Chapter 8 Problems

1, 2 = straightforward, intermediate

Section 8.1 Torque

1. A grinding wheel of radius 0.350 m rotation on a frictionless axle is brought to rest by applying a constant friction force tangential to its rim. The constant torque produced by this force is 76 N·m. Find the magnitude of the frictional force.

2. According to the manual of a certain car, a maximum torque of magnitude 65.0 N·m should be applied when tightening the lug nuts on the vehicle. If you use a wrench of length 0.350 m and you apply the force at the end of the wrench at an angle of 75° with respect to a line going from the lug nut through the end of the handle, (a) what is the magnitude of the maximum force you can exert on the handle without exceeding the recommendation? (b) How does that force change if the angle is smaller?

3. Calculate the net torque (magnitude and direction) on the beam in Figure P8.3 about (a) an axis through *O* perpendicular to the page and (b) an axis through *C* perpendicular to the page.

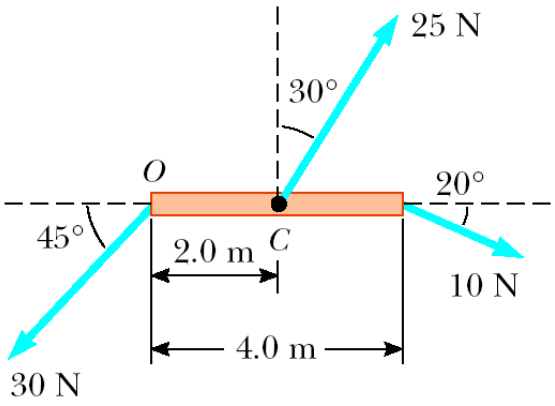

Figure P8.3

5. A simple pendulum consists of a small object of mass 3.0 kg hanging at the end of a 2.0-m-long light string that is connected to a pivot point.(a) Calculate the magnitude of the torque (due to the force of gravity) about this pivot point when the string makes a 5.0° angle with the vertical. (b) Does the torque increase or decrease as the angle increases? Explain.

Section 8.2 Torque and the Two Conditions for Equilibrium
Section 8.3 The Center of Gravity
Section 8.4 Examples of Objects in Equilibrium

7. The arm in Figure P8.7 weighs 41.5 N. The force of gravity acting on the arm acts through point *A*. Determine the magnitudes of the tension force $\vec{\mathbf{F}}_t$ in the deltoid muscle and the force $\vec{\mathbf{F}}_s$ exerted by the shoulder on the humerus (upper-arm bone) to hold the arm in the position shown.

Homework 1: Section 8.1 & 8.4 => 1 – 3, 5, 19, 20
Homework 2: Section 8.1 & 8.4 => 7, 8, 10, 21 - 23
Homework 3: Section 8.4 & Additional Problems => 28, 74, 79, 85

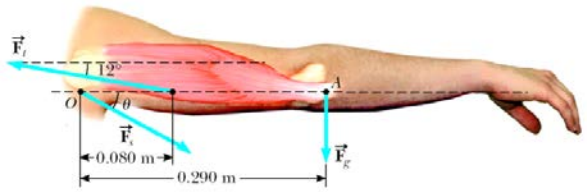

Figure P8.7

8. A uniform beam of length 7.6 m and weight 450N is carried by two workers, Sam and Joe, as shown in Figure P8.8. (a) Determine the forces that each person exerts on the beam. (b) Qualitatively, how would the answers change if Sam moved closer to the midpoint? (c) What would happen if Sam moved beyond the middle point?

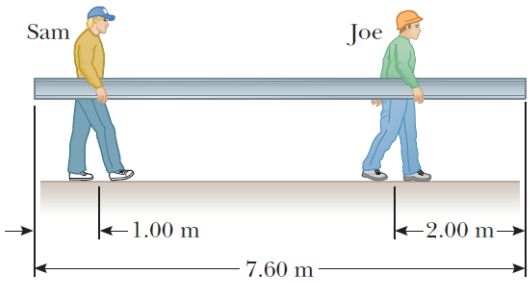

FIGURE P8.8

10. A meter stick is found to balance at the 49.7-cm mark when placed on a fulcrum. When a 50.0-gram mass is attached at the 10.0-cm mark, the fulcrum must be moved to the 39.2-cm mark for balance. What is the mass of the meter stick?

19. A 500-N uniform rectangular sign 4.00 m wide and 3.00 m high is suspended from a horizontal, 6.00-m-long, uniform, 100-N rod as indicated in Figure P8.19. The left end of the rod is supported by a hinge, and the right end is supported by a thin cable making a 30.0° angle with the vertical. (a) Find the tension T in the cable. (b) Find the horizontal and vertical components of force exerted on the left end of the rod by the hinge. (c) How would the tension change if the uniform sign was shorter making its center of gravity more towards the edge? Justify your answer

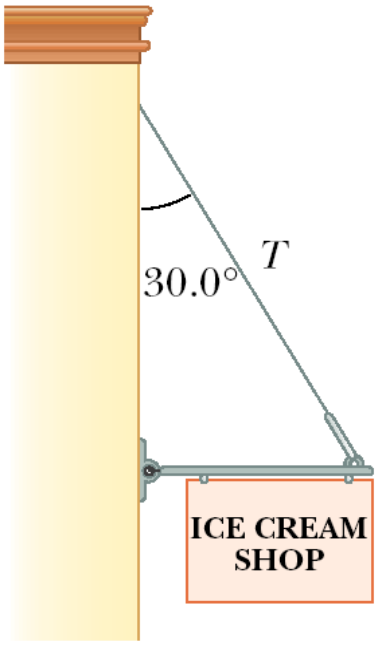

Figure P8.19

20. A window washer is standing on a scaffold supported by a vertical rope at each end. The scaffold weighs 200 N and is 3.00 m long. (a) What is the tension in each rope when the 700-N worker stands 1.00 m from one end? (b) How does the TOTAL of the two tensions change if he stands on the very edge of one side? Justify your answer.

21. A uniform plank of length 2.00 m and mass 30.0 kg is supported by three ropes, as indicated by the blue vectors in Figure P8.21. Find the tension in each rope when a 700-N person is 0.500 m from the left end.

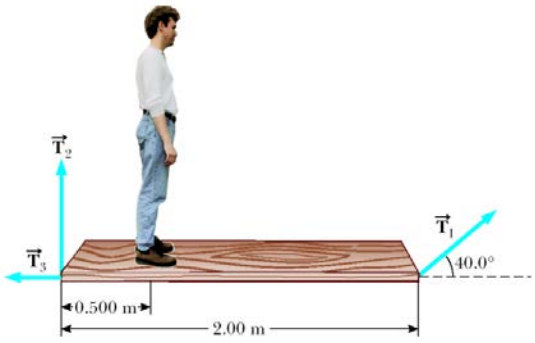

Figure P8.21

22. A hungry 700-N bear walks out on a beam in an attempt to retrieve some "goodies" hanging at the end (Fig. P8.22). The beam is uniform, weighs 200 N, and is 6.00 m long; the goodies weigh 80.0 N. (a) Draw a free-body diagram of the beam. (b) When the bear is at x = 1.00 m, find the tension in the wire and the components of the reaction force at the hinge. (c) If the wire can withstand a maximum tension of 900 N, what is the maximum distance the bear can walk before the wire breaks?

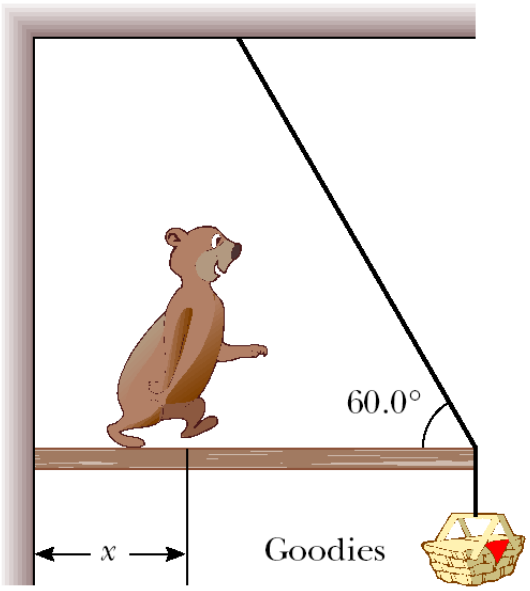

Figure P8.22

23. An 8.00-m, 200-N uniform ladder rests against a smooth wall. The coefficient of static friction between the ladder and the ground is 0.600, and the ladder makes a 50.0° angle with the ground. How far up the ladder can an 800-N person climb before the ladder begins to slip?

28. A 1 200-N uniform boom is supported by a cable perpendicular to the boom as in Figure P8.28. The boom is hinged at the bottom, and a 2 000-N weight hangs from its top. Find the tension in the supporting cable and the components of the reaction force exerted on the boom by the hinge.

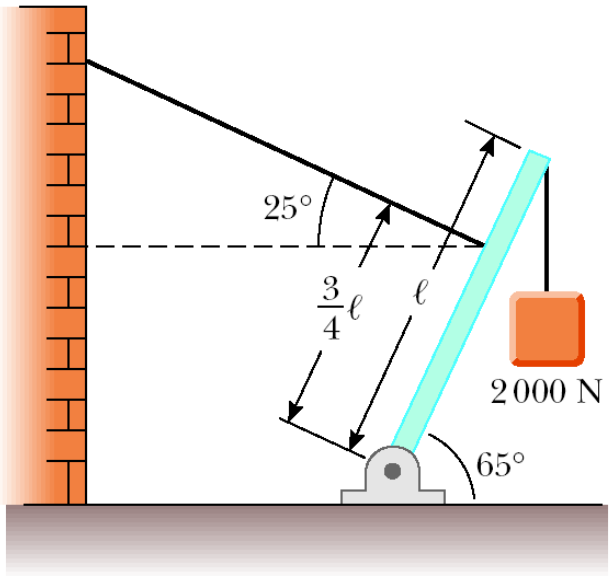

Figure P8.28

Additional Problems

74. Two window washers, Bob and Joe, are on a 3.00-m-long, 345-N scaffold supported by two cables attached to its ends. Bob weighs 750 N and stands 1.00 m from the left end, as shown in Figure P8.74. Two meters from the left end is the 500-N washing equipment. Joe is 0.500 m from the right end and weighs 1 000 N. Given that the scaffold is in rotational and translational equilibrium, what are the forces on each cable?

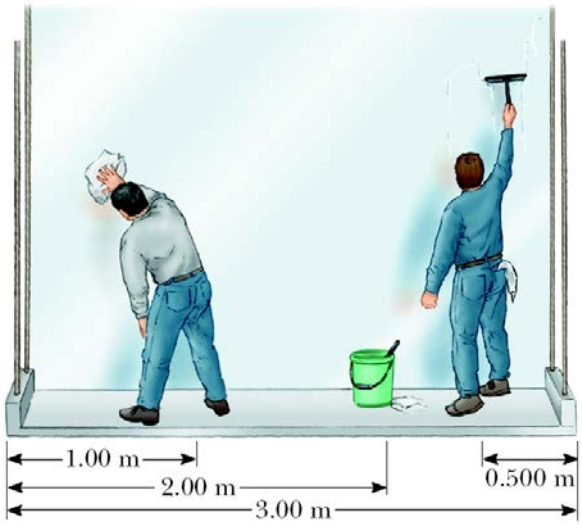

Figure P8.74

79. In exercise physiology studies, it is sometimes important to determine the location of a person's center of gravity. This can be done with the arrangement shown in Figure P8.79. A light plank rests on two scales that read $F_{g1} = 380$ N and $F_{g2} = 320$ N. The scales are separated by a distance of 2.00 m. How far from the woman's feet is her center of gravity?

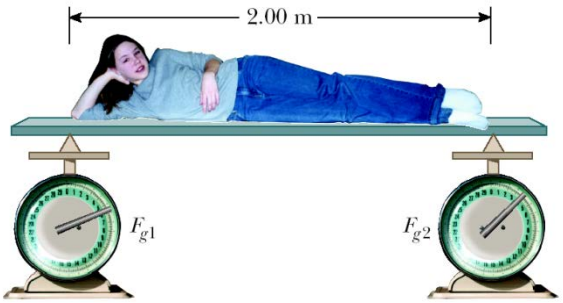

Figure P8.79

85. **The Iron Cross** When a gymnast weighing 750 N executes the iron cross as in Figure P8.85a, the primary muscles involved in supporting this position are the latissimus dorsi ("lats") and the pectoralis major ("pecs"). The rings exert an upward force on the arms and support the weight of the gymnast. The force exerted by the shoulder joint on the arm is labeled $\vec{\mathbf{F}}_s$ while the two muscles exert a total force $\vec{\mathbf{F}}_m$ on the arm. Estimate the magnitude of the force $\vec{\mathbf{F}}_m$. Note that one ring supports half the weight of the gymnast, which is 375 N as indicated in Figure P8.85b. Assume that the force $\vec{\mathbf{F}}_m$ acts at an angle of 45° below the horizontal at a distance of 4.0 cm from the shoulder joint. In your estimate, take the distance from the shoulder joint to the hand to be 70 cm and ignore the weight of the arm.

(a)

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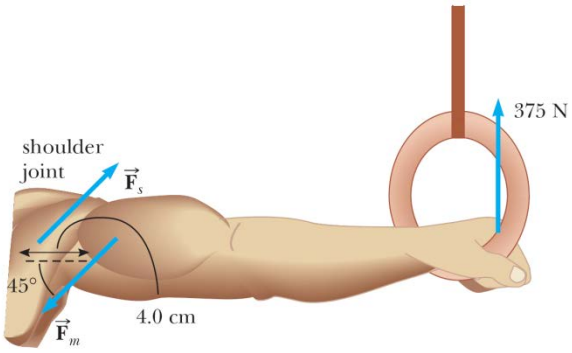

(b)

Figure P8.83