



Mark Scheme (Results)

October 2021

Pearson Edexcel International A Level
In Mechanics M2 (WME02) Paper 01

Q	Solution	Mark	Guidance
1a	$F = \mu R = \frac{1}{5} mg \cos \alpha$	B1	Seen or implied
	Work done = force x distance	M1	Correct method for work done against friction
	$= \frac{1}{5} mg \times \frac{12}{13} \times d = \frac{12}{65} mgd$ *	A1*	Obtain given answer from correct working.
		(3)	
1b	Work-energy equation	M1	All terms required and dimensionally correct. Condone sign errors and sin/cos confusion
	$\frac{1}{2} mv^2 = mg \times d \times \frac{5}{13} - \frac{12}{65} mgd \left(= \frac{13}{65} mgd \right)$	A1 A1	Unsimplified equation with at most one error Correct unsimplified equation
	$v = \sqrt{\frac{2gd}{5}}$	A1	Or exact equivalent e.g. $\sqrt{\frac{26}{65} gd}$, $\frac{1}{5} \sqrt{10gd}$ Accept $0.63\sqrt{gd}$ or better
		(4)	
		[7]	
2	Equation of motion down the slope	M1	First equation (either direction). Condone sign errors and sin/cos confusion
	$F_1 + 450g \times \frac{1}{15} - R = 450 \times 0.5$ $\left(\frac{P}{12} + 30g - R = 225 \right) \left(\frac{P}{12} - R = -69 \right)$	A1 A1	Unsimplified equation with at most one error. Correct unsimplified equation in P or F_1
	Equation of motion up the slope	M1	Second equation. Condone sin/cos confusion. Signs consistent with first equation and change in direction of motion
	$F_2 - 450g \times \frac{1}{15} - R = 450 \times -0.5$ $\left(\frac{P}{6} - 30g - R = -225 \right) \left(\frac{P}{6} - R = 69 \right)$	A1	Correct unsimplified equation in P or F_2
	$F_1 = \frac{P}{12}$ or $F_2 = \frac{P}{6} \left(= \frac{2P}{12} \right)$	M1	Use of $P = Fv$ at least once
	Solve for P	DM1	Dependent on all previous M marks
	$\left(R = \frac{P}{8} \right) P = 1660$ or $P = 1700$	A1	3 sf or 2 sf (follows use of 9.8) Allow 1.66 kW but not 1.66
		(8)	
		[8]	

[illegible]

5a			
	Moments about B:	M1	Dimensionally correct Condone sin/cos confusion and errors in angles OR: Correct moments equation and resolution Resolving where required
	$T \times 2.5 \sin \alpha = 70 \times 1.25 \sin 2\alpha$ Or $T \times 2.5 \sin \alpha = 70 \times 2 \sin \alpha$ Or use similar triangles $T \times \frac{3}{2} = 70 \times \frac{6}{5}$	A1 A1	Unsimplified equation in α with at most one error Correct unsimplified equation in α
	$T = 70 \times \frac{4}{5} = 56(\text{N})$ *	A1*	Obtain given answer from correct exact working and no errors seen
		(4)	
5b	Resolve horizontally:	M1	First equation
	$H = T \sin \alpha (= 33.6(\text{N}))$	A1ft	Correct unsimplified equation
	Resolve vertically	M1	Second equation
	$V + T \cos \alpha = 70$ ($V = 25.2(\text{N})$)	A1ft	Correct unsimplified equation
	$V = \mu H$	M1	Use of $F = \mu R$ with their V, H
	$\mu = \frac{3}{4}$	A1	Correct only (no subst for g required)
		(6)	
5balt	Resolve parallel to the rod:	M1	
	$H \sin 2\alpha + 70 \cos 2\alpha = 56 \cos \alpha + V \cos 2\alpha$	A1ft	$(24H - 7V = 630)$
	Resolve perpendicular to the rod:	M1	
	$70 \sin 2\alpha = 56 \sin \alpha + V \sin 2\alpha + H \cos 2\alpha$	A1ft	$(24V + 7H = 840)$
	$V = \mu H$	M1	Use of $F = \mu R$ with their V, H
	$\mu = \frac{3}{4}$	A1	Correct only (no subst for g required)
		(6)	
		[10]	

6a			
	$5mv = 2m(v - (-x))$	M1	Use of $I = mv - mu$
	$x = \frac{3v}{2}$	A1	Seen or implied
	$5mv = 3m(v - (-y))$ or $2mx - 3my = 3mv - 2mv$	M1	Use of $I = mv - mu$ or use of CLM
	$y = \frac{2v}{3}$	A1	Seen or implied
	$2v = e\left(\frac{3v}{2} + \frac{2v}{3}\right)$	M1	Correct use of impact law (not necessarily with values in terms of v) Allow $v - v$ on LHS
	$e = \frac{12}{13}$	A1	0.92 or better
		(6)	
6b	Speed of B after collision with wall = vf	B1	Seen or implied
	$2 \times \frac{1}{2} \times 3m(y^2 - (vf)^2) = \frac{1}{2} \times 2m(x^2 - v^2)$	M1	Use KE to form an equation in f . Condone use of change in KE rather than loss Condone 2 on wrong side
	$3\left(\frac{4}{9} - f^2\right) = \left(\frac{9}{4} - 1\right)$	A1	Correct unsimplified equation for f
	$\left(f^2 = \frac{1}{36}\right) \quad f = \frac{1}{6}$	A1	cao NB: $\frac{\sqrt{31}}{6}$ comes from inconsistent subtraction.
		(4)	
		[10]	

7a	Use of $\frac{2a \times \frac{1}{2}}{3 \times \frac{\pi}{6}} \left(= \frac{2a}{\pi} \right)$	B1	Seen or implied
	Moments about EC :	M1	Dimensionally correct Condone use of a parallel axis
	$ad \times \frac{d}{2} = \frac{1}{6} \pi a^2 \times \frac{2a}{\pi} \times \sin \frac{\pi}{6}$	A1	Correct unsimplified equation
	$\Rightarrow \left(d^2 = \frac{a^2}{3} \right) \quad a = \sqrt{3}d *$	A1*	Obtain given answer from correct working
		(4)	
7b	Mass ratios $\frac{a^2}{\sqrt{3}} : \frac{\pi a^2}{6} : \frac{a^2}{\sqrt{3}} + \frac{\pi a^2}{6}$	B1	Or equivalent. Seen or implied
	Moments about BC	M1	Dimensionally correct Condone use of a parallel axis
	$\frac{1}{\sqrt{3}} \times \frac{a}{2} + \frac{\pi}{6} \times \frac{2a}{\pi} \times \frac{\sqrt{3}}{2} = \left(\frac{1}{\sqrt{3}} + \frac{\pi}{6} \right) y$	A1ft	Correct unsimplified. Follow their $\frac{2a}{\pi}$
	Distance from $BC = y = \frac{6a}{6 + \sqrt{3}\pi}$	A1	Or equivalent $\left(y = \frac{6d}{2\sqrt{3} + \pi} \right)$
	Use of trig to find a relevant angle	M1	
	$\tan \beta^c = \frac{6}{6 + \sqrt{3}\pi} \times \sqrt{3} \quad \left(\frac{\bar{y}}{d} \right)$	A1ft	Or equivalent correct unsimplified equation for the required angle
	$\beta = 0.737 \quad (0.74)$	A1	0.74 or better 42.2° implies correct method
		(7)	
		[11]	

8a	Conservation of energy	M1	Need all three terms and dimensionally correct. Condone sign errors.
	$\frac{1}{2}m \times 10^2 + mgh = \frac{1}{2}m \times 18^2$	A1	Correct unsimplified equation
	$h = 11.4 \quad (11)$	A1	3 sf or 2 sf only (not $\frac{80}{7}$)
		(3)	
8b	Vertical distance	M1	Complete method using <i>suvat</i> to find angle of projection
	$10 \sin \alpha \times 2.5 - \frac{1}{2}g \times 2.5^2 = -11.4$	A1ft	Follow their h
	$\alpha = 50.2^\circ$ or $10 \sin \alpha = v_v = 7.7678\dots$	A1	50° or better (50.1618...) Accept 50.3° from 11.4 Seen or implied Might see $\sin \alpha = \frac{43}{56}$ or $v_v = \frac{215}{28}$
	Horizontal distance = $10 \cos \alpha \times 2.5$ or $\sqrt{100 - v_v^2} \times 2.5$	M1	
	$= 16.0 \quad (16)(\text{m})$	A1	3 sf or 2 sf only
		(5)	
8c	Using energy: $\frac{1}{2}m \times 64 + mgs = \frac{1}{2}m \times 100$	M1	Complete method to find height above A
	$s = 1.8367\dots$	A1	1.8 or better
	Use of <i>suvat</i> to form equation in t	M1	
	$1.84 = 10 \sin 50.2^\circ \times t - 4.9t^2$	A1	Correct unsimplified equation
	Solve for t and find difference between roots	DM1	Complete method to find the required time Dependent on 2 previous M marks
	$T = 0.98$ or 0.978	A1	2 sf or 3 sf
		(6)	
8c alt	Use of Pythagoras	M1	Complete method to find vertical component of speed
	Vertical speed $\sqrt{64 - (10 \cos \alpha)^2} = 4.8\dots$	A1	Awrt 4.8 or better
	Use of $10 \sin \alpha - gt = \pm v$ to find t	M1	
	$\begin{cases} 10 \sin 50.2^\circ - gt_1 = 4.8 \\ 10 \sin 50.2^\circ - gt_2 = -4.8 \end{cases}$	A1	Correct unsimplified equations Could also find time to top
	$T = t_2 - t_1 = 1.27\dots - 0.29\dots$	DM1	Complete method to find the required time Dependent on 2 previous M marks
	$= 0.98$ or 0.978	A1	Final answer. 2 sf or 3 sf
		(6)	
8calt	Use of Pythagoras to form quadratic in t	M1	
	$(10 \sin \theta - gt)^2 + (10 \cos \theta)^2 = 64$	A1	

	Simplify and substitute for trig	M1	
	$36 + 9.8^2 t^2 - 150.5t = 0$	A1	
	$T = t_2 - t_1 = 1.27.. - 0.29..$	DM1	Complete method to find the required time Dependent on 2 previous M marks
	$= 0.98 \text{ or } 0.978$	A1	Final answer. 2 sf or 3 sf
		[14]	