Mark Scheme (Results)

Summer 2010

GCE

GCE Mechanics M3 (6679/01)

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Mechanics M3 6679
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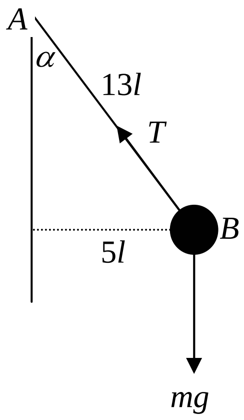
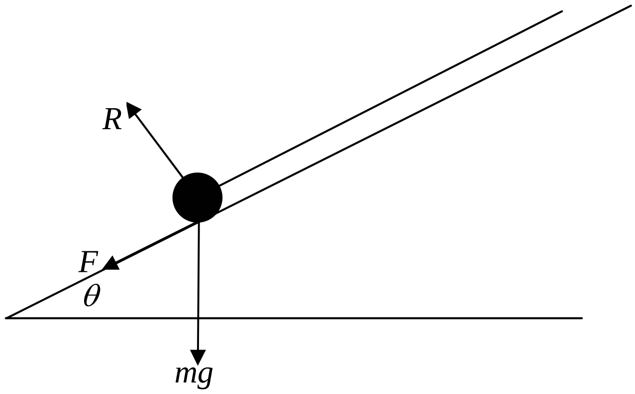
Question Number	Scheme	Marks	
Q1			
(a)	$\cos\alpha = \frac{12}{13}$	B1	
	$R(\uparrow)\quad T\cos\alpha = mg$	M1	
	$T \times \frac{12}{13} = mg$		
	$T = \frac{13}{12}mg \quad$ oe	A1	(3)
(b)	Eqn of motion $\quad T\sin\alpha = m\frac{v^2}{5l}$	M1 A1	
	$\frac{13mg}{12} \times \frac{5}{13} = m\frac{v^2}{5l}$	M1 dep	
	$v^2 = \frac{25gl}{12}$		
	$v = \frac{5}{2}\sqrt{\frac{gl}{3}} \qquad \left(\text{accept } 5\sqrt{\frac{gl}{12}} \text{ or } \sqrt{\frac{25gl}{12}} \text{ or any other equiv}\right)$	A1	(4)
			[7]

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

Question Number	Scheme	Marks
Q3		
	EPE lost $=\dfrac{\lambda\times0.6^2}{2\times0.9}-\dfrac{\lambda\times0.1^2}{2\times0.9}\left(=\dfrac{7}{36}\lambda\right)$	M1 A1
	$\text{R}(\uparrow)\quad R=mg\cos\theta$	M1
	$=0.5g\times\dfrac{4}{5}=0.4g$	
	$F=\mu R=0.15\times0.4g$	M1 A1
	P.E. gained = E.P.E. lost − work done against friction	
	$0.5\text{g}\times0.7\sin\theta=\dfrac{\lambda\times0.6^2}{2\times0.9}-\dfrac{\lambda\times0.1^2}{2\times0.9}-0.15\times0.4g\times0.7$	M1 A1 A1
	$0.1944\lambda=0.5\times9.8\times0.7\times\dfrac{3}{5}+0.15\times0.4\times9.8\times0.7$	
	$\lambda=12.70......$	
	$\lambda=13\text{ N}\quad$ or 12.7	A1
		[9]

Question Number	Scheme	Marks
Q4 (a)		

	cone	container	cylinder
mass ratio	$\frac{4\pi l^3}{3}$	$\frac{68\pi l^3}{3}$	$24\pi l^3$
	4	68	72
dist from O	l	$\bar{x}$	$3l$

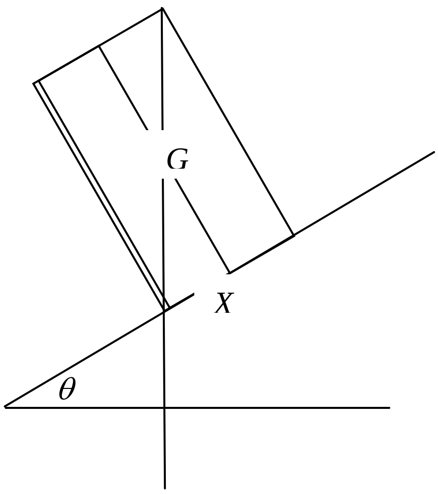
M1 A1

B1

Moments: $4l + 68\bar{x} = 72 \times 3l$ — M1 A1ft

$$\bar{x} = \frac{212l}{68} = \frac{53}{17}l \quad \text{accept } 3.12l$$ A1 (6)

(b)



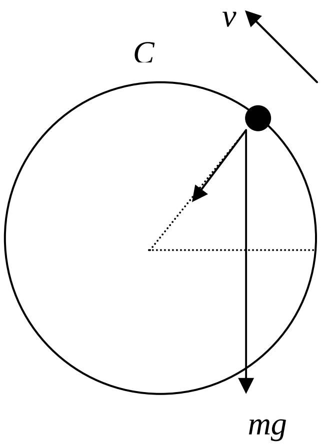
$GX = 6l - \bar{x}$ seen — M1

$$\tan\theta = \frac{2l}{6l - \bar{x}}$$ M1 A1

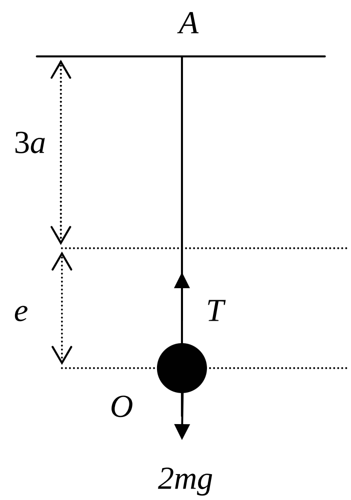
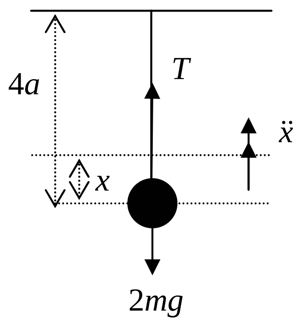
$$= \frac{2 \times 17}{49}$$

$$\theta = 34.75... = 34.8 \quad \text{or} \quad 35$$ A1 (4)

[10]

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

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

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

Question Number	Scheme	Marks
(c)	$v^2 = \omega^2\left(a^2 - x^2\right)$	
	$v_{\max}{}^2 = \frac{g}{a}\left(\left(\frac{a}{4}\right)^2 - 0\right)$	M1 A1
	$v_{\max} = \frac{1}{4}\sqrt{(ga)}$	A1 (3)
(d)	$x = -\frac{a}{8}$ $\quad v^2 = \frac{g}{a}\left(\frac{a^2}{16} - \frac{a^2}{64}\right)$	M1
	$= \frac{3ag}{64}$	
	$v^2 = u^2 + 2as$	M1
	$0 = \frac{3ag}{64} - 2gh$	A1
	$h = \frac{3a}{128}$	
	Total height above $O = \frac{a}{8} + \frac{3a}{128} = \frac{19a}{128}$	A1 (4)
		[15]

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