{2}mv^2 + mg2d$	B1		KE or PE correct
		M1		Equation formed (two terms)
	$10ga = v^2 + 4gd$	A1		Fully correct equation
	$v^2 = 2g(5a - 2d)$	A1	4	AG
(ii)	At Q $\quad T + mg = \frac{mv^2}{d}$	M1		Attempt to use $\frac{mv^2}{r}$ (anything for F)
		A1		T + $mg = \frac{mv^2}{r}$ correct (r or d seen)
	Using **(b)(i)** $\quad T + mg = \frac{m2g}{d}(5a - 2d)$	A1√		Substitute expression for v^2
	$T = \frac{2mg}{d}(5a - 2d) - mg$	A1	4	(or $\frac{10mga}{d} - 5mg$ OE)
(iii)	For complete vertical circle $T > 0$ at Q			
	$\therefore \frac{10mga}{d} - 5mg > 0$	M1		Sets $T > 0$ or $T = 0$
	$d < 2a$	A1	2	AG correctly obtained (if $T = 0$, must be fully justified)
(c)	Ball is assumed to be a particle/No air resistance/No jolt at P etc	B1	1	Any valid reason
	Total		**13**	
	Total		**60**	