Question	Answer	Marks	Guidance
1	$R = 0.4 \times 6^2 \times 0.5$ (= 7.2 N)	**B1**	Uses Newton's Second Law horizontally and $a = r\omega^2$.
	$F = 0.4g$	**B1**	Resolve vertically.
	$\mu = 4/7.2$	**M1**	Use $F = \mu R$.
	$\mu = 0.556$ or 5/9	**A1**	Accept $\mu = 0.56$.
		4	

Question	Answer	Marks	Guidance
2	$V\cos\theta = 4\cos45$	**B1**	Using horizontal motion with V = velocity of projection and θ = angle of projection.
	$(4\sin45)^2 = (V\sin\theta)^2 - 2g(9–1.5)$ (leads to $V\sin\theta = \sqrt{158}$)	**M1**	Uses $v^2 = u^2 + 2as$ vertically.
	$\tan\theta = \sqrt{158}/(4\cos45)$	**M1**	Uses trigonometry.
	$\theta = 77.3°$	**A1**	
		4	

Question	Answer	Marks	Guidance
3(i)	$T\sin60 + R = 0.6g$	**M1**	Resolves vertically.
	$T\cos60 = 0.6 \times 0.5^2/(0.4\cos60)$	**M1**	Uses Newton's Second Law horizontally.
	$T = 1.5$	**A1**	
	$R = 4.7(0)$ N	**A1**	
		4	
3(ii)	$T\sin60 = 0.6g$ (leads to $T = 6.9282...$)	**M1**	Resolve vertically. Note $R = 0$.
	$6.9282...\cos60 = 0.6v^2/(0.4\cos60)$	**M1**	Use Newton's second Law horizontally.
	$v = 1.07$	**A1**	Greatest value.
		3	

Question	Answer	Marks	Guidance
4(i)	$x = (25\cos 30)t$	**B1**	Horizontal motion.
	$y = (25\sin 30)t - gt^2/2$	**B1**	Vertical motion.
	$y = (25\sin 30)x / (25\cos 30) - 5[x/(25\cos 30)]^2$	**M1**	Attempts to eliminate t.
	$y = \frac{x}{\sqrt{3}} - \frac{4x^2}{375}$	**A1**	AG
		4	
4(ii)	$5 = x/\sqrt{3} - 4x^2/375$ (leads to $4x^2 - 216.5x + 1875 = 0$)	**M1**	Substitutes $y = 5$ into the trajectory equation.
	$x = 43.3, 10.8$	**A1**	Solves the quadratic equation.
	Distance = 43.3 – 10.8 = 32.5 m	**A1**	
		3	

Question	Answer	Marks	Guidance
5(i)	$0.3g = 24e$	**M1**	Use $T = \lambda x/L$
	$e = 0.1$	**A1**	
	$EE = 24 \times (1.2–0.8)^2/(2 \times 0.8)$ or $24 \times 0.1^2/(2 \times 0.8)$	**B1**	Use $EE = \lambda x^2/(2L)$.
	$0.3v^2/2 = 0.3 \times 4^2/2 + 24 \times (1.2 - 0.8)^2/(2 \times 0.8)$ $-24 \times 0.1^2/(2 \times 0.8) - 0.3g(1.2 - 0.8)$	**M1**	Sets up a 5 term energy equation involving EE, KE and PE.
	$v = 5$ m s^{-1}	**A1**	
		5	
5(ii)	$0.5 \times 5^2/2 + 24 \times 0.1^2/(2 \times 0.8) = 0.3(x + 0.9) \times 10$	**M1**	Sets up a 3 term energy equation where x is the distance above 0 when $v = 0$.
	$x = 0.4$	**A1**	
	Distance moved = 0.8 + 0.4 = 1.2 m	**A1**	AG
		3	

Question	Answer	Marks	Guidance
6(i)	$20 \times 3 \times 0.4/8 = 20 \times h/2$	**M1**	Takes moments about the common surface.
	$h = 0.3$ m	**A1**	AG
		2	
6(ii)	Cylinder moment $= 10 \times 0.15/2$	**B1**	
	$20 \times 3 \times 0.4/8 - 10 \times 0.15/2 = 30x$	**M1A1**	Takes moments about the base of the cylinder.
	$x = 0.075$ m	**A1**	
		4	
6(iii)	$30 \times 0.075\sin 60 = P \times 0.4\sin 60$	**M1A1**	Takes moments about point of contact of the cylinder with the surface.
	$P = 5.625$	**A1**	
		3	

Question	Answer	Marks	Guidance
7(i)	$0.2v\mathrm{d}v/\mathrm{d}x = 0.2g\sin 60 - 0.3 \times 0.2g\cos 60 - 0.6x$	**M1A1**	Uses Newton's Second Law parallel to the plane. Correct equation.
	$v\mathrm{d}v/\mathrm{d}x = 5\sqrt{3} - 1.5 - 3x$	**A1**	AG
		3	
7(ii)	$x = (5\sqrt{3} - 1.5)/3$ (= 2.39)	**B1**	Uses $a = 0$.
	$\int v\,\mathrm{d}v = \int(5\sqrt{3} - 1.5 - 3x)\,\mathrm{d}x$	**M1**	Separates the variables and attempts to integrate.
	$v^2/2 = 5\sqrt{3}\,x - 1.5x - 3x^2/2\ (+c)$	**A1**	Allow $c = 0$ without calculation seen.
	$v = 4.13$	**A1**	Substitutes $x = 2.39$.
		4	

Question	Answer	Marks	Guidance
7(iii)	$0 = 5\sqrt{3}\,x - 1.5x - 3\,x^2/2$	**M1**	Puts $v = 0$ and attempts to solve a quadratic equation.
	$x = 4.77(35...)$	**A1**	
	$a = 5\sqrt{3} - 1.5 - 3 \times 4.77(35\ldots)$	**M1**	
	Magnitude of $a = 7.16\ \text{m s}^{-2}$	**A1**	
		4	