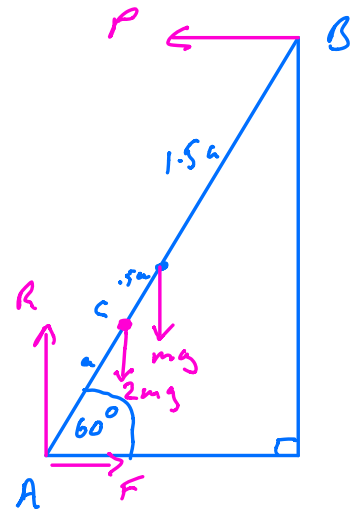
Static Rigid Bodies

Example 8



$R(\leftrightarrow)$ $\quad P = F = \mu R$ (since limiting equilibrium)

$R(\updownarrow)$ $\quad R = 3mg$

Moments about B

$$mg \times 1.5a\cos 60 + 2mg \times 2a\cos 60 + F \times 3a\sin 60 = R \times 3a\cos 60$$

$$0.75mg + 2mg + \mu \times 3mg \times 3 \times \frac{\sqrt{3}}{2} = 3mg \times \frac{3}{2}$$

$$2.75 + \frac{9\sqrt{3}}{2}\mu = 4.5$$

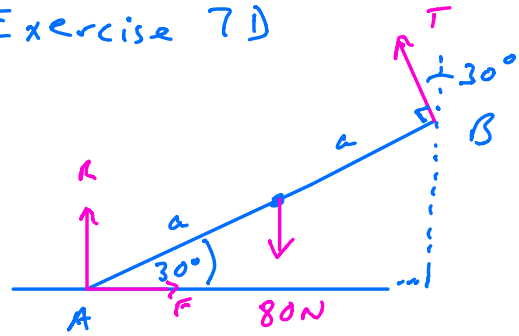
$$\frac{9\sqrt{3}}{2}\mu = 1.75$$

$$\mu = \frac{1.75 \times 2}{9\sqrt{3}}$$

$$\mu = 0.225 \quad \text{to } 3 \text{ s.f.}$$

Exercise 7D

1)



Let $AB = 2a$

$R(\leftrightarrow)$ $\quad T\sin 30 = F$

$R(\updownarrow)$ $\quad T\cos 30 + R = 80$

Moments about A $\quad 80 \times a\cos 30° = T \times 2a$

$$40\cos 30° = T$$

$$\underline{T = 20\sqrt{3} \text{ N}}$$

$$F = T\sin 30 = 20\sqrt{3} \times \frac{1}{2} = 10\sqrt{3} \text{ N}$$

$$R = 80 - T\cos 30 = 80 - \frac{\sqrt{3}}{2} \times 20\sqrt{3}$$
$$= 80 - 30$$
$$= 50\,N$$

$T = 20\sqrt{3}\,N, \quad F = 10\sqrt{3}\,N \quad R = 50\,N$

$$F \leq \mu R$$
$$10\sqrt{3} \leq 50\mu$$
$$\frac{10\sqrt{3}}{50} \leq \mu$$
$$\mu \geq \frac{\sqrt{3}}{5}$$

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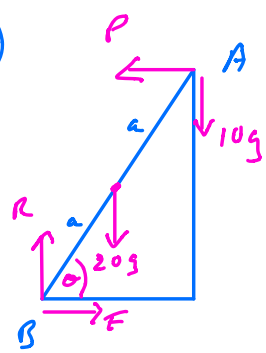
3) a)



Let $AB = 2a$ $\qquad \mu = \frac{3}{4}$

$R(\updownarrow) \quad R = 10g + 20g = 30g$

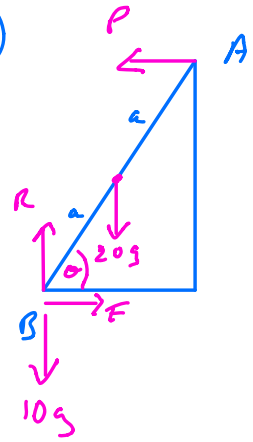
$F = \mu R = \frac{3}{4} \times 30g = 22.5g$

$R(\leftrightarrow) \quad P = F = 22.5g$

Moments about B

$$20g \times a\cos\theta + 10g \times 2a\cos\theta = 22.5g \times 2a\sin\theta$$
$$40\cos\theta = 45\sin\theta$$
$$\frac{40}{45} = \frac{\sin\theta}{\cos\theta} = \tan\theta$$
$$\theta = \tan^{-1}\left(\frac{40}{45}\right) = 41.6^\circ$$

3 b)



$R(\updownarrow)$ $\quad R = 10g + 20g = 30g$

$F = \mu R = \frac{3}{4} \times 30g = 22.5g$

$R(\leftrightarrow)$ $\quad P = F = 22.5g$

Moments about B

$P \times 2a \sin\theta = 20g \times a\cos\theta$

$45g \times a\sin\theta = 20g \times a\cos\theta$

$45\sin\theta = 20\cos\theta$

$\tan\theta = \frac{\sin\theta}{\cos\theta} = \frac{20}{45}$

$\theta = \tan^{-1}\left(\frac{20}{45}\right)$

$\theta = 24.0°$

c) Assumption wall is smooth means reaction at wall is $\perp$ to wall with no vertical component.

Homework

Read notes and read through Example 7

Do Exercise 7D Q2, Q4