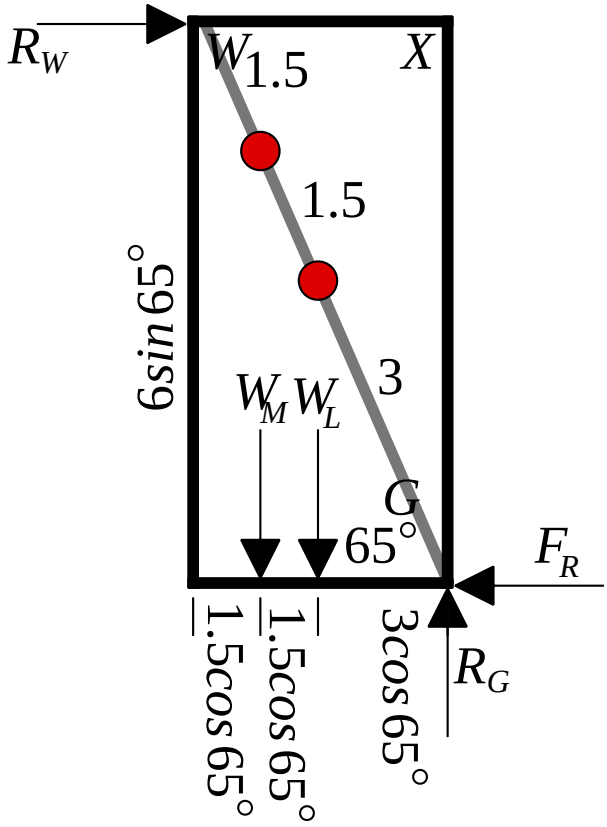
3.7 Answers

3.7.1 Solution to Introductory Example (2.3, 2.4, 2.5)



Take moments about X,
Note that "the line of action" of R_W and R_G passes through X and so has no turning effect about X,

$$F_R \times 6 \sin 65 = W_L \times 3 \times \cos 65 + W_M \times 4.5 \times \cos 65$$
$$5.438 F_R = 120 \times 3 \times \cos 65 + 750 \times 4.5 \times \cos 65$$
$$5.438 F_R = 152.1 + 1426$$
$$F_R = 290 \text{ N}$$

Balancing forces vertically,

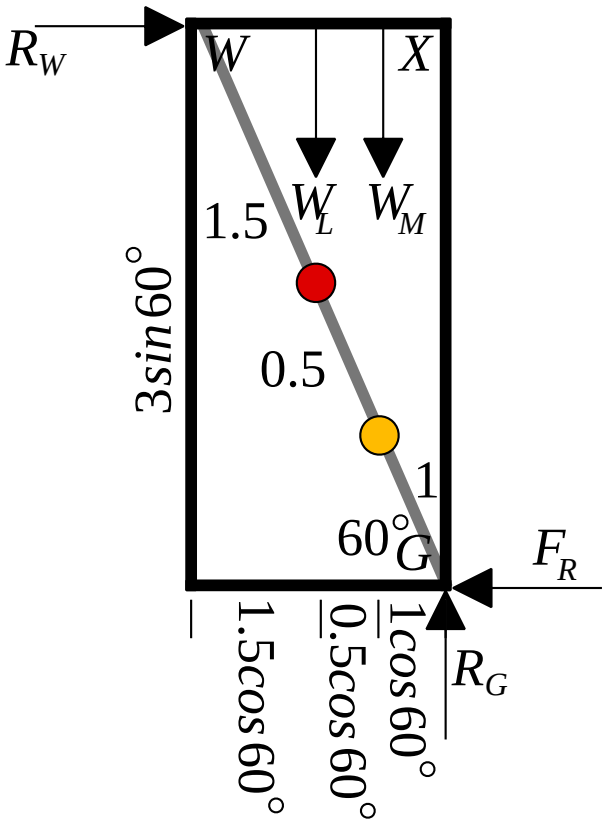
$$R_G = 120 + 750$$
$$= 870$$

$$F_R = \mu R_G$$
$$\therefore \mu = \frac{290}{870}$$
$$= 0.333$$

3.7.1 Solution to 2.6 Exercise

Answer 1

(i)



(ii) Take moments about X,

Note that "the line of action" of R_W and R_G passes through X and so has no turning effect about X,

$$F_R \times 3\sin 60 = W_M \times 1 \times \cos 60 + W_L \times 1.5 \times \cos 60$$

$$2.598\,F_R = 2m \times g \times 1 \times \cos 60 + m \times g \times 1.5 \times \cos 60$$

$$2.598\,F_R = mg + 0.75mg$$

$$F_R = 0.6736mg \text{ N}$$

Balancing forces vertically,

$$R_G = W_M + W_L$$

$$= 2mg + mg$$

$$= 3mg$$

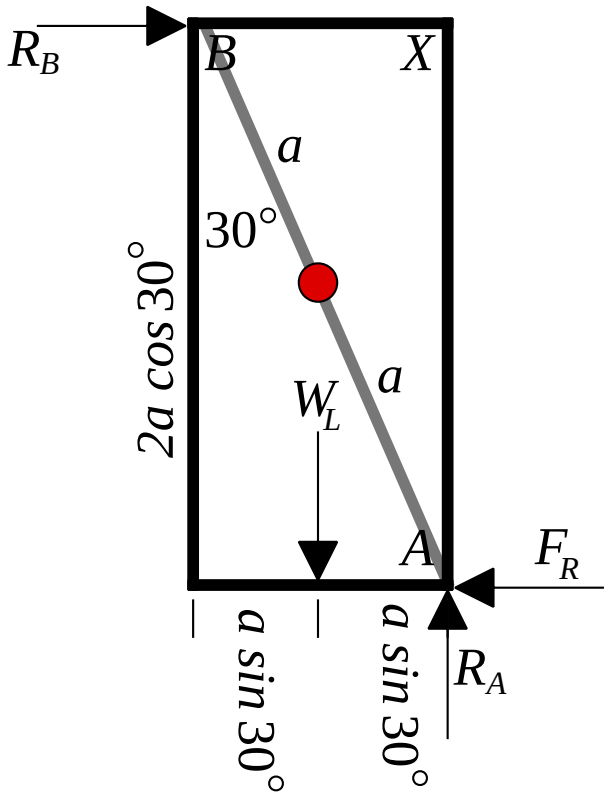
$$F_R = \mu R_G$$

$$\therefore \mu = \frac{0.6736mg}{3mg}$$

$$= 0.22$$

Answer 2

(a) First a working diagram,



Take moments about *A*,

$$R_B \times 2a\cos 30 = W_L \times a\sin 30$$

$$R_B \times 2 \times a \times \frac{\sqrt{3}}{2} = m \times g \times a \times \frac{1}{2}$$

$$\sqrt{3}\, R_B = \frac{mg}{2}$$

$$R_B = \frac{mg}{2\sqrt{3}}$$

$$= \frac{\sqrt{3}\, mg}{6}$$

(b) Balancing forces horizontally,

$$F_R = R_B$$

$$= \frac{\sqrt{3}\, mg}{6}$$

Balancing forces vertically,

$$R_A = W_L$$

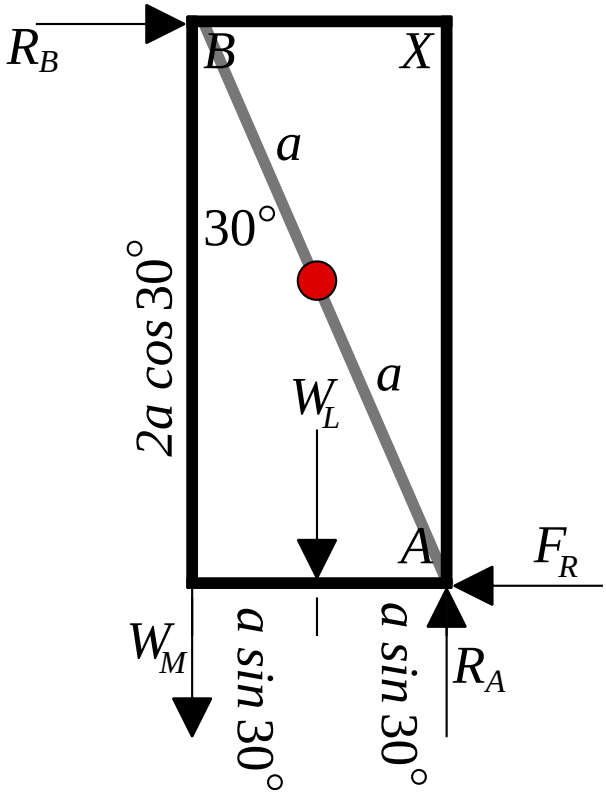
$$= mg$$

$$F_R \leqslant \mu R_A$$

$$\frac{\sqrt{3}\,mg}{6} \leqslant \mu\, mg$$

$$\mu \geqslant \frac{\sqrt{3}}{6} \qquad \square$$

(c) Amended working diagram,



Balancing forces vertically,

$$\begin{aligned} R_A &= W_L + W_M \\ &= mg + kmg \\ &= mg\,(1 + k) \end{aligned}$$

Considering friction,

$$\begin{aligned} F_R &= \mu R_A \\ &= \frac{\sqrt{3}\,mg}{5}\,(1 + k) \end{aligned}$$

Take moments about X,

$$F_R \times 2a\cos 30 = kmg \times 2a\sin 30 + mg \times a\sin 30$$

$$\sqrt{3}\,F_R = kmg + \frac{mg}{2}$$

$$\sqrt{3} \times \frac{\sqrt{3}\,mg}{5}(1 + k) = \frac{mg}{2}(2k + 1)$$

$$6(1 + k) = 5(2k + 1)$$

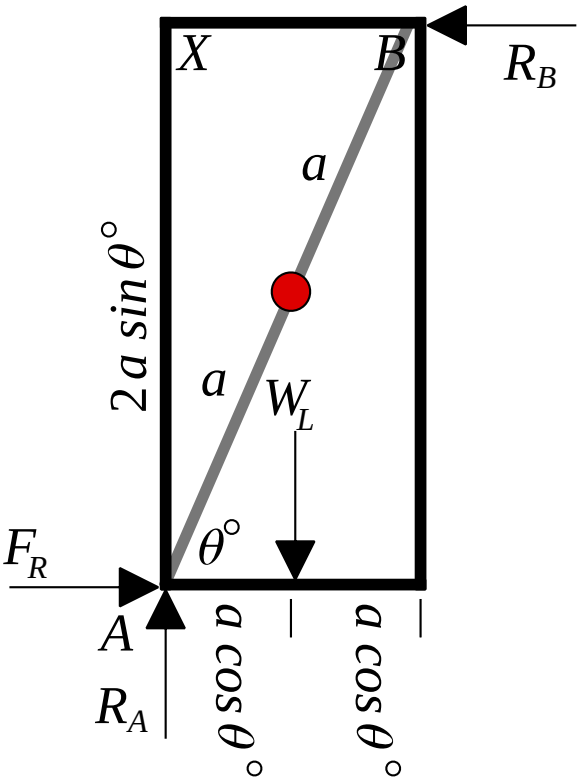
$$6 - 5 = 10k - 6k$$

$$4k = 1$$

$$k = \frac{1}{4}$$

Answer 3

(a) First a working diagram,



Take moments about X,

$$F_R \times 2 \times a \times \sin\theta = W_L \times a \times \cos\theta$$

$$F_R = \frac{W_L\, a \cos\theta}{2\, a \sin\theta}$$

$$F_R = \frac{W_L}{2\tan\theta}$$

Balance forces vertically,

$$R_A = W_L$$

Consider friction,

$$F_R = \mu R_A$$

$$\frac{W_L}{2\tan\theta} = \mu \times W_L$$

$$\mu = \frac{1}{2\tan\theta} \qquad \square$$