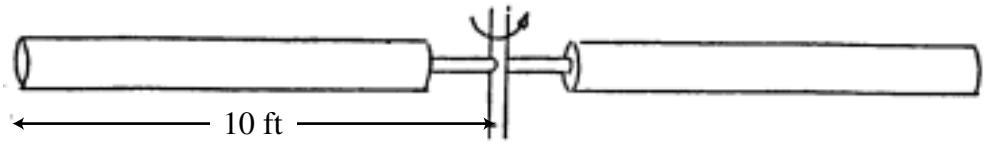
Physics 1114: Unit 5 Homework

Problem set 1

1. The flywheel on an experimental bus is rotating at 420 RPM. a) What is its angular velocity in rad/s (radians/second)? b) What is the linear (i.e., tangential) speed of a point 16 cm from the center of the flywheel?

2. A helicopter has blades that are 10 ft long extending from the axle. The tip of the blade should not exceed 1100 ft/s (the speed of sound). a) Find the maximum angular velocity in rad/s for the blades. b) Convert this angular velocity to RPM.



3. (a) A ball on the end of a string is whirled in a horizontal circle with 0.5 m radius at a rate of one revolution every two seconds. Find the ball's centripetal acceleration.

   (b) If the ball has a mass of 0.65 kg, find the horizontal component of the tension in the string (i.e. the centripetal force). Then find the total tension by accounting for the weight of the ball.

   (c) Now the 0.65 kg ball is whirled in a vertical circle of 0.5 m radius. The maximum tension the string can withstand is 40 N. Find the maximum allowed speed of the ball when the ball is i) at the top, ii) at the side (i.e., when the string is horizontal) and iii) at the bottom of the circle.

4. A 1550 kg car is traveling at 12 m/s on a level road where the coefficient of static friction between the tires and the road is 0.80.

   (a) Find the minimum turning radius of the car. (Hint: What is the maximum frictional force that could act centripetally?)

   (b) When it rains, the coefficient of friction on the road drops to 0.10. Find the maximum speed with which the car can safely negotiate a turn with the same radius as found above.

5. A wheel starts from rest and rotates with constant angular acceleration. After 6.0 s have elapsed, it has rotated through 25 rad. Find (a) the angular acceleration, and (b) the angular velocity at t = 6.0 s.

Problem set 2

1. A wheel on a moving car slows uniformly from 72 rad/s to 44 rad/s in 7.0 seconds. Find (a) the angular acceleration, (b) the angle through which the wheel turns in the 7.0 s interval.

2. A motorcycle wheel turning at 0.25 rad/s is brought to rest by the brakes in exactly two revolutions. What was the angular acceleration of the wheel?

3. The sun has a mass of 1.99×10^{30} kg, while the mass of Mars is only 6.34×10^{23} kg. What is the force of attraction between these two bodies if the radius of Mars's orbit is 2.28×10^{8} km? ($G = 6.67 \times 10^{-11}$ N m^2/kg^2)

4. What torque is produced by a person who applies a 70 lb force to the end of a 9 inch wrench if the angle between the force and wrench is 80°?

5. Find the tension in the cable (Figure 1) if the beam is 8 m long and has a mass of 20 kg.

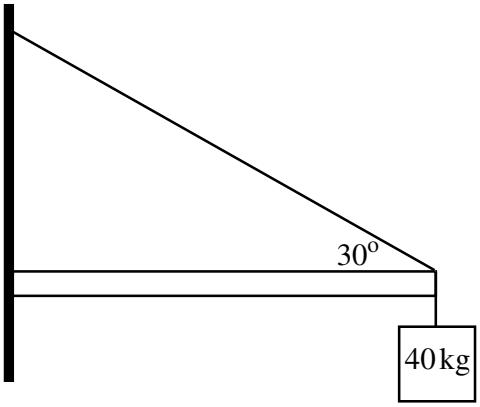


Figure 1

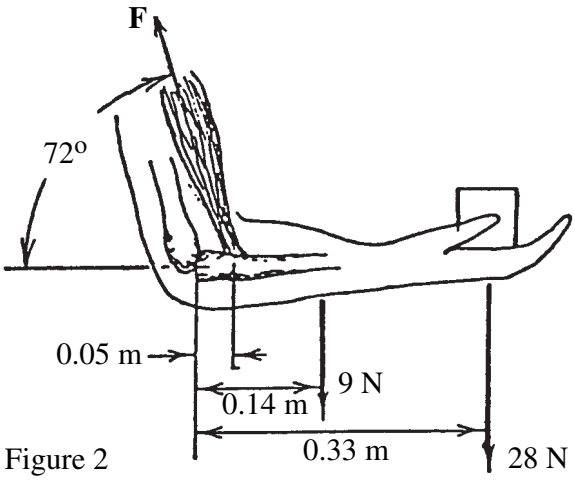


Figure 2

Problem set 3

1. The biceps muscle contracts to provide the supporting force **F** as shown in Figure 2. It acts at a 72° angle and is attached 0.05 m from the joint. The center of gravity for the 9-N arm is 0.14 m from the joint. A 28-N box is held in the hand at a distance of 0.33 m from the joint. Determine the force in the biceps muscle. Begin with a free-body diagram.

2. The moment of inertia of the human arm about the shoulder joint is approximately 0.21 ML^2, where L is the arm length. Find the angular acceleration of an 8.0 kg arm, 0.66 m long, when subject to a torque of $\tau = 27$ N m.

3. A solid steel disk ($I = \frac{1}{2}MR^2$) has a radius of 0.52 m and a mass of 290 kg. It is mounted on its axle so that it is free to spin. What net torque (τ_{net}) would be needed to give the disk an acceleration of 1.20 rad/s^2?

4. A ball of mass 0.78 kg and radius of 0.06 m ($I = \frac{2}{5}MR^2$) starts from rest and rolls without slipping for a distance of 1.2 m down a 25° incline. How fast is it traveling at that point?

5. A small ball of mass 0.22 kg is attached to a light string which passes through a hollow tube. The tube is held by one hand and the string by the other. The object is set to rotating in a horizontal circle of radius 1.2 m with a speed of 2.2 m/s. The string is pulled down, shortening the radius to 0.70 m. Find the new speed of the ball.