

## 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

<b>M</b>	mark is for	method
<b>m</b>	mark is dependent on one or more M marks and is for	method
<b>A</b>	mark is dependent on M or m marks and is for	accuracy
<b>B</b>	mark is independent of M or m marks and is for	accuracy
<b>E</b>	mark is for	explanation
<b>✓ or ft or F</b>		follow through from previous incorrect result
<b>CAO</b>		correct answer only
<b>AWFW</b>		anything which falls within
<b>AWRT</b>		anything which rounds to
<b>AG</b>		answer given
<b>SC</b>		special case
<b>OE</b>		or equivalent
<b>A2,1</b>		2 or 1 (or 0) accuracy marks
<b>-x EE</b>		deduct $x$ marks for each error
<b>NMS</b>		no method shown
<b>PI</b>		possibly implied
<b>SCA</b>		substantially correct approach
<b>c</b>		candidate
<b>sf</b>		significant figure(s)
<b>dp</b>		decimal place(s)


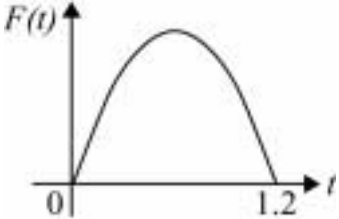
## Abbreviations used in Marking

<b>MC – <math>x</math></b>	deducted $x$ marks for mis-copy
<b>MR – <math>x</math></b>	deducted $x$ marks for mis-read
<b>ISW</b>	ignored subsequent working
<b>BOD</b>	given benefit of doubt
<b>WR</b>	work replaced by candidate
<b>FB</b>	formulae book

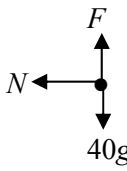
## Application of Mark Scheme

<b>No method shown:</b>	
Correct answer without working	mark as in scheme
Incorrect answer without working	zero marks unless specified otherwise
<b>More than one method / choice of solution:</b>	
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
<b>Crossed out work</b>	do not mark unless it has not been replaced
<b>Alternative solution</b> using a correct or partially correct method	award method and accuracy marks as appropriate

**MAM2/W**

Q	Solution	Marks	Total	Comments
<b>1</b>	areas	distance from $N$		
	small $\pi(1)^2$	2	M1	attempt to find area of one circle (evidence of $\pi r^2$ )
	large $\pi(2)^2$	3		
	earring $\pi(2)^2 - \pi(1)^2$	$\bar{x}$		
	using $\sum(mx) = (\sum m)\bar{x}$		M1	
$2(4\pi) - 3(\pi) = 3\pi\bar{x}$		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
<b>Total</b>			<b>5</b>	
<b>2(a)</b>	$2\text{ms}^{-1}$	$1\text{ms}^{-1}$		
				
	impulse = $mv - mu$		M1	attempt to use $ mv - mu $
	= $240(1) - 240(-2)$		A1	correct signs
	= 720 N s		A1✓	3 must have units; ft applies to 240 N s only
<b>(b)(i)</b>	$t = 0, 1.2$		B1	1
<b>(ii)</b>			B1 B1	2 shape symmetrical / axis / labels
<b>(iii)</b>	max when $t = 0.6$ (symmetry)		B1	$t$ value found/stated
	$F(0.6) = 500(0.6)(6 - 5 \times 0.6)$		M1	attempt to find $F$
	= $300 \times 3$			
	= 900 N		A1	3 AG
<b>(iv)</b>	total area below curve = impulse magnitude		E1	1
<b>Total</b>			<b>10</b>	

## MAM2/W (cont)

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

## MAM2/W (cont)

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

## MAM2/W (cont)

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

## MAM2/W (cont)

Q	Solution	Marks	Total	Comments	
6(a)	use of $mgh$	M1	3	20cos60° seen	
	$60(9.8)(20 - 20\cos 60^\circ)$	B1			
	$= 5880\text{J}$	A1			
(b)(i)	energy at $M =$ energy at $P$		4	AG	
	$\frac{1}{2}mu^2 + mgh = \frac{1}{2}mv^2$				
	$\frac{1}{2}(60)(6)^2 + 60(9.8)(20 - 20\cos\theta)$	M1			M1 one term correct
	$= \frac{1}{2}(60)v^2$	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			
(ii)	$mg\cos\theta - N = \frac{mv^2}{r}$	B1	4	$\frac{mv^2}{r}$ used or seen attempt at Newton's law substitute $v^2$	
	$60(9.8)\cos\theta - N = \frac{60}{20}(428 - 392\cos\theta)$	M1			
	$60(9.8)\cos\theta - N = \frac{60}{20}(428 - 392\cos\theta)$	A1			
	$N = 588\cos\theta - 1284 + 1176\cos\theta$ or $1764\cos\theta - 1284$	A1			can be unsimplified – must be $N = \dots$
(iii)	$N > 0$ from $M$ to $N$		3	solve equation or inequality finding an angle $< 90^\circ$ correct interpretation	
	$1764\cos\theta - 1284 > 0$	M1			
	$\therefore \cos\theta > \frac{1284}{1764} \approx 0.72789$				
	$\theta < 43.2 \dots$	A1✓			
	loses contact since $43^\circ < 60^\circ$	A1			
	<b>Alternative method:</b>				
when $\theta = 60^\circ$	(M1)	evaluate $N$ at end of bridge			
$N = -402 < 0$	(A1✓)	their $N$ evaluated			
loses contact before end of bridge	(A1)	correct interpretation			
	<b>Total</b>		<b>14</b>		
	<b>TOTAL</b>		<b>60</b>		