

Question	Answer	Marks	Guidance
1		M1	Equate initial horizontal velocity to final horizontal velocity
	$v\cos 20 = 38\cos 30$	A1	
	$v = 35(.0) \text{ m s}^{-1}$	A1	
		3	

Question	Answer	Marks	Guidance
2(i)		M1	Attempt to take moments about the vertex of the cone
	$(\pi \times 0.3^2 \times 0.4/3) \times (3 \times 0.4/4) + (\pi \times 0.3^2 \times 0.4 \times (0.4 + 0.2))$	A1	
	$= (\pi \times 0.3^2 \times 0.4/3 + \pi \times 0.3^2 \times 0.4)\bar{x}$	A1	
	$\bar{x} = 0.525 \text{ m}$	A1	
		4	
2(ii)		M1	Attempt to take moments about a point on the circumference of the base of the cone
	$kW\cos 30 \times 0.3 + kW\sin 30 \times 0.8 = 0.3W$	A1	
	$k = 0.455$	A1	
		3	

Question	Answer	Marks	Guidance
3(i)	$0.4a (= 0.4v dv/dx) = 8x - (2e^{-x} + 4)$	M1	Use Newton's Second Law horizontally
	$v dv/dx = 20x - 10 - 5e^{-x}$	A1	
		2	
3(ii)	$\int v dv = \int (20x - 10 - 5e^{-x}) dx$	M1	Attempt to integrate the equation from part (i)
	$\left[\frac{v^2}{2} \right]_6^v = \left[10x^2 - 10x + 5e^{-x} \right]_0^{0.5}$	M1	Use correct limits in the integration
	$v = 5.2(0)$	A1	
		3	
3(iii)	$8x - 4 = T = \lambda(x - 0.5)/0.5 (= \lambda x/0.5 - \lambda)$	M1	Use $T = \lambda x/L$
	$\lambda = 4 \text{ N}$	A1	
		2	

Question	Answer	Marks	Guidance
4(i)	$x = Vt \text{ or } y = -\frac{1}{2}gt^2$	B1	Use horizontal motion or vertical motion
		M1	Attempt to eliminate t
	$y = -5x^2/V^2$	AG	A1
		3	

Question	Answer	Marks	Guidance
4(ii)	$-a = -5a^2/V^2$ or $-16a = -5(a^2)^2/V^2$	B1	
		M1	Attempt to eliminate V
	$a = 4$	A1	
		3	
4(iii)	$y = -5(5 \times 4)^2/(5 \times 4) (= -100)$	M1	Use the value of a found in part ii
	Height = 100 m	A1	
		2	

Question	Answer	Marks	Guidance
5(i)	$15(0.2 + x)^2/(2 \times 0.6)$ or $15 \times 0.2^2/(2 \times 0.6)$	B1	
		M1	Set up a 4 term energy equation
	$15(0.2 + x)^2/(2 \times 0.6) = 15 \times 0.2^2/(2 \times 0.6) + 0.7gx + (0.7 \times 2^2)/2$	A1	$0.5 + 5x + 12.5x^2 = 0.5 + 7x + 1.4$
	$x = 0.424$ m	A1	
		4	

Question	Answer	Marks	Guidance
5(ii)	$0.7g = 15e/0.6$	M1	Use $T = \lambda x/L$
	$e = 0.28 \text{ m}$	A1	
	$(0.7 \times 2^2)/2 + 0.7g(0.28 - 0.2) + (15 \times 0.2^2)/(2 \times 0.6)$ $= (0.7 \times v^2)/2 + (15 \times 0.28^2)/(2 \times 0.6)$	M1	Set up a 5 term energy equation
	$v = 2.06 \text{ m s}^{-1}$	A1	
		4	

Question	Answer	Marks	Guidance
6(i)	Centre of mass of triangles below $O = r/6$	B1	
	Centre of mass of quadrant below $O = (2r\sin\pi/4)/(3\pi/4)$	B1	
		M1	Attempt to take moments about O
	$(rx)(x/2) = (r^2/4)(r/6) + (\pi r^2/4)(2r\sin\pi/4)/(3\pi/4)$	A1	
	$x^2 = 2(r^2/24 + r^2\sqrt{2}/3)$	M1	Attempt to express x in terms of r
	$x = 1.01r$	A1	
		6	

Question	Answer	Marks	Guidance
6(ii)	Within quadrant as the square will be smaller than the rectangle Or if $x < r$ in part (i), within the square as the square will be larger than the rectangle	B1ft	
		1	

Question	Answer	Marks	Guidance
7(i)	$T\cos 30 + U\cos 30 = 0.1g (= 1)$	B1	Resolve vertically for P Note T and U are the tensions in PR and PB respectively
	$T\cos 60 - U\cos 60 = 0.1 \times 6^2 \times 0.3 (= 1.08)$	M1A1	Use Newton's Second Law horizontally
	$2T\cos 30\cos 60 = 1.08\cos 30 + 1\cos 60$	M1	Attempt to eliminate U
	$T (= 1.65735) = 1.66 \text{ N}$ AG	A1	
		5	
7(ii)	$F - T\cos 60 = 0.2 \times 6^2 \times 0.15$ or $R = 0.2g + T\cos 30$	M1	Use Newton's Second Law horizontally or resolve vertically
	$F (= 1.9086) = 1.91 \text{ N}$	A1	
	$R (= 3.4353) = 3.44 \text{ N}$	A1	
	$\mu = 1.9086/3.4353$	M1	Use $F = \mu R$
	$\mu = 0.556$	A1	Accept $\mu = 0.56$
		5	