GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics A
(MAM2)

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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

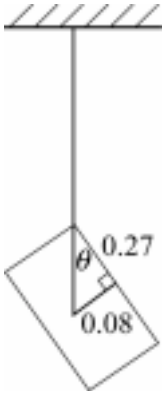
Crossed out work — do not mark unless it has not been replaced

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

MAM2

Q	Solution	Marks	Total	Comments
1(a)	$\text{KE} = \frac{1}{2}mv^2$			
	$v^2 = 3^2 + 4^2 = 25$	M1		Attempt to use $\frac{1}{2}mv^2$ or $\frac{1}{2}$ m **v.v** to evaluate v^2
	$\text{KE} = \frac{1}{2}(2)25$			
	$= 25(\text{J})$	A1	2	
(b)	Power = **F**.**v**			
	$= \begin{pmatrix} 6 \\ -1 \end{pmatrix} \cdot \begin{pmatrix} 3 \\ 4 \end{pmatrix}$	M1		Use of formula (18 or 4 seen)
	$= 14(\text{W})$	A1	2	
	Total		**4**	

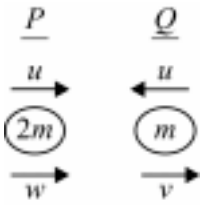
MAM2 (cont)

Q	Solution	Marks	Total	Comments
2(a)	$3(2M)+3(3M)=15M$	B1	1	
(b)(i)	From BC, $\sum Mx = \left(\sum M\right)\bar{x}$	M1		Attempt to use (one term correct)
	$2M(0.6) + 3M(0.15) + 3M(0.15) +$ $3M(0.45) + 2M(0.3) = 15M\bar{x}$	A1√ A1√		2 terms All correct
	$\bar{x} = 0.27$ metres	A1	4	AG, ft incorrect part (a)
(ii)	From CE $\sum My = \left(\sum M\right)\bar{y}$			
	$2M(0.1) + 2M(0.1) + 2M(0.1) + 3M(0.2)$ $= 15M\bar{y}$	M1A1√		M1 – one term correct
	$\bar{y} = 0.08$ metres	A1	3	
(c)				
	$\tan\theta = \frac{\bar{y}}{\bar{x}}$	M1		Application
	$= \frac{8}{27}$ or 0.0296	A1√		$\bar{x}$ and <u>their</u> $\bar{y}$
	$\theta \approx 16.5^\circ$	A1	3	CAO
	Total		**11**	

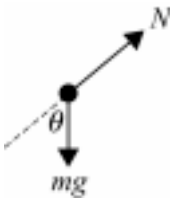
MAM2 (cont)

Q	Solution	Marks	Total	Comments
3(a)	KE = Initial PE			Alternative for (a):
	$\frac{1}{2}(50)v^2 = (50)g(20)$	M1		Use of $v^2 = u^2 + 2as$
	$\therefore v^2 = 40g$			$v^2 = 0^2 + 2g\,(20)$
	$v \approx 19.8 \text{ ms}^{-1}$	A1	2	$v = 19.8 \text{ ms}^{-1}$
				Alternative for (b)(i):
(b)(i)	EPE after stretching = PE at start	M1		EPE after stretching = PE + KE at natural length
	= 50g (32)			$= 50(g)\,(12) + \frac{1}{2}\,(50)\,(19.8..)^2$
	= 15 680 J	A1	2	AG $= 15680$ J
(ii)	$\frac{1}{2}k(32-20)^2 = 15\,680$	M1B1		B1 for $\frac{1}{2}\,k\,x^2$; M1 for equation
	$72k = 15\,680$			
	$k = 218$	A1	3	A1 CAO
	Total		**7**	

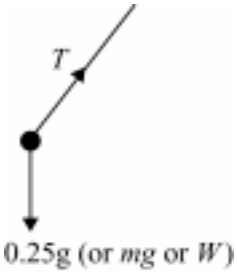
MAM2 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)				
	Conservation of momentum			
	$2mu - mu = mv + 2mw$	M1A1		M1 one momentum term correct
	$u = v + 2w$ **(1)**			
	Restitution			
	$v - w = 2ue$ (2)	M1A1		M1 $e\times$speed of approach seen
	$(1)-(2)$ gives $3w = u - 2ue$	M1		
	$w = \frac{u}{3}(1-2e)$	A1		
	$(1)+2(2)$ gives $u(1+4e) = 3v$			
	$v = \frac{u}{3}(1+4e)$	B1√	7	
(ii)	v always positive, so same direction			
	when $\frac{u}{3}(1-2e) > 0$	M1		For > 0 or solving = 0
	$\therefore 1-2e > 0$	A1	2	Must be convincing about <
	$e < \frac{1}{2}$			
(b)(i)	$I = mv - mu$	M1		Use of $mv - mu$
	$= m\frac{u}{3}(1+4e) + mu$	A1		Paired speeds correct
	$= 4\frac{mu}{3}(1+e)$	A1	3	Printed answer
(ii)	$0 \le e < \frac{1}{2}$	M1		Use of e values in I
	$\therefore \frac{4mu}{3}(1+0) \le I < \frac{4mu}{3}(1+\frac{1}{2})$			
	$\frac{4mu}{3} \le I < 2mu$	A1	2	Printed answer
	Total		**14**	

MAM2 (cont)

Q	Solution	Marks	Total	Comments
5(a)	KE at Q = Change in PE from P to Q	B1		Any one term considered
		M1		Attempt at eqn – KE and PE included
	$\frac{1}{2}mv^2 = mgr(\cos 30^\circ - \cos\theta)$	A1		Fully correct
	$v^2 = gr\left(\sqrt{3} - 2\cos\theta\right)$	A1	4	AG
(b)				$\frac{mv^2}{r}$ used
	$mg\cos\theta - N = \frac{mv^2}{r}$	M1A1B1		Res force = $\frac{mv^2}{r}$ for M1
	$mg\cos\theta - N = mg\left(\sqrt{3} - 2\cos\theta\right)$	M1		– use of v^2 from (a)
	$N = mg\left(3\cos\theta - \sqrt{3}\right)$	A1	5	Must rearrange for N = ….
(c)	When $\theta = \alpha$, $N = 0$			
	$\therefore 3\cos\alpha - \sqrt{3} = 0$	M1		N = 0 and solve
	$\cos\alpha = \frac{\sqrt{3}}{3}$			
	$\alpha = 55^\circ$	A1√	2	Follow through but $30^\circ < \alpha < 90^\circ$
	Total		**11**	

MAM2 (cont)

Q	Solution	Marks	Total	Comments
6(a)	Period $= \dfrac{2\pi}{\omega}$	M1		
	$\therefore 1.5 = \dfrac{2\pi}{\omega}$			
	$\omega = \dfrac{2\pi}{1.5} = \dfrac{4\pi}{3} = 1.3\pi$	A1	2	Any – must leave π
(b)(i)	Acceleration $= r\omega^2$			
	$= 0.6\left(\dfrac{4\pi}{3}\right)^2$	M1		Attempt to use formula
	$= 10.5$ or $\dfrac{16\pi^2}{15}$	A1√	2	Follow through their ω
(ii)		B1	1	could be on a single diagram
(c)(i)		B1	1	could be on a single diagram
(ii)	Vertically			
	(let $A\hat{B}O = \alpha$) $T\sin\alpha = mg\ (1)$	M1A1		Values may or may not be substituted in each equation throughout
	Horizontally			
	$T\cos\alpha = mr\omega^2 \qquad (2)$	M1A1√		ft $r\omega^2$ from b(i)
	$(1) \div (2) \qquad \tan\alpha = \dfrac{g}{r\omega^2}$	M1		Dividing to get $\tan\alpha$ or square and add to get T first
	$\alpha = \tan^{-1}\dfrac{9.8}{0.6\left(\dfrac{4\pi}{3}\right)^2}$ or $\tan^{-1}(0.9308)$			
	$\alpha = 43^\circ$	A1	6	Rounds to 43°
(d)	No air resistance			
	Modelled as a particle	E1	1	
	Total		**13**	
	Total		**60**	