

Question	Answer	Marks	Guidance
1	$v^2 = 25^2 - (30\cos 60)^2$	M1	v = vertical velocity at the required point
	$v = (\pm) 20$	A1	
	$-20 = 30\sin 60 - gt$	M1	Use $v = u + at$ vertically
	$t = 4.6(0) \text{ s}$	A1	
		4	

Question	Answer	Marks	Guidance
2(i)	$\cos\theta = 0.2/0.3$	B1	Axis makes an angle θ with the horizontal
	$\tan\theta = x/0.3$	M1	
	$x = 0.335(41\dots)$	A1	
		3	
2(ii)		M1	Attempt to take moments about A
	$(\pi 0.3^2 h/3) \times (h/4) = (2\pi 0.2^3/3)(3 \times 0.2/8)$	A1	
	$h = 0.231$	A1	
		3	

Question	Answer	Marks	Guidance
3(i)	$20e/0.5 = 0.4g$	M1	Use $T = \lambda x/L$
	$e = 0.1$	A1	
	$0.4v^2/2 = 0.4g(0.5 + 0.1) - 20 \times 0.1^2/(2 \times 0.5)$	M1	Attempt to set up a 3 term energy equation
	$v = \sqrt{11} = 3.32$	A1	
		4	
3(ii)	$0.4g(5 + x) = 20x^2/(2 \times 0.5)$	M1	Attempt to set up a 2 term energy equation
	$[0 = 20x^2 - 4x - 2] [x = 0.432]$	M1	Attempt to solve a 3 term quadratic equation
	Distance below O = $(0.5 + 0.432) = 0.932$ m	A1	
		3	

Question	Answer	Marks	Guidance
4(i)	$T = 16(1.6 - 0.8 - x)/0.8 (= 16 - 20x)$	B1	Use $T = \lambda x/L$
	$0.5v dv/dx = 16(1.6 - 0.8 - x)/0.8 - 48x^2$	M1	Use Newton's Second Law horizontally
	$v dv/dx = 32 - 40x - 48x^2$	AG	A1
		3	

Question	Answer	Marks	Guidance
4(ii)	$48x^2 + 40x - 32 = 0$	M1	Put acceleration = 0 for maximum velocity
	$x = 0.5$	A1	
	$\int v dv = \int (32 - 40x - 48x^2) dx$ $(v^2/2 = 32x - 40x^2/2 - 48x^3/3 + c)$	M1	Attempt to integrate the equation from part (i)
	$4.5^2/2 = 32 \times 0.5 - 20 \times 0.5^2 - 16 \times 0.5^3 + c, c = 1.125$	M1	Substitute $x = 0.5, v = 4.5$ to find c
	$v = 1.5$	A1	Use $x = 0$
			5

Question	Answer	Marks	Guidance
5(i)	$0.1 \times 1.5^2 / 0.4 = T \cos \theta$	M1	Note $r = 0.4, \cos \theta = 0.8, \sin \theta = 0.6$ Use Newton's Second Law horizontally
	$T = 0.703$	A1	
	$R = 0.1g - T \sin \theta$	M1	Resolve vertically for P
	$R = 0.578$	A1	
			4

Question	Answer	Marks	Guidance
5(ii)	$T + T\sin\theta = 0.1g$	M1	Resolve vertically for P
	$T = 0.625$	A1	
	$0.1\omega^2 \times 0.4 = 0.625\cos\theta$	M1	Use Newton's Second Law horizontally
	$\omega = 3.54 \text{ rad s}^{-1}$	A1	
		4	

Question	Answer	Marks	Guidance
6(i)	Area of cross-section of prism = $0.5 \times 0.6 - 0.3 \times 0.3 / 2 = 0.375 \text{ m}^2$	B1	Area of cross-section of prism = area of rectangle – area of triangle
	$0.375y = 0.42 \times 0.6 / 2 - 0.045(0.6 - 0.3/3)$	M1	Take moments about BC
	$y = 0.276 \text{ m}$	AG A1	
	$0.375x = 0.42 \times 0.7 / 2 - 0.045(0.7 - 0.3/3)$	M1	Take moments about AB
	$x = 0.32 \text{ m}$	A1	
		5	
6(ii)		M1	Attempt to take moments about D
	$2\cos 45^\circ \times (0.7 - 0.32) = 2\cos 45^\circ \times (0.3 - 0.276) + W(0.3 - 0.276)$	A1	
	$W = 21(.0) \text{ N}$	A1	
		3	

Question	Answer	Marks	Guidance
7(i)	$x = (24\cos 60)t$	B1	Use horizontal motion
	$y = (24\sin 60)t - gt^2/2$	B1	Use vertical motion
	$(24\cos 60)t = (24\sin 60)t - gt^2/2$	M1	Recognise that $x = y$
	$t = 1.76$	A1	
		4	
7(ii)	$h = (24\sin 60)t - gt^2/2 - (24\cos 60)t$	B1	
		M1	Attempt to differentiate
	$dh/dt = 24(\sin 60 - \cos 60) - gt$	A1	
	$24(\sin 60 - \cos 60) - gt = 0, t = 0.878(46..)$	M1	Equate $dh/dt = 0$ to find t
	$h = 3.86 \text{ m}$	A1	
		5	