

- (20%) Consider the flexed forearm that is holding a ball, as shown in Figure 1. Gravity pulls downward on the forearm and the ball, while the biceps muscles pull upward. With the biceps muscles supporting the forearm at 90° of elbow flexion, the lever arm from the tendon to the axis of the elbow joint is 4 cm. Suppose the forearm weighs 15N, its center of mass is 15 cm from the elbow joint. The ball weighs 20N and is placed in the hand at 30 cm from the elbow center. Solve for the bicep muscle force B and elbow joint reaction force R .
- (20%) Wheel OA of the reciprocating mechanism shown in Figure 2 rotates at a constant counterclockwise angular velocity ω . In terms of r , θ , d , and ω , derive expressions for the velocity v_B of collar B and for the angular velocity ω_{AB} of rod AB.
- (20%) A commercial type sprinkler consists of four curved pipes attached to a central stem as shown in Figure 3. Each of the four pipes has a constant radius of curvature of 0.5 m as shown. The sprinkler rotates at a constant angular speed $\omega = 200$ rpm and the constant velocity of the water relative to the pipes is 10 m/s. Determine (a) the absolute velocity of a particle of water just prior to leaving the pipe at point A and (b) the absolute acceleration of a particle of water just prior to leaving the pipe at point A.
- (20%) (a) Explain Euler's theorem. (b) Is finite rotation of a rigid body a vector? (c) What is the definition of Power? (d) What is mass moment of inertia?
- (20%) A young person B weighting 400 N starts from rest at the top of a smooth slide and leaves the bottom of the slide with a horizontal velocity parallel to the x axis. At the same time, a friend imparts a constant velocity $v_C = 10$ m/s to a cart C weighting 200 N which moves in the smooth x - y plane. The velocity of the cart makes an angle of 45° with the x axis. All of this information is depicted in the plan and elevation views shown in Figure 4. The young person and the cart reach the bottom of the slide simultaneously enabling him to land on the cart without moving relative to it, and the two of them continue to move as a single entity in the x - y plane. Determine their combined velocity immediately after the young person lands on the cart.

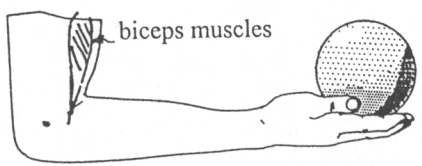


Figure 1

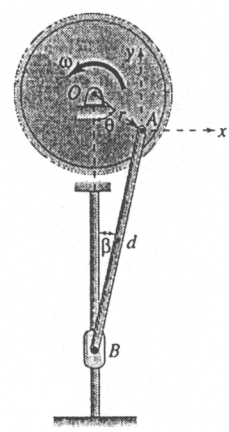


Figure 2

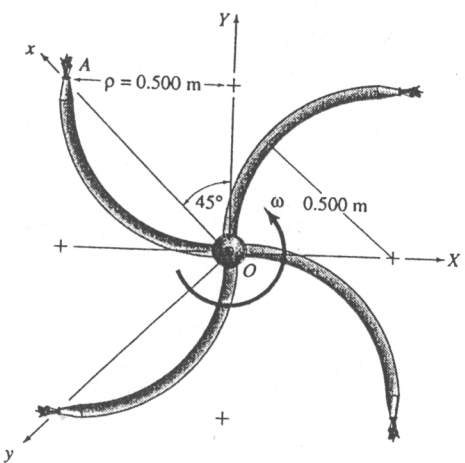


Figure 3

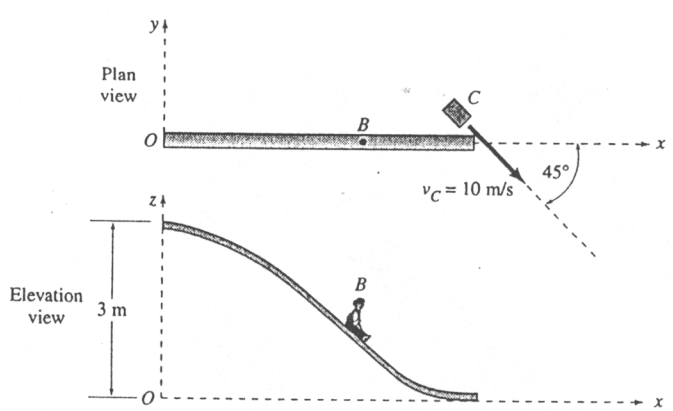


Figure 4