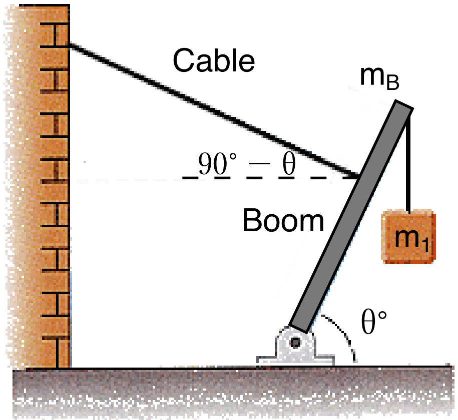
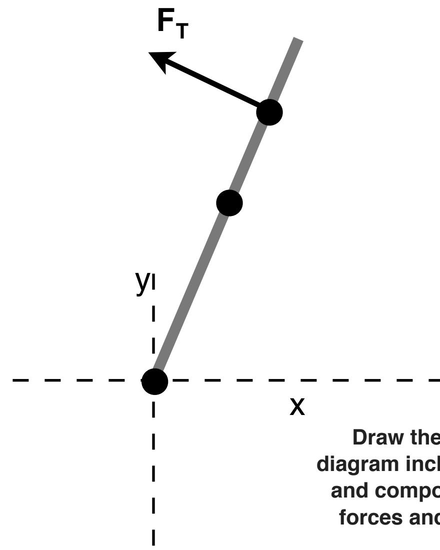
A 1350 kg uniform boom is supported by a cable. The length of the boom is *l*. The cable is connected 1/4 the way from the top of the boom. The boom is pivoted at the bottom, and a 2250 kg mass hangs from its top. The angle between the ground and the boom is 55°. Find the **tension** in the cable and the **components of the Normal force** on the boom by the floor.



FreeBody Diagram

(4 pts)



What is the rotational equivalent of Newton's Second law in Static Equilibrium?

(1 pt)

Draw the Freebody diagram include all forces and components of the forces and distances.

B) Find the tension in the cable.

Write the sum of torques symbolically

Circle the forces that cause a negative torque? (3 pts)

Sum of Torques $\sum\tau =$

Where did you place the pivot point? a. at the origin, b. where the Normal force is applied, c. parallel to the boom?

solve for F_T

(2 pts)

$F_T =$

C) Find the components of the Normal Force.

Look for ALL the Forces pointing in the x or y direction on your diagram

Sum of Forces $\Sigma F_x = F_{Nx} - F_T \cos(90° - \theta) = 0$

solve for F_{Nx}

$F_{Nx} =$

Write the sum of the forces in the y-dir symbolically (2 pts)

$\Sigma F_y =$

solve for F_{Ny}

(1 pt)

$F_{Ny} =$

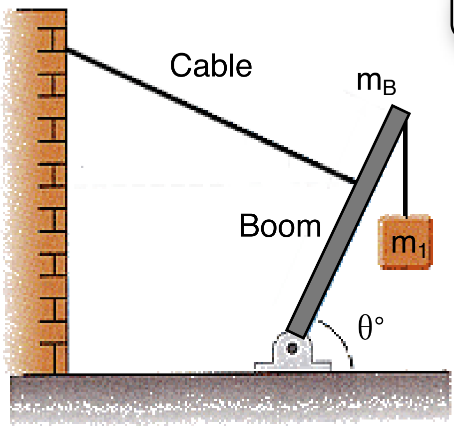
D) Find the Normal Force

(2 pts) $F_N = \sqrt{(\quad)^2 + (\quad)^2} =$ $\quad \theta = \tan^{-1}\frac{\quad}{\quad} =$

Why did you place the pivot point here? a. that is the only place it can be placed, b. to make the calculation easier c. to eliminate the torque due to the Normal Force?

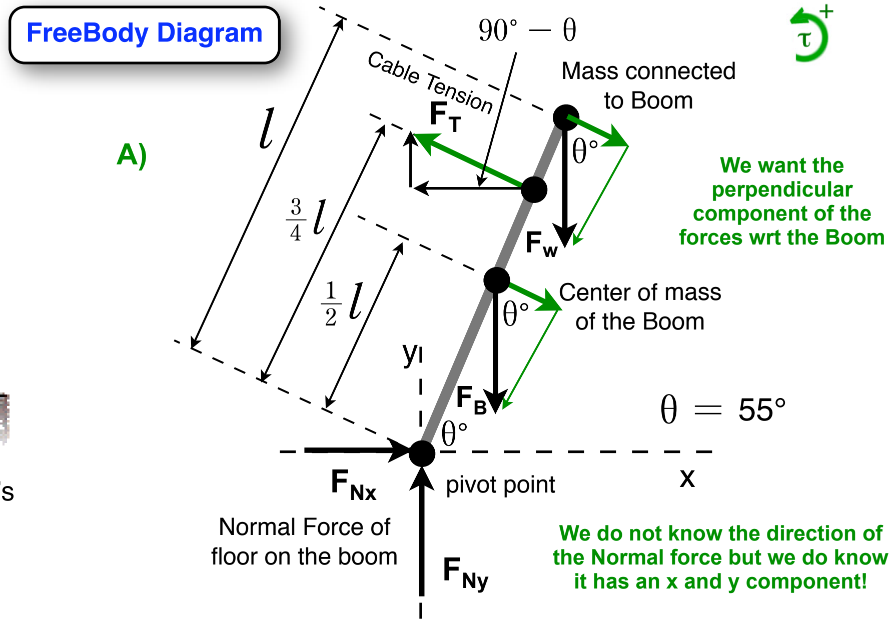
Physics 195 Chapter 12 Problem 40

A 1350 kg uniform boom is supported by a cable. The length of the boom is *l*. The cable is connected 1/4 the way from the top of the boom. The boom is pivoted at the bottom, and a 2250 kg mass hangs from its top. The angle between the ground and the boom is 55°. Find the **tension** in the cable and the **components of the Normal force** on the boom by the floor.



The rotational equivalent of Newton's Second Law in Static Equilibrium.

$$\tau = F_{\perp} d = I\alpha = 0$$



B) Find the tension in the cable.

We want the perpendicular component of the forces wrt the Boom

The Normal Force acts on the pivot so the torque is zero.

Sum of Torques

$$\Sigma\tau = -F_B \cos\theta\left(\tfrac{1}{2}l\right) + F_T\left(\tfrac{3}{4}l\right) - F_W \cos\theta\,(l) = I\alpha = 0 \quad \textit{Static Equilibrium}$$

The force due to the center mass and the weight are causing a negative torque.

$$F_T\left(\tfrac{3}{4}l\right) = F_B \cos\theta\left(\tfrac{1}{2}l\right) + F_W \cos\theta\,(l)$$

$$F_T = \frac{F_B \cos\theta\left(\tfrac{1}{2}l\right) + F_W \cos\theta\,(l)}{\left(\tfrac{3}{4}l\right)} = \left(\tfrac{2}{3}\right)F_B \cos\theta + \left(\tfrac{4}{3}\right)F_W \cos\theta$$

$$F_T = \left(\tfrac{2}{3}\right)1350kg\,(9.8m/s^2)\cos 55^\circ + \left(\tfrac{4}{3}\right)2250kg\,(9.8m/s^2)\cos 55^\circ = \underline{21,900N}$$

C) Find the components of the Normal Force.

Sum of Forces Look for ALL the Forces pointing in the x or y direction on your diagram

$$\Sigma F_x = F_{Nx} - F_T \cos(90^\circ - \theta) = 0 \quad \textit{Static Equilibrium}$$

$$F_{Nx} = F_T \cos(90^\circ - \theta) = 21,900N \cos(90^\circ - 55^\circ) = \underline{17,900N}$$

$$\Sigma F_y = F_{Ny} + F_T \sin(90^\circ - \theta) - F_B - F_W = 0 \quad \textit{Static Equilibrium}$$

$$F_{Ny} = -F_T \sin(90^\circ - \theta) + F_B + F_W$$

$$F_{Ny} = -21,900N \sin(90^\circ - 55^\circ) + (1350kg + 2250kg)\,9.8m/s^2 = \underline{22,700N}$$

The Normal Force

$$F_N = \sqrt{(17,900N)^2 + (22,700N)^2} = \underline{28,900N} \qquad \theta = \tan^{-1}\frac{22,700N}{17,900N} = \underline{51.7^\circ}$$