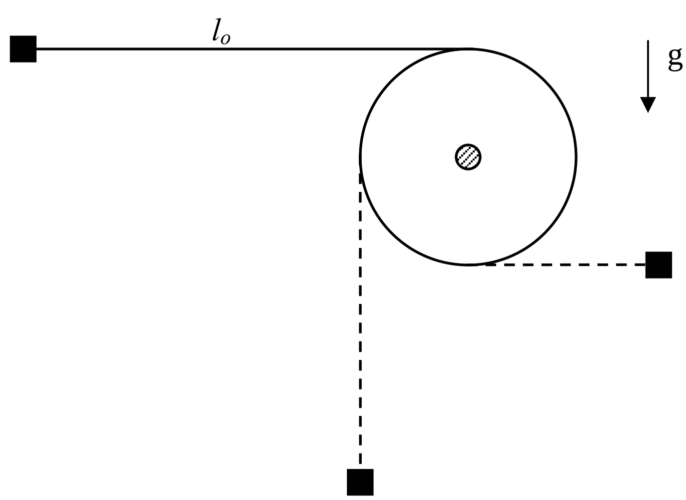
2.003J/1.053J Dynamics and Control I
Fall 2007

Problem Set 3
Out: Monday, 24 September, 2007
Due: Monday, 1 October, 2007

1. Pulley problem

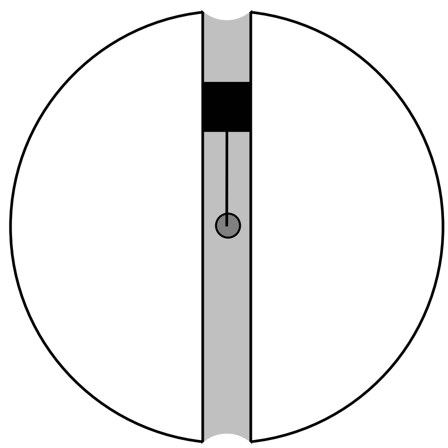
A pulley of radius R is *rigidly* fixed to the wall as shown in the figure. A point mass is attached to one end of a *non-elastic* string of length l_o and the other end of the string is fixed to the top of the pulley as shown in the figure. Initially the mass is held such that the string is tight and horizontal and is suddenly released. In the previous problem set we found the velocity and acceleration of the mass with respect to a stationary observer on the ground. Note that gravity acts. Find the equation of motion of the mass:

a. Using Newton's laws
b. Using the work-energy principle



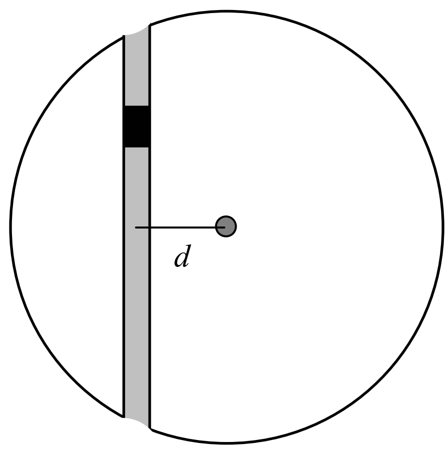
2. Normal reaction due to Coriolis Effect

A mass m lies in a straight radial channel dug on the surface of a circular, horizontal platform of radius R, as shown in the figure below. The platform rotates anticlockwise at a constant angular velocity ω about the vertical axis (coming out of the page through the center of the platform). The mass is attached to a string that is being pulled in from the center of the platform at a constant rate $dr(t)/dt = -v$. Find the normal force $N = N(r)$ that the mass exerts on the wall of the channel.



3. Normal reaction due to Coriolis Effect

A mass m lies in a straight channel dug on the surface of a circular, horizontal platform of radius R, as shown in the figure below. The center of the channel is at a distance d from the center of the platform. The platform rotates anticlockwise at a constant angular velocity ω about the vertical axis (coming out of the page through the center of the platform). The mass is free to slide in the channel and the contact surface is frictionless. Find the normal force that the mass exerts on the wall of the channel as a function of the distance of the mass from the center of the channel.



4. Coefficient of restitution

A ball of mass m is released from height H_o as shown in the figure below. It collides with the floor for the first time and bounces back and rises up to height H_1 and again drops down. The second time it collides with the floor and again bounces back to height H_2 and so on…

The coefficient of restitution in each collision is c, where c is strictly less than 1. Thus, after each collision, the height up to which the ball rises back is reduced.

- What is the relation between H_o and H_1?
- As time tends to infinity, how many times the ball would have bounced off the floor?
- What is the total distance traveled by the ball?