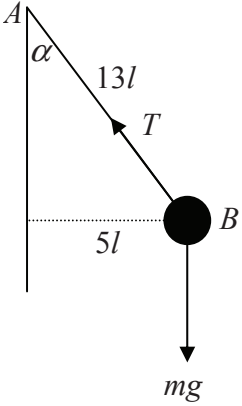


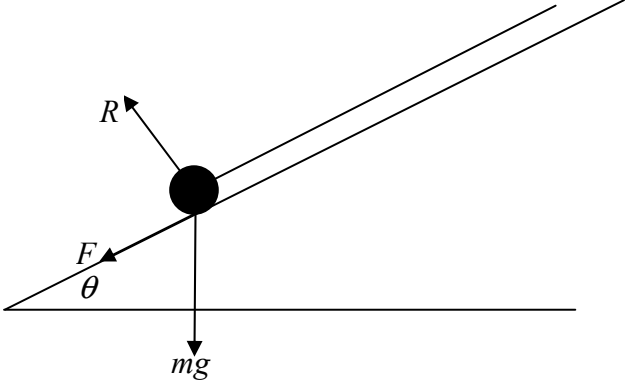
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Question Number	Scheme	Marks
<p>Q1</p> <p>(a)</p>	 <p> $\cos \alpha = \frac{12}{13}$ $R(\uparrow) \quad T \cos \alpha = mg$ $T \times \frac{12}{13} = mg$ $T = \frac{13}{12} mg \quad \text{oe}$ </p>	<p>B1</p> <p>M1</p> <p>A1 (3)</p>
<p>(b)</p>	<p>Eqn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

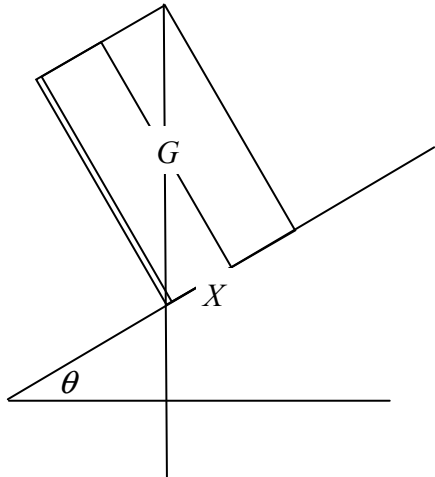
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Question Number	Scheme	Marks
Q2 (a)	$F = (-)\frac{k}{x^2}$ $mg = (-)\frac{k}{R^2}$ $F = \frac{mgR^2}{x^2} *$	M1 M1 A1 (3)
(b)	$m\ddot{x} = -\frac{mgR^2}{x^2}$ $v \frac{dv}{dx} = -\frac{gR^2}{x^2}$ $\frac{1}{2}v^2 = \int \left(-\frac{gR^2}{x^2}\right)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

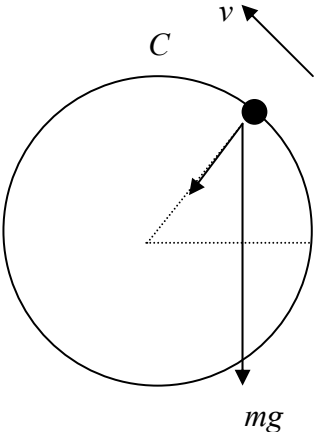
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Question Number	Scheme	Marks
Q3	 <p> $\text{EPE lost} = \frac{\lambda \times 0.6^2}{2 \times 0.9} - \frac{\lambda \times 0.1^2}{2 \times 0.9} \left(= \frac{7}{36} \lambda \right)$ $R(\uparrow) \quad R = mg \cos \theta$ $= 0.5g \times \frac{4}{5} =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

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Question Number	Scheme			Marks	
Q4 (a)		cone	container	cylinder	
	mass ratio	$\frac{4\pi l^3}{3}$	$\frac{68\pi l^3}{3}$	$24\pi l^3$	M1 A1
		4	68	72	
	dist from O	l	\bar{x}	$3l$	B1
	Moments: $4l + 68\bar{x} = 72 \times 3l$ $\bar{x} = \frac{212l}{68} = \frac{53}{17}l$ accept $3.12l$			M1 A1ft A1 (6)	
(b)	 <p>$GX = 6l - \bar{x}$ seen</p> $\tan \theta = \frac{2l}{6l - \bar{x}}$ $= \frac{2 \times 17}{49}$ $\theta = 34.75\dots = 34.8 \text{ or } 35$			M1 M1 A1 A1 (4) [10]	

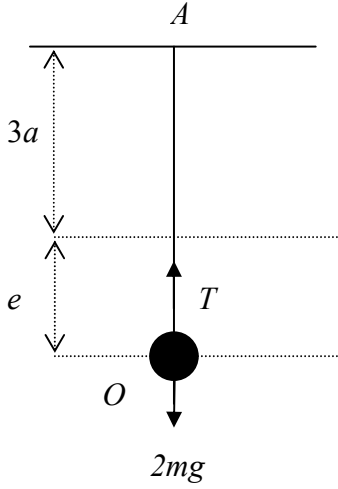
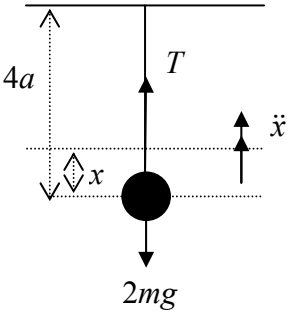
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Question Number	Scheme	Marks
Q5		
(a)	<p>Energy: $mga \sin \theta = \frac{1}{2} m \times 5ag - \frac{1}{2} mv^2$</p> $v^2 = 5ag - 2ag \sin \theta$	<p>M1 A1 A1 (3)</p>
(b)	<p>Eqn of motion along radius:</p> $T + mg \sin \theta = \frac{mv^2}{a}$ $T =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

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

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Question Number	Scheme	Marks
<p>Q7</p> <p>(a)</p>	 <p style="text-align: center;">A</p> <p style="text-align: center;">3a</p> <p style="text-align: center;">e</p> <p style="text-align: center;">T</p> <p style="text-align: center;">O</p> <p style="text-align: center;">2mg</p> <p>R(↑) $T = 2mg$</p> <p>Hooke's law: $T = \frac{6mge}{3a}$</p> <p>$2mg = \frac{6mge}{3a}$</p> <p>$e = a$</p> <p>$AO = 4a$</p>	<p>B1</p> <p>M1</p> <p>A1 (3)</p>
<p>(b)</p> <p>H.L.</p> <p>Eqn. of motion</p>	 <p style="text-align: center;">4a</p> <p style="text-align: center;">T</p> <p style="text-align: center;">x</p> <p style="text-align: center;">x</p> <p style="text-align: center;">2mg</p> <p>H.L.</p> $T = \frac{6mg(a-x)}{3a} = \frac{2mg(a-x)}{a}$ <p>Eqn. of motion</p> $-2mg + T = 2m\ddot{x}$ $-2mg + \frac{2mg(a-x)}{a} = 2m\ddot{x}$ $-\frac{2mgx}{a} = 2m\ddot{x}$ $\ddot{x} = -\frac{g}{a}x$ <p>period $2\pi\sqrt{\frac{a}{g}}$ *</p>	<p>B1ft</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>A1 (5)</p>

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