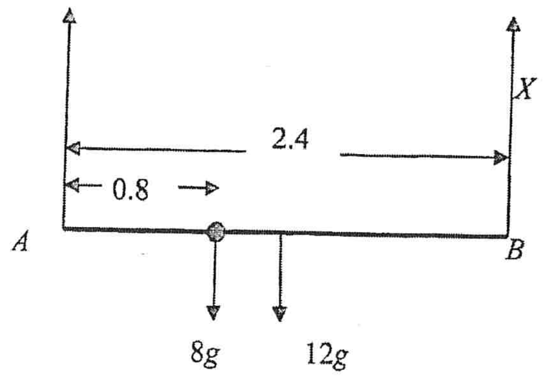
Mechanics 11 Solutions

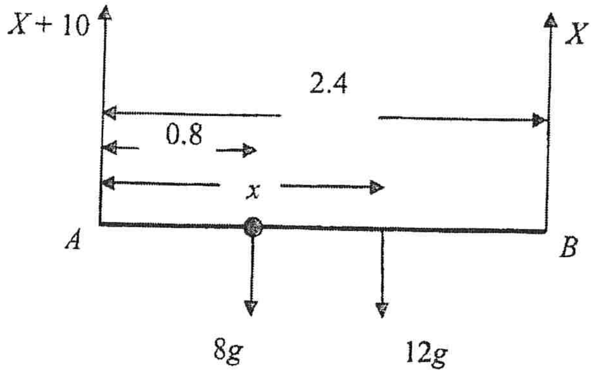
Section 1

1 (a)



$M(A)$ $\quad 8g \times 0.8 + 12g \times 1.2 = X \times 2.4$		M1 A1
$X \approx 85$ (N)	accept 84.9, $\frac{26g}{3}$	DM1 A1 (4)

(b)



$R(\uparrow)$ $\quad \underline{(X+10)} + \underline{X} = 8g + 12g$		M1 B1 A1
$(X = 93)$		
$M(A)$ $\quad 8g \times 0.8 + 12g \times x = X \times 2.4$		M1 A1
$x = 1.4$ (m)	accept 1.36	A1 (6)
		(10 marks)

2 a.) $H_0: \mu = 4.38 \qquad H_1: \mu > 4.38$

b.) Test statistic $= \dfrac{6.76 - 4.38}{\sqrt{14/150}} = 7.79$

Critical value $= 1.645$ ⇒ critical region is $\bar{X} > 1.645$

c) The test statistic is in the critical region ⇒ the null hypothesis is rejected.

There is sufficient evidence to suggest that June 2015 was a particularly sunny month

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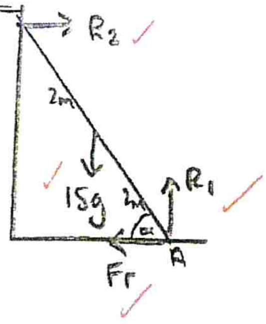
Section 2

① a)



b.) $15g(2\cos\alpha) = 30g\cos\alpha$ (or $294\cos\alpha$)

Units : Nm

Sense : consistent with diagram!
(anti-clockwise if like mine)

c.) Horizontally : $F_r = R_2$

Vertically : $R_1 = 15g$

Any two

Moments about A : $30g\cos\alpha = R_2(4\sin\alpha)$

Limiting equilibrium : $F_r = \frac{1}{3}R_1$

$F_r = \frac{1}{3}(15g) = 5g = R_2$

$\Rightarrow 30g\cos\alpha = 20g\sin\alpha$

$\tan\alpha = 1.5 \Rightarrow \underline{\underline{\alpha = 56.3°}}$

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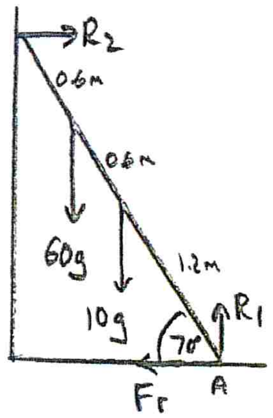
② a)



Horizontally : $F_r = R_2$

Vertically : $R_1 = 60g + 10g = 70g$

Moments about A : $10g(1.2\cos 70°) + 60g(1.8\cos 70°) = R_2(2.4\sin 70°)$

$\Rightarrow 120g\cos 70° = 2.4R_2\sin 70°$

Limiting equilibrium : $F_r = \mu R_1$

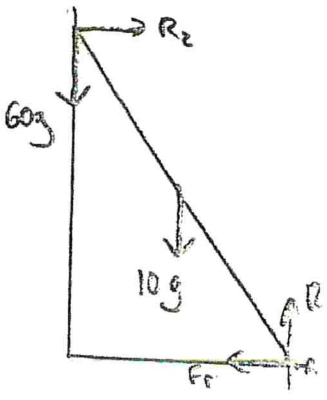
Any two

$F_r = \mu(70g) = R_2$

$\Rightarrow 120\cancel{g}\cos 70° = 2.4\mu\, 70\cancel{g}\sin 70°$

$\mu = \dfrac{120\cos 70°}{168\sin 70°} = \underline{\underline{0.260}}$ to 3sf

b.)



Horizontally : $F_r = R_2$

Vertically : $R_1 = 70g + x$

Any two

Mom. about A : $10g(1.2\cos 70°) + 60g(2.4\cos 70°) = R_2 \times 2.4\sin 70°$

Limiting equ. : $F_r = \mu R_1$

$R_2 = \dfrac{12g\cos 70° + 144g\cos 70°}{2.4\sin 70°} = 231.85\text{N}$

$\mu R_1 = 231.85 \Rightarrow \mu(70g + x) = 231.85$

$0.260(70g + x) = 231.85 \Rightarrow x = 206\text{N}$ to 3sf

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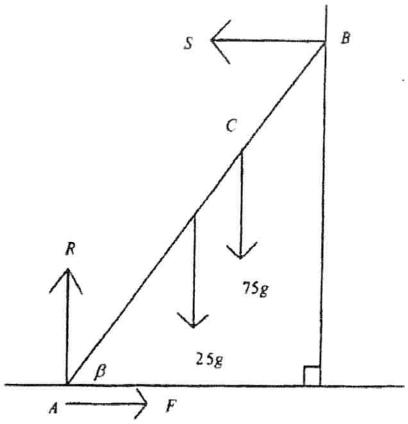
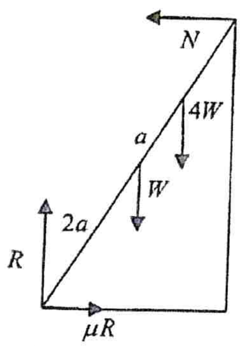
3 (a)	$R(\uparrow): R = 25g + 75g (= 100g)$	B1	
	$F = \mu R \Rightarrow F = \frac{11}{25} \times 100g$	M1	
	$= 44g\ (=431)$	A1	
			(3)
(b)	M(A): $25g \times 2\cos\beta + 75g \times 2.8\cos\beta = S \times 4\sin\beta$	M1 A2,1,0	
	$R(\leftrightarrow): F = S$		
	$176g\sin\beta = 260g\cos\beta$	M1A1	
	$\beta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



4 (a)



	μR		
	$\uparrow\ R = 5W$	B1	
		B1	
	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 $F \le 0.35S$	M1	
	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	
	$k \geq \frac{10}{7}$ ft their k, accept $>$ and decimals	A1ft	(7)
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5	$m(B): R \times 4\cos\alpha = F \times 4\sin\alpha + 20g \times 2\cos\alpha$	M1 A2	
	Use of $F = \frac{1}{2}R$	M1	
	Use of correct trig ratios	B1	
	R = 160N or 157N	DM1 A1	(6)