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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6300
Specification A

MAM2/W Mechanics 2

Mark Scheme

2005 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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	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)

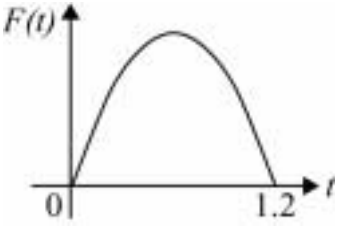
Abbreviations used in Marking

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 book

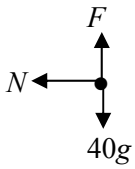
Application of Mark Scheme

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	areas | distance from N			
	small $\pi(1)^2$ | 2	M1		attempt to find area of one circle (evidence of πr^2)
	large $\pi(2)^2$ | 3			
	earring $\pi(2)^2-\pi(1)^2$ | $\bar{x}$			
	using $\sum(mx)=\left(\sum m\right)\bar{x}$	M1		$3\pi\bar{x}$ or (difference of their areas) $\bar{x}$
	$2(4\pi)-3(\pi)=3\pi\bar{x}$	M1		one other moment evident
	$5\pi=3\pi\bar{x}$	A1		fully correct
	$\bar{x}=\frac{5}{3}$ or $1\frac{2}{3}$ or 1.67cm	A1	5	
	Total		**5**	
2(a)	2ms^{-1} 1ms^{-1} 			
	impulse = $mv - mu$	M1		attempt to use $\lvert mv-mu\rvert$
	$=240(1)-240(-2)$	A1		correct signs
	$=720$ N s	A1√	3	must have units; ft applies to 240 N s only
(b)(i)	$t = 0, 1.2$	B1	1	
(ii)		B1		shape
		B1	2	symmetrical / axis / labels
(iii)	max when $t = 0.6$ (symmetry)	B1		t value found/stated
	$F(0.6)=500(0.6)(6-5\times0.6)$	M1		attempt to find F
	$=300\times3$			
	$=900$ N	A1	3	AG
(iv)	total area below curve = impulse magnitude	E1	1	
	Total		**10**	

MAM2/W (cont)

Q	Solution	Marks	Total	Comments
3(a)		B1	1	F towards centre scores B0
(b)(i)	$F = 40g$ or 392 N	B1	1	
(ii)	$F \le \mu N$			
	$392 \le \mu 784$	M1		use of $\le$ or =
	$\mu \ge \frac{784}{392} = 0.5$	A1	2	
(iii)	$N = mr\omega^2$	M1		$mr\omega^2$ seen or used
	$784 = 40(3)\omega^2$	A1		values substituted
	$\omega^2 = 6.5\dot{3}$			
	$\omega \approx 2.56$	A1	3	AG
(c)	Martin modelled as a particle	B1	1	any suitable assumption
	Total		**8**	

MAM2/W (cont)

Q	Solution	Marks	Total	Comments
4(a)	use KE at floor = PE on release:			
	$\frac{1}{2}mv^2 = mgh$	M1		energy or $v^2 = u^2 + 2as$
	$\therefore v = \sqrt{2gh}$	A1		
	after the floor has been hit:			
	speed $= e\sqrt{2gh}$	A1√	3	follow through their v
(b)	KE after collision $= \frac{1}{2}m\left(e\sqrt{2gh}\right)^2$			
	$= e^2mgh$	B1	1	AG
(c)(i)	use KE at floor = PE at peak:			
	$e^2mgh = mgh_1$	M1		energy or $v^2 = u^2 + 2as$
	$h_1 = e^2h$	A1	2	
(ii)	for h_2:			
	bounce height $= e^2 \times$ drop height	M1		use of either result (part (c)) or energy method – must appreciate $v = 0$ at highest point
	$h_2 = e^4h$	A1		
	$h_3 = e^6h$	A1√	3	use of generalised result: $e^2 \times$ their h_2
(iii)	total distance =	M1		at least one correct multiple of '2'
	$h + 2e^2h + 2e^4h + 2e^6h + \ldots$	M1		4 (or more) terms included
		A1	3	fully correct - any form
	Total		**12**	

MAM2/W (cont)

Q	Solution	Marks	Total	Comments
5(a)	$\mathbf{F} = m\mathbf{a}$			
	$= \begin{bmatrix} 2e^{2t} \\ 3e^{3t} \end{bmatrix}$	M1		use of $\mathbf{F} = m\mathbf{a}$
	When $t = \ln 3$, $\mathbf{F} = \begin{bmatrix} 2e^{2\ln 3} \\ 3e^{3\ln 3} \end{bmatrix}$			
	$= \begin{bmatrix} 18 \\ 81 \end{bmatrix}$ N	A1	2	
(b)	$\mathbf{v} = \int \mathbf{a}\, dt$			
	$= \begin{bmatrix} 2e^{2t} \\ 2e^{3t} \end{bmatrix} + \mathbf{c}$	M1 A1 A1		attempt at integration $2e^{2t}$ or $2e^{3t}$ seen fully correct
	$t = 0,\ \mathbf{v} = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \therefore \mathbf{c} = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$	M1		finding **c**
	$\mathbf{v} = \begin{bmatrix} 2e^{2t} - 1 \\ 2e^{3t} \end{bmatrix}$	A1	5	AG
(c)	When $t = \ln 3$, $\mathbf{v} = \begin{bmatrix} 2e^{2\ln 3} - 1 \\ 2e^{3\ln 3} \end{bmatrix}$	M1		their expression for **v** evaluated
	$= \begin{bmatrix} 17 \\ 54 \end{bmatrix}$	A1		
	power = $\mathbf{F} \bullet \mathbf{v}$			
	$= \begin{bmatrix} 18 \\ 81 \end{bmatrix} \bullet \begin{bmatrix} 17 \\ 54 \end{bmatrix}$	M1		
	$= 4680$ W	A1√	4	ft their **v**, **F**
	Alternative method:			
	Attempt at **F . v**	(M1)		
	$4e^{4t} - 2e^{2t} + 6e^{6t}$	(A1)		
	substitute $t = \ln 3$ into their expression	(M1)		
	their expression evaluated	(A1√)		
	Total		**11**	

MAM2/W (cont)

Q	Solution	Marks	Total	Comments
6(a)	use of mgh	M1		
	$60(9.8)(20-20\cos 60^\circ)$	B1		$20\cos 60^\circ$ seen
	$=5880\,\text{J}$	A1	3	
(b)(i)	energy at M = energy at P			
	$\frac{1}{2}mu^2+mgh=\frac{1}{2}mv^2$			
	$\frac{1}{2}(60)(6)^2+60(9.8)(20-20\cos\theta)$	M1		M1 one term correct
		A1		A1 two terms correct
	$=\frac{1}{2}(60)v^2$	A1		fully correct
	$18+196-196\cos\theta=\frac{1}{2}v^2$			
	$v^2=428-392\cos\theta$	A1	4	AG
(ii)	$mg\cos\theta-\text{N}=\frac{mv^2}{r}$	B1		$\frac{mv^2}{r}$ used or seen
		M1		attempt at Newton's law
	$60(9.8)\cos\theta-\text{N}=\frac{60}{20}(428-392\cos\theta)$	A1		substitute v^2
	$\text{N}=588\cos\theta-1284+1176\cos\theta$			
	or $1764\cos\theta-1284$	A1	4	can be unsimplified – must be $\text{N}=\ldots$
(iii)	$\text{N}>0$ from M to N			
	$1764\cos\theta-1284>0$	M1		solve equation or inequality
	$\therefore\cos\theta>\frac{1284}{1764}\approx 0.72789$			
	$\theta<43.2\ldots$	A1√		finding an angle $<90^\circ$
	loses contact since $43^\circ<60^\circ$	A1	3	correct interpretation
	Alternative method:			
	when $\theta=60^\circ$	(M1)		evaluate N at end of bridge
	$\text{N}=-402<0$	(A1√)		their N evaluated
	loses contact before end of bridge	(A1)		correct interpretation
	Total		**14**	
	TOTAL		**60**	