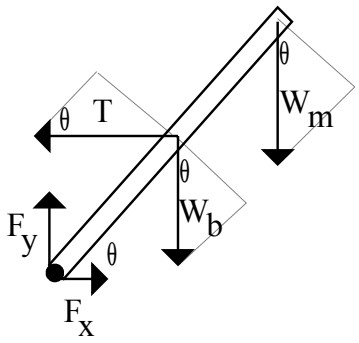
Chapter 12 Problem 33 [†]



Given
$m_m = 2200\ kg$
$m_b = 1700\ kg$
$l_b = 18\ m$
$\theta = 50°$

Solution
Find the tension in the cable holding the boom in place.

By choosing the pivot point at the base of the boom, we can get a torque equation with only one unknown, which is the tension in the cable.
On the diagram given above is a free-body diagram of the boom with the components of the three forces perpendicular and parallel to the boom indicated. The torque equation about the pivot at the base of the boom is

$$\Sigma\vec{\tau} = \vec{\tau}_b + \vec{\tau}_T + \vec{\tau}_m = 0$$

$$-\tfrac{1}{2}lm_b g\cos\theta + \tfrac{1}{2}lT\sin\theta - lm_m g\cos\theta = 0$$

Solving for tension gives

$$T = \frac{\frac{1}{2}lm_b g\cos\theta + lm_m g\cos\theta}{\frac{1}{2}l\sin\theta} = \frac{g\cos\theta(\frac{1}{2}m_b + m_m)}{\frac{1}{2}\sin\theta}$$

$$T = \frac{(9.80\ m/s^2)\cos(50°)(\frac{1}{2}(1700\ kg) + (2200\ kg))}{\frac{1}{2}\sin(50°)}$$

$$T = 50,200\ N = 50.2\ kN$$

[†]Problem from Essential University Physics, Wolfson