Question	Answer	Marks	Guidance
1	Vertical component of velocity = $25 - 4g$	**M1**	Use $v = u + at$
	$v^2 = 18^2 + (25-4g)^2$ **or** $\tan\theta = \dfrac{(25-4g)}{18}$	**M1**	
	$v = 23.4$ ms^{-1}	**A1**	
	$\theta = 39.8°$ below the horizontal	**A1**	
		4	

Question	Answer	Marks	Guidance
2		**M1**	Attempt to take moments about A
	$8x\cos30 = 0.5 \times 12\sin30$	**A1**	Correct equation
	$x = 0.433$ m	**A1**	
		3	

Question	Answer	Marks	Guidance
3(i)	$0.4\dfrac{dv}{dt} = 0.8t - 2e^{-t}$	**M1**	Use Newton's Second Law horizontally
	$\dfrac{dv}{dt} = 2t - 5e^{-t}$	**A1**	**AG**
		2	
3(ii)	$\int dv = \int(2t - 5e^{-t})dt$ $v = t^2 + 5e^{-t}(+ c)$	**M1**	Attempt to integrate the equation from part **(i)**
	$t = 1$ and $v = 8$ so c = 5.16	**M1**	Attempt to find the constant of integration, c
	$v = t^2 + 5e^{-t} + 5.16$ or $v = t^2 + 5e^{-t} + 7 - 5e^{-1}$	**A1**	
		3	
3(iii)	Evaluates v for $t = 0$	**M1**	
	$V = 10.2$ ms^{-1}	**A1**	
		2	

Question	Answer	Marks	Guidance
4(i)	$x = (V\cos 45)t$	**B1**	Use horizontal motion
	$y = (V\sin 45)t - \dfrac{gt^2}{2}$	**B1**	Use $s = ut + \frac{1}{2}gt^2$ vertically
	$y = \dfrac{(V\sin 45)x}{(V\cos 45)} - \dfrac{1}{2}g\left(\dfrac{x}{V\cos 45}\right)^2$	**M1**	Attempt to eliminate t
	$y = x - \dfrac{10x^2}{V^2}$	**A1**	
		4	
4(ii)	$18 = 24 - \dfrac{10\times 24^2}{V^2}$	**M1**	Substitutes $x = 18$, $y = 24$ in part **(i)** equation
	$V = 31(.0)$	**A1**	
		2	
4(iii)	$22.5 = x - \dfrac{10x^2}{960}$	**M1**	Put $y = 22.5$ in part **(i)**
	$x^2 - 96x + 2160 = 0$	**M1**	Attempt to solve a quadratic equation
	$x = 36, 60$	**A1**	
		3	

Question	Answer	Marks	Guidance
5(i)	$1.8 = \frac{20e^2}{(2\times 0.5)}$	**M1**	Use $T = \frac{\lambda x}{l}$
	$e = 0.3$, OA = 0.8	**A1**	
		2	
5(ii)	$0.7g\sin 30 = \frac{20x}{0.5}$	**M1**	Use Newton's Second Law up the plane
	$x = 0.0875$ m	**A1**	
	$\text{EPE} = \frac{20\times 0.0875^2}{(2\times 0.5)}$	**B1**	
	$\frac{0.7v^2}{2} = 1.8 + 1.8 - 0.7g(0.3 - 0.0875)\sin 30 - \frac{20\times 0.0875^2}{(2\times 0.5)}$	**M1**	Attempt to set up a 5 term energy equation
		A1	Correct equation
	$v = 2.78$ ms^{-1}	**A1**	
		6	

Question	Answer	Marks	Guidance
6(i)	r [= 0.6 – (0.4-0.3)]= 0.5	**B1**	
	$T = 0.3\text{g}$	**B1**	Resolve vertically for Q
	$0.2v^2 / 0.5 = 0.3g$	**M1**	Use Newton's Second Law horizontally for P
	$v = 2.74$ ms^{-1}	**A1**	
		4	
6(ii)	$r = 0.5 + e$	**B1**	e = extension of the string
	$T = \dfrac{15e}{0.3} = 50e$	**B1**	Use $T = \lambda x/l$
	$0.2 \times 8^2 (5 + e) = 50e + 0.3\text{g}$	**M1**	Use Newton's Second Law horizontally with $a = r\omega^2$
	$e = \dfrac{(6.4 - 3)}{(50 - 12.8)}$ (= 0.0914)	**A1**	
	HP = 0.591 m	**A1**	
		5	

Question	Answer	Marks	Guidance
7(i)	Height of conical tip $= 1.2 \times \frac{0.2}{0.5} = 0.48$	**M1**	Use ratio of corresponding sides, similar figures
	Cylindrical height = 1.2 – 0.48 = 0.72	**A1**	**AG**
	Volume removed $= \pi 0.2^2 \times \frac{0.48}{3} + \pi 0.2^2 \times 0.72$ $(= 0.0064\pi + 0.0288\pi)$	**M1**	
	Volume removed = 0.0352π	**A1**	**AG**
		4	
7(ii)	Moment of cone removed about the base $= 0.0064\pi(0.72 + \frac{0.48}{4}) = 0.0064\pi \times 0.84$	**B1**	
	Moment of cylinder removed about the base $= 0.0288\pi \times \frac{0.72}{2} = 0.0288\pi \times 0.36$	**B1**	
	Moment of the original cone about the base $= \pi\ 0.5^2 \times \frac{1.2}{3} \times 0.3 = 0.1\pi \times 0.3$	**B1**	
		M1	Attempt to take moments about the base
	$0.1\pi \times 0.3 = 0.0064\pi \times 0.84 + 0.0288\pi \times 0.36 + 0.0648\pi x$	**A1**	Note 0.0648π is the volume of the object
	x = 0.22 m	**A1**	
		6	