Question	Answer	Marks	Guidance
1	$R = 0.4 \times 6^2 \times 0.5 \ (= 7.2 \text{ N})$	B1	Uses Newton's Second Law horizontally and $a = r \omega^2$.
	F = 0.4 g	B1	Resolve vertically.
	$\mu = 4/7.2$	M1	Use $F = \mu R$.
	$\mu = 0.556 \text{ or } 5/9$	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 $\theta =$ angle of projection.
	$(4\sin 45)^2 = (V\sin\theta)^2 - 2g(9-1.5)$ (leads to $V\sin\theta = \sqrt{158}$)	M1	Uses $v^2 = u^2 + 2as$ vertically.
	$\tan\theta = \sqrt{158} / (4\cos 45)$	M1	Uses trigonometry.
	$\theta = 77.3^{\circ}$	A1	
		4	

Question	Answer	Marks	Guidance
3(i)	$T\sin 60 + R = 0.6g$	M1	Resolves vertically.
	$T\cos 60 = 0.6 \times 0.5^2 / (0.4 \cos 60)$	M1	Uses Newton's Second Law horizontally.
	T = 1.5	A1	
	R = 4.7(0) N	A1	
		4	
3(ii)	$T\sin 60 = 0.6g$ (leads to $T = 6.9282$)	M1	Resolve vertically. Note $R = 0$.
	$6.9282\cos 60 = 0.6 v^2 / (0.4\cos 60)$	M1	Use Newton's second Law horizontally.
	<i>v</i> = 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 <i>t</i> .
	$y = \frac{x}{\sqrt{3}} - \frac{4x^2}{375}$	A1	AG
		4	
4(ii)	$5 = \frac{x}{\sqrt{3}} - 4\frac{x^2}{375}$ (leads to $4x^2 - 216.5x + 1875 = 0$)	M1	Substitutes $y = 5$ into the trajectory equation.
	<i>x</i> = 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	
	$EE = 24 \times (1.2 - 0.8)^2 / (2 \times 0.8) \text{ or } 24 \times 0.1^2 / (2 \times 0.8)$	B1	Use $EE = \lambda x^2 / (2L)$.
	$0.3 v^2 / 2 = 0.3 \times 4^2 / 2 + 24 \times (1.2 - 0.8)^2 / (2 \times 0.8)$ -24 × 0.1 ² / (2 × 0.8) - 0.3g(1.2 - 0.8)	M1	Sets up a 5 term energy equation involving <i>EE</i> , <i>KE</i> and <i>PE</i> .
	$v = 5 \text{ m s}^{-1}$	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.
	<i>P</i> = 5.625	A1	
		3	

Question	Answer	Marks	Guidance
7(i)	$0.2vdv/dx=0.2gsin60 - 0.3 \times 0.2gcos60 - 0.6x$	M1A1	Uses Newton's Second Law parallel to the plane. Correct equation.
	$v dv/dx = 5\sqrt{3} - 1.5 - 3x$	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)	$0 = 5\sqrt{3} x - 1.5x - 3x^2/2$	M1	Puts $v = 0$ and attempts to solve a quadratic equation.
	x = 4.77(35)	A1	
	$a = 5\sqrt{3} - 1.5 - 3 \times 4.77(35)$	M1	
	Magnitude of $a = 7.16 \text{ m s}^{-2}$	A1	
		4	