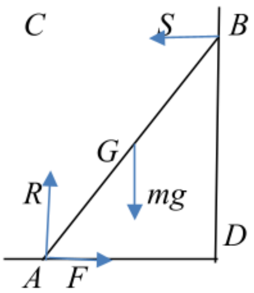
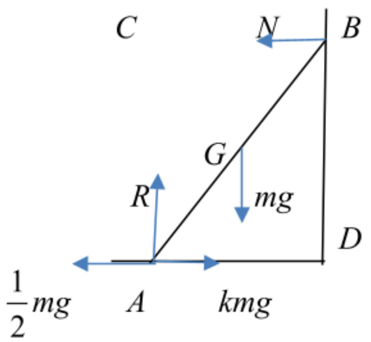
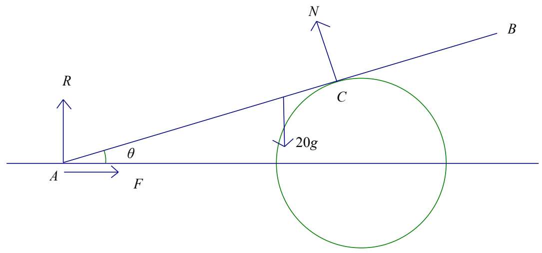
Question	Scheme	Marks	AOs
	Part (a) is a 'Show that..' so equations need to be given in full to earn A marks		
3(a)			
	Moments equation: (M1A0 for a moments inequality)	M1	3.3
	M(A), $mga\cos\theta = 2Sa\sin\theta$ M(B), $mga\cos\theta + 2Fa\sin\theta = 2Ra\cos\theta$ M(C), $F\times 2a\sin\theta = mga\cos\theta$ M(D), $2Ra\cos\theta = mga\cos\theta + 2Sa\sin\theta$ M(G), $Ra\cos\theta = Fa\sin\theta + Sa\sin\theta$.	A1	1.1b
	($\updownarrow$) $R = mg$ **OR** ($\leftrightarrow$) $F = S$	B1	3.4
	Use their equations <u>(they must have enough)</u> and $F \le \mu R$ to give an inequality in μ and θ **only** (allow DM1 for use of $F = \mu R$ to give an *equation* in μ and θ only)	DM1	2.1
	$\mu \ge \frac{1}{2}\cot\theta$ *	A1*	2.2a
		(5)	
3(b)			
	Moments equation:	M1	3.4
	M(A), $mga\cos\theta = 2Na\sin\theta$ M(B), $mga\cos\theta + 2kmga\sin\theta = 2Ra\cos\theta + \frac{1}{2}mg2a\sin\theta$ M(D), $2Ra\cos\theta = mga\cos\theta + N2a\sin\theta$ M(G), $kmga\sin\theta + Na\sin\theta = \frac{1}{2}mga\sin\theta + Ra\cos\theta$	A1	1.1b

	S.C. M(C), $mga\cos\theta+\frac{1}{2}mg2a\sin\theta=kmg2a\sin\theta$ **M1A1B1** $1+\frac{5}{4}=\frac{5k}{2}$ **M1** $k=0.9$ **A1**		
	$N=kmg-F$ **OR** $R=mg$	B1	3.3
	Use their equations (they must have enough) to solve for k (numerical)	DM1	3.1b
	$k=0.9$ oe	A1	1.1b
		(5)	
			(10 marks)

Notes:

3a	M1	Any moments equation with correct terms, condone sign errors and sin/cos confusion
	A1	Correct equation
	B1	Correct equation
	DM1	Dependent on M1, for using their equations (they must have enough) and $F\le\mu R$ to give an inequality in μ and θ only (allow M1 for use of $F=\mu R$ to give an equation in μ and θ only)
	A1*	Given answer correctly obtained with no wrong working seen (e.g. if they use $F=\mu R$ anywhere, A0)
3b	M1	Any moments equation with correct terms, condone sign errors
	A1	Correct equation
	B1	Correct equation
	DM1	Dependent on M1, for using their equations (they must have enough) with trig substituted, to solve for k, which must be numerical.
	A1	cao

Question	Scheme	Marks	AOs
9(a)	Moments about A (or any other complete method)	M1	3.3
	$T2a\sin\alpha = Mga + 3Mgx$	A1	1.1b
	$T = \dfrac{Mg(a+3x)}{2a \times \frac{3}{5}} = \dfrac{5Mg(3x+a)}{6a}$ * GIVEN ANSWER	A1*	2.1
		(3)	
(b)	$\dfrac{5Mg(3x+a)}{6a}\cos\alpha = 2Mg$ **OR** $2Mg.2a\tan\alpha = Mga + 3Mgx$	M1	3.1b
	$x = \dfrac{2a}{3}$	A1	2.2a
		(2)	
(c)	Resolve vertically **OR** Moments about B	M1	3.1b
	$Y = 3Mg + Mg - \dfrac{5Mg(3.\frac{2a}{3}+a)}{6a}\sin\alpha$ $2aY = Mga + 3Mg(2a - \frac{2a}{3})$ **Or**: $Y = 3Mg + Mg - \left(\dfrac{2Mg}{\cos\alpha}\right)\sin\alpha$	A1**ft**	1.1b
	$Y = \dfrac{5Mg}{2}$ **N.B.** May use $R\sin\beta$ for Y and/or $R\cos\beta$ for X throughout	A1	1.1b
	$\tan\beta = \dfrac{Y}{X}$ or $\dfrac{R\sin\beta}{R\cos\beta} = \dfrac{\frac{5Mg}{2}}{2Mg}$	M1	3.4
	$= \dfrac{5}{4}$	A1	2.2a
		(5)	
(d)	$\dfrac{5Mg(3x+a)}{6a} \le 5Mg$ and solve for x	M1	2.4
	$x \le \dfrac{5a}{3}$	A1	2.4
	For rope not to break, block can't be more than $\dfrac{5a}{3}$ from A oe Or just: $x \le \dfrac{5a}{3}$, if no incorrect statement seen. **N.B. If the correct inequality is not found,** their comment must mention 'distance from A'.	B1 **A1**	2.4
		(3)	
		(13 marks)	

Question	Scheme	Marks	AO
4(a)	Drum **smooth**, or no friction, (therefore reaction is perpendicular to the ramp)	B1	2.4
		(1)	
(b)	**N.B.** In (b), for a moments equation, if there is an extra $\sin\theta$ or $\cos\theta$ on a length, give M0 for the equation e.g. $\mathrm{M}(A)$: $20g \times 4\cos\theta = 5N\sin\theta$ would be given M0A0		
			
	Possible equns $(\nearrow): F\cos\theta + R\sin\theta = 20g\sin\theta$	M1	3.3
	$(\nwarrow): N + R\cos\theta = 20g\cos\theta + F\sin\theta$	A1	1.1b
	$(\uparrow) R + N\cos\theta = 20g$	M1	3.4
	$(\rightarrow): F = N\sin\theta$	A1	1.1b
	$\mathrm{M}(A)$: $20g \times 4\cos\theta = 5N$	M1	3.4
	$\mathrm{M}(B)$: $3N + R \times 8\cos\theta = F \times 8\sin\theta + 20g \times 4\cos\theta$ $\mathrm{M}(C)$: $R \times 5\cos\theta = F \times 5\sin\theta + 20g \times \cos\theta$ $\mathrm{M}(G)$: $R \times 4\cos\theta = F \times 4\sin\theta + N$	A1	1.1b
	(The values of the 3 unknowns are: $N = 150.528$; $F = 42.14784$; $R = 51.49312$)		
	Alternative 1: using cpts along ramp (X) and perp to ramp(Y) Possible equations:	M1	3.3
	$(\nearrow): X = 20g\sin\theta$	A1	1.1b
	$(\nwarrow): Y + N = 20g\cos\theta$ $(\uparrow): X\sin\theta + Y\cos\theta + N\cos\theta = 20g$	M1	3.4
	$(\rightarrow): X\cos\theta = Y\sin\theta + N\sin\theta$	A1	1.1b
	$\mathrm{M}(A): 20g \times 4\cos\theta = 5N$	M1	3.4
	$\mathrm{M}(B): 20g \times 4\cos\theta = 8Y + 3N$ $\mathrm{M}(C): 20g \times \cos\theta = 5Y$ $\mathrm{M}(G): 4Y = N \times 1$	A1	1.1b
	(The values of the 3 unknowns are: $N = 150.528$; $X = 54.88$; $Y = 37.632$)		

	Alternative 2: using horizontal cpt (H) and cpt perp to ramp (S)		
	$(\nearrow): H\cos\theta = 20g\sin\theta$	M1	3.3
	$(\nwarrow): S + N = H\sin\theta + 20g\cos\theta$	A1	1.1b
	$(\uparrow): S\cos\theta + N\cos\theta = 20g$ $(\rightarrow): H = S\sin\theta + N\sin\theta$	M1	3.4
	$\mathrm{M}(A): 20g \times 4\cos\theta = 5N$	A1	1.1b
	$\mathrm{M}(B): 20g \times 4\cos\theta + H \times 8\sin\theta = 8S + 3N$ $\mathrm{M}(C): 20g \times \cos\theta + H \times 5\sin\theta = 5S$	M1	3.4
	$\mathrm{M}(G): 4S = N \times 1 + H \times 4\sin\theta$	A1	1.1b
	(The values of the 3 unknowns are: $N = 150.528$; $H = 57.1666\ldots$; $S = 53.638666\ldots$)		
	Solve their 3 equations for F and R **OR** X and Y **OR** H and S	M1	1.1b
	$\lvert\text{Force}\rvert = \sqrt{R^2 + F^2}$ Main scheme **OR** $= \sqrt{X^2 + Y^2}$ Alternative 1 **OR** $= \sqrt{(H^2 + S^2 - 2HS\cos(90^o - \theta)}$ Alternative 2	M1	3.1b
	Magnitude = 67 or 66.5 (N)	A1	2.2a
		(9)	
(c)	Magnitude of the normal reaction (at C) will **decrease**.	B1	3.5a
		(1)	
		(11)	

Question	Scheme	Marks	AOs
4(a)	Take moments about A	M1	3.3
	$N \times \dfrac{4a}{\sin\alpha} = Mg \times 3a\cos\alpha$	A1	1.1b
	$\dfrac{9Mg}{25}$ *	A1*	1.1b
		(3)	
4(b)	Resolve horizontally	M1	3.4
	$(\rightarrow)\ F = \dfrac{9Mg}{25}\sin\alpha$	A1	1.1b
	Resolve vertically	M1	3.4
	$(\uparrow)\ R + \dfrac{9Mg}{25}\cos\alpha = Mg$	A1	1.1b
	Other possible equations: $(\nwarrow), R\cos\alpha + \dfrac{9Mg}{25} = Mg\cos\alpha + F\sin\alpha$ $(\nearrow), Mg\sin\alpha = F\cos\alpha + R\sin\alpha$ $\mathrm{M}(C), Mg.2a\cos\alpha + F.5a\sin\alpha = R.5a\cos\alpha$ $\mathrm{M}(G), \dfrac{9Mg}{25}.2a + F.3a\sin\alpha = R.3a\cos\alpha$ $\mathrm{M}(B), Mg.3a\cos\alpha + F.6a\sin\alpha = R.6a\cos\alpha + \dfrac{9Mg}{25}a$ $(F = \dfrac{36Mg}{125}\ ,\ R = \dfrac{98Mg}{125})$		
	$F = \mu R$ used	M1	3.4
	Eliminate R and F and solve for μ	M1	3.1b
	Alternative equations if they have at A: X horizontally and Y perpendicular to the rod. $(\nwarrow), Y + \dfrac{9Mg}{25} = Mg\cos\alpha + X\sin\alpha$ $(\nearrow), Mg\sin\alpha = X\cos\alpha$ $(\uparrow), \dfrac{9Mg}{25}\cos\alpha + Y\cos\alpha = Mg$ $(\rightarrow), Y\sin\alpha + \dfrac{9Mg}{25}\sin\alpha = X$		

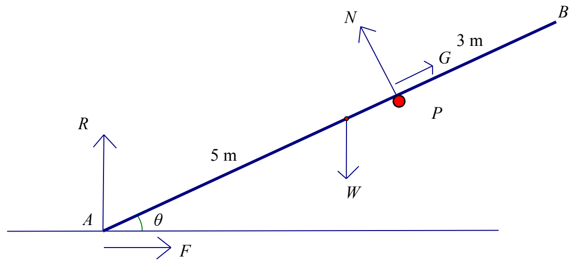
	$\text{M}(C), Mg.2a\cos\alpha + X.5a\sin\alpha = Y.5a$ $\text{M}(G), \frac{9Mg}{25}.2a + X.3a\sin\alpha = Y.3a$ M1A1 M1A1 $\text{M}(B), Mg.3a\cos\alpha + X.6a\sin\alpha = Y.6a + \frac{9Mg}{25}a$ $(X = \frac{4Mg}{3}, Y = \frac{98Mg}{75})$ Then $F = \mu R$ becomes: $X - Y\sin\alpha = \mu Y\cos\alpha$ M1 Eliminate X and Y and solve for μ M1		
	$\mu = \frac{18}{49}$ (0.3673…..accept 0.37 or better)	A1	2.2a
		(7)	
			(10 marks)

Notes:

4a	M1	Correct no. of terms, dim correct, condone sin/cos confusion and sign errors for an equation in N and Mg only. For perp distance allow any of : $\frac{4a}{\sin\alpha}, \frac{4a}{\cos\alpha}, 5a$ but use of any of : $6a, 5a\sin\alpha, 4a\cos\alpha, \ldots$ or anything involving $\tan\alpha$ is M0 Also M0 if no a's in their first equation.
	A1	Correct equation, trig does not need to be substituted
	A1*	Given answer correctly obtained.
4b	M1	Correct no. of terms, dim correct, condone sin/cos confusion and sign errors
	A1	Correct equation, trig does not need to be substituted but N does.
	M1	Correct no. of terms, dim correct, condone sin/cos confusion and sign errors
	A1	Correct equation, trig does not need to be substituted but N does.
		N.B. The above 4 marks are for any two equations, either resolutions or moments or one of each. Mark best two equations. Equations may appear in part (a) but must be used in (b) to earn marks.
	M1	Must be used, e.g. seen on the diagram. i.e. M0 if merely quoting it. (M0 if $F = \mu \times \frac{9Mg}{25}$ used)
	M1	Must have 3 equations (<u>and all 3 previous M marks</u>)
	A1	Accept 0.37 or better

Question	Scheme	Marks	AOs
9(a)	Take moments about A (or any other complete method to produce an equation in S, W and α only)	M1	3.3
	$Wa\cos\alpha\ +\ 7W2a\cos\alpha\ = S\,2a\sin\alpha$	A1 A1	1.1b 1.1b
	Use of $\tan\alpha\ =\ \frac{5}{2}$ to obtain S	M1	2.1
	$S = 3W$ *	A1*	2.2a
		(5)	
(b)	$R = 8W$	B1	3.4
	$F = \frac{1}{4}R\ (= 2W)$	M1	3.4
	$P_{\text{MAX}} = 3W + F$ or $P_{\text{MIN}} = 3W - F$	M1	3.4
	$P_{\text{MAX}} = 5W$ or $P_{\text{MIN}} = W$	A1	1.1b
	$W \leq P \leq 5W$	A1	2.5
		(5)	
(c)	M(A) shows that the reaction on the ladder at B is unchanged	M1	2.4
	also R increases (resolving vertically)	M1	2.4
	which increases max F available	M1	2.4
		(3)	
			(13 marks)

Question Number	Scheme	Marks	Notes
4(a)	M(A) or alternative complete method to an equation in T only	M1	Must have all terms. Terms must be dimensionally correct. Condone sign errors and sin/cos confusion.
	$T\times 2a = mg\times 3a\sin 60° + mg\times 6a\sin 60°$	A1	Unsimplified equation with at most one error
		A1	Correct unsimplified equation
	$T = 9mg\dfrac{\sqrt{3}}{4}$	A1 (4)	With trig. substituted. $3.90mg$ or better
(b)	$\text{R}(\rightarrow)\quad R = T\cos 60°$	M1	Resolve horizontally. Condone sin/cos confusion
	$\left(= 9mg\dfrac{\sqrt{3}}{4}\times\dfrac{1}{2}\right)$	A1ft	Follow their T. Allow with $\cos 60°$
	$R = \dfrac{9\sqrt{3}}{8}mg$	A1ft (3)	$1.95mg$ or better. Follow their (a).
Alt 4(b)	$2mg\cos 60° = R\cos 30° - F\cos 60°$ $T - F\cos 30 = 2mg\cos 30° + R\cos 60°$	(M1)	Resolve parallel and perpendicular to the rod and eliminate F
	$\dfrac{5mg\sqrt{3}}{4} - \dfrac{R}{2} = -\sqrt{3}mg + \dfrac{3R}{2}$	(A1ft)	Equation in R only. Follow their T
	$R = \dfrac{9\sqrt{3}}{8}mg$	(A1ft)	With trig. substituted. Follow their (a)
(c)	$\text{R}(\uparrow)\quad T\cos 30° - F = mg + mg$	M1	Resolve vertically. Need all terms. Condone sign errors and sin/cos confusion. Allow for $\pm F$
		A1	Unsimplified equation with at most one error. Allow for $\pm F$
	$F = 9mg\dfrac{\sqrt{3}}{4}\times\dfrac{\sqrt{3}}{2} - 2mg\left(=\dfrac{11}{8}mg\right)$	A1	Correct unsimplified expression for F, with trig. substituted. Allow for $\pm F$. Seen or implied.
	$\mu = \dfrac{F}{R} = \dfrac{\frac{11}{8}mg}{\frac{9\sqrt{3}}{8}mg}$	dM1	Use of $F = \mu R$ Dependent on the two previous M marks
	$= \dfrac{11}{9\sqrt{3}}\quad (= 0.71 \text{ or } 0.706 \text{ or better})$	A1 (5)	(g cancels)
(c) alt 1st 3 marks	$2mg\cos 60° = R\cos 30° - F\cos 60°$	(M1)	Resolve parallel to the rod. Need all terms. Condone sign errors and sin/cos confusion. Allow for $\pm F$
	$mg = \dfrac{27}{16}mg - \dfrac{1}{2}F$	(A1)	Unsimplified equation with at most one error. Allow for $\pm F$. sin/cos confusion is one error
	$F = \dfrac{11}{8}mg$	(A1)	Correct unsimplified expression for F. Allow for $\pm F$. Seen or implied.
		[12]	

Q	Scheme	Marks	Notes
5a			
	Take moments about A:	M1	Must be dimensionally correct. Condone sin/cos confusion
	$5N = 4\cos\theta W$	A1	
	$N = \frac{12}{25}W = 0.48W$ ***Given Answer***	A1	
		(3)	
5b	$G = \frac{1}{4}N = 0.12W$	B1	Seen or implied
	Resolve vertically	M1	Needs all terms. Condone sin/cos confusion and sign errors
	$\updownarrow$: $R + N\cos\theta + G\sin\theta = W$	A1	$(R = 0.616W)$
	Resolve horizontally	M1	Needs all terms. Condone sin/cos confusion and sign errors
	$\leftrightarrow$: $F + G\cos\theta = N\sin\theta$	A1	$(F = 0.312W)$
	$\mu = \frac{N\sin\theta - G\cos\theta}{W - N\cos\theta - G\sin\theta}$	DM1	Use $F = \mu R$ to find μ Dependent on 2 preceding M marks
	$= \frac{0.48W \times 0.8 - 0.12W \times 0.6}{W - 0.48W \times 0.6 - 0.12W \times 0.8} = \frac{0.312}{0.616}$		
	$= 0.51 \quad (0.50649\ldots) \quad \left(\frac{39}{77}\right)$	A1	
		(7)	
		[10]	
	NB, One of the two equations required for part (b) could be a moments equation: M(P) $1 \times W\cos\theta + 5F\sin\theta = 5R\cos\theta$ M(B) $3N + 8R\cos\theta = 4W\cos\theta + 8F\sin\theta$		

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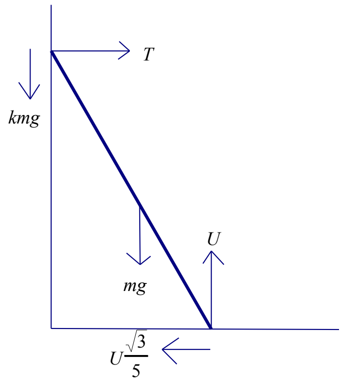
Question Number	Scheme	Marks
4a	Moments about A: $0.5\times 2g+2\times 5g\left(=11g\right)=T\cos\theta\times 4=T\times\frac{3}{5}\times 4$	M1A2
	$T=11g\times\frac{5}{12}=\frac{55}{12}g=44.9$ (45) (N)	A1 (4)
	Notes	
	N.B. If all g's are missing, mark as a MR. M1 for M(A), with usual rules First A1 and second A1 for a correct equation in T only i.e. must be using a correct angle (but value of trig ratio not needed at this stage) Deduct 1 mark for each incorrect term. (A1A0 or A0A0) Third A1 for 45 or 44.9 (N) (A0 for 45.0)	
4b	Resolving: $\leftrightarrow H=T\sin\theta$ **OR** M(D), $H\times 3=2g\times 0.5+5g\times 2$	M1
	$\updownarrow T\cos\theta+V=7g$ **OR** M(B), $V\times 4=2g\times 3.5+5g\times 2$	M1A1
	Pythagoras: $\lvert R\rvert=\sqrt{41.65^2+35.93^2}=55.0$ (55) (N)	M1A1 (5)
	Notes	
	First M1 for resolving horizontally or M(D) with usual rules to give equation in T only. (T does not need to be substituted) Second M1 for resolving vertically or M(B) with usual rules First A1 for a correct equation in T only. (T does not need to be substituted) Third M1 (independent but must have found 2 components) for squaring, adding and rooting their 2 components Second A1 for 55 or 55.0	
4c	Use of $F\le F_{\max}=\mu R$: $V\le\mu H$ (Must have found H and V)	M1
	$\mu\ge\frac{V}{H}=\frac{41.65}{35.93..}=\frac{51}{44}$, 1.2 or better.	A1 (2)
	Notes	
	M1 for use of $V\le\mu H$ M0 for use of $V=H$ or $V<H$ $\mu\ge\frac{V}{H}=\frac{51}{44}$ Allow fraction (since g cancels) or 1.2 or better	

Question Number	Scheme	Marks
5a	Moments about *A*: $6g(\times 1)\times \sin 70 = T\sin 30\times 2$	M1A2
	$T = 55.3$(N) or 55 (N)	A1 (4)
5b	Resolve horizontally: $T\cos 50 = R(=35.5)$	B1 **ft**
	Resolve vertically: $T\sin 50 = 6g \pm F$	M1A1 **ft**
	$\lvert F\rvert = 16.5 \quad (16.473\ldots)$	
	Use $F=\mu R$: $\mu = \dfrac{6g - T\sin 50}{T\cos 50}$ (with their values)	M1
	= 0.464 or 0.46	A1 (5)
5c	Use of tan and their components: $\tan^{-1}\left(\dfrac{35.5}{16.5}\right)$	M1
	$= 65.1°$ or $65°$ to the upward vertical	A1 (2)
	or equivalent (24.9° or 25° above the	[11]
	horizontal)	
	Notes	
5a	First M1 for a complete method to find *T*, with usual rules, correct no. of terms, allow sin/cos confusion, dim correct (missing g is an A error) and allow incorrect angles. First A2 for a correct equation (A1A0 for one error) Third A1 for 55 (N) or 55.3 (N)	
5b	First B1 **ft** for resolving horizontally (*T* does not need to be substituted) First M1 for resolving vertically with usual rules, must be using 40^0 or 50^0 First A1 **ft** for a correct equation (*T* does not need to be substituted) Second M1, independent, for use of $F=\mu R$, must have found an *F* and an *R* Second A1 for 0.46 or 0.464 **N.B.** They may resolve in other directions e.g. along the rod or perpendicular to the rod or take moments e.g. about *B* or *C* First B1 for a correct equation seen M1A1 for the better equation seen, usual rules etc.	
5c	First M1 for a complete method to find the angle (must have found the two components) with either the horizontal or vertical	
	First A1 for 65^0 or 65.1^0 to the upward vertical oe (A0 for just an angle)	
	Or the angle marked on a clear diagram with an arrow.	

Question Number	Scheme	Marks	Notes
7(a)	$M(A)\quad S.2a\cos 30^{\circ} = mga\sin 30^{\circ}$	M1	Correct number of terms. Terms must be dimensionally correct Condone trig confusion
		A1	At most one error Consistent trig confusion is one error
		A1	Correct unsimplified equation
	$S = \frac{mg\sqrt{3}}{6}$	A1 (4)	Accept exact equivalent Accept 0.289mg or better
(b)	$R = mg\ ;\quad F = S$	B1	Resolve vertically and horizontally - must be stated or shown on a diagram. (Used here if seen in (a))
	$\frac{mg\sqrt{3}}{6} \le \mu mg$	M1	Use of $F \le \mu R$ (not for $F = \mu R$ followed by a fudge of the inequality)
	$\frac{\sqrt{3}}{6} \le \mu$	A1 (3)	***Answer Given*** CSO
(c)			
	$\updownarrow$: $U = mg + kmg = mg(1+k)$	B1	Or equation in U and k from a second moments equation.
	M(A): $T\times 2a\times\frac{\sqrt{3}}{2} = mga\times\frac{1}{2} + kmg2a\times\frac{1}{2}$ M(B): $mg\times\frac{a}{2} + \frac{U\sqrt{3}}{5}\times\sqrt{3}a = Ua$ M(X): $kmga + mg\times\frac{a}{2} = \frac{U\sqrt{3}}{5}\times\sqrt{3}a$ M(corner): $aU = Ta\sqrt{3} + mg\frac{a}{2}$	M1	Need all three terms. Condone $\mu = \frac{\sqrt{3}}{6}$ Terms must be dimensionally correct. Condone trig confusion. Condone sign errors (X is point of intersection of lines of action of T and U)
	$\Rightarrow 2T\cos 30^{\circ} = mg\sin 30^{\circ} + 2kmg\sin 30^{\circ}$	A1	Correct unsimplified moments equation
	$\Rightarrow \frac{3}{5}U = \frac{1}{2}mg + kmg$	A1	Correct equation in U (and k) μ correct if used
	$\Rightarrow \frac{3}{5}(1+k) = \frac{1}{2} + k$	DM1	Solve for k. Dependent on preceding M
	$k = \frac{1}{4}$	A1 (6)	
		13	

Question Number	Scheme	Marks	Notes
6a	Taking moments about A:	M1	Requires all terms - condone trig confusion and sign errors
	$bF = 3mga\cos\theta + mg \times 2a\cos\theta$	A2	-1 each error
	$bF = 5mga\cos\theta \qquad F = \dfrac{5mga}{b}\cos\theta$	A1 (4)	***Given answer***
6b	Component of **R** parallel to AB: $\left(R\cos(\phi-\theta)\right)$	M1	Requires all terms - condone trig confusion
	$= 3mg\sin\theta + mg\sin\theta = 4mg\sin\theta$	A1	Correct unsimplified
	Component of **R** perpendicular to AB:	M1	Requires all terms - condone consistent trig confusion and sign errors
	$\left(R\sin(\phi-\theta)\right) + F = 4mg\cos\theta$	A1	Correct unsimplified
	Alternatives for M1A1: $M(B)$		$2aR\sin(\phi-\theta) + 3mga\cos\theta = F(2a-b)$
	$M(C)$		$bR\sin(\phi-\theta) + (2a-b)mg\cos\theta$ $= 3mg(b-a)\cos\theta$
	$\left(R\sin(\phi-\theta)\right) = 4mg\cos\theta - \dfrac{5mga}{b}\cos\theta$	A1	Correct with F substituted.
	ISW for incorrect work after correct components seen	(5)	
6c	Use of $R\sin(\phi-\theta) > 0$	M1	
	Solve for b in terms of a: $4 > \dfrac{5a}{b}, \quad (2a \geq)b > \dfrac{5}{4}a$	A1	$2a$ not required CSO
		(2)	
		[11]	
SC	Misread of directions in (b)		NB This MR can score full marks
6(b)	$X = F\sin\theta = \dfrac{5mga}{b}\cos\theta\sin\theta$	M1	Allow with F. Requires all terms - condone trig confusion
		A1	F substituted.
	$Y = 4mg - F\cos\theta = 4mg - \dfrac{5mga}{b}\cos^2\theta$	M1	Allow with F. Requires all terms - condone trig confusion and sign errors.
		A1	Correct unsimplified
		A1	Correct substituted
6(c)	For $\varphi > \theta$, $\tan\phi > \tan\theta$		
	$\tan\varphi = \dfrac{Y}{X} = \dfrac{4 - \frac{5a}{b}\cos^2\theta}{\frac{5a}{b}\cos\theta\sin\theta} > \tan\theta$	M1	
	$4 - \dfrac{5a}{b}\cos^2\theta > \dfrac{5a}{b}\sin^2\theta$		
	$4 > \dfrac{5a}{b}\left(\cos^2\theta + \sin^2\theta\right) \quad \Rightarrow b > \dfrac{5}{4}a$	A1	CSO