The picture below shows a modified atwood machine composed of a large YoYo mounted on a central axle so that it spins in place. Two blocks of equal mass are attached to the system by ropes. One rope is wound around the inner axle of the YoYo the outer disk. The mass of the YoYo is the same as the mass of the two blocks and $R_2 = \frac{1}{2} R_1$.

Assume that the moment of inertia of the pulley is

a) If the masses are initially at rest, which way will the pulley rotate, clockwise or counter clockwise?
b) Using **Torque and Kinematics**, find an expression for the angular velocity of the pulleys after the mass attached to the large pulley has moved a distance d.
c) Using **Work/Energy** techniques, find an expression for the angular velocity of the pulleys after the mass attached to the large pulley has moved a distance d.
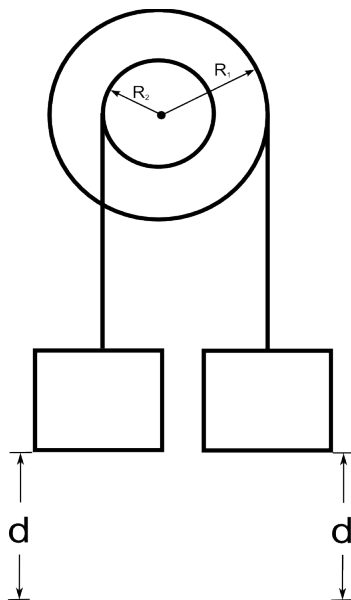
Use **Torque and Kinematics** to solve this problem.

A rolling object with a radius R, mass m, and moment of inertia I, starts from rest at the top of an incline plane of height h that makes an angle θ with the horizontal.

a) Find an expression for the linear and angular acceleration, α, of the object in terms of I, m, R, g, and θ.
b) Using kinematics, find an expression for the linear and angular velocity of the object at the bottom of the ramp in terms of I.

c) Assume that the object is a disk with   and plug I into your velocity expressions. Verify that your answers are the same as when you solved this problem using energy.
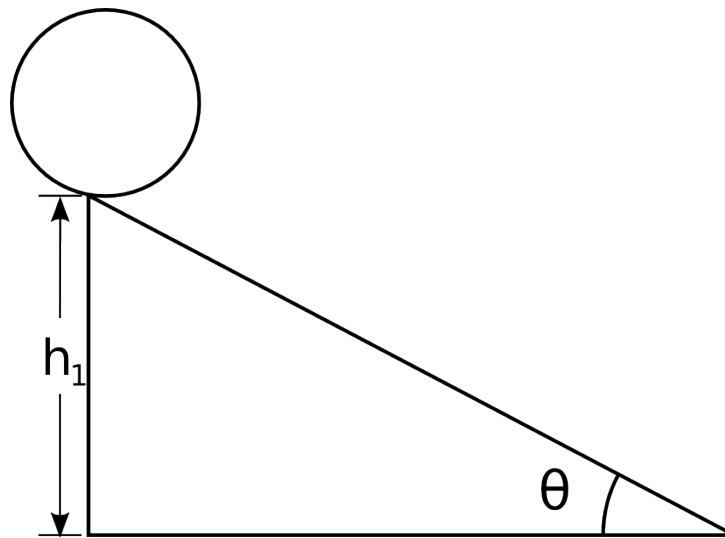
4. The picture below represents the side view of a yo-yo. The inner dashed circle represents the axle that the string is wound around. The top of the string is held stationary and the yo-yo is allowed to fall, unwinding the string as it descends.

The moment of inertia of the yo-yo is:

a) Use **Torque/Kinematics** to answer the following question.
b) Use **Conservation of Energy** to answer the following question.

If the yo-yo starts from rest, what is its angular velocity after a length of string, d, is unwound?
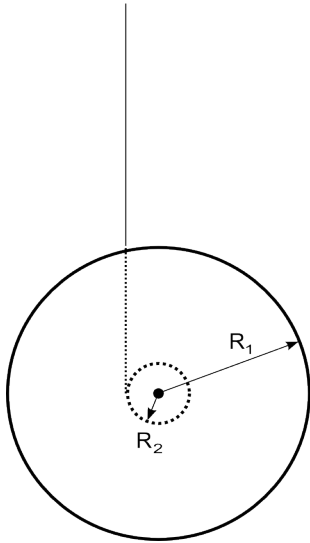
A small 0.75 kg ball is attached to one end of a 1.25 m long massless rod. The other end of the rod is hung from a pivot under the influence of gravity. When the resulting pendulum is 30^0 from vertical:

a) What is the magnitude of the torque about the pivot? (Draw a free body diagram)
b) What is the instantaneous angular acceleration (the acceleration at the moment when the pendulum is released)?
c) Can we use kinematics to find the angular velocity of the pendulum at the bottom of its swing? Why or why not?

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 moment of inertia of the pendulum (or look it up if you've already calculated it!).
b) Calculate the center of mass of the pendulum *as measured from the axis of rotation*.
c) Assuming that the pendulum is pivoted so that it makes an angle θ with the vertical, use **Torque** to calculate the angular acceleration as a function of θ, l_{cm}, and I.
d) Assume that we then release the pendulum from rest. Can we use Kinematics to find the angular velocity of the pendulum when $\theta=0$? Why or why not?
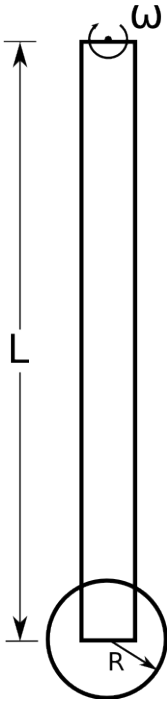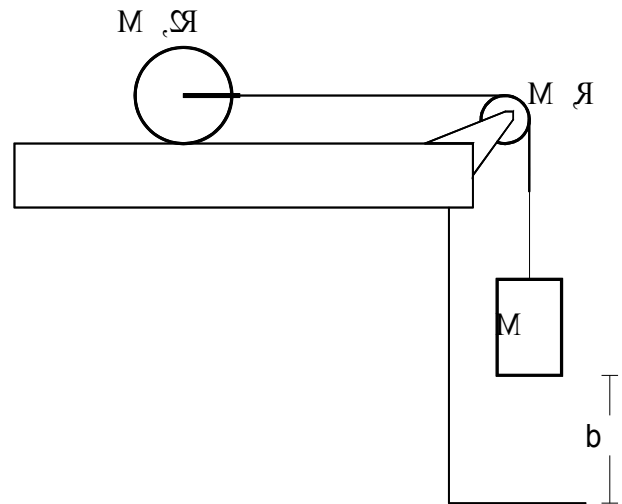
Use **Torque and Newton's Second Law** solve this problem.

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 acceleration of the system?

Use **Torque and Newton's Second Law** solve this problem.

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.

Find the acceleration of this system.