Question	Answer	Marks	Guidance
1	$d = \sqrt{(0.2^2 + 0.2^2)}$ (= 0.2828) OR $AC = \sqrt{(0.4^2 + 0.4^2)}$ (= 0.56568..)	**B1**	Note $d = \frac{1}{2}AC$
	$\tan 30 = 0.2828 / (h / 2)$	**M1**	
	$h = 0.98(0)$	**A1**	$2\sqrt{6} / 5$
		3	

Question	Answer	Marks	Guidance
2	$u = 15\cos 35$ (= 12.287)	**B1**	Use horizontal motion
	$v = 15\sin 35 – 2g$ (= –11.396)	**B1**	Use vertical motion
	$V = \sqrt{(12.287^2 + 11.396^2)}$ OR $\tan\theta = \pm 11.396 / 12.287$	**M1**	
	$V = 16.8$ m s^{-1}	**A1**	
	$\theta = 42.8°$ below the horizontal	**A1**	
		5	

Question	Answer	Marks	Guidance
3(i)	$mg = 12(0.7 – 0.4) / 0.4$	**M1**	Use $T = \lambda x / L$
	$m = 0.9$ kg **AG**	**A1**	
		2	

Question	Answer	Marks	Guidance
3(ii)	EPE = $12(0.7 – 0.4)^2 / (2 \times 0.4)$	**B1**	Correct EPE term
	$0.9v^2 / 2 = 0.9g(0.7 – 0.4) + 0.9 \times 1^2 / 2 – 12(0.7 – 0.4)^2 / (2 \times 0.4)$	**M1**	Attempts a 4 term energy equation
		A1	Correct equation
	$v = 2$ m s^{-1}	**A1**	
		4	

Question	Answer	Marks	Guidance
4(i)	$(\tan\theta = 3)$ $\theta = 71.6°$	**B1**	Use the formula sheet for the trajectory equation
	$0.05 = g / (2V^2 cos^2 71.6)$	**M1**	
	$V = 10\sqrt{10} = 31.6$ m s^{-1}	**A1**	
		3	
4(ii)	$x = 3x – 0.05x^2$	**M1**	Use y = x
	$x = 40$ and y = 40	**A1**	
		2	

Question	Answer	Marks	Guidance
4(iii)	$dy / dx = 3 – 0.1x = 0$	**M1**	Use the fact that the gradient is zero at the highest point
	$x = 30$, $y = (3 \times 30 – 0.05 \times 30^2) = 45$	**A1**	
	$30 = (31.6\cos 71.6)t$	**M1**	Use horizontal motion
	$t = 3.01$	**A1**	$t = 3$ if exact arithmetic used
		4	

Question	Answer	Marks	Guidance
5(i)	*EITHER:* $R\cos 60 = 0.3g$	**(M1**	Resolve vertically
	$R = 6$ N	**A1**	
	$6\cos 30 = 0.3\omega^2 \times 0.4\cos 30$	**M1**	Use Newton's Second Law horizontally
	$\omega = 5\sqrt{2} = 7.07$ rad s^{-1}	**A1)**	
	OR: $0.3g\cos 30 = 0.3 \times (0.4\cos 30)\omega^2\cos 60$	**(M1**	Resolve along the tangent
		A1	Correct equation
	$\omega = 5\sqrt{2} = 7.07$ rad s^{-1}	**M1**	Attempt to solve for ω
		A1)	
		4	

Question	Answer	Marks	Guidance
5(ii)	$R\cos60 = 0.3g + 5\sin30$	**M1**	Resolve vertically
	$R = 11$ N	**A1**	
	$11\cos30 + 5\cos30 = 0.3v^2 / (0.4\cos30)$	**M1**	Resolve horizontally
	$v = 4$ m s^{-1}	**A1**	
		4	

Question	Answer	Marks	Guidance
6(i)	$R = 0.2g + 0.4t\sin\theta$ ($= 2 + 0.24t$) $F = 0.5(2 + 0.24t) = 1 + 0.12t$	**M1**	Note $\sin\theta = 0.6$ and $\cos\theta = 0.8$ ($\theta = 36.87°$) Resolve vertically and use $F = \mu R$
	$0.4t\cos\theta = 1 + 0.12t$	**M1**	Resolve horizontally
	$t = 5$	**A1**	
		3	
6(ii)	$0.2\mathrm{d}v/\mathrm{d}t = 0.4t \times 0.8 – (1 + 0.12t)$	**M1**	Use Newton's Second Law horizontally
	$\mathrm{d}v / \mathrm{d}t = t – 5$ **AG**	**A1**	
		2	

Question	Answer	Marks	Guidance
6(iii)	$\int \mathrm{d}v = \int (t-5)\,\mathrm{d}t$ $v = t^2/2 - 5t + c$	**M1**	Attempt to integrate the equation from part **(ii)**
	$v = 0$ when $t = 5$ hence $c = 12.5$	**A1**	Finds the constant of integration, c
	$v = 8^2/2 - 5 \times 8 + 12.5 = 4.5$	**A1**	Find v when $t = 8$
	$a = -0.5 \times 0.2g / 0.2 = -5\ \mathrm{m\,s^{-1}}$ and $s = 4.5^2/(2 \times 5)$	**M1**	Finds a and uses $v^2 = u^2 + 2as$
	$s = 2.025$ m	**A1**	
		5	

Question	Answer	Marks	Guidance
7(i)	$\tan 48 = \bar{x}/0.3$	**M1**	$\bar{x}$ is the distance of the centre of mass from AD
	$\bar{x} = 0.3332$	**A1**	
	$0.6^2 \times 0.3 = \pi r^2 \times 0.25 + (0.6^2 - \pi r^2)\bar{x}$ OR $0.6^2 \times 0.3 = \pi r^2 \times 0.35 + (0.6^2 - \pi r^2) \times (0.6 - \bar{x})$	**M1**	Take moments about AD Take moments about BC
	$\pi r^2 \times (0.3332 - 0.25) = 0.6^2 \times (0.3332 - 0.3)$ OR $\pi r^2 (0.6 - 0.3332 - 0.35) = 0.6^2\,(0.6 - 0.3332 - 0.3)$	**A1**	
	$r = 0.214$ **AG**	**A1**	
		5	

Question	Answer	Marks	Guidance
7(ii)	$0.3W = 0.6 \times 15\cos 60$	**M1**	Take moments about C.(W = weight of the lamina)
	$W = 15$	**A1**	
	Square = $15 \times 0.6^2 / (0.6^2 - \pi \times 0.214^2)$	**M1**	Recognise that the ratio of weights = ratio of areas
	Square = 25(.0) N	**A1**	
		4	