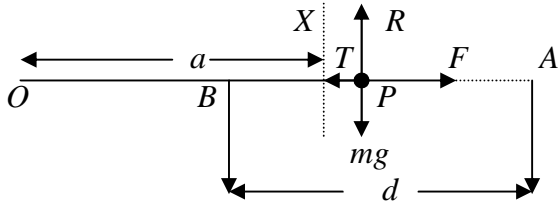
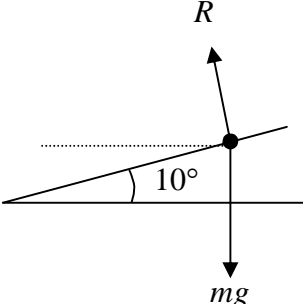
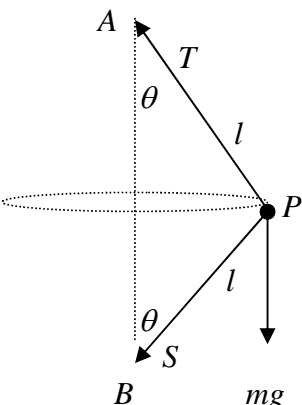
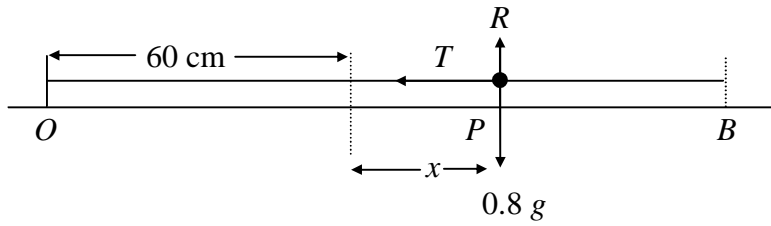


Question Number	Scheme	Marks
1.	 <p>Attempt to relate <math>Fd</math> to EPE</p> $\frac{2}{3} mg d = \frac{4mg\left(\frac{a}{2}\right)^2}{2a}$ <p>Final answer: <math>d = \frac{3}{4} a</math></p>	$R = mg$ $F = \mu R = \mu mg$  B1 B1  M1  M1 A1 ft  A1 (6)  <b>(6 marks)</b>
2.	 <p>(<math>\updownarrow</math>) <math>R \cos 10^\circ = mg</math></p> <p>(<math>\leftrightarrow</math>) <math>R \sin 10^\circ = \frac{mv^2}{r}</math></p> <p>Solving for <math>r</math>: <math>r = \left[ \frac{18^2}{g \tan 10^\circ} \right]</math></p> <p><math>r = 190</math> (m) [Accept 187, 188]</p>	M1 A1 M1 A1ft  M1  A1 (6)  <b>(6 marks)</b>
3.	<p>(a) <math>\frac{1}{10} x(4 - 3x) = 0.2 a</math></p> <p><math>\frac{1}{10} x(4 - 3x) = 0.2v \frac{dv}{dx}</math> or <math>\frac{1}{10} x(4 - 3x) = 0.2 \frac{d(\frac{1}{2} v^2)}{dx}</math></p> <p>Integrating: <math>v^2 = 2x^2 - x^3 (+ C)</math> or equivalent</p> <p>Substituting <math>x = 6, v = 0</math> to find candidate's <math>C</math></p> <p><math>v^2 = 2x^2 - x^3 + 144</math></p> <p>(b) Substituting <math>x = 0</math> and finding <math>v</math>; <math>v = 12</math> (m s<sup>-1</sup>)</p>	M1 A1  M1  M1 A1  M1  A1 (7)  M1; A1 ft (2)  <b>(9 marks)</b>

(ft = follow through mark)

Question Number	Scheme	Marks
<p>4. (a)</p> 	$(\updownarrow) (T - S) \cos \theta = mg$ $(\leftrightarrow) (T + S) \sin \theta = mr\omega^2$ $= m(l \sin \theta)\omega^2$ <p>Finding <math>T</math> in terms of <math>l, m, \omega^2</math> and <math>g</math></p> $T = \frac{1}{6}m(3l\omega^2 + 4g) \quad (*)$	<p>M1 A1</p> <p>M1 A1 ft</p> <p>A1</p> <p>M1</p> <p>A1 (7)</p>
(b)	$S = \frac{1}{6}m(3l\omega^2 - 4g)$	<p>any correct form M1 A1 (2)</p>
(c)	<p>Setting <math>S \geq 0</math>; <math>\omega^2 \geq \frac{4g}{3l} \quad (*)</math></p>	<p>(no wrong working seen) M1 A1 (2)</p>
<b>(11 marks)</b>		
<p>5. (a)</p>	 <p>Hooke's Law: <math>T = \frac{12x}{0.6} \quad [= 20x]</math></p> <p>Equation of motion: <math>(-)T = 0.8 \ddot{x}</math></p> $-\frac{12x}{0.6} = 0.8 \ddot{x} \quad \ddot{x} = -25x$ <p>Finding <math>\omega</math> from derived equation of form <math>\ddot{x} = -\omega^2 x</math></p> <p>Period = <math>\frac{2\pi}{\omega} = \frac{2\pi}{5} \quad (*)</math></p>	<p><math>\lambda = 12 \text{ N}</math></p> <p><math>OB = 85 \text{ cm}</math></p> <p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1 (5)</p> <p>M1; A1 (2)</p> <p>M1 A1</p> <p>M1 A1 ft</p> <p>A1 (5)</p> <p>B1 (1)</p> <p><b>(13 marks)</b></p>
(b)	<p>Substituting (candidate's) <math>\omega</math> and <math>a</math> in <math>\omega^2 a</math>; <math>= 25 \times 0.25 = 6.25 \text{ (m s}^{-2}\text{)}</math></p> <p>(or finding <math>T_{\max} = 0.8a \Rightarrow a = 5/0.8 = 6.25</math>)</p>	
(c)	<p>Complete method for <math>x</math>; <math>x = 0.25 \cos 10^\circ \quad (-0.2098)</math></p> <p>Using <math>v^2 = \omega^2 (a^2 - x^2) \Rightarrow v = (\pm)5\sqrt{[(0.25)^2 - (0.25 \cos 10^\circ)^2]}</math></p> $v = (\pm) 0.68 \text{ (m s}^{-1}\text{)}$	
(d)	<p>Direction <math>\overrightarrow{OB}</math> or equivalent</p>	

(ft = follow through mark; (\*) indicates final line is given on the paper)

Question Number	Scheme	Marks
<p>6. (a)</p> <p>(b)</p>	<p>Energy: <math>\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = mga(1 - \cos \theta)</math></p> <p>Radial: <math>(\pm R) + mg \cos \theta = \frac{mv^2}{a}</math></p> <p>Eliminating <math>v</math> and finding <math>\cos \theta = \frac{u^2 + 2ga}{3ga}</math></p> <p>Energy (C and ground): <math>\frac{1}{2}m\left(\frac{9ag}{2}\right) - \frac{1}{2}mv^2 = mga(1 - \cos \theta)</math></p> <p>Eliminating <math>v</math>: <math>\frac{1}{2}m\left(\frac{9ag}{2}\right) - \frac{1}{2}mag \cos \theta = mga(1 + \cos \theta)</math></p> <p><math>\cos \theta = \frac{5}{6}</math></p> <p><math>\theta = 34^\circ</math></p>	<p>M1 A1 A1</p> <p>M1 A1</p> <p>M1, A1 (7)</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1 ft</p> <p>A1 (7)</p> <p><b>(14 marks)</b></p>
<p>Alt (b)</p>	<p>Or energy (A and ground): <math>\frac{1}{2}m\left(\frac{9ag}{2}\right) - \frac{1}{2}mu^2 = 2mga</math></p> <p><math>u^2 = \frac{1}{2}ga</math></p> <p>Using with (a) to find <math>\cos \theta = \frac{5}{6}; \theta = 34^\circ</math></p>	<p>M1 A1</p> <p>M1 A1</p> <p>M1 A1; A1 (7)</p>
<p>Alt</p>	<p>Projectile approach: <math>V_x = v \cos \theta; V_y^2 = (v \sin \theta)^2 + 2ga(1 + \cos \theta)</math></p> <p><math>\left(\frac{9ag}{2}\right) = V_x^2 + V_y^2 \Rightarrow \left(\frac{9ag}{2}\right) - v^2 = 2ga(1 + \cos \theta) -</math> M1 A1, then scheme</p>	

(ft = follow through mark)

Question Number	Scheme	Marks
<p>7. (a)</p> <p>(b)</p> <p>(c)</p>	$V = \pi \int y^2 dx = \frac{1}{4}\pi \int (x-2)^4 dx$ $\int (x-2)^4 dx = \frac{1}{5}(x-2)^5$ $V = \frac{8\pi}{5}$	<p>M1</p> <p>M1 A1</p> <p>A1 (4)</p>
	<p>Using <math>\pi \int xy^2 dx = \frac{1}{4}\pi \int x(x-2)^4 dx</math></p> <p>Correct strategy to integrate [e.g. substitution, expand, by parts]</p> <p>[e.g. <math>\frac{1}{4}\pi \int (u-2)^4 du</math> ; <math>\frac{1}{4}\pi \int (x^5 - 8x^4 + 24x^3 - 32x^2 + 16x) dx</math> ]</p> $= \frac{1}{4}\pi \left[ \frac{2u^5}{5} + \frac{u^6}{6} \right] \text{ or } \frac{1}{4}\pi \left[ \frac{x^6}{6} - \frac{8x^5}{5} + 6x^4 - \frac{32x^3}{3} + 8x^2 \right]$ $= \frac{8\pi}{15}$ <p style="text-align: right;">limits need to be used correctly</p>	<p>M1</p> <p>M1</p> <p>M1 A1</p> <p>A1 (7)</p>
	$V_c(\rho) \bar{x} = \pi(\rho) \int xy^2 dx$ <p style="text-align: right;">seen anywhere</p> $\bar{x} = \frac{1}{3} \text{ cm } (*)$ <p style="text-align: right;">no incorrect working seen</p>	<p>M1</p> <p>A1</p>
	<p>Moments about B: <math>8A = 10W - 2W(\frac{1}{3})</math></p> $A = \frac{59W}{12} \quad (4.9W)$	<p>M1 A1 A1</p> <p>M1 A1 (5)</p> <p><b>(16 marks)</b></p>

(ft = follow through mark; (\*) indicates final line is given on the paper)