Question	Answer	Marks	Guidance
1	$v^2 = 25^2 - (30\cos 60)^2$	**M1**	v = vertical velocity at the required point
	v = (±) 20	**A1**	
	–20 = 30sin60 – gt	**M1**	Use v = u + at vertically
	t = 4.6(0) 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**	
	$x = 0.335(41..)$	**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**	
	$0.4v^2/2 = 0.4g(0.5 + 0.1) – 20\times0.1^2/(2\times0.5)$	**M1**	Attempt to set up a 3 term energy equation
	$v = \sqrt{11} = 3.32$	**A1**	
		4	
3(ii)	$0.4g(5 + x) = 20x^2/(2\times0.5)$	**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 $T = \lambda x/L$
	$0.5v\mathrm{d}v/\mathrm{d}x = 16(1.6 – 0.8 – x)/0.8 – 48x^2$	**M1**	Use Newton's Second Law horizontally
	$v\mathrm{d}v/\mathrm{d}x = 32 – 40x – 48x^2$ **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)**
	$4.5^2/2 = 32\times0.5 - 20\times0.5^2 - 16\times0.5^3 + c$, $c = 1.125$	**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)	$0.1\times1.5^2/0.4 = T\cos\theta$	**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
	$\omega = 3.54$ rad s^{-1}	**A1**	
		4	

Question	Answer	Marks	Guidance
6(i)	Area of cross-section of prism $= 0.5\times0.6 - 0.3\times0.3/2 = 0.375$ m^2	**B1**	Area of cross-section of prism = area of rectangle – area of triangle
	$0.375y = 0.42\times0.6/2 - 0.045(0.6 - 0.3/3)$	**M1**	Take moments about BC
	$y = 0.276$ m **AG**	**A1**	
	$0.375x = 0.42\times0.7/2 - 0.045(0.7 - 0.3/3)$	**M1**	Take moments about AB
	$x = 0.32$ m	**A1**	
		5	
6(ii)		**M1**	Attempt to take moments about D
	$2\cos45\times(0.7 - 0.32) = 2\cos45\times(0.3 - 0.276) + W(0.3 - 0.276)$	**A1**	
	$W = 21(.0)$ 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
	$h = 3.86$ m	**A1**	
		5	