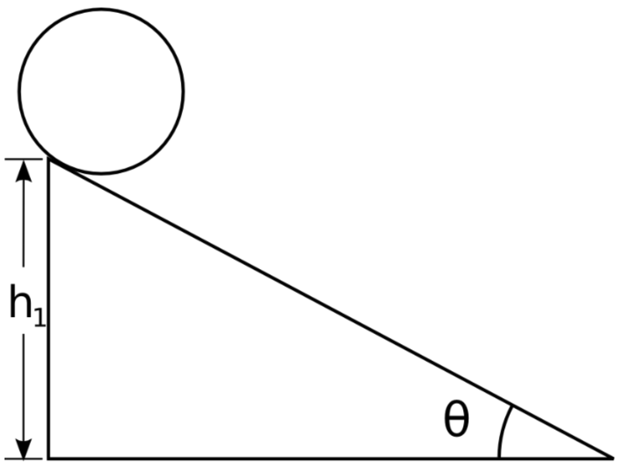
Rotation – Set 6

Name: ______________________ **Problems Solved __/ 6**

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 $I = \frac{1}{2}mR^2$ and plug I into your velocity expressions. Verify that your answers are the same as when you solved this problem using energy.

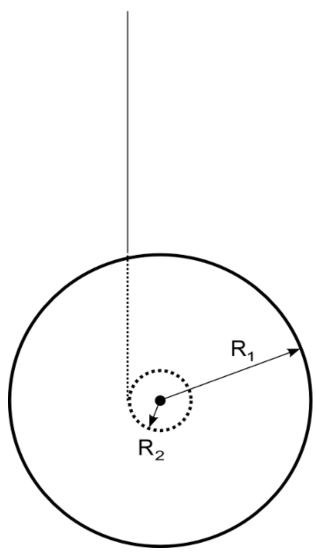


4. The picture below represents the side view of a yo-yo. The inner dashed circle represents the axle that the string is wound around. The top of the string is held stationary and the yo-yo is allowed to fall, unwinding the string as it descends.

   The moment of inertia of the yo-yo is: $I_{cm} = \frac{1}{2}MR_1^2$

   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?

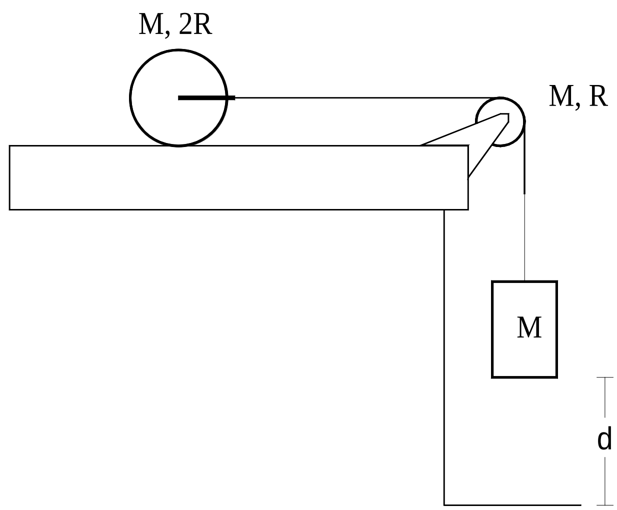


Use **Torque and Newton's Second Law** solve this problem.

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).

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

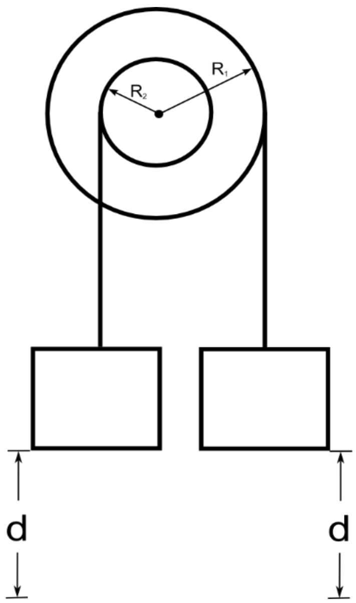
What is the acceleration of the system?



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 $R_2 = ½ R_1$.

Assume that the moment of inertia of the pulley is $I = \frac{1}{2} M R_1^2$

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.



Rotation Set 5, Modified Atwood – Extra Space

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.

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