

Mark Scheme (Results) Summer 2010

GCE

GCE Mechanics M3 (6679/01)



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Summer 2010 Mechanics M3 6679 Mark Scheme

Question Number	Scheme	Marks	
Q1	$ \begin{array}{c c} A & & \\ \hline & 13l \\ \hline & T \\ \hline & 5l \\ \hline & mg $		
(a)	$\cos \alpha = \frac{12}{13}$ $R(\uparrow) T \cos \alpha = mg$ $T \times \frac{12}{13} = mg$ $T = \frac{13}{12} mg \text{oe}$	B1 M1	(3)
(b)	Eqn of motion $T \sin \alpha = m \frac{v^2}{5l}$ $\frac{13mg}{12} \times \frac{5}{13} = m \frac{v^2}{5l}$ $v^2 = \frac{25gl}{12}$	M1 A1 M1 dep	
	$v = \frac{5}{2} \sqrt{\frac{gl}{3}}$ $\left(\text{accept } 5\sqrt{\frac{gl}{12}} \text{ or } \sqrt{\frac{25gl}{12}} \text{ or any other equiv} \right)$	A1	(4)
			[7]



Que: Num	stion nber	Scheme	Marks
Q2	(a)	$F = \left(-\right) \frac{k}{x^2}$	M1
		$mg = \left(-\right)\frac{k}{R^2}$	M1
		$F = \frac{mgR^2}{x^2} *$	A1 (3)
	(b)	$m\ddot{x} = -\frac{mgR^2}{x^2}$	M1
		$v\frac{\mathrm{d}v}{\mathrm{d}x} = -\frac{gR^2}{x^2}$	M1
		$\frac{1}{2}v^2 = \int \left(-\frac{gR^2}{x^2}\right) dx$	M1 dep on 1st M mark
		$\frac{1}{2}v^2 = \frac{gR^2}{x} (+c)$	A1
		$x = R, v = 3U \qquad \frac{9U^2}{2} = gR + c$	M1 dep on 3rd M mark
		$\frac{1}{2}v^2 = \frac{gR^2}{x} + \frac{9U^2}{2} - gR$	
		$x = 2R$, $v = U$ $\frac{1}{2}U^2 = \frac{gR^2}{2R} + \frac{9U^2}{2} - gR$	M1 dep on 3rd M mark
		$U^2 = \frac{gR}{8}$	
		$U = \sqrt{\frac{gR}{8}}$	A1 (7)
			[10]



Question Number	Scheme	Marks
Q3	R mg	
	EPE lost $ = \frac{\lambda \times 0.6^2}{2 \times 0.9} - \frac{\lambda \times 0.1^2}{2 \times 0.9} \left(= \frac{7}{36} \lambda \right) $ $R\left(\uparrow\right) R = mg \cos \theta $ $= 0.5g \times \frac{4}{5} = 0.4g$	M1 A1
	$F = \mu R = 0.15 \times 0.4g$ P.E. gained = E.P.E. lost – work done against friction	M1 A1
	$0.5g \times 0.7 \sin \theta = \frac{\lambda \times 0.6^2}{2 \times 0.9} - \frac{\lambda \times 0.1^2}{2 \times 0.9} - 0.15 \times 0.4g \times 0.7$ $0.1944\lambda = 0.5 \times 9.8 \times 0.7 \times \frac{3}{5} + 0.15 \times 0.4 \times 9.8 \times 0.7$	M1 A1 A1
	$\lambda = 12.70$ $\lambda = 13 \text{ N}$ or 12.7	A1 [9]



Ques Num	tion ber			,	Scheme				Mar	·ks
Q4	(a)		cone	container	cylinder					
		mass ratio	$\frac{4\pi l^3}{3}$	$\frac{68\pi l^3}{3}$	$24\pi l^3$				M1 A1	
			4	68	72					
		dist from O	_	\overline{x}	31				B1	
		Moments:	41	$+68\overline{x} = 72 \times$					M1 A1ft	:
				$\overline{x} = \frac{212t}{68}$	$\frac{l}{l} = \frac{53}{17}l \text{acc}$	ccep	t 3.12 <i>l</i>		A1	(6)
(b)		θ								
			GX = 6l -						M1	
				$\tan \theta = \frac{2l}{6l - \bar{x}}$ $= \frac{2 \times 17}{3}$					M1 A1	
				49	5 = 34.8	or 3	35		A1	(4) [10]



Question Number	Scheme	Marks	;
Q5	C V C		
(a)	Energy: $mga \sin \theta = \frac{1}{2}m \times 5ag - \frac{1}{2}mv^2$ $v^2 = 5ag - 2ag \sin \theta$	M1 A1	(3)
(b)	Eqn of motion along radius: $T + mg \sin \theta = \frac{mv^2}{a}$ $T = \frac{m}{a} (5ag - 2ag \sin \theta) - mg \sin \theta$ $T = mg (5 - 3\sin \theta)$	M1 A1 M1 A1	(4)
(c)	At C , $\theta = 90^{\circ}$ $T = mg(5-3) = 2mg$ $T > 0 \therefore P \text{ reaches } C$	M1 A1 A1	(3)
(d)	Max speed at lowest point $(\theta = 270^{\circ}; v^{2} = 5ag - 2ag \sin 270)$ $v^{2} = 5ag + 2ag$ $v = \sqrt{7ag}$	M1 A1	(2) [12]



	stion nber	Scheme	Marks
Q6	(a)	$\frac{\mathrm{d}^2 x}{\mathrm{d}t^2} = -\frac{3}{(t+1)^2}$ $\frac{\mathrm{d}x}{\mathrm{d}t} = \int -3(t+1)^{-2} \mathrm{d}t$ $= 3(t+1)^{-1}(+c)$	M1 M1 A1
		$t = 0, \ v = 2 2 = 3 + c c = -1$ $\frac{dx}{dt} = \frac{3}{t+1} - 1$	M1 A1 (5)
	(b)	$x = \int \left(\frac{3}{t+1} - 1\right) dt$ $= 3\ln(t+1) - t (+c')$	M1 A1
		$t = 0, x = 0$ $\Rightarrow c' = 0$ $x = 3\ln(t+1) - t$	B1
		$v = 0 \Rightarrow \frac{3}{t+1} = 1$ $t = 2$	M1 A1
		$x = 3 \ln 3 - 2$ = 1.295 = 1.30 m (Allow 1.3)	M1 A1 (7) [12]



Question Number	Scheme	Marks
Q7	$ \begin{array}{c c} A \\ \hline O \\ \hline O \\ \hline \end{array} $	
(a)	$R(\uparrow) T = 2mg$ $R(\uparrow) T = 2mg$ Hooke's law: $T = \frac{6mge}{3a}$ $2mg = \frac{6mge}{3a}$ $e = a$ $AO = 4a$	B1 M! A1 (3)
(b)	H.L. $T = \frac{6mg(a-x)}{3a} = \frac{2mg(a-x)}{a}$ Eqn. of motion $-2mg + T = 2m\ddot{x}$ $-2mg + \frac{2mg(a-x)}{a} = 2m\ddot{x}$ $-\frac{2mgx}{a} = 2m\ddot{x}$ $\ddot{x} = -\frac{g}{a}x$ period $2\pi\sqrt{\frac{a}{g}}$	B1ft M1 M1 A1 (5)



Question Number	Scheme	Marks	
(c)	$v^2 = \omega^2 \left(a^2 - x^2 \right)$		
	$v_{\text{max}}^2 = \frac{g}{a} \left(\left(\frac{a}{4} \right)^2 - 0 \right)$	M1 A1	
	$v_{\max} = \frac{1}{4} \sqrt{(ga)}$	A1 ((3)
(d)	$x = -\frac{a}{8} \qquad v^2 = \frac{g}{a} \left(\frac{a^2}{16} - \frac{a^2}{64} \right)$	M1	
	$= \frac{3ag}{64}$ $v^2 = u^2 + 2as$	M1	
	$0 = \frac{3ag}{64} - 2gh$ $h = \frac{3a}{128}$	A1	
	Total height above $O = \frac{a}{8} + \frac{3a}{128} = \frac{19a}{128}$		(4) 5]

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