

**INTERNATIONAL A-LEVEL
MATHEMATICS**

MA05

(9660/MA05) Unit M2 Mechanics

Mark scheme

June 2025

Version: 0.1 Pre-Standardisation



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Key to mark scheme abbreviations

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	Follow through from previous incorrect result
CAO	Correct answer only
CSO	Correct solution only
AWFW	Anything which falls within
AWRT	Anything which rounds to
ACF	Any correct form
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
sf	Significant figure(s)
dp	Decimal place(s)
ISW	Ignore subsequent working

Q	Answer	Marks	Comments
1(a)	$a = \frac{2 \times 3 + 8 \times 9 + 6 \times 9 + 10 \times 3 + 7 \times 6}{2 + 8 + 6 + 10 + 7}$	M1	At least 4 correct terms in the numerator
	$a = \frac{68}{11}$	A1	ACF
		2	

Q	Answer	Marks	Comments
1(b)	$\bar{y} = \frac{2 \times 4 + 8 \times 4 + 6k + 10k + 7 \times 10}{2 + 8 + 6 + 10 + 7}$	M1	At least 4 correct terms in the numerator
	$\frac{110 + 16k}{33} = 14$		
	$110 + 16k = 462$	A1	CAO
	$k = 22$		
		2	

	Question 1 Total	4	
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Q	Answer	Marks	Comments
2(a)(i)	$ r = \sqrt{(30\cos(4t))^2 + (30\sin(4t))^2}$	M1	
	$ r = \sqrt{30^2\cos^2(4t) + 30^2\sin^2(4t)}$		
	$ r = \sqrt{30^2}$		
	$ r = 30$		
		A1	Must be convincingly shown
		2	

Q	Answer	Marks	Comments
2(a)(ii)	Circular path [with centre O and radius 30 metres]	E1	Any correct description
		1	

Q	Answer	Marks	Comments
2(b)	$ F = m\omega^2r$	M1	
	$ F = 7.5 \times (4)^2 \times 30$		
	$ F = 3600$ [N]		
	Direction: Towards O		
		A1	
		B1	oe
		3	

	Question 2 Total	6	
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Q	Answer	Marks	Comments
3(c)	[Maximum speed] increases A component of the weight will also act down the hill/slope in the direction of motion	B1 E1	Any valid reason
		2	
	Question 3 Total	8	

Q	Answer	Marks	Comments
4(a)	$\mathbf{r} = \begin{bmatrix} \ln(2+t) + c_1 \\ \frac{t}{4e^2} + c_2 \end{bmatrix}$	M1 A1	M1: At least one component correct A1: Both components correct Condone omission of constants of integration for M1 A1
	When $t = 0$ $\begin{bmatrix} \ln(2) + c_1 \\ 4 + c_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 7 \end{bmatrix}$		
	$\mathbf{r} = \begin{bmatrix} \ln(2+t) - \ln(2) \\ \frac{t}{4e^2} + 3 \end{bmatrix}$	M1 A1	M1: At least one component correct A1: Both components correct ACF For i component
		4	

Q	Answer	Marks	Comments
4(b)	$\mathbf{a} = \begin{bmatrix} -(2+t)^{-2} \\ \frac{t}{e^2} \end{bmatrix}$	M1 A1	M1: At least one component correct A1: Both components correct
	When $t = 2$		
	$\mathbf{a} = \begin{bmatrix} -(2+0.05)^{-2} \\ \frac{0.05}{e^2} \end{bmatrix}$		
	$ \mathbf{a} = \sqrt{\left(\frac{1}{2.05^2}\right)^2 + \left(\frac{0.05}{e^2}\right)^2}$		
	$ \mathbf{a} = 1.053 \text{ [ms}^{-2}\text{]}$	A1	PI
		5	

	Question 4 Total	9	
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Q	Answer	Marks	Comments
5(b)(iii)	Conservation of Energy $3727.49... - 1477.49...$ $= 2250 \text{ [J]}$	B1ft	ft Their GPE – their work done
		1	

	Question 5 Total	13	
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Q	Answer	Marks	Comments
6	$\bar{X} = \frac{m \times \left(-\frac{4 \times 3}{3\pi} \right) + 2m \times \left(\frac{4 \times 3}{3\pi} \right)}{m + 2m}$ $\bar{X} = \frac{4}{3\pi}$ $\tan \theta = \frac{\left(\frac{4}{3\pi} \right)}{3}$ $\theta = 8^\circ$	M1 A1 A1 M1 A1	M1: At least one numerator term correct PI A1: Fully correct PI Correct x -coordinate for COM of C ft Their x -coordinate for the COM Note: unrounded answer is $8.052...^\circ$

	Question 6 Total	5	
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Q	Answer	Marks	Comments
7(c)	$\tan \alpha = \frac{3}{4} \left[= \frac{1.2}{1.6} \right]$ $\sin \beta = \frac{4}{5} \left[= \frac{1.6}{2.0} \right] \quad \cos \beta = \frac{3}{5} \left[= \frac{1.2}{2.0} \right]$ <p>Equilibrium of forces in the vertical direction</p> $T_R \cos \alpha = mg + T_S \cos \beta$ <p>Resultant force towards O</p> $T_R \sin \alpha + T_S \sin \beta = \frac{mv^2}{r}$ $T_R = \frac{mg + T_S \cos \beta}{\cos \alpha}$ $\tan \alpha (mg + T_S \cos \beta) + T_S \sin \beta = \frac{mv^2}{r}$ $T_S = \frac{\frac{mv^2}{r} - mg \tan \alpha}{\tan \alpha \cos \beta + \sin \beta}$ $T_S = \frac{15 \times 7^2}{0.96} - 15 \times 9.8 \times \frac{3}{4} \div \left(\frac{3}{4} \times \frac{3}{5} + \frac{4}{5} \right)$ $T_S = 524$ $T_R = 577$	<p>B1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>A1</p>	<p>Three trigonometric relationships or correct values for α and β seen or used anywhere in the solution</p> <p>Attempts to solve equations simultaneously by eliminating T_R or T_S</p> <p>PI By at least one correct value for T_R or T_S</p> <p>At least one value for T_R or T_S correct, to 3 sf or more Note: unrounded value for T_S is 524.3...</p> <p>Both values of T_R and T_S correct to 3 sf Note: unrounded value for T_R is 576.975</p>
		6	

	Question 7 Total	12	
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Q	Answer	Marks	Comments
8(a)	<p>[Time taken for the ball to cover the 5 m or 5.25 m horizontal displacement]</p> $T = \frac{5}{8 \cos \theta}, T = \frac{5.25}{8 \cos \theta} \text{ or } T = \frac{d}{8 \cos \theta}$ $[s =] 8 \sin \theta T - 0.5 \times 9.8 \times T^2$ $[s =] 8 \sin \theta \times \frac{d}{8 \cos \theta} - 0.5 \times 9.8 \times \left(\frac{d}{8 \cos \theta} \right)^2$ $[s =] d \tan \theta - \frac{49d}{640 \cos^2 \theta}$ $[s =] d \tan \theta - \frac{49d}{640} \times (1 + \tan^2 \theta)$ $0.75 = d \tan \theta - \frac{49d^2}{640} - \frac{49d^2}{640} \tan^2 \theta$ $0.75 = d \tan \theta - \frac{49d^2}{640} - \frac{49d^2}{640} \tan^2 \theta$ <p>When $d = 5$ $\tan \theta = 1.8665... [, 0.7456...]$ $\theta = 61.82...$</p> <p>When $d = 5.25$ $\tan \theta = 1.6820... [, 0.8058...]$ $\theta = 59.26...$</p> $59.3 < \theta < 61.8$	<p>B1</p> <p>M1 A1</p> <p>m1</p> <p>m1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>A1ft</p> <p>10</p>	<p>Any subject</p> <p>M1: Use of $s = ut + \frac{1}{2}at^2$ with $u = 8 \sin \theta$ and $a = \pm 9.8$ PI A1: Fully correct</p> <p>Eliminating T PI</p> <p>Correct simplification with second term in $\cos^2 \theta$</p> <p>Use of $\sec^2 \theta = 1 + \tan^2 \theta$</p> <p>Use of $s = 0.75$</p> <p>PI At least one correct value for $\tan \theta$ for either $d = 5$ or $d = 5.25$</p> <p>At least one correct value of θ</p> <p>Both values of θ correct</p> <p>Range of values to 3 sf, ft their two values of θ</p>

Q	Answer	Marks	Comments
8(b)	61.8 [$^{\circ}$] This angle means the coin bounces on the front of the top of the platform, and therefore gives the best chance of the coin coming to rest on the platform	B1ft E1	Upper limit of range Any plausible reason
		2	
	Question 8 Total	12	

Q	Answer	Marks	Comments
9(a)	See artwork below	B1	Both forces correctly drawn and named. Do not condone 'gravity' in place of 'weight'
		1	

Q	Answer	Marks	Comments
9(b)(i)	Taking moments about B $14g \cos \theta \times 3 = R_{\text{peg}} \times 6$ $R_{\text{peg}} = 7g \cos \theta$	M1 A1	At least one side correct R_{peg} = reaction force on rod due to peg oe, such as $R_{\text{peg}} = 68.6 \cos \theta$
		2	

