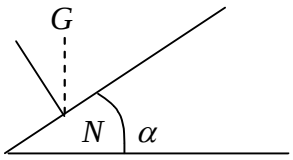
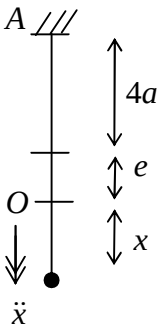
Question Number		Scheme	Marks
1.	(*a*)	$a = 0.25$	B1
		$\frac{2\pi}{\omega} = 2 \Rightarrow \omega = \pi$	B1
		$-0.125 = 0.25 \cos \omega t$	M1A1
	(*b*)	$t = \frac{1}{\pi}\cos^{-1}(-0.5)$	M1
		$= \frac{2}{3}$	A1 **(6)**
			(6 marks)
2.	(*a*)	$(\uparrow)\ 3mg \cos \alpha° = mg$	M1 A1
		$\alpha = \cos^{-1}(\frac{1}{3})$	M1
		$= 70.5$	A1 **(4)**
	(*b*)	$(\leftarrow)\ 3mg \sin \alpha = mr \times 2gk$	M1 A1
		$l \sin \alpha = r$	B1
		$l = \frac{3}{2}k$	M1 A1 **(5)**
			(9 marks)
3.	(*a*)	$2e^{-0.1x} = 2.5a$	M1 A1
		$\frac{4}{5} e^{-0.1x} = v\frac{dv}{dx}$	M1
		$-8e^{-0.1x} = \frac{1}{2}v^2 (+c)$	A1
		$x = 0, v = 2 \Rightarrow c = -10$	M1
		$v^2 = 20 - 16e^{-0.1x}$	A1 **(6)**
	(*b*)	$16 = 20 - 16e^{-0.1x} \Rightarrow e^{-0.1x} = \frac{1}{4}$	M1
		$0.1x = \ln 4$	M1
		$x = 13.9$	A1 **(3)**
	(*c*)	Appropriate comment.	B1 **(1)**
			(10 marks)

Question Number	Scheme	Marks
4. (*a*)	$\frac{1}{2}\times 0.2\times 5^2-\frac{1}{2}\times 0.2\times u^2=\frac{1}{2}\times\frac{20(0.5)^2}{1.5}$	M1 A1 A1
	$u^2=\frac{25}{3}$	M1
	$u=2.89\ \text{ms}^{-1}$	A1 **(5)**
(*b*)	$\frac{1}{2}\times 0.2\times 5^2-\frac{1}{2}\times 0.2\times 1.5^2=\frac{1}{2}\times\frac{20x^2}{1.5}$	M1 A1
	$x^2=0.34125$	M1
	$T=\frac{20x}{1.5}=7.8\ \text{N}$	M1 A1 **(5)**
		(10 marks)
5. (*a*)	Cone: $\frac{1}{3}\pi(2r)^2h$ (4); Cylinder: πr^2h (3); Whole: $\frac{1}{3}\pi(2r)^2h+\pi r^2h$ (7)	M1 A1
	$\frac{1}{4}h$ $\quad$ $\frac{1}{2}h$ $\quad$ $\bar{x}$	B1 B1
	$-4\times\frac{1}{4}h+3\times\frac{1}{2}h=7\bar{x}$	M1 A1
	$\bar{x}=\frac{1}{14}h$	M1 A1 cso **(8)**
(*b*)		
	Use of *G* above *N*	M1
	$\tan\alpha=\frac{r}{h-\frac{1}{14}h}=\frac{7}{26}$	M1 A1
	$r=\frac{1}{4}h$	A1 **(4)**
		(12 marks)

Question Number	Scheme	Marks
6. (*a*)	$mg = \dfrac{8mge}{4a}$ 	M1
	$\frac{9}{2}a = AO$	A1 **(2)**
(*b*)	$mg - \dfrac{8mg}{4a}(e + x) = m\ddot{x}$	M1 M1 A1
	$\ddot{x} = -\dfrac{2g}{a}x$	M1 A1
	$T = 2\pi\sqrt{\dfrac{a}{2g}} = \pi\sqrt{\dfrac{2a}{g}}$ (✱)	M1 A1 **(7)**
	$v = d\omega$	M1
	$\frac{1}{2}\sqrt{ga} = d\sqrt{\dfrac{2g}{a}}$	A1 ft on ω
	$d = \dfrac{a}{2\sqrt{2}} = a\dfrac{\sqrt{2}}{4} = 0.35a$ (awrt)	A1 **(3)**
(*d*)	Partly under gravity, partly SHM	B1 B1 **(2)**
		(14 marks)
7. (*a*)	$\frac{1}{2}mu^2 = mgl(1 - \cos\theta)$	M1 A1 A1
	$u = \sqrt{\frac{2}{3}gl}$	A1 **(4)**
(*b*)	$T - mg\cos\theta = \dfrac{mv^2}{l}$	M1 A1
	$\frac{1}{2}mu^2 - \frac{1}{2}mv^2 = mgl(1 - \cos\theta)$	M1 A1
	eliminating v^2, $T = \dfrac{mg}{3}(9\cos\theta - 4)$ (✱)	M1, A1 cso **(6)**
(*c*)	max T, $\theta = 0$, $T_{MAX} = \dfrac{5mg}{3}$	M1
	min T, $\cos\theta = \frac{2}{3}$, $T_{MIN} = \dfrac{2mg}{3}$	M1 A1
	$\dfrac{2mg}{3} \le T \le \dfrac{5mg}{3}$	A1 **(4)**
		(14 marks)