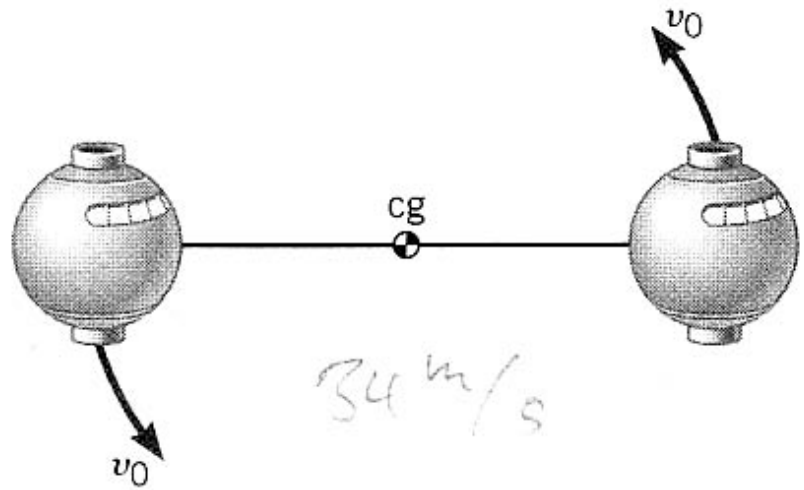
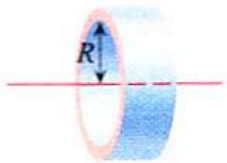
* **69.** In outer space two space modules are joined together by a massless cable. These modules are rotating about their center of mass, which is at the center of the cable, because the modules are identical (see the drawing). In each module, the cable is connected to a motor, so that the modules can pull each other together. The initial tangential speed of each module is $v_0 = 17$ m/s. Then they pull together until the distance between them is reduced by a factor of two. Determine the final tangential speed v_f for each module.



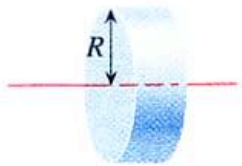
Thin-walled hollow cylinder or hoop

$I = MR^2$



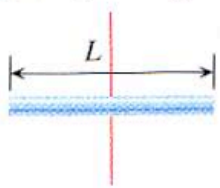
Solid cylinder or disk

$I = \frac{1}{2}MR^2$



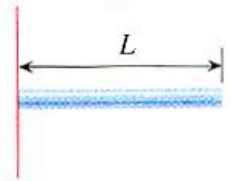
Thin rod, axis perpendicular to rod and passing through center

$I = \frac{1}{12}ML^2$



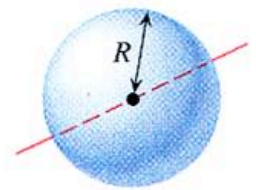
Thin rod, axis perpendicular to rod and passing through one end

$I = \frac{1}{3}ML^2$



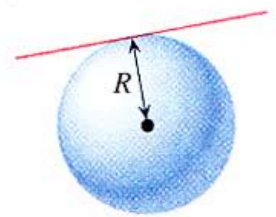
Solid sphere, axis through center

$I = \frac{2}{5}MR^2$



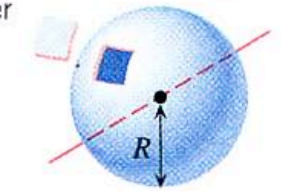
Solid sphere, axis tangent to surface

$I = \frac{7}{5}MR^2$



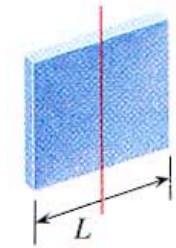
Thin-walled spherical shell, axis through center

$I = \frac{2}{3}MR^2$



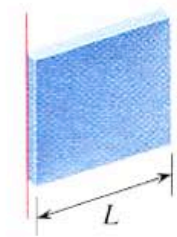
Thin rectangular sheet, axis parallel to one edge and passing through center of other edge

$I = \frac{1}{12}ML^2$



Thin rectangular sheet, axis along one edge

$I = \frac{1}{3}ML^2$



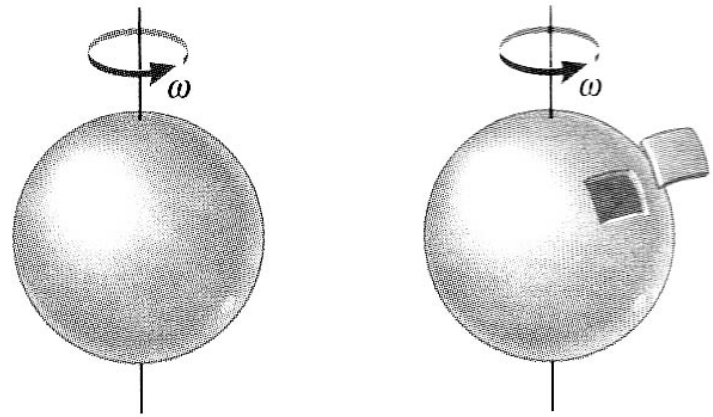
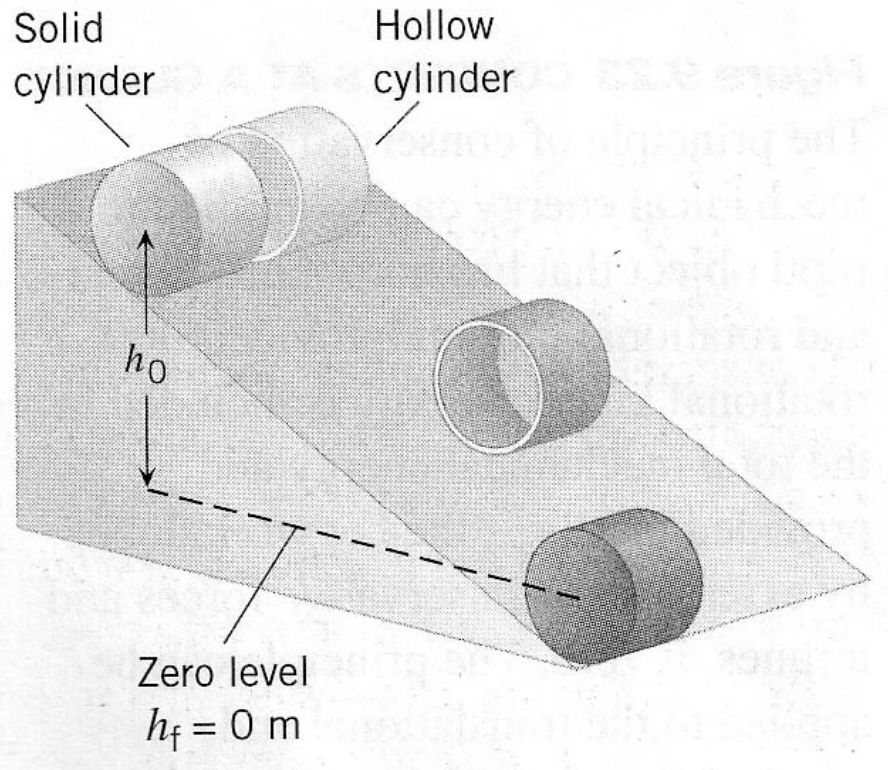
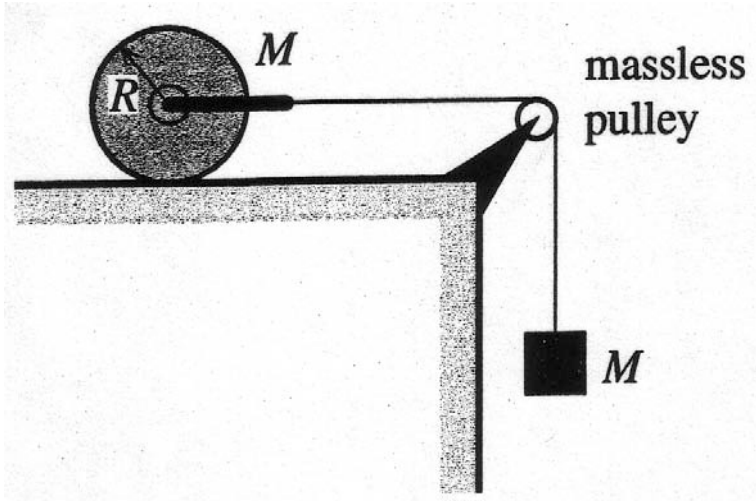


Figure 9.30 The two spheres have identical radii and masses; initially, they also have the same angular velocities. Which one comes to rest first as they slow down due to friction?

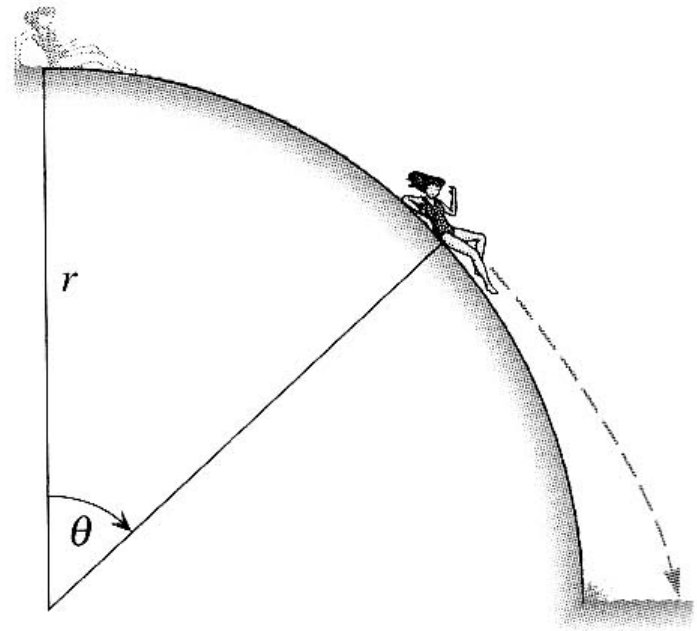

Solid
cylinder
Hollow
cylinder
h_0
Zero level
$h_f = 0$ m

On a play ground a child runs and jumps in tangential direction on a simple merry-go-round, which is just a disk of mass M and radius R. The mass of the child is m, his/her velocity at the instant he/she jumps onto the disk v. How fast will the merry-go-round with the child rotate?



A uniform solid cylinder of mass M and radius R rolls without slipping on a horizontal surface. The cylinder has a frictionless axle which is pulled by a light rope. The rope is wrapped around a massless frictionless pulley and connected to a block, also of mass M. The block is released from rest. Calculate the acceleration of the block. (The moment of inertia of a solid cylinder is $MR^2/2$.)

* **78.** A person starts from rest at the top of a large frictionless spherical surface, and slides into the water below (see the drawing). At what angle θ does the person leave the surface? *(Hint: When the person leaves the surface, the normal force is zero.)*



Variation 1: What if friction needs to be included?

Variation 2: What if it is not gravitation that pulls the person down but some mysterious force of magnitude *kh* ?

(Hint: It is certainly healthy to try to solve the problem and its variation. However, you should stop when the algebra gets too messy. I guess that the equations eventually can only be solve numerically.)