Question	Answer	Marks	Guidance
1	$\tan 40 = v / 20\cos 60$	**M1**	
	$v = 10\tan 40$ (= 8.3909...)	**A1**	
	$-10\tan 40 = 20\sin 60 - gt$	**M1**	Uses $v = u + at$ vertically
	$t = 1.27$ s	**A1**	
	Total:	**4**	
2(i)	$7 = 0.35\lambda / 0.25$	**M1**	Uses $T = \lambda x / L$
	$\lambda = 5$	**A1**	
	Total:	**2**	
2(ii)	EE $= 0.35^2 \times 5 / (2 \times 0.25)$ or $0.05^2 \times 5 / (2 \times 0.05)$	**B1**	Uses EE $= \lambda x^2 / 2L$
	PE $= mg \times 0.3\sin 30$	**B1**	
	$mg \times 0.3\sin 30 = 0.35^2 \times 5 / (2 \times 0.25) - 0.05^2 \times 5 / (2 \times 0.25)$	**M1**	Sets up a 3 term energy equation involving EE, KE and PE
	$m = 0.8$	**A1**	
	Total:	**4**	

Question	Answer	Marks	Guidance
3(i)	CofM of hemisphere $= \frac{3}{8} \times 0.56$ or $\frac{3}{8} \times 0.28$	**B1**	
	$[\frac{2}{3}\pi \times 0.56^3 - \frac{2}{3}\pi \times 0.28^3]X = \frac{2}{3}\pi \times 0.56^3 \times \frac{3}{8} \times 0.56 - \frac{2}{3}\pi \times 0.28^3 \times \frac{3}{8} \times 0.28$	**M1A1**	Take moments about O
	$X = 0.225$ m	**A1**	
	Total:	**4**	
3(ii)	$24 \times 0.225 + W(3 \times 0.28 / 8) = (24 + W) \times 0.15$	**M1A1**	Attempts to take moments about O W = weight of uniform hemi-sphere
	$W = 40$ N	**A1**	
	Total:	**3**	
4(i)	$x = 10t$ or $y = gt^2 / 2$	**B1**	
	$y = 15x / 10 - g(x / 10)^2 / 2$	**M1A1**	Attempts to eliminate t
	$y = 1.5x - 0.05x^2$	**A1**	
	Total:	**4**	

Question	Answer	Marks	Guidance
4(ii)	$0 = 1.5x - 0.05x^2$	**M1**	Substitute $y = 0$ into the trajectory equation
	$x = 30$	**A1**	
	Total:	**2**	
4(iii)	$-14 = 1.5x - 0.05x^2$	**M1**	Sets up a quadratic equation and attempts to solve it
	$x = 37.5$	**A1**	
	Total:	**2**	
5(i)	OG = $2 \times 0.7\sin(\pi / 2) / (3\pi / 2)$ (= 0.297)	**B1**	
	$0.9R = 14(0.7\cos30 - 0.297\sin30)$	**M1A1**	Attempts to take moments about A
	$R = 7.12$ N	**A1**	
	Total:	**4**	
5(ii)	H = 7.12sin30 and V = 14 − Rcos30	**M1**	Resolves horizontally and vertically
	$\tan\theta = (14 - 7.12\cos30) / (7.12\sin30)$	**M1**	Uses $\tan\theta$ = V / H, where θ is the required angle
	$\theta = 65.6$	**A1**	
	Total:	**3**	

Question	Answer	Marks	Guidance
6(i)	$T = 12 \times 0.1 / 0.4$ (= 3 N)	**B1**	Uses $T = \lambda x / L$
	$3\sin\theta = 0.15\,\omega^2 (0.5\sin\theta)$	**M1**	Uses Newton's Second Law horizontally
	$\omega = 6.32$ rad s^{-1}	**A1**	
	$T\cos\theta = 0.15g$ $(\cos\theta = 0.5)$	**M1**	Resolves vertically
	$\theta = 60$	**A1**	
	Total:	**5**	
6(ii)	$v = 6.32 \times 0.5\sin 60$	**B1 FT**	Uses $v = r\omega$ and r = 0.5sin60
	KE = $0.15(6.32 \times 0.5\sin 60)^2 / 2$ (=0.5625J)	**B1**	
	Difference = $0.5625 - 12 \times 0.1^2 / (2 \times 0.4)$	**M1**	Uses EE = $\lambda x^2 / (2L)$
	Difference = 0.4125 J	**A1**	
	Total:	**4**	
7(i)	$\mu = 0.6 \times 0.5^2 / (0.5\,g)$ (= 0.03)	**B1**	Uses $F = \mu R$
	$0.5\mathrm{d}v / \mathrm{d}t = 0.6\,t^2 - 0.03 \times 0.5g$	**M1**	Uses Newton's Second Law horizontally
	$\mathrm{d}v / \mathrm{d}t = 1.2\,t^2 - 0.3$	**A1**	
	Total:	**3**	

Question	Answer	Marks	Guidance
7(ii)	$\int dv = \int (1.2t^2 - 0.3)\, dt$ $v = 0.4t^3 - 0.3t\ (+c)$	**M1**	Separates the variables and attempts to integrate
	$t = 0.5$, $v = 0$ hence c = 0.1	**M1**	Attempts to find c
	$v = 0.4t^3 - 0.3t + 0.1$	**A1**	
	Total:	**3**	
7(iii)	$\int dx = \int (0.4t^3 - 0.3t + 0.1)\, dt$ $x = 0.1t^4 - 0.15t^2 + 0.1t\ (+c)$	**M1**	Attempts to integrate
	$t = 0.5$, $x = 0$ hence c = –0.01875	**M1**	Finds c or substitutes the limits
	$x(1.2) = 0.0926(1)$	**A1**	
	Total:	**3**	