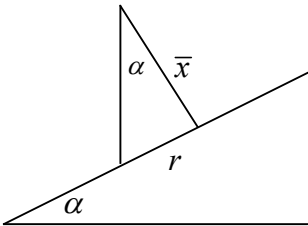
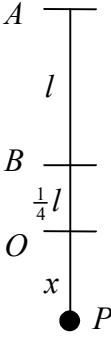
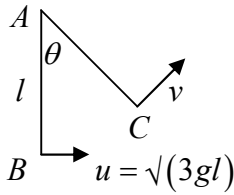
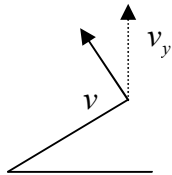
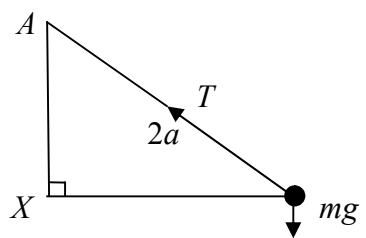


Question Number	Scheme	Marks
1.	<p>(a) $\rightarrow F = T \sin 60^\circ \quad \uparrow \quad T \cos 60^\circ = 0.8g$ both</p> <p>[or $\nearrow F \cos 60^\circ = 0.8g \cos 30^\circ$]</p> <p>$F = 0.8g \tan 60^\circ \approx 14$ (N) accept 13.6</p> <p>(b) $T = \frac{0.8g}{\sin 30^\circ} (= 15.68)$ allow in (a)</p> <p>HL $15.68 = \frac{24 \times x}{1.2} \Rightarrow x \approx 0.78$ (cm) accept 0.784</p> <p>(c) $E = \frac{24 \times x^2}{2 \times 1.2} \approx 6.1$ (J) accept 6.15</p>	<p>M1 (M2) M1 A1 (3)</p> <p>M1 M1 A1 (3)</p> <p>M1 A1ft (2)</p> <p>Total 8 marks</p>
2.	<p>(a) $\frac{dv}{dt} = 2 \sin \frac{1}{2}t \Rightarrow v = A - 4 \cos \frac{1}{2}t$</p> <p>$v = 4, t = 0 \Rightarrow 4 = A - 4 \Rightarrow A = 8$</p> <p>$v = 8 - 4 \cos \frac{1}{2}t$</p> <p>(b) $\int \dots \left(8 - 4 \cos \frac{1}{2}t \right) dt = 8t - 8 \sin \frac{1}{2}t$ ft constants</p> <p>$[\dots]_0^{\pi/2} = 4(\pi - \sqrt{2})$ awrt 6.9</p>	<p>M1 A1 M1 A1 (4)</p> <p>M1 A1ft M1 A1 (4)</p> <p>Total 8 marks</p>

Question Number	Scheme	Marks
3.	<p>(a) N2L $ma = -\frac{cm}{x^2}$</p> $\frac{d}{dx}\left(\frac{1}{2}v^2\right) = -\frac{c}{x^2} \Rightarrow \frac{1}{2}v^2 = A + \frac{c}{m}$ $v^2 = B + \frac{2c}{m}$ $x = R, v = U \Rightarrow B = U^2 - \frac{2c}{R}$ <p>Leading to $v^2 = U^2 + 2c\left(\frac{1}{x} - \frac{1}{R}\right)$ *</p> <p>(b) $\frac{1}{2}\left[\frac{1}{2}mU^2\right] = \frac{1}{2}m\left[U^2 + 2c\left(\frac{1}{2R} - \frac{1}{R}\right)\right]$</p> <p>Leading to $c = \frac{1}{2}RU^2$</p>	<p>B1</p> <p>M1 A1</p> <p>ignore A</p> <p>M1</p> <p>A1</p> <p>cs0</p> <p>M1 A1</p> <p>A1</p> <p>(5)</p> <p>(3)</p> <p>Total 8 marks</p>
4.	<p>(a) $5M\bar{x} = 3M \times \frac{h}{2} + 2M\left(h + \frac{3}{8}r\right)$</p> $5\bar{x} = \frac{3h}{2} + 2h + \frac{3}{4}r = \frac{7h}{2} + \frac{3}{4}r$ $\bar{x} = \frac{14h + 3r}{20}$ * <p>(b) </p> $\tan \alpha = \frac{20r}{14h + 3r} = \frac{4}{3}$ <p>Leading to $h = \frac{6}{7}r$</p>	<p>M1 A2(1,0)</p> <p>cs0</p> <p>M1 A1</p> <p>(5)</p> <p>M1 A1</p> <p>M1 A1</p> <p>(4)</p> <p>Total 9 marks</p>

Question Number	Scheme	Marks
5.	<div style="text-align: center;">  </div> <p>(a) HL $T = mg = \frac{\lambda \times \frac{1}{4}l}{l} \Rightarrow \lambda = 4mg$</p> <p>(b) N2L</p> $mg - T = m\ddot{x}$ $mg - \frac{4mg(\frac{1}{4}l + x)}{l} = m\ddot{x}$ $\frac{d^2x}{dt^2} = -\frac{4g}{l}x \quad *$ <p>(c)</p> $v^2 = \omega^2(a^2 - x^2) = \frac{4g}{l} \left(\frac{l^2}{4} - \frac{l^2}{16} \right)$ <p>Leading to $v = \frac{1}{2}\sqrt{3gl}$</p> <p>or energy, $\frac{1}{2} \frac{4mg \cdot gl^2}{l \cdot 16} = \frac{1}{2}mv^2 + mg \cdot \frac{3l}{4}$ for the first M1 A1 in (c)</p> <p>(d) P first moves freely under gravity, then (part) SHM.</p>	<p>M1 A1</p> <p>(2)</p> <p>M1</p> <p>M1 A1</p> <p>M1 A1</p> <p>(5)</p> <p>M1 A1</p> <p>M1 A1</p> <p>(4)</p> <p>B1</p> <p>B1</p> <p>(2)</p> <p>Total 13 marks</p>

Question Number	Scheme	Marks
6.	<p>(a)</p>  <p>Energy $\frac{1}{2}m(u^2 - v^2) = mgl(1 - \cos \theta)$ $[v^2 = gl + 2gl \cos \theta]$</p> <p>N2L $T - mg \cos \theta = \frac{mv^2}{l}$ $= \frac{mg\lambda(1 + 2 \cos \theta)}{\lambda}$ $T = mg(1 + 3 \cos \theta) *$</p> <p>(b)</p> $T = 0 \Rightarrow \cos \theta = -\frac{1}{3}$ $v^2 = gl - \frac{2}{3}gl \Rightarrow v = \left(\frac{gl}{3}\right)^{\frac{1}{2}}$ <p>(c)</p>  $\uparrow v_y = \left(\frac{gl}{3}\right)^{\frac{1}{2}} \sin \theta \left[= \left(\frac{gl}{3}\right)^{\frac{1}{2}} \cdot \frac{2\sqrt{2}}{3} \right]$ $v^2 = u^2 - 2gh \Rightarrow 2gh = \frac{gl}{3} \cdot \frac{8}{9} \Rightarrow h = \frac{4l}{27}$ $H = l(1 - \cos \theta) + \frac{4l}{27} = \frac{40l}{27}$	<p>M1 A1</p> <p>M1 A1</p> <p>M1</p> <p>cs0 A1</p> <p>(6)</p> <p>B1</p> <p>M1 A1</p> <p>(3)</p> <p>M1</p> <p>M1 A1</p> <p>M1 A1</p> <p>(5)</p> <p>Total 14 marks</p>

Question Number	Scheme	Marks
7.	<p>(a) N2L $\leftarrow T \cos 30^\circ = m(2a \cos 30^\circ) \left(\frac{kg}{3a} \right)$</p> $T = \frac{2kmg}{3} *$	<p>M1 A1 A1 (3)</p>
	<p>(b) $\uparrow R = mg - T \sin 30^\circ$</p> $= mg \left(1 - \frac{k}{3} \right)$	<p>M1 A1 A1 (3)</p>
	<p>(c) $(R \geq 0) \Rightarrow k \leq 3$ ignore $k > 0$, accept $k < 3$</p>	<p>M1 A1 (2)</p>
	<p>(d)</p>  <p>N2L $\leftarrow T \cos \theta = m(2a \cos \theta) \left(\frac{2g}{a} \right)$</p> $(T = 4mg)$ <p>$\uparrow T \sin \theta = mg$</p> <p>Eliminating T</p> $AX = 2a \sin \theta = \frac{1}{2}a$ <p>$AO = 2a \sin 30^\circ = a \Rightarrow AX = \frac{1}{2}AO$, as required *</p>	<p>M1 A1 M1 M1 A1 B1, A1 (7) Total 15 marks</p>