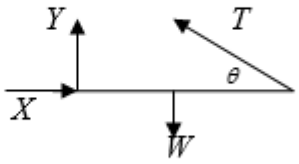
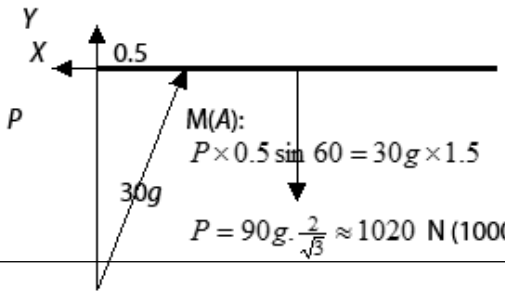
Question 1: Jan 05 Q1

Question Number	Scheme	Marks
1.	 (a) $M(A)$ $W\times 4a = T\times 8a\sin\theta$ Using a value of $\sin\theta$ and solving $T=\frac{5}{6}W$ ✱ cso (b) $\rightarrow$ $X = T\cos\theta$ $=\frac{2}{3}W$	M1 A1 M1 A1 4 M1 A1 A1 3 7

Question 2: June 05 Q6

(a)



M(A):

$P\times 0.5\sin 60 = 30g\times 1.5$ M1 A2

$P = 90g.\frac{2}{\sqrt{3}} \approx 1020$ N (1000N) A1

(4)

(b) $\rightarrow$ $X = P\cos 60 = \frac{1}{2}P$ M1 A1

$(\approx 509$ N (510N))

$\uparrow$ $Y + P\cos 30 = 30g$ M1 A1

$(\Rightarrow Y = -588$ N)

resultant $= \sqrt{(X^2+Y^2)} = \sqrt{(509^2+588^2)} \approx 778$ N M1 A1

or 780N (6)

(c) In equilibrium all forces act through a point M1

P and weight meet at mid-point;

hence reaction also acts through mid-point so reaction horizontal A1 cso

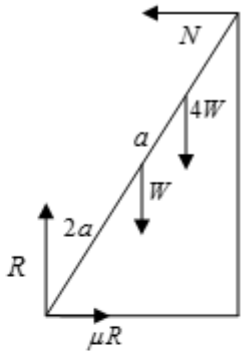
(2)

OR M(mid-point): Y x $1.5 = 0 \Rightarrow Y = 0$ M1

Hence reaction is horizontal A1

Question 3: Jan 06 Q6

(a)



μR B1

$\uparrow \; R = 5W$ B1

$\mathcal{M}(B)$: $4Wa\cos\theta + W.2a\cos\theta + \mu R 4a\sin\theta = R.4a\cos\theta$ M1 A1

Having enough equations & solving them for μ M1

$\mu = 0.35$ A1 (6)

(b) $\uparrow \; S = (5+k)W$ B1

Use of $F = 0.35S$ or $F \leq 0.35S$ M1

$\mathcal{M}(B)$: $kW4a\cos\theta + W.2a\cos\theta + F4a\sin\theta = S.4a\cos\theta$ M1 A1

Having enough equations & solving them for k M1

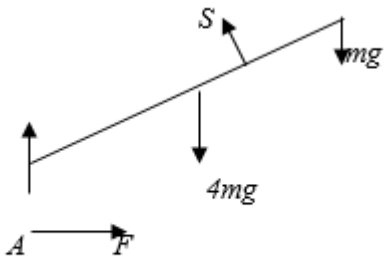
$k = \frac{10}{7}$ awrt 1.42 A1

$k \geqslant \frac{10}{7}$ ft their k, accept > and decimals A1ft (7)

13

Question 4: June 06 Q6

(a)



M(A):

$S.3a = 4mg.2a\cos\alpha + mg.4a\cos\alpha$ M1 A1

$= \frac{48}{5}mga \Rightarrow S = \frac{16}{5}mg$ * A1 **(3)**

(b)

R(↑): $R + S\cos\alpha = 5mg$ M1 A1

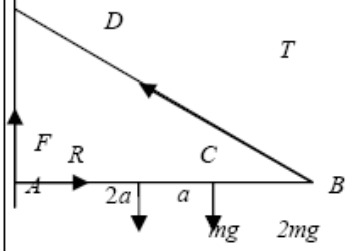
R(→): $F = S\sin\alpha$ M1 A1

$F \leq \mu R \Rightarrow \mu \geq \frac{48}{61}$ * dep on both previous M's M1 A1 **(6)**

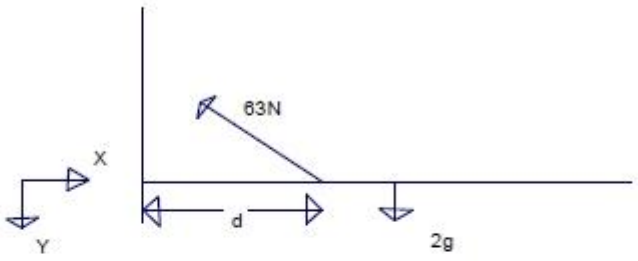
(c)

Direction of S is perpendicular to plank
or No friction at the peg B1 **(1)**

Question 5: Jan 07 Q5

Question Number	Scheme	Marks
5.	(a)  M(A) $T\sin\theta\times 4a = mg\times 2a + 2mg\times 3a$ $T = \frac{8mg}{4}\times\frac{5}{3} = \frac{10}{3}mg$ Accept 32.7*m*, *33m*	M1* A1=A1 DM1* A1 5
	(b) $\rightarrow$ $R = T\cos\theta = \frac{10}{3}mg\times\frac{4}{5}\,;\ = \frac{8}{3}mg$ * cso ft their T	M1 A1ft; A1 3
	(c) $\uparrow$ $F + T\sin\theta = 3mg \Rightarrow F = mg$ ft their T Or: M(B) $F\times 4a = mg\times 2a + 2mg\times a \Rightarrow F = mg$ $F = \mu R \Rightarrow \mu = \frac{3}{8}$	M1 A1ft M1 A1 4 **12**
	(a) Alternative approach: $\rightarrow$ $R = T\cos\theta$ $\uparrow$ $F + T\sin\theta = 3mg$ M(B) $F\times 4a = mg\times 2a + 2mg\times a (\Rightarrow F = mg)$ $\Rightarrow mg + T\sin\theta = 3mg \Rightarrow T = \frac{2mg}{\sin\theta} = \frac{10mg}{3}$ If they use this method, watch out for F=mg just quoted in (c): M1A1	

Question 6: June 07 Q5

Question Number	Scheme	Marks
(a)	 M(*A*) 63 sin 30 . 14 = 2*g* . *d* Solve: *d* = 0.225m Hence *AB* = 45 cm	M1 A1 A1 A1 (4)
(b)	R(→) *X* = 63 cos 30 (≈ 54.56) R(↑) *Y* = 63 sin 30 – 2*g* (≈ 11.9) *R* = √(X^2 + Y^2) ≈ 55.8, 55.9 or 56 N	B1 M1 A1 M1 A1 (5)

M1 Take moments about A. 2 recognisable force x distance terms involving 63 and 2(g).
A1 63 N term correct
A1 2g term correct.
A1 *AB* = 0.45(m) or 45(cm). No more than 2sf due to use of *g*.

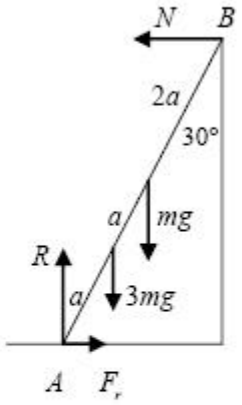
B1 Horizontal component (Correct expression – no need to evaluate)
M1 Resolve vertically – 3 terms needed. Condone sign errors. Could have cos for sin.
Alternatively, take moments about B : $0.225\times 2g = 0.31\times 63\sin 30 + 0.45Y$
or C : $0.14Y = 0.085\times 2g$
A1 Correct expression (not necessarily evaluated) - direction of Y does not matter.
M1 Correct use of Pythagoras
A1 55.8(N), 55.9(N) or 56 (N)

OR For X and Y expressed as F $\cos\theta$ and F $\sin\theta$.
M1 Square and add the two equations, or find a value for $\tan\theta$, and substitute for $\sin\theta$ or $\cos\theta$

A1 As above .

N.B. Part (b) can be done before part (a). In this case, with the extra information about the resultant force at A, part (a) can be solved by taking moments about any one of several points. M1 in (a) is for a complete method - they must be able to substitute values for all their forces and distances apart from the value they are trying to find..

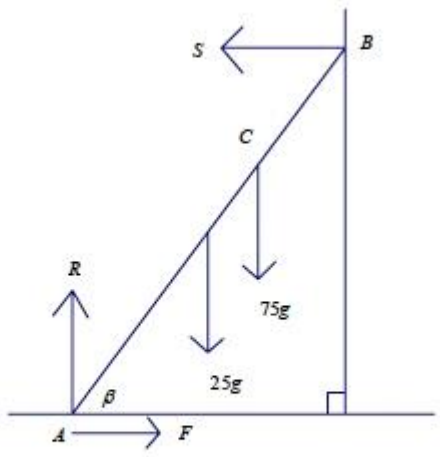
Question 7: Jan 08 Q5

Question Number	Scheme	Marks
	(a) 	
	$\mathcal{M}(A)$ $N \times 4a\cos 30° = 3mg \times a\sin 30° + mg \times 2a\sin 30°$	M1 A2(1,0)
	$N = \frac{5}{4}mg\tan 30°$ $\left(= \frac{5}{4\sqrt{3}}mg = 7.07\ldots \text{m}\right)$	DM1 A1
	$\rightarrow \quad F_r = N \quad , \quad \uparrow \quad R = 4mg$	B1, B1
	Using $F_r = \mu R$	B1
	$\frac{5}{4\sqrt{3}}mg = \mu R$ for their R	M1
	$\mu = \frac{5}{16\sqrt{3}}$ awrt 0.18	A1 **(10)**
		[10]
	Alternative method:	
	M(B): $mg \times 2a\sin 30 + 3mg \times 3a\sin 30 + F \times 4a\cos 30 = R \times 4a\sin 30$	
	$11mga\sin 30 + F \times 4a\cos 30 = R \times 4a\sin 30$	M1A3(2,1,0)
	$\frac{11mg}{2} + F\frac{4\sqrt{3}}{2} = 2R$	DM1A1
	$\uparrow \quad R = 4mg$,	B1
	Using $F_r = \mu R$	B1
	$8\mu\sqrt{3} = \frac{5}{2}, \quad \mu = \frac{5}{16\sqrt{3}}$	M1 A1

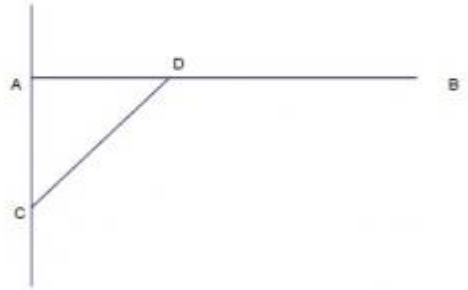
Question 8: June 08 Q5

Question Number	Scheme	Marks
(a)	N2L $(6t-5)\mathbf{i}+(t^2-2t)\mathbf{j}=0.5\mathbf{a}$	M1
	$\mathbf{a}=(12t-10)\mathbf{i}+(2t^2-4t)\mathbf{j}$	A1
	$\mathbf{v}=(6t^2-10t)\mathbf{i}+\left(\frac{2}{3}t^3-2t^2\right)\mathbf{j}\quad(+\mathbf{C})$ ft their a	M1 A1ft+A1ft
	$\mathbf{v}=(6t^2-10t+1)\mathbf{i}+\left(\frac{2}{3}t^3-2t^2-4\right)\mathbf{j}$	A1 (6)
(b)	When $t=3$, $\mathbf{v}_3=25\mathbf{i}-4\mathbf{j}$	M1
	$-5\mathbf{i}+12\mathbf{j}=0.5(\mathbf{v}-(25\mathbf{i}-4\mathbf{j}))$ ft their $\mathbf{v}_3$	M1 A1ft
	$\mathbf{v}=15\mathbf{i}+20\mathbf{j}$	A1
	$\lvert\mathbf{v}\rvert=\sqrt{(15^2+20^2)}=25\quad(\text{ms}^{-1})$ cso	M1 A1 (6)
		(12 marks)

Question 9: Jan 09 Q2

(a)	$R(\uparrow): R=25g+75g(=100g)$	B1
	$F=\mu R \Rightarrow F=\frac{11}{25}\times 100g$	M1
	$=44g\ (=431)$	A1 (3)
(b)		
	M(A): $25g\times 2\cos\beta+75g\times 2.8\cos\beta=S\times 4\sin\beta$	M1 A2,1,0
	$R(\leftrightarrow): F=S$	
	$176g\sin\beta=260g\cos\beta$	M1A1
	$\beta=56(°)$	A1 (6)
(c)	So that Reece's weight acts directly at the point C.	B1 [10]

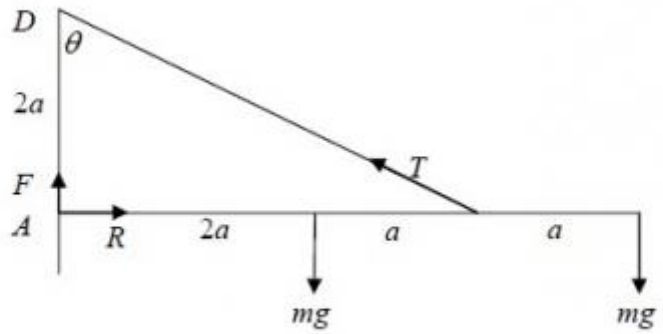
Question 10: June 09 Q4

Question Number	Scheme	Marks
(a)	 Taking moments about A: $3g \times 0.75 = \frac{T}{\sqrt{2}} \times 0.5$ $T = 3\sqrt{2}g \times \frac{7.5}{5} = \frac{9\sqrt{2}g}{2} (= 62.4N)$	M1A1A1 A1 (4)
(b)	$\leftarrow \pm H = \frac{T}{\sqrt{2}} (= \frac{9g}{2} \approx 44.1N)$	B1
	$\uparrow \pm V + \frac{T}{\sqrt{2}} = 3g \quad (\Rightarrow V = 3g - \frac{9g}{2} = \frac{-3g}{2} \approx -14.7\text{N})$	M1A1
	$\Rightarrow \lvert R \rvert = \sqrt{81+9} \times \frac{g}{2} \approx 46.5(N)$	M1A1
	at angle $\tan^{-1}\frac{1}{3} = 18.4^\circ$ (0.322 radians) below the line of BA	M1A1
	161.6° (2.82 radians) below the line of AB (108.4° or 1.89 radians to upward vertical)	(7) [11]

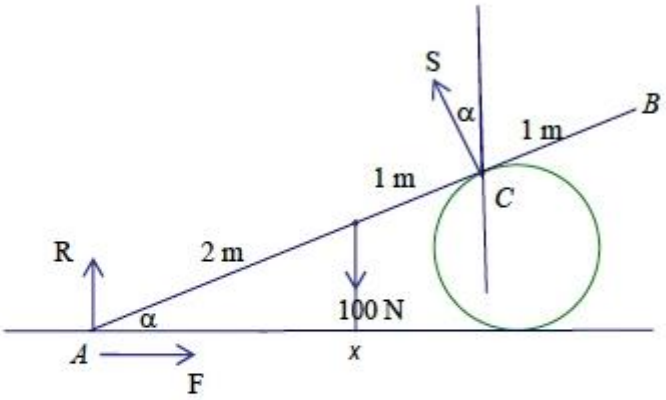
Question 11: Jan 10 Q6

	$m(B): R \times 4\cos\alpha = F \times 4\sin\alpha + 20g \times 2\cos\alpha$	M1 A2
	Use of $F = \frac{1}{2}R$	M1
	Use of correct trig ratios	B1
	R = 160N or 157N	DM1 A1
		[7]

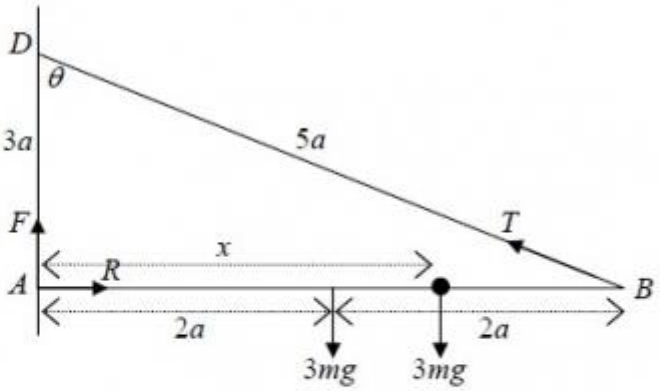
Question 12: June 10 Q6

Question Number	Scheme	Marks
(a)	 M(A) $3a \times T\cos\theta = 2amg + 4amg$	M1 A1 A1
	$\cos\theta = \left(\frac{2}{\sqrt{9+4}} = \right)\frac{2}{\sqrt{13}}$	B1
	$\frac{6}{\sqrt{13}}T = 6mg$ $T = mg\sqrt{13}$ *	A1 (5)
(b)	$3a \times T \times \cos\theta = 2amg + 4aMg$	M1
	$T = \frac{(2mg + 4Mg)}{6}\sqrt{13} \leq 2mg\sqrt{13}$	A1
	$mg + 2Mg < 6mg$ $M \leq \frac{5}{2}m$ * cso	A1 (3)
		[8]

Question 13: Jan 11 Q7

Question Number	Scheme	Marks
		
	Taking moments about A: $3S = 100 \times 2 \times \cos\alpha$	M1 A1
	Resolving vertically: $R + S\cos\alpha = 100$	M1 A1
	Resolving horizontally: $S\sin\alpha = F$	M1 A1
	(Most alternative methods need 3 independent equations, each one worth M1A1. Can be done in 2 e.g. if they resolve horizontally and take moments about X then $R \times 2 \times \cos\alpha = S \times (3 - 2 \times \cos^2\alpha)$ scores M2A2)	
	Substitute trig values to obtain correct values for F and R (exact or decimal equivalent). $\left(S = \frac{200\sqrt{8}}{9}\right)$, $R = 100 - \frac{1600}{27} = \frac{1100}{27} \approx 40.74$, $F = \frac{200\sqrt{8}}{27} \approx 20.95...$	DM1 A1
	$F \le \mu R$, $200\sqrt{8} \le \mu \times 1100$, $\mu \ge \frac{200\sqrt{8}}{1100} = \frac{2\sqrt{8}}{11}$. Least possible μ is 0.514 (3sf), or exact.	M1 A1 **[10]**

Question 14: June 11 Q7

Question Number	Scheme	Marks
(a)	 M(A) $3mg \times 2a + 3mgx = T\cos\theta \times 4a$ $= \frac{12}{5}aT$ $\frac{12}{5}aT = 6mga + 3mgx$ $T = \frac{25}{4}mg$ $\frac{12}{5}a \times \frac{25}{4}mg = 6mga + 3mgx$ $15a = 6a + 3x$ $x = 3a$ **	M1 A2,1,0 M1 A1 (5)
(b)	R$(\rightarrow)$ $R = T\sin\theta$ $= \frac{25}{4}mg \times \frac{4}{5}$ $= 5mg$ **	M1 A1 A1 (3)
(c)	R$(\uparrow)$ $F + \frac{25}{4}mg \times \frac{3}{5} = 3mg + 3mg$ $F = 6mg - \frac{15}{4}mg = \frac{9}{4}mg$ $\mu = \frac{F}{R} = \frac{\frac{9}{4}mg}{5mg} = \frac{9}{20}$	M1 A2,1,0 DM1 A1 (5) **13**