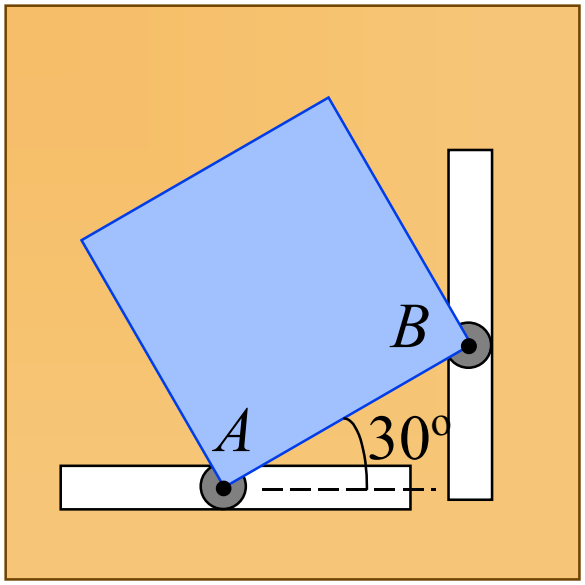
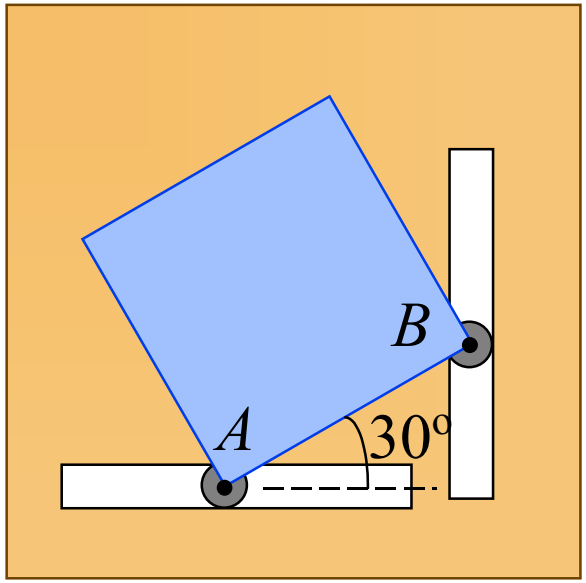
Problem 16.163



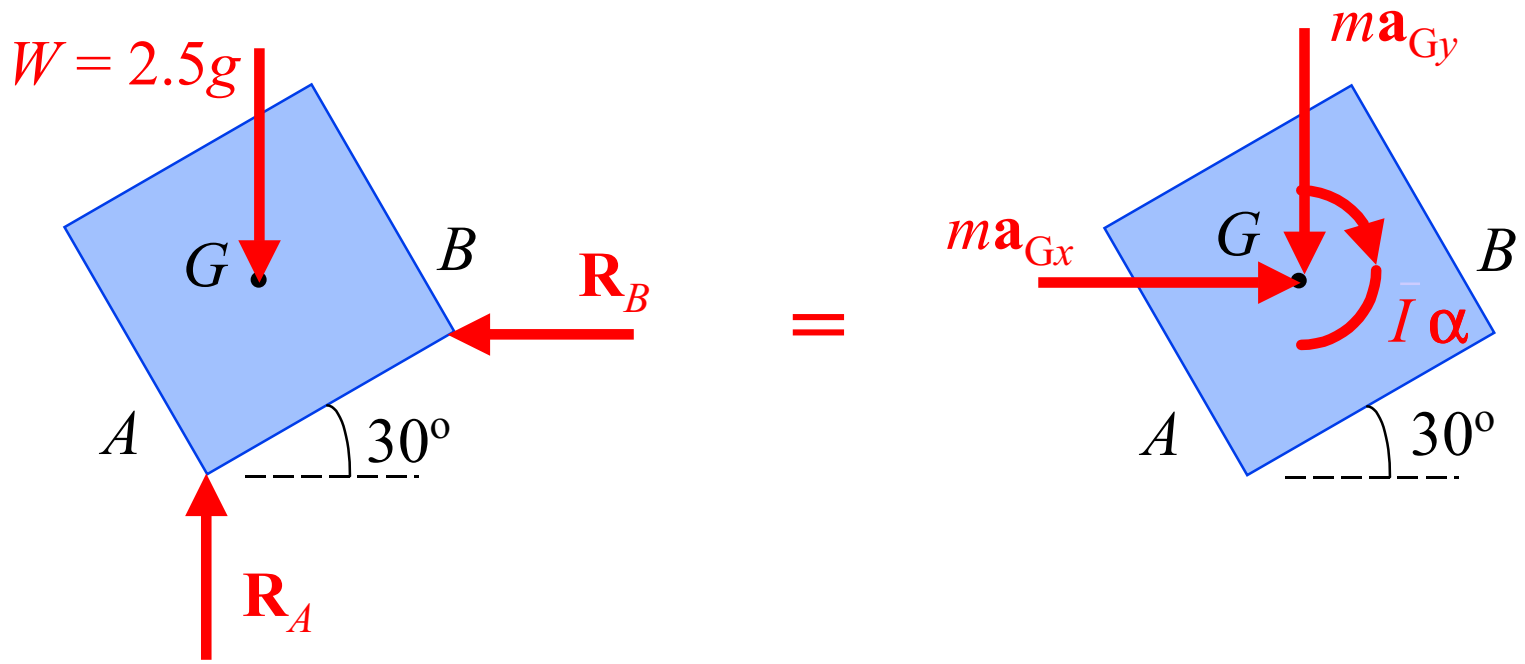
The motion of a square plate of side $150\ \text{mm}$ and mass $2.5\ \text{kg}$ is guided by pins at corners A and B that slide in slots cut in a vertical wall. Immediately after the plate is released from rest in the position shown, determine (a) the angular acceleration of the plate, (b) the reaction at corner A.

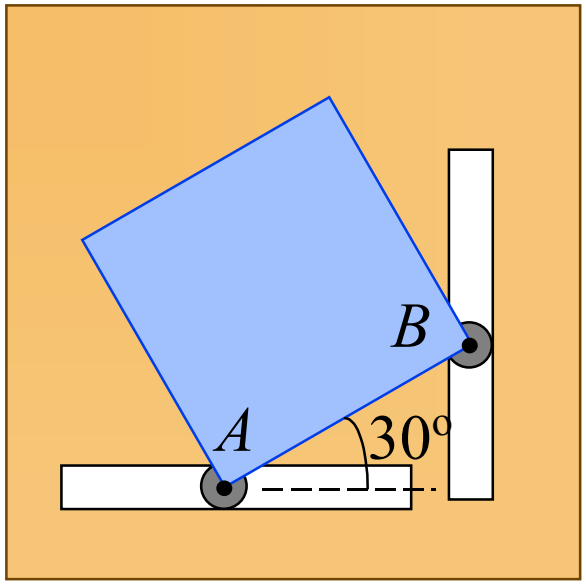


Kinetics: draw a free body diagram.

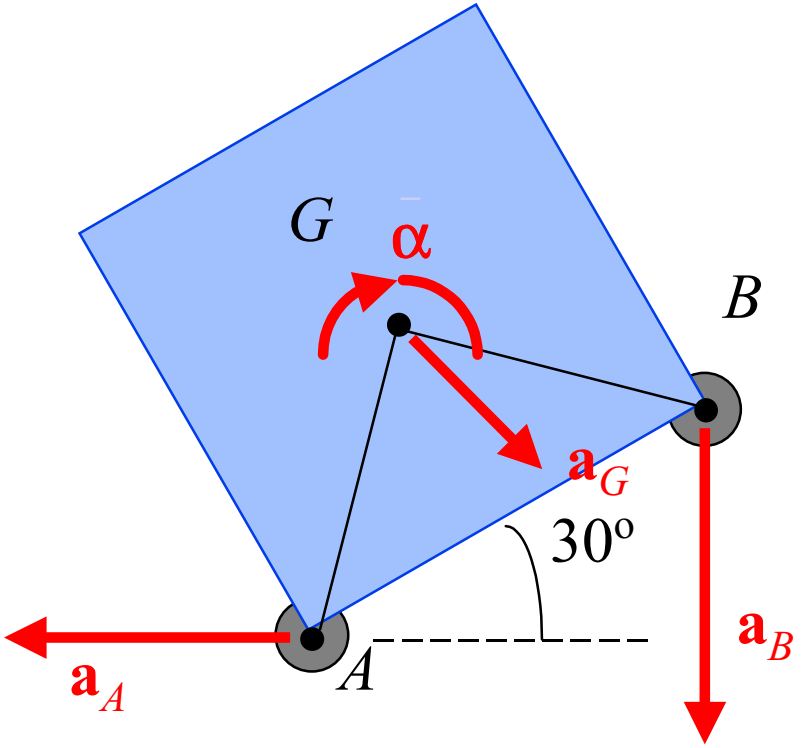
$$\bar{I} = \frac{1}{12}\, m\,(b^2 + c^2)$$

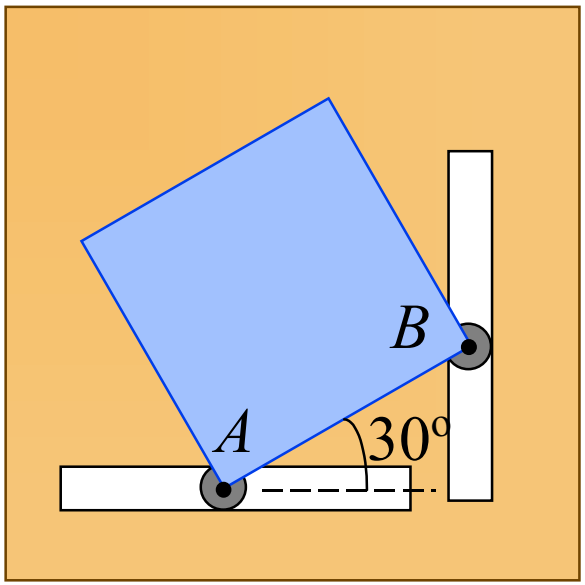
$$\bar{I} = \frac{1}{12} 2.5(0.15^2 + 0.15^2) = 0.009375\ \text{kg}\cdot\text{m}^2$$





Kinematics:

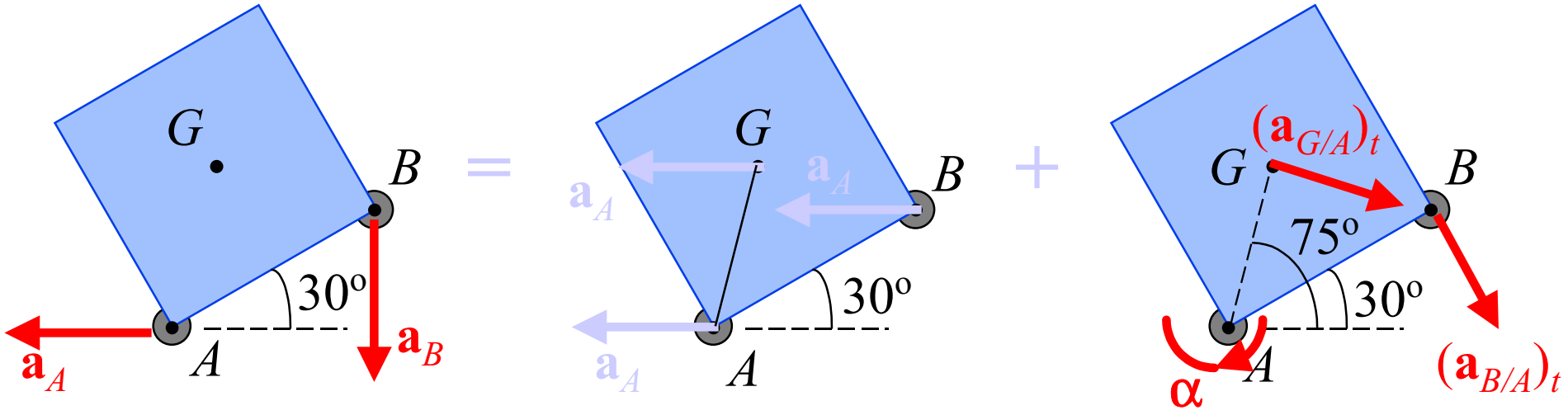


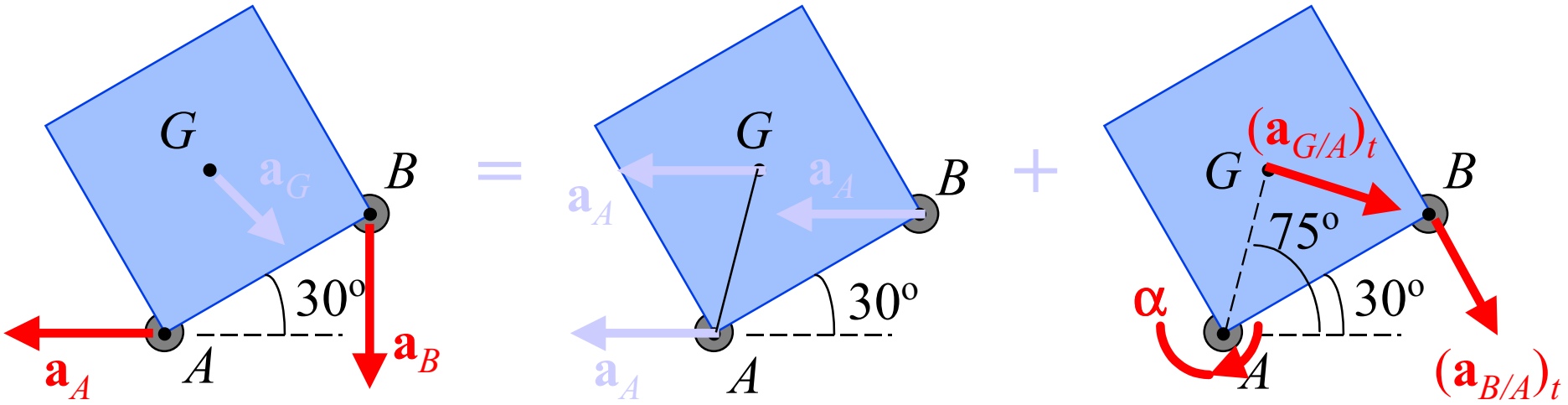


Kinematics:

$$(a_{B/A})_t = \alpha\, r_{B/A} = 0.15\ \alpha$$

$$(a_{G/A})_t = \alpha\, r_{G/A} = 0.1061\ \alpha$$





$$\mathbf{a}_B = \mathbf{a}_A + \mathbf{a}_{B/A}$$

The x component (+ →) : $\quad 0 = -a_A + 0.15\alpha \sin 30^\circ$

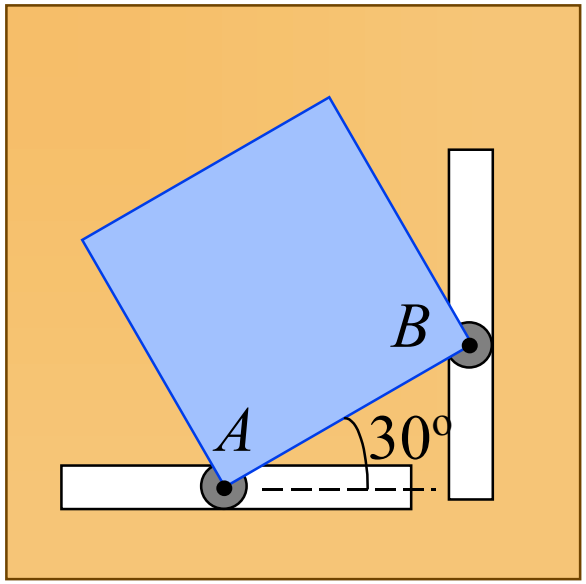
$$a_A = 0.075\alpha$$

$$\mathbf{a}_G = \mathbf{a}_A + \mathbf{a}_{G/A}$$

$$\mathbf{a}_G = -0.075\alpha\,\mathbf{i} + (a_{G/A})_t \cos 15^\circ\,\mathbf{i} - (a_{G/A})_t \sin 15^\circ\,\mathbf{j}$$

$$\mathbf{a}_G = -0.075\alpha\,\mathbf{i} + 0.1061\alpha \cos 15^\circ\,\mathbf{i} - 0.1061\alpha \sin 15^\circ\,\mathbf{j}$$

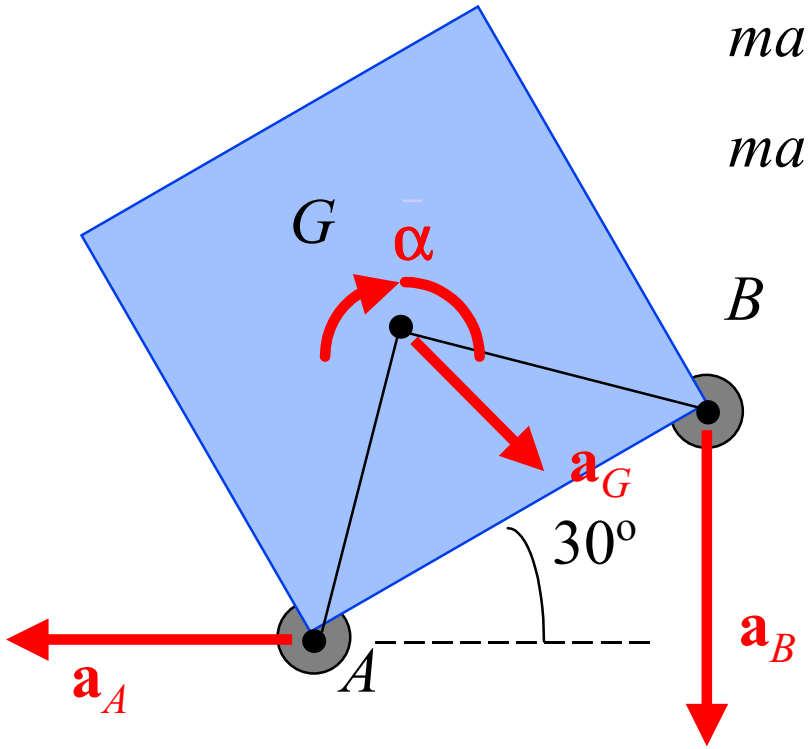
$$\mathbf{a}_G = 0.02745\,\alpha\,\mathbf{i} - 0.02745\alpha\,\mathbf{j}$$

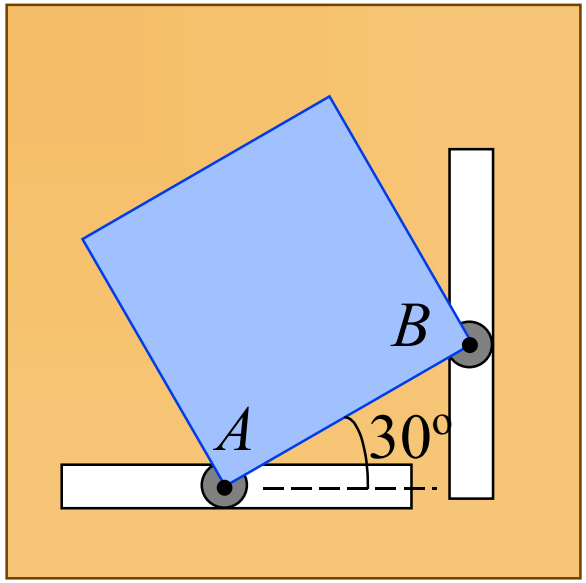


Kinematics:

$$ma_{Gx} = 2.5\,(\,0.02745\,\alpha\,) = 0.068745\alpha \quad \text{N}$$

$$ma_{Gy} = 2.5\,(\,0.02745\,\alpha\,) = 0.068745\alpha \quad \text{N}$$





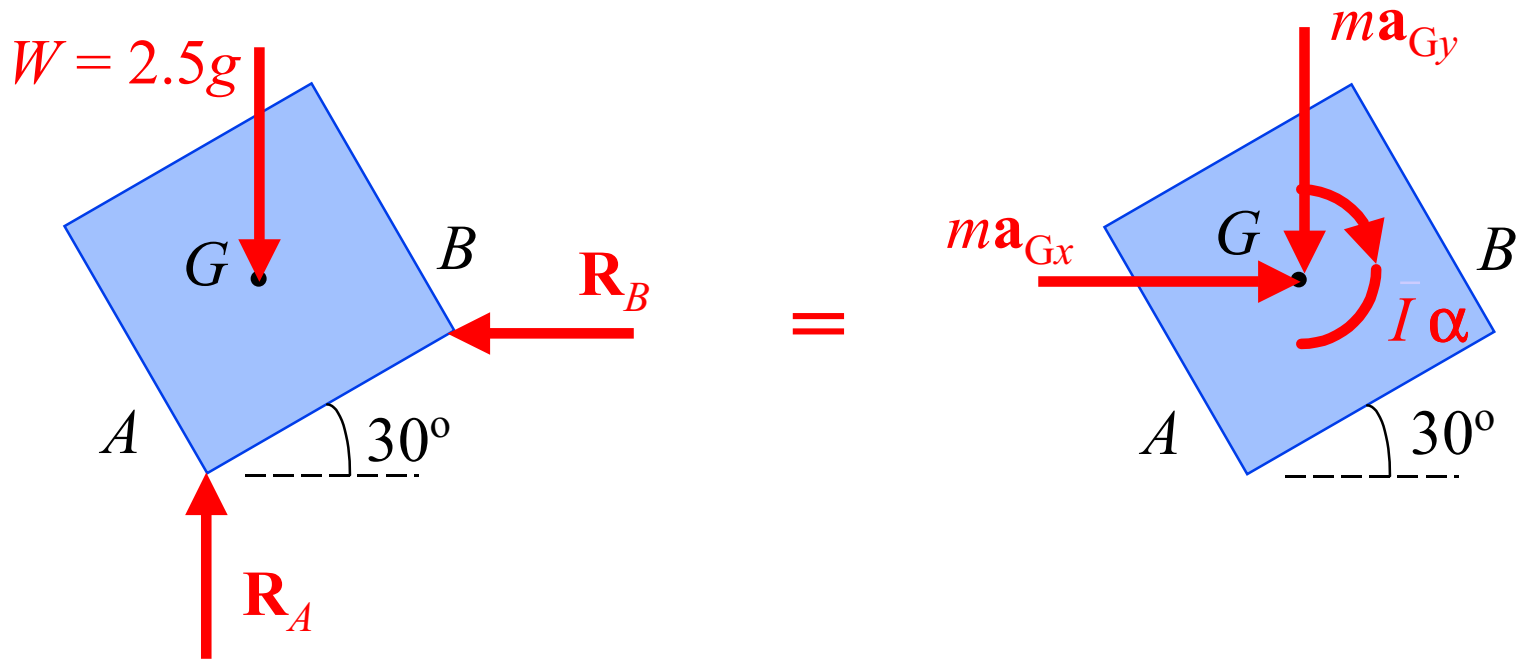
Kinetics: draw a free body diagram.

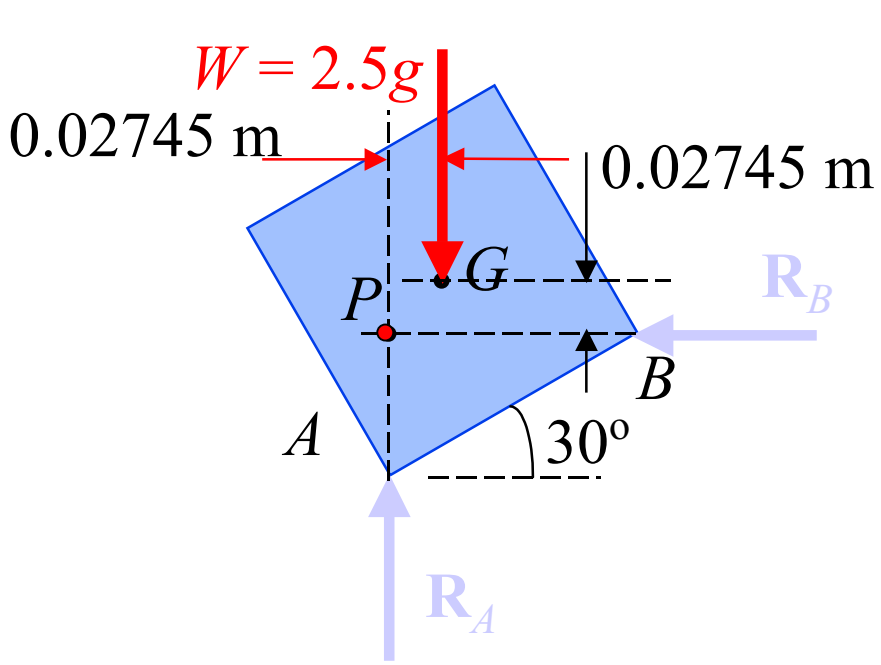
$$\bar{I} = \frac{1}{12}\, m\,(b^2 + c^2)$$

$$\bar{I} = \frac{1}{12} 2.5(\,0.15^2 + 0.15^2\,) = 0.009375\ \text{kg}\cdot\text{m}^2$$

$$ma_{Gx} = 2.5\,(\,0.02745\ \alpha\,) = 0.068745\alpha \quad \text{N}$$

$$ma_{Gy} = 2.5\,(\,0.02745\ \alpha\,) = 0.068745\alpha \quad \text{N}$$





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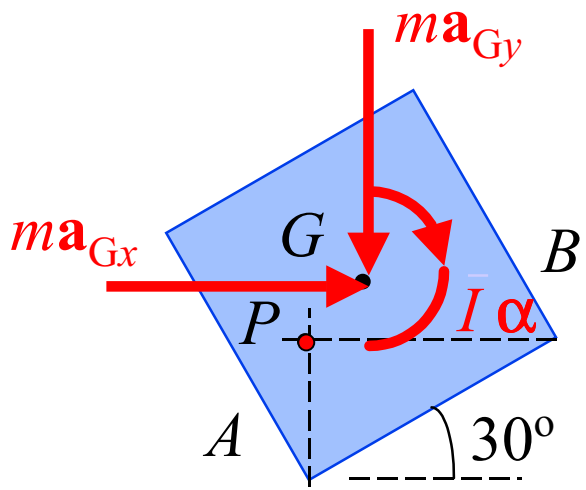


$\bar{I} = 0.009375 \text{ kg m}^2$

$ma_{Gx} = 0.06863\alpha \text{ N}$

$ma_{Gy} = 0.06863\alpha \text{ N}$

(a) Angular acceleration of the plate:

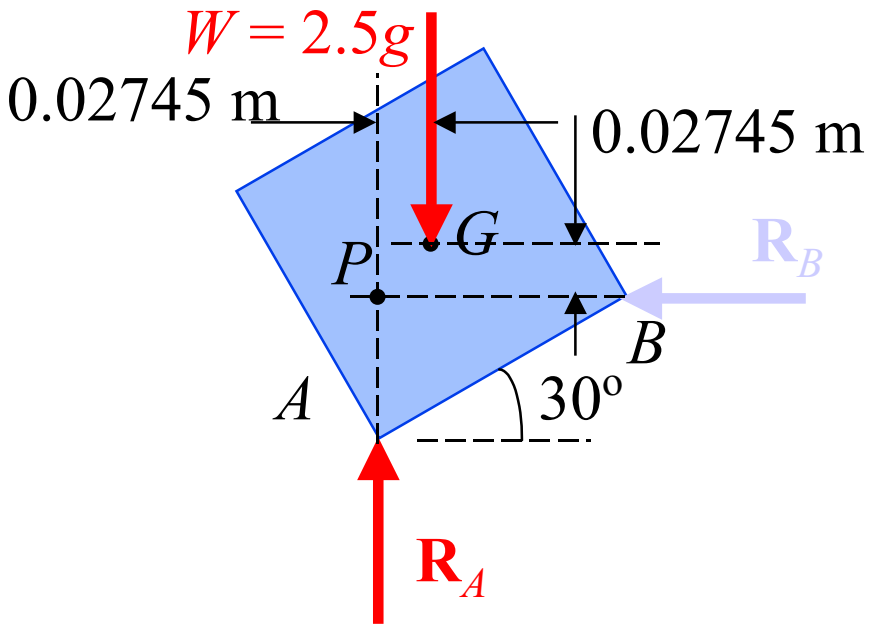
Moments about point P (+ ↻) :

$$2.5(9.81)(0.02745) = 0.009375\alpha + 2[(0.06863\alpha)(0.02745)]$$

$\alpha = 51.2 \text{ rad/s}^2$

$\boxed{\alpha = 51.2 \text{ rad/s}^2 \circlearrowright}$

Problem 16.163 Solution



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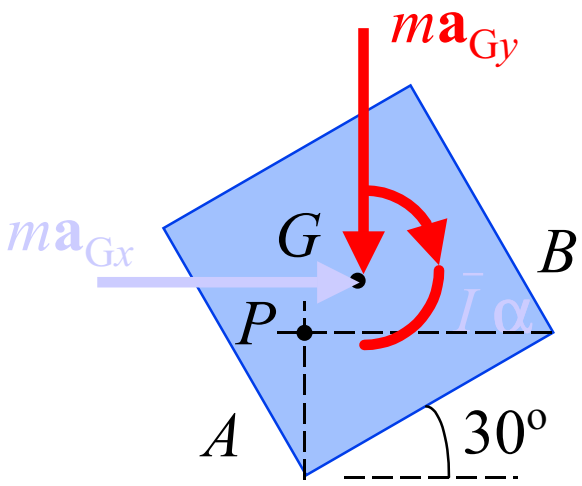

$$ma_{Gy} = 0.06863\alpha \quad \text{N}$$

$$\alpha = 51.2 \quad \text{rad/s}^2$$

(b) The reaction at A:

$$+\uparrow \Sigma F_y = m\,a_y: \qquad R_A - 2.5(9.81) = -0.06863\,(51.2)$$

$$R_A = 21.0 \quad \text{N}$$

$$\mathbf{R}_A = 21.0 \quad \text{N} \uparrow$$