1	**(i)**	$F = 0.4 \times 1.5^2/(0.6/2)$	M1		$Acc^n = v^2/r$ (accept 0.6 as r)	
		$F = 3$ N	A1	[2]		
	(ii)	$R^2 = 3^2 + (0.4g)^2$	M1		Uses Pythagoras with normal force from base and answer (i)	
		$R = 5$ AG	A1		From g = 10 only	**[4]**
2	**(i)**	OG = (0.1061) = 0.106 m	B1	[1]	$OG = (2 \times 0.25\sin\pi/2)/(3\pi/2)$	
	(ii)	$\tan\theta = 0.1061/0.25$	M1		Candidate's OG	
		$\theta = 23(.0)^\circ$	A1	[2]		
	(iii)		M1		Takes moments about A	
		$0.1061W = (6\cos45) \times (2 \times 0.25)$	A1ft		ft cv(OG(i))	
		W = 20(.0) N	A1	[3]		**[6]**
3	**(i)**	$EE = 18 \times (1.8 - 1.6)^2/(2 \times 1.6)$	B1			
		$0.2 \times 1.5^2/2 = 18(1.8 - 1.6)^2/(2 \times 1.6) + KE_B$	M1		Energy equation, 3 terms	
		$KE_B = 0$ leads to $v_B = 0$	A1	[3]		
	(ii)	$T = 18 \times (1.8 - 1.6)/1.6$	B1		T = 2.25	
		$T\cos\theta + R = 0.2g$	M1			
		$2.25 \times 1.6/1.8 + R = 0.2g$	A1			
		R = 0	A1	[4]	Needs g = 10	**[7]**
4	**(i)**	$V\sin40 - (1.8/2)g = 0$	M1		Or $0 = (V\sin40) \times 1.8 - g \times 1.8^2/2$	
		$V = 14(.0)$ ms^{-1}	A1	[2]		
	(ii)	$(14\sin40)^2 = 2gh$	M1		Or $h = (V\sin40) \times 0.9 - g \times 0.9^2/2$	
		h = 4.05 m	A1	[2]		
	(iii)	$d = (14\cos40) \times 1.8$	M1		Or $d = V^2\sin80/g$	
		d = 19.3 m	A1	[2]		**[6]**
5	**(i)**	Ext = 0.8 + 0.9 – 1.4 (= 0.3 m)	B1		Ext when in limiting equilibrium	
		$EE = 70 \times 0.30^2/(2 \times 1.4)$ (= 2.25 J)	B1		EE in limiting equilibrium	
			M1		EE/PE/KE balance	

		$0.3v^2/2 = 0.3gx0.8 - 2.25$	A1			
		$v = 1\ ms^{-1}$	A1	[5]		
	(ii)	$T = 70 \times 0.3/1.4$ (= 15N)	B1		Uses ext from part (i)	
		$15 = \mu(3g)$	M1		F = μR, using mass of B	
		$\mu = 0.5$	A1	[3]		**[8]**
6	**(i)**		M1		Taking moments with 3 terms	
		$OG(0.5 + 0.2) = 0.5 \times 0.6/4 + 0.2 \times (0.6 - 0.4\cos 60)$	A1		Correct equation	
		$OG = 0.221$ m	A1	[3]		
	(ii)	$T\cos 60 + R\sin 60 = 0.2\ g$	M1		Either for resolving horizontally or vertically	
		$T\sin 60 - R\cos 60 = 0.2 \times 4^2 \times (0.4\sin 60)$	A1		Both equations correct	
		Solves 2 simultaneous equations	M1		2 equations, 2 unknowns	
		$T = 1.96$ N AG	A1		g = 10 only	
		$R = 1.18$ N	A1	[5]	Allow values from g not 10	
	OR	$0.2 \times 4^2 \times 0.4\sin 60\cos 30 = T - 0.2g\cos 60$	M1		Resolves acc^n and weight parallel to the slope	
		$T = 1.96$ N AG	A1		From g = 10 only	
		$0.2 \times 4^2 \times 0.4\sin 60\cos 60 = 0.2g\sin 60 - R$	M1		Resolves acc^n and weight perpendicular to the slope	
			A1		Both equations correct	
		$R = 1.18$ N	A1		Allow values from g not 10	
	(iii)	$v = 1.39\ ms^{-1}$	B1	[1]	$r\omega$ = 1.3856..	**[9]**
7	**(i)**	$0.5a = 0.16e^x$	M1		N2L, single force	
		$a = 0.32e^x$	A1			
		$\int v\,dv = \int 0.32e^x\,dx$	M1		Forms integral from $v\,dv/dx = a$	
		$v^2/2 = 0.32e^x$ (+c)	A1		Award if c omitted	
		$x = 0$, $v = 0.8$ hence c = 0, so $v^2 = 0.64e^x$	M1		Trying to find the value of c	

	$v = 0.8e^{x/2}$ AG	A1	[6]		
OR	$dv/dt = 0.8e^{x/2}\, x dx/dt$	M1		Uses chain rule on given answer	
	$dv/dt = 0.4e^{x/2}.v$	A1		Maybe implied by later work	
	$x = 0$, $v = 0.8e^{0}$	M1		Finding speed where $x = 0$	
	$x = 0$, $v = 0.8$	A1			
	$0.5dv/dt = (0.2e^{x/2})(0.8e^{x/2})$	M1		Expresses "ma" in terms of x	
	$0.5acc^{n} = 0.16e^{x}$	A1			
(ii)	$\int e^{-x/2}dx = \int 0.8dt$	M1		Forms integral from $dx/dt = 0.8e^{x/2}$	
	$e^{-x/2}/(-1/2) = 0.8t$ (+c)	A1		Award if c omitted	
	$x = 0$, $t = 0$, hence c = –2 and $-2e^{-1.4/2} = 0.8t - 2$	M1		Finding c and using $x = 1.4$ or $[e^{-x/2}/(-1/2)]_0^{1.4} = 0.8t$	
	$t = 1.26$ s	A1	[4]	1.2585..	**[10]**