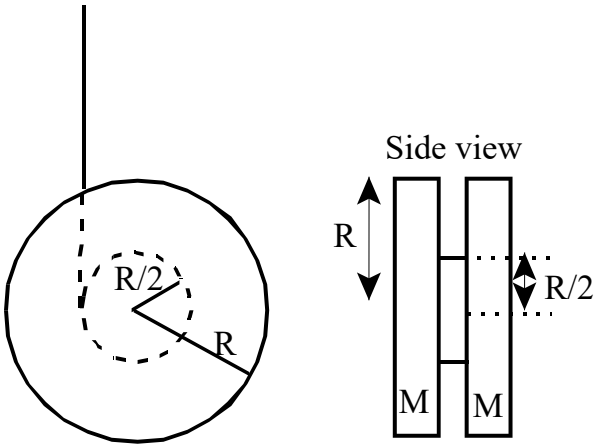
Phys 1135: Homework #20: Rotational Kinetic Energy

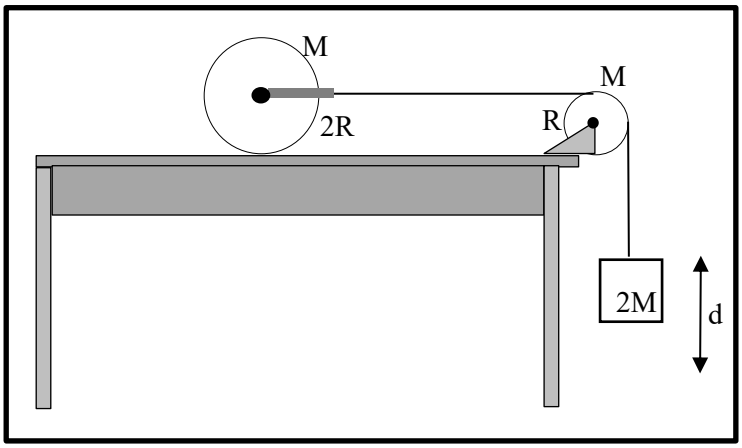
1. A uniform solid sphere of mass *M* and radius *R* is at the end of a thin massless rod which rotates about its other end at point P. The distance between P and the center of the sphere is *L*. Find the sphere's moment of inertia about point P if you
a) treat the sphere as a point mass
b) consider the finite radius of the sphere and use the parallel axis theorem.
c) How big is the percentage error of the point mass approximation if $L=4R$?

2. A solid sphere is rolling without slipping on a horizontal surface with a constant linear speed of 2.5m/s. It encounters a slope that is inclined by 30º with the horizontal. What distance along the slope will the sphere travel before it momentarily comes to rest?

3. A yo-yo is made of two uniform disks, each of mass *M* and radius *R*, which are glued to a smaller central axle of negligible mass and radius ½*R*. A string is wrapped tightly around the axle. The yo-yo is then released from rest and allowed to drop downwards, as the string unwinds without slipping from the central axle. Calculate the yo-yo's linear speed and angular speed when it has descended a distance D.



4. A uniform, solid cylinder with mass *M* and radius 2*R* rests on a horizontal tabletop. A massless string is attached to a massless yoke which is in turn attached to a frictionless axle that runs through the central axis of the cylinder, so that the cylinder can rotate about the axle. The string passes over a solid cylindrical pulley with mass *M* and radius *R* that is mounted on a frictionless axle. A block of mass 2*M* is suspended from the free end of the string. The string does not slip over the pulley surface, and the cylinder rolls without slipping on the tabletop.



Use energy methods to derive an expression for the speed of the block after it has descended a distance *d*.