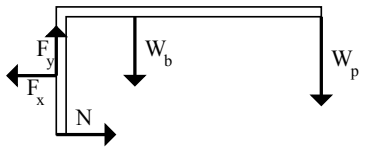
Chapter 12 Problem 60 †



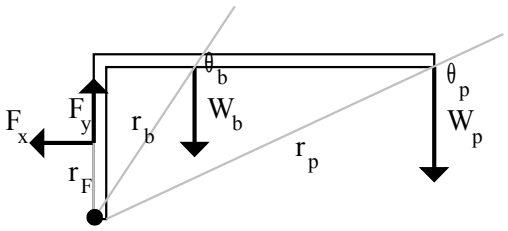
Given

$m_p = 4.2\ kg$
$m_b = 0.85\ kg$
Measurements from Figure 12-33

Solution

Find the horizontal force exerted by the screw.

The free-body diagram is given for the bracket. By choosing the pivot point at the bottom of the bracket, the torque provided by this force is zero. The torque equation is the sum of all the forces times their force arms times the sine of the angles between the force arm and its respective force.



The force F_v is parallel to the force arm and does not contribute to the torque. The torque provided by the weight of the bracket and the weight of the plant is the portion of the force arm which is perpendicular to the weight multiplied by the weight. The total torque becomes

$$\Sigma\vec{\tau} = \vec{\tau}_F + \vec{\tau}_b + \vec{\tau}_p = 0$$

$$r_F F_x \sin 90^\circ - r_b \sin\theta_b W_b - r_p \sin\theta_p W_p = 0$$

Solving for F_x gives

$$F_x = \frac{r_b \sin\theta_b W_b + r_p \sin\theta_p W_p}{r_F} = \frac{(r_b \sin\theta_b) m_b g + (r_p \sin\theta_p) m_p g}{r_F}$$

$$F_x = \frac{(0.090\ m)(0.85\ kg)(9.80\ m/s^2) + (0.28\ m)(4.2\ kg)(9.80\ m/s^2)}{0.072\ m}$$

$$F_x = 171\ N$$

†Problem from Essential University Physics, Wolfson