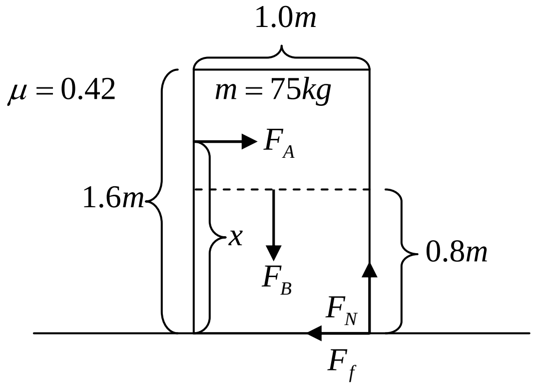
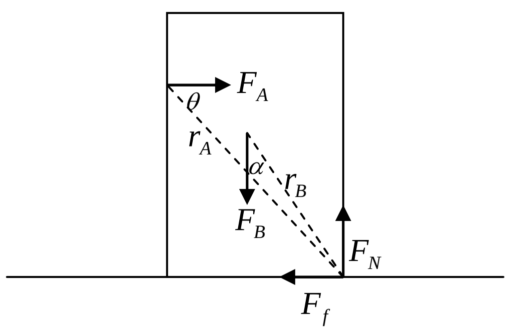
Pg: 178, question 41



O.K, here is the deal, F_B is the force of gravity acting on the centre of mass of the box, F_A is the applied force, F_N is the normal force, F_f is the frictional force acting at the corner of the box.

Note, we found $F_B = 735N$ and $F_f = 308N$

Now, we will set the pivot point to be at the corner of the box where the normal force and the frictional force meet.



Now if we look at the pivot, we consider the two radial lines (r_B and r_A) to be two lever arms that act through the pivot. Here is the torque equation

$$\vec{\tau}_{net} = \vec{\tau}_A + \vec{\tau}_B + \vec{\tau}_N + \vec{\tau}_f$$

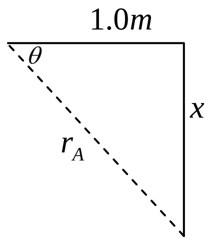
$$0 = -\tau_A + \vec{\tau}_B + 0 + 0$$

$$\tau_A = \tau_B$$

$$r_A F_A \sin\theta = r_B F_B \sin\alpha$$

To finish solving the rest of the equation we need an expression for r_A , r_B , $\sin\theta$ and $\sin\alpha$

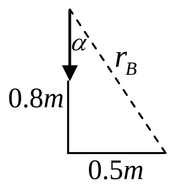
Find r_A and $\sin\theta$



$$r_A = \sqrt{x^2 + 1^2}$$

$$\sin\theta = \frac{x}{r_A}$$

$$\sin\theta = \frac{x}{\sqrt{x^2 + 1^2}}$$



$$r_B = \sqrt{(0.8)^2 + (0.5)^2}$$

$$\sin\alpha = \frac{0.5}{r_B}$$

$$\sin\alpha = \frac{0.5}{\sqrt{(0.8)^2 + (0.5)^2}}$$

$$r_A F_A \sin\theta = r_B F_B \sin\alpha$$

$$\sqrt{x^2 + 1} \cdot F_A \cdot \frac{x}{\sqrt{x^2 + 1}} = \sqrt{(0.5)^2 + (0.8)^2} \cdot F_B \frac{0.5}{\sqrt{(0.5)^2 + (0.8)^2}}$$

$$F_A x = F_B 0.5$$

$$x = 0.5\frac{F_B}{F_A}$$

$$x = 0.5\frac{735}{308}$$

$$x = 1.19$$