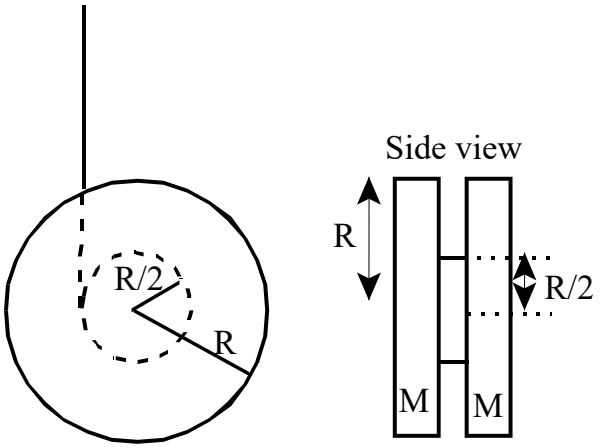
Phys 1135: Homework #21: Torque

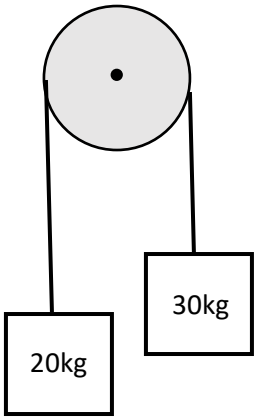
1. A yo-yo is made of two uniform disks, each of mass *M* and radius *R*, which are glued to a smaller central axle of negligible mass and radius ½*R* . A string is wrapped tightly around the axle. The yo-yo is then released from rest and allowed to drop downwards, as the string unwinds without slipping from the central axle.



a) Use forces and torques to find the yo-yo's linear acceleration.
b) Use this acceleration and kinematics to find the speed after the hoop has descended a distance D. Compare with your result from HW#18, problem 3.

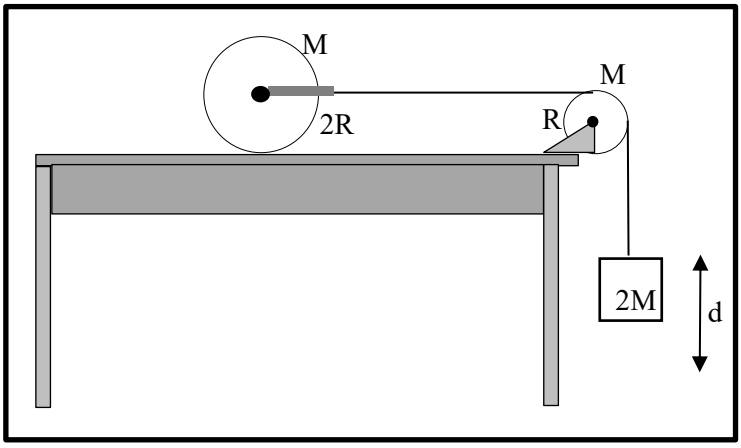
2. A uniform disk of mass 2kg and radius 10cm is rolling without slipping down a slope that is inclined by 30º with the horizontal.
a) Find the disk's linear acceleration.
b) Find the minimum coefficient of static friction between disk and ramp for which the disk can roll without slipping.

3. Atwood machine revisited. A 20kg box and a 30kg crate are attached to the two ends of a massless string that passes over a disk shaped pulley of mass 10kg and radius 30cm. The system is released from rest.



a) Without performing a calculation, rate, smallest to largest, the magnitudes of the tensions in the string on the two sides of the pulley and the weights of box and crate, respectively.
b) Calculate the acceleration of the system.
c) Verify that, if the pulley's mass approaches zero, your symbolic answer coincides with your answer for HW#6, problem 2.

4. A uniform, solid cylinder with mass M and radius $2R$ 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 $2M$ 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 force and torque methods to derive an expression for the acceleration of the block after the system has been released from rest.