PHY 211 Recitation

April 17, 2020

1

A diver off the high board imparts an initial rotation with his body fully extended before going into a tuck and executing three back somersaults before hitting the water. His moment of inertia before the tuck is $16.9\,\mathrm{kg\,m^2}$, and after the tuck during the somersaults it is $4.2\,\mathrm{kg\,m^2}$.

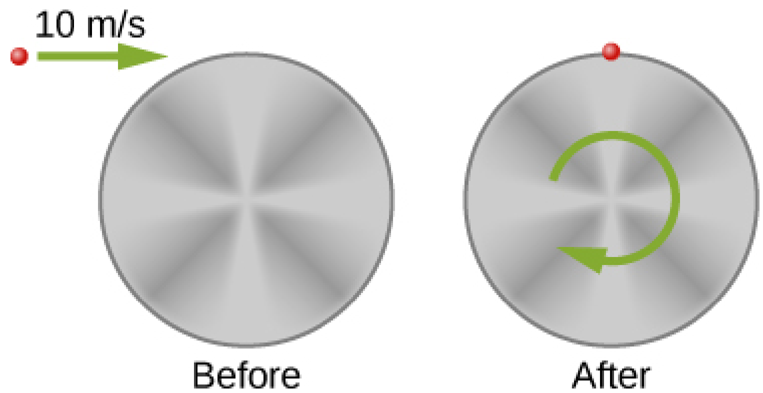
Problem 1(a). Is angular momentum conserved during the tuck? Why or why not?

Problem 1(b). What must be his tucked rotational velocity if he takes $1.4\,\mathrm{s}$ to execute the somersaults before hitting the water?

Problem 1(c). What rotation rate must he impart to his body directly off the board and before the tuck to achieve this rotational velocity?

2

Shown below is a small particle of mass 20 g that is moving at a speed of 10.0 m/s when it collides and sticks to the edge of a uniform solid cylinder. The cylinder is free to rotate about its axis through its center and is perpendicular to the page. The cylinder has a mass of 0.5 kg and a radius of 10 cm, and is initially at rest.



(a) What is the angular momentum of the initial system of incoming particle and cylinder at rest?

(b) What is the angular velocity of the system after the collision?

(c) How much kinetic energy is lost in the collision?

3

A uniform rod with a mass of 100 g and a length of 50.0 cm rotates in a horizontal plane about a fixed, vertical, frictionless pin passing through its center. Two small beads, each having a mass of 30.0 g, are mounted on the rod so that they are able to slide without friction along its length. Initially, the beads are held by catches at positions 10.0 cm on each side of center; at this time, the system rotates at an angular speed of 20.0 rad/s. Suddenly, the catches are released, and the small beads slide outward along the rod.

(a) You will first find the angular velocity of the beads at the instant they get to the ends of the rod.

(i) Sketch the rod and the beads in its initial and final configuration. Mark the point the axis of rotation goes through. Indicate known dimensions in the figure.

Initial

Final

(ii) Is the moment of inertia of the rod and bead system the same in the initial and final configurations?

(iii) Calculate the initial and final moments of inertia, treating the beads as point particles.

(iv) Calculate the initial angular momentum of the system.

(v) Write down the formula for the final angular momentum in terms of the unknown ω_f.

(vi) Use conservation of angular momentum to find ω_f.

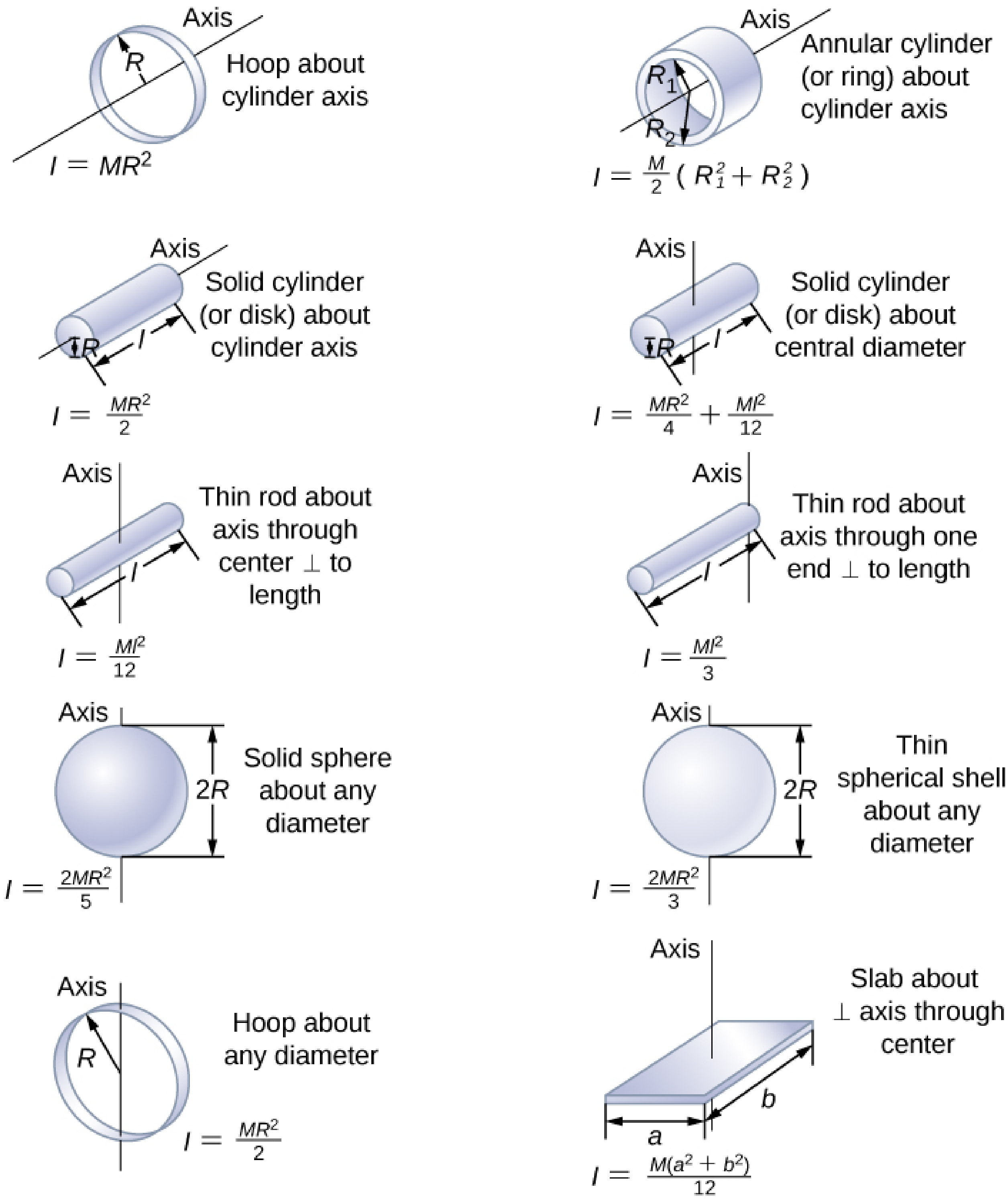
(b) Now you will consider the angular speed of the rod after the beads fly off the ends.

  (i) Indicate in your previous figure the direction of motion of the beads after they fly off the ends of the rod.

  (ii) Do the beads have angular momentum about the rotation axis of the rod after they fly off?

  (iii) Is their angular momentum the same or different from just before they fly off to the instant after they do?

  (iv) What does this imply for the angular momentum and angular velocity of the rod after the beads fly off?


Axis
Hoop about cylinder axis
$I = MR^2$
Axis
Annular cylinder (or ring) about cylinder axis
$I = \frac{M}{2}(R_1^2 + R_2^2)$
Axis
Solid cylinder (or disk) about cylinder axis
$I = \frac{MR^2}{2}$
Axis
Solid cylinder (or disk) about central diameter
$I = \frac{MR^2}{4} + \frac{Ml^2}{12}$
Axis
Thin rod about axis through center ⊥ to length
$I = \frac{Ml^2}{12}$
Axis
Thin rod about axis through one end ⊥ to length
$I = \frac{Ml^2}{3}$
Axis
Solid sphere about any diameter
$I = \frac{2MR^2}{5}$
Axis
Thin spherical shell about any diameter
$I = \frac{2MR^2}{3}$
Axis
Hoop about any diameter
$I = \frac{MR^2}{2}$
Axis
Slab about ⊥ axis through center
$I = \frac{M(a^2 + b^2)}{12}$