1	$V_v^2 = 18^2 - (25\cos 50)^2$		**M1**		Finds vertical comp of velocity
	$V_v = 8.1095656..$		**A1**		
	$8.1095656... = 25\sin 50 - gt$		**M1**		$v = u - gt$ vertically
	$t = 1.1(0)\,\text{s}$		**A1**	4	
2	**(i)** $T\cos\theta = 0.2g$ $T \times \frac{0.4}{0.5} = 2$		**M1**		Weight = vertical comp of tension
	$T = 2.5\,\text{N}$	AG	**A1**	2	
	(ii) $2.5\sin\theta = \frac{0.2v^2}{r}$		**M1**		Horiz comp of tension and accn = v^2/r
	$2.5 \times \frac{0.3}{0.5} = \frac{0.2v^2}{0.3}$		**A1**		
	$v = 1.5\,\text{ms}^{-1}$		**A1**	3	
3	$4V\cos\theta = 40\cos 30$		**B1**		
	$4V\sin\theta - \frac{4^2 g}{2} = 40\sin 30$		**B1**		
	$V^2 = (10\cos 30)^2 + 25^2$ or $\tan\theta = \frac{25}{10\cos 30}$		**M1**		
	$V = 26.5$		**A1**		
	$\theta = 70.9$		**A1**	5	
4	**(i)** $4 = 10r$		**B1**		$v = \omega r$, r < 0.5
	$\theta = 53.1°$		**B1**	2	From $\sin\theta = 0.4/0.5$
	(ii) (a) $0.4g = 6\cos\theta$		**M1**		
	$\theta = 48.2°$		**A1**	2	
	(b) $6\sin\theta = 0.4\omega^2 \times 0.5\sin\theta$		**M1** **A1**√		Accn = $\omega^2 \times 0.5\sin\theta$ Using cv(48.2), allow any acute θ
	$\omega = 5.48$ rad s^{-1}		**A1**	3	
5	**(i)** $0.5v\frac{dv}{dx} = -0.5g - 0.02v^2$		**M1**		
	$v\frac{dv}{dx} = -10 - 0.04v^2$	AG	**A1**	2	

(ii)	$\int_{8}^{0} \frac{v}{-10-0.04v^2}\,\mathrm{d}v = \int_{0}^{x}\mathrm{d}x$	**M1**		Separates the variables and attempts to integrate
	$x = \left[-\ln(10+0.04v^2)/0.08\right]_{8}^{0}$	**M1**		Uses limits or finds constant
	$x = 2.85$	**A1**	3	
(iii)	$v\frac{\mathrm{d}v}{\mathrm{d}x} = 10 - 0.04v^2$	**B1**		
	$\int_{0}^{v} \frac{v}{10-0.04v^2}\,\mathrm{dv} = \int_{0}^{2.85}\mathrm{d}x$	**M1**		Integrates new acceleration
	$\ln\left[(10-0.04v^2)/10\right]/-(0.08) = 2.85$	**M1**		Uses earlier answer as distance
	$v = 7.14\,\mathrm{ms}^{-1}$	**A1**	4	
6 (i)	$\mathrm{d}\cos\theta = \mathrm{h}/\cos\theta$	**M1**		θ = semi-vertical angle
	$\cos\theta = \frac{h}{\sqrt{(0.2^2+h^2)}}$			
	$d = \frac{h}{(h^2/(0.04+h^2))}$	**M1**		
	$d = h + \frac{0.04}{h}$ AG	**A1**	3	
(ii)	$0.6\times 4 + 0.9W = d(4+W)$	**M1** **A1**		Table of moments idea
	$d = 0.8 + \frac{0.2^2}{0.8}$	**B1**		0.85
	$2.4 + 0.9W = 0.85(4+W)$	**M1**		
	$0.05W = 1$	**A1**		
	$W = 20$	**A1**	6	

7 (i)	$Mg = \dfrac{12.5e}{0.8}$	**M1**		Uses $T = \lambda e/l$
	$e = 0.64M$ AG	**A1**	2	
(ii)	$Mg(0.8 + e) =$ $\dfrac{M \times 44^2}{2} + \dfrac{12.5e^2}{(2 \times 0.8)}$	**M1** **A1**		PE/KE/EE conservation
	$10M(0.8 + 0.64M) =$ $9.68M + \dfrac{12.5(0.64M)^2}{1.6}$	**M1** **A1**		$8M+6.4M^2= 9.68M +3.2M^2$
	$8+6.4M = 9.68 + 3.2M$	**M1**		Attempt to solve equation in M
	$M = 0.525$	**A1**	6	
(iii)	$0.525gd = \dfrac{12.5(d - 0.8)^2}{(2 \times 0.8)}$	**M1**		PE/EE balance
	$0.672d = d^2 - 1.6d + 0.64$	**M1**		
	$d = 1.94$	**A1**	3	