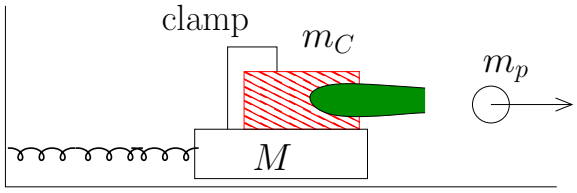
A small cannon of mass m_C shoots pellets of mass m_p with a speed of u_o when held stationary and shot from the ground. The cannon is subsequently mounted on top of a block of mass M an held in place by clamps as shown below. The block slides along a frictionless surface but is attached to a spring, with a spring constant of k. A pellet is shot and the clamps withstand the initial explosion.



1. Determine the recoil velocity of the block-cannon combo (Hint: Read the problem carefully).

2. Suppose, first that the clamps are well built and can withstand a large force, Determine the maximum compression of the spring.

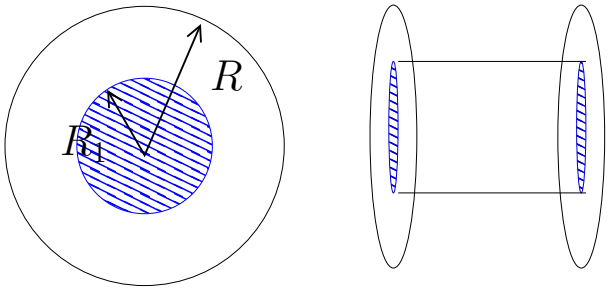
3. Determine the time it takes for the spring to be compressed.

4. Sketch the position versus time of the block/cannon indicating on your graph the results of #2 and #3.

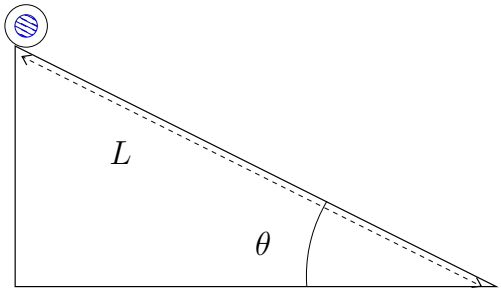
5. What is the force $F_{\max}$ that that the clamp must withstand during the oscillation to hold the cannon in place.

6. (**Do last – may not be graded**) Now suppose the clamp can hold only $0.7F_{\max}$. Determine how long after the initial explosion the cannon will break free from from the block.

A cylindrical rolling wheel consists of a central cylinder of mass M and radius $R_1 = R/2$, and two larger outer wheels each of radius R and each also of mass M. The total mass is $3M$.

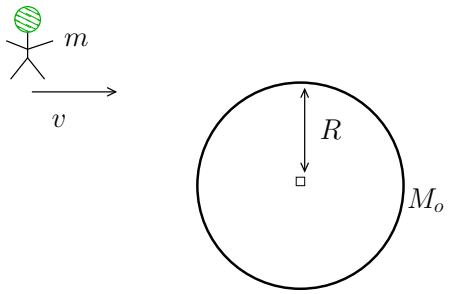


This cylinder released from the top of a hill and rolls without slipping to the bottom. The static and kinetic friction coefficients are μ_s and μ_k respectively



1. Determine the moment of inertia of the wheel.
2. Determine the speed of the wheel when the wheel reaches the bottom.
3. Determine the time it takes to roll a distance L down the slope
4. As the the angle of incline is increased, determine at what angle will the wheel start to slip.

A man mass m is running with a speed of v and jumps onto the end of a merry-go-round of mass $M_o = 4m$ and radius R. You can treat the man as a point-like mass After jumping on the wheel and making one complete revolution, the man then walks at a slow and steady rate directly towards the center of the circle. The static and kinetic friction coefficients are μ_s and μ_k respectively



1. Determine the time t_1 it takes for him to make the first revolution before he starts walking towards the center?

2. After he completes his walk to the center, determine the time t_2 it takes for him to make one complete revolution?.

3. As he walks from the exterior of the merry-go-round towards the center, determine the force of friction as $F_{\text{fr}}(r)$ on his shoes when he is at a radius r.

4. Calculate the work that he does in walking from the exterior towards the center.