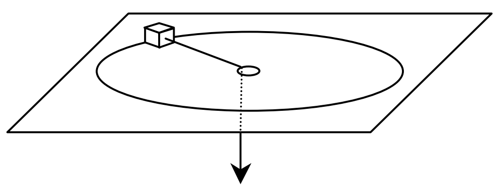
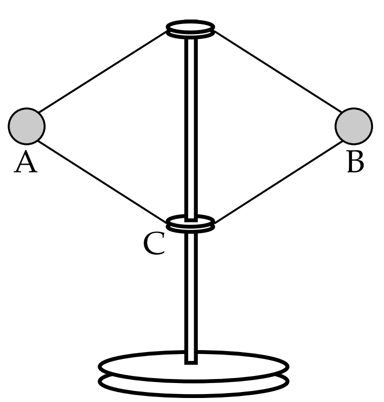
1. A woman sits on an old-fashioned piano stool. She is holding a pair of dumbbells at a distance of 0.60 m from the axis of rotation of the stool. The woman is given an angular velocity of 3.00 rad/s, after which she pulls the dumbbells in until they are only 0.20 m from the axis of rotation. The woman's moment of inertia about the axis of rotation is 5.00 $kg \cdot m^2$ and may be considered constant. Each dumbbell has a mass of 5.00 kg and may be considered a point mass. Neglect friction.

a. What is the initial angular momentum of the system?
b. What is the angular velocity of the system after the dumbbells are pulled in toward the axis?
c. Compute the kinetic energy of the system before and after the dumbbells are pulled in. Account for the difference, if any.

2. A puck on a frictionless air-hockey table has a mass of 0.0500 kg and is attached to a cord passing through a hole in the table surface. The puck is originally revolving at a distance of 0.300 m from the hole with an angular velocity of 2.50 rad/s. The cord is pulled down from below, shortening the radius of the circle in which the puck revolves to 0.100 m. The puck may be considered to be a point mass.

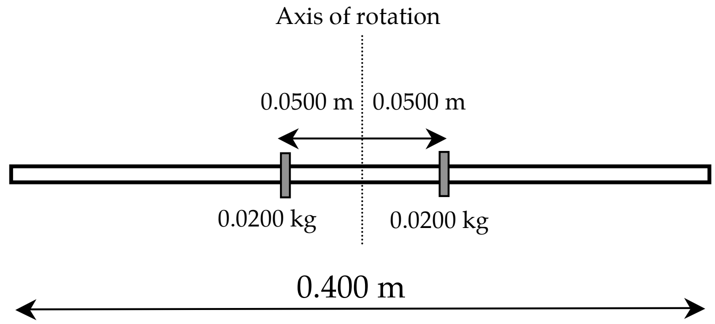


a. What is the new angular velocity?
b. Find the change in kinetic energy of the puck.
c. How much work was done by the person who pulled the cord?



3. The accompanying diagram shows part of a "fly-ball" governor, a speed-controlling device used in old-fashioned steam engines. Each of the steel balls (A and B) had a mass of 0.200 kg and is rotating around the vertical axis with an angular velocity 4.00 rad/s at a distance of 0.150 m from the axis. Collar C is now forced down until the balls are at a distance of 0.0500 m from the axis of rotation. How much work must be done to move the collar down?

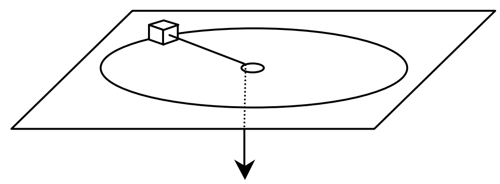
4. A uniform rod with a mass of 0.0300 kg and a length of 0.400 m rotates freely in a horizontal plane about a fixed axis through it center and perpendicular to the rod (see diagram). Two small objects, each with a mass of 0.0200 kg, are mounted so that they can slide along the rod. They are initially held by catches at positions 0.0500 m on each side of the center of the rod, and the system is rotating at 45 rev/min. Without otherwise changing the system, the catches are released, and the masses slide outward along the rod and fly off at the ends.



a. What is the angular velocity of the system at the instant the small masses reach the ends of the rod?

b. What is the angular velocity of the rod after the small mass fly off the end of the rod?

5. A small block with a mass of 0.800 kg is attached to a cord passing through a hole a frictionless horizontal surface. The block is originally revolving in a circle with a radius of 0.500 m about the hole, with a tangential speed of 4.00 m/s. The cord is then pulled slowly from below, shortening the radius of the circle in which the block revolves. The breaking strength of the cord is 600 N. What is the radius of the circle when the cord breaks?



Answers:

1. a. 25.8 kg·m^2/sec
   b. 4.78 rad/s
   c. 38.7 J; 61.7 J; work done by woman on the masses

2. a. 22.5 rad/s
   b. 0.113 J
   c. 0.113 J

3. Work = ΔKE = 0.576 J

4. 45 rev/min → 4.71 rad/sec. All answers will be given in rad/s.
   a. 1.18 rad/s
   b. same as (a)…the momentum of the <u>system</u> is conserved. The angular speed of the rod is the same regardless of whether the small masses are just on or just off the rod.

5. 0.175 m. (Hint: 2 equations, 2 unknowns…conservation of L and centripetal force)