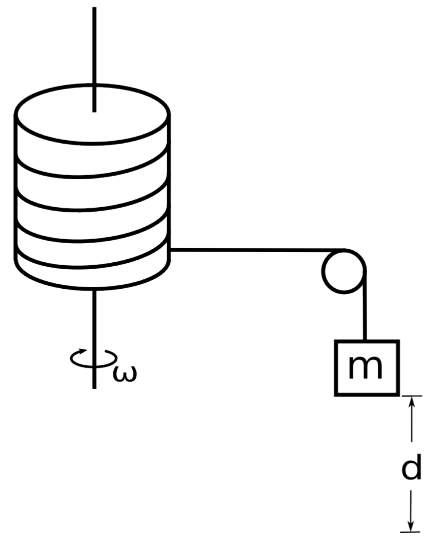
A solid cylinder of mass *M*, radius *R*, and moment of inertia $I = \frac{1}{2}MR^2$ is allowed to rotate without friction about an axis through its center as shown. A massless string is wrapped around the cylinder, passes over a small massless frictionless pulley and is attached to a small mass *m*.

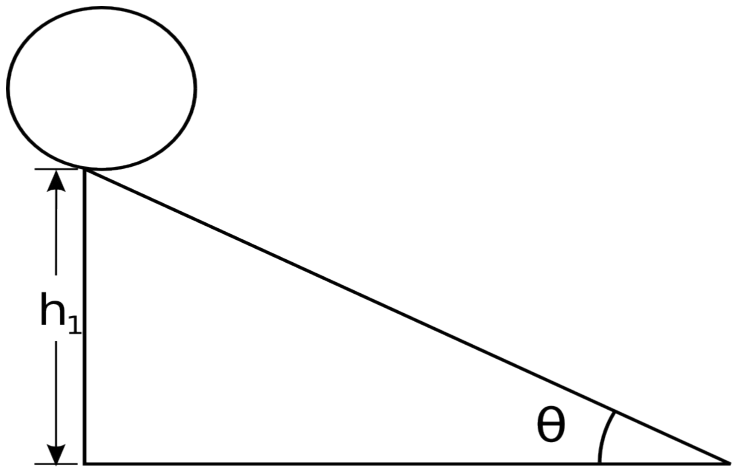


If the mass and the cylinder start from rest, what will the angular velocity of the cylinder be after the mass falls through a distance d?

Using conservation of energy, find an expression for ω_f in terms of *d*, *M*, *m*, and *R*.

A rolling object with a radius *R*, mass *m*, and moment of inertia $I_{cm}=\frac{1}{2}mR^2$, starts from rest at the top of an incline plane of height *h* that makes an angle θ with the horizontal.

a) What is the linear velocity of disk at the bottom?
b) What is the angular velocity of the disk at the bottom?

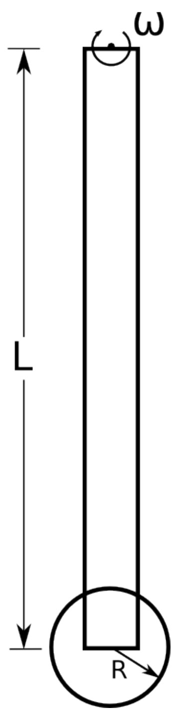


A clock pendulum is constructed from a solid bar of length *L* and mass *M* with a disk of radius *R* and mass *m*. The bar is then hung from a pivot at one end and the disk is attached to the opposite end, as in the picture below.

a) The moment of inertia of a uniform rod about an axis perpendicular to the rod through its center of mass is $I_{cm}=\frac{1}{12}ML^2$. Using the **Parallel Axis Theorem**, calculate the moment of inertia of the rod about one end.

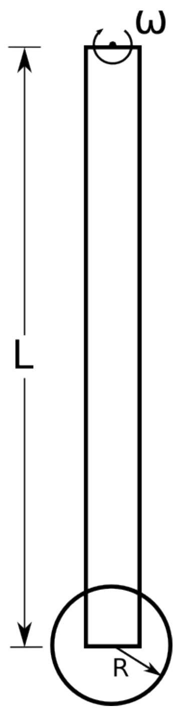
b) The moment of inertia of a disk about an axis perpendicular to its surface through its center of mass is $I_{cm}=\frac{1}{2}mR^2$. Using the **Parallel Axis Theorem**, calculate the moment of inertia of the disk when it's attached to the pendulum as shown in the picture below.

c) Using the **Principal of Superposition**, calculate the moment of inertia of the combined rod-disk system.



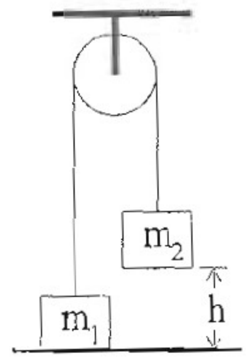
Consider, once again, the clock pendulum pictured below. The disk has a mass m and radius r and the bar has mass M and length L.

a) Calculate the center of mass of the combined bar-disk system *as measured from the axis of rotation*.
b) If the pendulum is pivoted so that it makes an angle θ with the vertical, what will the angular velocity be when θ=0?



Two masses are connected by a light string passing over a frictionless pulley. the Mass m_2 is released from rest at a height of 4.0 m above the ground. You can treat the pulley as a solid disk.

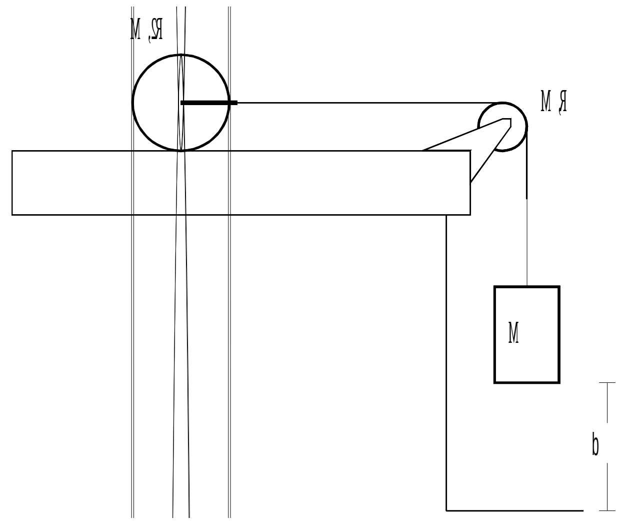
Determine the speed of m_1 as m_2 hits the ground.



$m_1 = 3.0$ kg
$m_2 = 5.0$ kg
$m_{pulley} = 0.5$ kg
$r_{pulley} = 0.1$ m

A solid cylinder (radius = 2R, mass = M) rolls without slipping as it is pulled by a massless yoke attached to a string. The string goes over a frictionless pulley shaped as a solid disk (radius = R, mass = M) and is attached to a hanging weight (mass = M).

What is the velocity of the hanging weight after it has fallen a distance d?



A block of mass M rests on a rough table with $\mu_k = 0.3$. A massless string is attached to the block, wrapped around a solid cylinder having a mass M and a radius R, runs over a massless frictionless pulley, and is attached to a second block of mass M that is hanging freely.

Using work/energy techniques, calculate the velocity of the blocks after they have moved a distance d.

$$I_{cylinder} = \frac{1}{2} MR^2$$