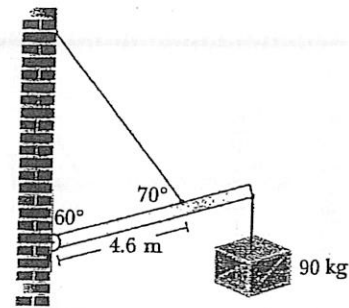


PROBLEM 3 Rotational Equilibrium: $\Sigma\tau = 0$

A 7.0 m uniform beam of mass 30 kg is attached to a vertical wall by a cable as shown in the diagram. A 90 kg crate hangs from the far end of the beam. Find the tension in the cable connected to the wall.



Solution $m_B = 30 \text{ kg}$, $m_C = 90 \text{ kg}$, $d_{CG} = 3.5 \text{ m}$, $d_C = 7.0 \text{ m}$, $d_T = 4.6 \text{ m}$

Draw a free-body diagram and determine the directions of torques.

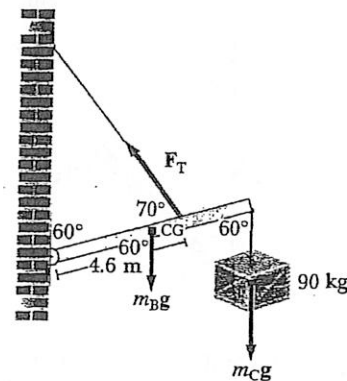
$$\tau_{CC} = (F_T)(d_T) \sin 70^\circ = (F_T)(4.6) \sin 70^\circ$$

$$\tau_C = (m_B g)(d_{CG}) \sin 60^\circ + (m_C g)(d_C) \sin 60^\circ \\ = (30)(9.8)(3.5) \sin 60^\circ + (90)(9.8)(7.0) \sin 60^\circ = 6238 \text{ N}\cdot\text{m}$$

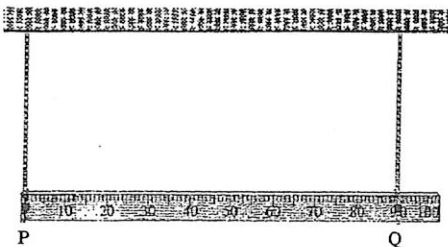
Rotational equilibrium: $\Sigma\tau = 0$

$$\Sigma\tau = \tau_{CC} + (-\tau_C) = (F_T)(4.6) \sin 70^\circ - 6238 = 0$$

$$F_T = 1443 \approx 1400 \text{ N}$$

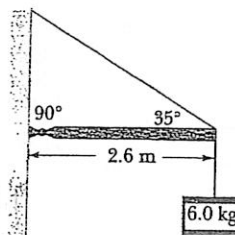
**RELATED PROBLEMS**

12. A 200 g metre stick is supported horizontally by two strings, one at the 0-cm mark and the other at the 90-cm mark as shown in the diagram.

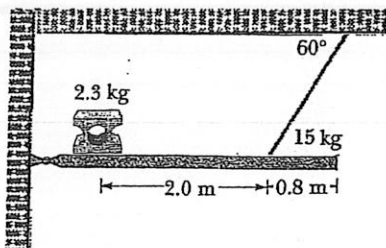


- Find the sum of the torques about point P.
- If the tension in the left hand string is 0.87 N, what is the sum of the torques about point Q?

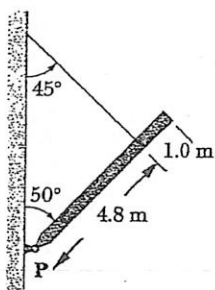
13. A 6.0 kg box is supported by a uniform 2.6 m strut as shown in the diagram. The strut has a mass of 1.8 kg. Find the tension in the cable connected to the wall.



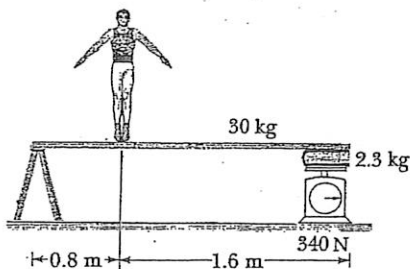
14. A uniform 15 kg plank of length 4.0 m holding a 2.3 kg block is attached by a rope to a ceiling as shown in the diagram. What is the tension in the rope?



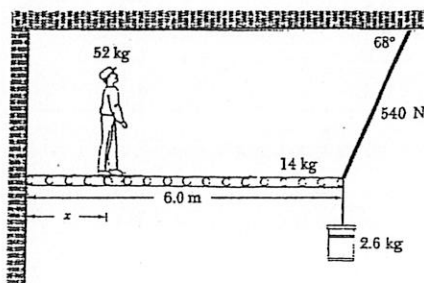
15. A 5.8 m uniform beam is supported by a cable having a tension of 1300 N. What is the mass of this beam?



16. A gymnast stands on a uniform 2.4 m beam with a mass of 30 kg. The beam is held level by a 2.3 kg physics book resting on a scale at the other end. The scale on the right end reads 340 N. What is the mass of the gymnast?



17. A 52 kg painter walks out on a uniform scaffold with a mass of 14 kg and a length of 6.0 m in an attempt to fetch a 2.6 kg paint can hanging at the right end of the scaffold. A rope which can withstand 540 N is supporting the scaffold as shown in the figure. Can the painter fetch the paint can safely? If not, what is the maximum distance that the painter can walk out on the scaffold?



18. A uniform plank of mass 40 kg is balanced at one end by a 60 kg tourist as shown in the diagram. What is the length of this plank?

