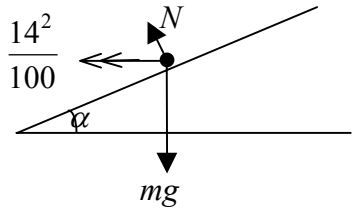
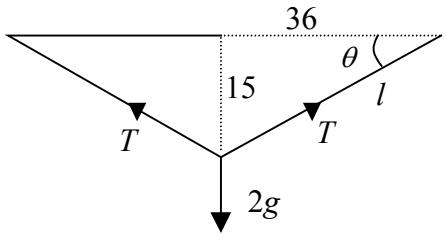
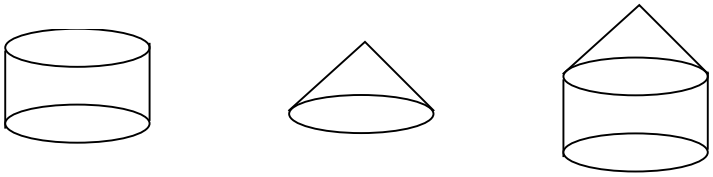
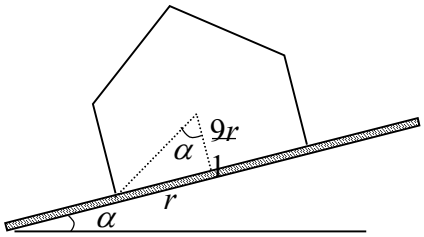
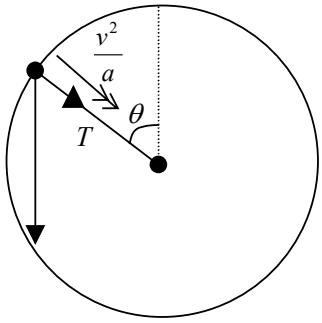
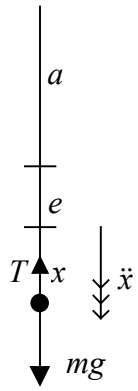
Question Number	Scheme	Marks
1.	 $R(\uparrow)$ $N\cos\alpha = mg$ $R(\rightarrow)$ $N\sin\alpha = \frac{m.14^2}{100}$ $\therefore \tan\alpha = \frac{14^2}{100\times 9.8} = 0.2$ $\alpha \approx 11.3°$	M1 A1 M1 A1 M1 A1 ft A1 (7) **(7 marks)**
2. (*a*)	 $l^2 = 36^2 + 15^2$ $\Rightarrow l = 39$, ext = 9 cm $T = \frac{\lambda\times 0.09}{0.3}$ $2T\sin\theta = mg \Rightarrow \frac{2\lambda\times 0.09}{0.3}\times\frac{15}{39} = 2\times 9.8$ $\lambda \approx 84.9$	M1 A1 B1 M1 A1 A1 (6)
(*b*)	By taking P as single <u>point</u> from which to measure all distances	B1 (1) **(7 marks)**

Question Number	Scheme	Marks
3.	$0.5\ddot{x} = -\dfrac{2}{x^2}$	M1
	$v\dfrac{\mathrm{d}v}{\mathrm{d}x} = -\dfrac{4}{x^2}$	M1
	$\int v\,\mathrm{d}v = -\int \dfrac{4}{x^2}\,\mathrm{d}x$	M1
	$\left[\dfrac{1}{2}v^2\right]_3^{\frac{3}{2}} = \left[\dfrac{4}{x}\right]_1^d$	M1 A1
	(limits or 'C')	A1
	$\dfrac{9}{8} - \dfrac{9}{2} = 4\left(\dfrac{1}{d} - 1\right) \Rightarrow d = \dfrac{32}{5} = 6.4$ m	M1 A1 (8)
		(8 marks)
4. (*a*)	Elastic energy gained $= \dfrac{\lambda x^2}{2l}$	M1
	$\therefore \dfrac{\lambda.6^2}{2\times 12} = \text{PE lost} = 75\times 9.8\times 18$	M1 A1
	$\rightarrow \lambda = 8820$ N	M1 A1 ft (5)
(*b*)	At 2 m off ground $\dfrac{1}{2}\times 75\times v^2 = 75\times 9.8\times 17 - \dfrac{1}{2}\times\dfrac{8820\times 5^2}{12}$	M1 A1 A1ft
	$\rightarrow v^2 = 88.2$	
	$v \approx 9.39$ ms^{-1}	M1 A1 (5)
		(10 marks)

Question Number	Scheme	Marks
5. (*a*)		
	Vol. πr^3 $\quad \frac{1}{3}\pi r^2 h$ $\quad \pi r^3 + \frac{1}{3}\pi r^2 h$	M1 A1
	Dist of CM $\frac{r}{2}$ $\quad r+\frac{h}{4}$ $\quad \bar{x}$	B1 B1
	$\frac{\pi r^4}{2} + \frac{1}{3}\pi r^2 h\left(r+\frac{h}{4}\right) = \left(\pi r^3 + \frac{1}{3}\pi r^2 h\right)\bar{x}$	M1 A1 A1ft
	$\rightarrow \bar{x} = \frac{6r^2+4hr+h^2}{4(3r+h)}$	A1 (8)
(*b*)	 $h = 2r \Rightarrow \bar{x} = \frac{18r}{20} = \frac{9r}{10}$	M1 A1
	$\therefore \tan\alpha = \frac{r}{9r/10} = \frac{10}{9}$	M1 A1 ft
	$\alpha \approx 48^\circ$	A1 (5)
		(13 marks)

Question Number	Scheme	Marks
6.		
(*a*)	$R(\searrow)\ \ T + mg\cos\theta = \dfrac{mv^2}{a}$	M1 A1
	Energy $\dfrac{1}{2}mu^2 - \dfrac{1}{2}mv^2 = mga(1+\cos\theta)$	M1 A1 A1
	$u^2 = 3ga \rightarrow v^2 = ga\,(1 - 2\cos\theta)$	
	$\therefore T = -mg\cos\theta + \dfrac{mv^2}{a} = mg(-3\cos\theta + 1)$	M1 A1
	$T = 0 \Rightarrow \cos\theta = \dfrac{1}{3}$	M1 A1 (9)
(*b*)	$v^2 = \dfrac{ga}{3}$	B1
	$\sin^2\theta = 1 - \left(-\dfrac{1}{3}\right)^2 = \dfrac{8}{9}$	M1 A1
	$\text{Ht} = \dfrac{v^2\sin^2\theta}{2g} = \dfrac{ga}{3}\cdot\dfrac{8}{9}\cdot\dfrac{1}{2g} = \dfrac{4a}{27}$	M1 M1 A1
		(6)
		(15 marks)

Question Number	Scheme	Marks
7.		
(*a*)	In equilibrium $\frac{6mge}{a} = mg \Rightarrow e = \frac{a}{6}$	M1 A1 (2)
(*b*)	$m\ddot{x} = -\frac{6mg(e+x)}{a} + mg$	M1 A1 A1
	$\rightarrow \ddot{x} = -\frac{6g}{a}x \Rightarrow$ SHM	M1 A1
	Period $= \left(\frac{2\pi}{\omega}\right) = 2\pi\sqrt{\frac{a}{6g}}$	A1 (6)
(*c*)	Greatest speed $= a\omega = \frac{a}{3}\sqrt{\frac{6g}{a}} = \frac{1}{3}\sqrt{6ga}$	M1 A1 (2)
(*d*)	$x = \frac{a}{3}\cos\omega t$	M1
	String slack $\Rightarrow x = -e \Rightarrow -\frac{a}{6} = \frac{a}{3}\cos\omega t$	M1 A1
	$\Rightarrow \omega t = \frac{2\pi}{3},\ t = \frac{2\pi}{3}\sqrt{\frac{a}{6g}}$	M1 A1 ft

		(5) **(15 marks)**