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1	**(i)**	$D = 2(0.8/2)\sin(\pi/2)/[3(\pi/2)]$	M1		
		$D = 0.17(0)$ m	A1	2	
	(ii)	$0.17mg = 0.8(6\cos20)$	M1 A1✓		Moments about B ft candidate value (0.17)
		$m = 2.66$ kg	A1	3	Accept 2.65
2	**(i)**	Vert comp vel $= V\sin60 - 1.5g$	B1		
		$V\cos60 = V\sin60 - 1.5g$	M1		$(V\sin60-1.5g)/(V\cos60) = \tan45$
		$V = 41(.0)$	A1	3	
	(ii)	$X\,[= (41\cos60) \times 1.5] = 30.7$ m	B1✓		ft candidate value $(41.0) \times 0.75$ Allow 30.8
		$Y\,[=(41\sin60) \times 1.5 - g1.5^2/2]=42(.0)$ m	B1✓	2	ft candidate value $(41.0) \times 1.3 - 11.25$
3	**(i)**	$20x/0.4 = 0.5g\sin30$	M1		λext/nat length = comp weight
		$x = 0.05$ m	A1	2	
	(ii)	$20(0.05)^2/(2 \times 0.4)+0.5 \times 5^2/2 =$ $20e^2/(2 \times 0.4)+0.5 \times 2^2/2$ $-0.5(e-0.05)g\sin30$	M1 A1		KE/PE/EE balance with 2 KE and 2 EE terms All terms without e correct
		$2.5e^2 - 2.5e - 5.1875 = 0$	M1		Creates /attempts to solve a 3 term quadratic equation
		$e = 0.508$	A1	4	
4	**(i)**	$-1.5 = 29\sin30t - gt^2/2$	M1		$5t^2 - 14.5t - 1.5 = 0$
		$t = 3$ AG	A1	2	
	(ii)	$y' = 29\sin30 - 3g$	B1		15.5 ms^{-1} down, landing
		$v^2 = (29\cos30)^2 + 15.5^2$ or $v^2 = 29^2 + 2g \times 1.5$ or $\tan\theta=(3g-29\sin30)/(29\cos30)$	M1		
		$v = 29.5$ ms^{-1}	A1		
		$\theta = 31.7°$ with the horizontal	A1	4	58.3° to the vertical
5	**(i)**	C of M is 0.1 m from AB	B1		
		$0.05T = 20(0.25 - 0.1)$	M1		Moments about D
		$T = 60$ N AG	A1	3	

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	(ii)	$60 = 48e/0.6$	M1		Toppling $T = \lambda$ext/nat length	
		$e = 0.75$ m	A1			
		$2.5v^2/2 + 48(0.75)^2/(2 \times 0.6) =$ $2.5g(0.75 + 0.6)$	M1 A1		KE/EE/PE balance	
		$v = 3$ ms^{-1}	A1	5		
6	(i)	$60dv/dt = 150 - 12v$	M1		Newton's Second Law, 2 force terms	
		$5dv/dt = 12.5 - v$ AG	A1	2		
	(ii)	$\int 5dv/(12.5 - v) = \int dt$	M1		Separates variables and attempts to integrate	
		$-5\ln(12.5 - v) = t\ (+c)$	A1			
		$t = 0, v = 11.5$ hence $c = 0$	M1		Explicit after integration (or limits)	
		$v = 12.5 - e^{-0.2t}$ AG	A1	4		
	(iii)	$x = \int(12.5 - e^{-0.2t})\,dt$ $x = 12.5t - e^{-0.2t}/(-0.2)\ (+c)$	B1		Award if $+c$ omitted	
		$t = 0, x = 0$ so $c = -5$	M1		Or limits	
		$x = 12.5t + 5e^{-0.2t} - 5$	A1	3		
7	(i)	$T\cos\theta = 0.7g$	M1		$\cos\theta = 0.14/0.5$	
		$T = 25$ N	A1			
		$25 \times 0.48/0.5 \geqslant 0.7\omega^2 \times 0.48$	M1		Uses accn. $= \omega^2 r$	
		$\omega \leqslant 8.45$ rad s^{-1}	A1	4	Accept <	
	(ii)	$T\cos\theta = 0.7g - 1.4$	B1		$T\cos\theta = 5.6$	
		$T\sin\theta = 0.7 \times 2.5^2/(0.5\sin\theta)$	M1			
		$T\sin^2\theta = 8.75$	A1			
		$T\sin^2\theta/T\cos\theta = 8.75/5.6$	M1		$T\sin^2\theta + T\cos^2\theta = 8.75 + 5.6^2/T$	
		$1 - \cos^2\theta = 1.5625\cos\theta$	A1		$T^2 = 8.75T + 5.6^2$	
		$\cos\theta = 0.487(746..)$ $T = 11.5$ N	A1		$\theta = 60.8°$ $T = 11.5$ N	
		$h = 0.244$	A1	7		