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1	$\frac{dv}{dt} = e^{-0.5v}$ $\int \frac{1}{e^{-0.5v}} dv = \int dt$ $\frac{e^{-0.5v}}{0.5} = t(+c)$ $t = 0, v = 2 \text{ so } c = 2e$ $v = 2.4(0) \text{ when } t = 1.2$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p>	4	<p>Separates the variables and attempts to integrate</p> <p>$c = 5.4365\dots$ or use of limits</p>
2 (i)	$T = \frac{20(0.8\sin\theta)}{0.8}$ <p>AG</p>	B1	1	Hence $20\sin\theta$
(ii)	No friction (so perpendicular) AG	B1	1	Or ring smooth
(iii)	$20\sin\theta(0.8\cos\theta) = 8(0.6\sin\theta) + 2(1.2\sin\theta)$ $\theta = 63.3^\circ$	<p>M1</p> <p>A1</p> <p>A1</p>	3	<p>Moments about A (3 terms)</p> <p>All terms correct</p> <p>Accept 1.1 radians</p>
3 (i)	$0.3v \frac{dv}{dx} = -2x$ $k = -\frac{20}{3} = -6\frac{2}{3}$	<p>M1</p> <p>A1</p>	2	
(ii)	$\int_8^0 v dv = -\frac{20}{3} \int_0^x x dx$ $x = 3.1(0)$	<p>M1</p> <p>M1</p> <p>A1</p>	3	<p>Integrates acceleration</p> <p>Uses limits or finds constant of integration</p>
4 (i)	$T\cos 30^\circ - T\cos 45^\circ = 0.3g$ $T = 18.9$ $18.9\sin 30^\circ + 18.9\sin 45^\circ = \frac{0.3v^2}{0.6}$ $v = 6.75 \text{ ms}^{-1}$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1</p>	5	<p>Resolves vertically</p> $T = 6\sqrt{3} + 6\sqrt{2}$ <p>Resolves horizontally, Acceleration = v^2/r</p>
(ii)	$L = \frac{0.6}{\sin 30^\circ} + \frac{0.6}{\sin 45^\circ}$ $0.3 \times 3^2 (2.05\sin\theta) = T\sin\theta$ $T = 5.53 \text{ N}$	<p>B1</p> <p>M1</p> <p>A1</p>	3	2.0485...

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5	(i)	$0.2g = R + 21 \times \frac{0.05}{0.75}$ $R = 0.6\text{N}$	M1 A1	2	
	(ii)	$21 \left(\frac{0.8}{\cos \theta - 0.75} \right) / (0.75 \cos \theta) = 0.2g$ $e = 0.0735$ <p>OR</p> $\frac{21e}{0.75} \times \frac{0.8}{(e + 0.75)} = 0.2g$ $e = 0.073529\dots$	M1 A1 A1 M1 A1 A1	3	$\theta = \text{angle of string with vertical}$ Comp of tension = weight $\theta = 13.7(291\dots)$ $e = 0.8/\cos \theta - 0.75 = 0.073529\dots$ $e = \text{extension}$ Comp of tension = weight
	(iii)	$\frac{0.2(3)^2}{2} + \frac{21(0.05)^2}{(2 \times 0.75)} = \frac{0.2v^2}{2} + \frac{21 \times 0.0735^2}{1.5}$ $v = 2.93 \text{ms}^{-1}$	M1 A1 A1	3	Uses EE/KE balance
6	(i)	Mass of disc = $\pi(1.2^2 - 0.4^2 - 0.3^2)$ $0 = \pi(1.2^2 - 0.4^2 - 0.3^2)y - (0.4^2) \times 0.7$ $y = 0.0941 \text{m}$	B1 M1 A1 A1	4	1.19π (or in (ii)) $\text{LHS} = \pi(1.2^2 - 0.3^2) \times 0$
	(ii)	$0 = \pi(1.2^2 - 0.4^2 - 0.3^2)x - \pi(0.3^2) \cdot 5$ $x = 0.0378 \text{m}$	M1 A1 A1	3	$\text{LHS} = \pi(1.2^2 - 0.4^2) \times 0$
	(iii)	$\tan \theta = \frac{0.0941176}{0.0378151}$ $\theta = 68.1^\circ$	M1 A1	2	

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7	(i)	$(x =) V\cos 45t = V\cos 60(t+1)$ $t = 2.414$	M1 A1 A1	AG	3	Equates horizontal distances Terms correct
	(ii)	$(y =) V\sin 45t - \frac{gt^2}{2} =$ $V\sin 60(t+1) - \frac{g(t+1)^2}{2}$ $V\{\sin 60(3.414) - \sin 45(2.414)\} =$ $5\{(3.414)^2 - (2.414)^2\}$ $V = 23.3$	M1 A1 M1 A1		4	Equates vertical distances Terms correct Gathers terms correctly 23.32...
	(iii)	Greatest $H = \frac{23.32^2 \sin^2 60}{(2g)}$ $h = 23.3\sin 60(3.414) - \frac{g(3.414)^2}{2}$ $h = 10.67$ Falls 9.72 m	B1 ^h M1 A1 A1		4	20.39, ft cv(23.3) ² ×3/80