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1	$Y = g1.6^2 / 2$ $12.8 / (1.6V) = \tan 30$ $V = 13.9 \text{ m s}^{-1}$	B1 M1 A1	[3]	12.8 m $1.6V = X = 22.17 \text{ m}$
2 (i)	$5 = 24e / 0.6$ $AP = 0.725 \text{ m}$	M1 A1	[2]	Hence $e = 0.125$
(ii)	$24 \times 0.125^2 / 2 \times 0.6$ $0.5g \times 0.725 =$ $24 \times 0.125^2 / 2 \times 0.6 + 0.5v^2 / 2$ $v = 3.64 \text{ m s}^{-1}$	B1 M1 A1	[3]	EE at eqm (= 0.3125) KE/EE/PE conservation
3 (i)	$F \cos 45 = 10 \cos 60$ $F = 7.07$ $F \sin 45 + 10 \sin 60 = W$ $W = 13.7$	M1 A1 M1 A1	[4]	Resolving horizontally $7.071 \dots = 5\sqrt{2}$ Resolving vertically $13.660 \dots = 5(\sqrt{2} + \sqrt{3})$
(ii)	$Wd \cos 30 = (F \sin 75) 0.5$ $d = 0.289 \text{ m}$	M1 A1 A1	[3]	Moments about A
4 (i)	$-20 \sin 30 = 20 \sin 30 - gT$ $T = 2 \text{ s}$ $OA = 34.6 \text{ m}$	M1 A1 B1	[3]	
(ii)	$V_v^2 = 18^2 - (20 \cos 30)^2$ $V_v = (\pm) 4.899$ $4.899 = 20 \sin 30 - gt$ $t = 0.51(0) \text{ s}$ $-4.899 = 8 - gt$ $t = 1.29$ $T = 3.29 \text{ s}$	M1 A1 M1 A1 A1	[5]	

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5	(i)	$0.4dv/dt = 3e^{-t} - 0.4g\sin 30$ $dv/dt = 7.5e^{-t} - 5$ AG	M1 A1	[2]	
	(ii)	$\int_0^v dv = \int_0^t (7.5e^{-t} - 5) dt$ $v = 7.5 - 7.5e^{-t} - 5t$ AG	M1 M1 A1	[3]	Integrates accn Limits or finds integration constant
	(iii)	Solves $dv/dt = 0$ $\int_0^x dx = \int_0^{0.405} (7.5 - 7.5e^{-t} - 5t) dt$ $x = 0.13(0) \text{ m}$ AG	M1 M1 A1	[3]	$t = 0.405(46\dots)$ Integrates expression for v and uses $t = 0.405$
6	(i)	CoM semi-circle from $DF = 4r/3\pi$ $(0.4 \times 1.8) \times 0.2 = (\pi r^2 / 2) \times (4r/3\pi)$ $r = 0.6$ AG	B1 M1 A1	[3]	Moments about A
	(ii)	$P\cos 60(0.4 + 0.6\cos 60)$ $P\cos 30(1.8 - 0.6 + 0.6\sin 60)$ $15 \times 0.4 =$ $P\cos 60(0.4 + 0.6\cos 60)$ $+ P\cos 30(1.8 - 0.6 + 0.6\sin 60)$ $P = 3.26 \text{ N}$ AG	B1 B1 M1 A1	[4]	Moment of vertical component Moment of horiz component 3.2622...
	(iii)	$\mu = 3.262\sin 60 / (15 - 3.262\cos 60)$ $\mu = 0.211$ AG	M1 A1	[2]	
7	(i)	$R\cos 30 = 0.5g$ $R = 5.77(35\dots)$ $R\sin 30 = 0.5\omega^2 \times 0.4$ $\omega = 3.8(0) \text{ rad s}^{-1}$ AG	M1 A1 M1 A1	[4]	

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(ii)	$T = 36(0.5 - 0.45) / 0.45$	M1	[6]	4 N
	$\text{Vert cmpt} = 4 \times 0.3 / 0.5 = 2.4$	A1		
	$\text{Horiz cmpt} = 4 \times 0.4 / 0.5 = 3.2$	A1		
	$R \cos 30 + 2.4 = 0.5g$	M1		
	$R = 3(.00\dots) \text{ N}$	M1		
	$0.5v^2 / 0.4 = 3.2 + R \sin 30$	M1		
	$v = 1.94 \text{ m s}^{-1}$	A1		