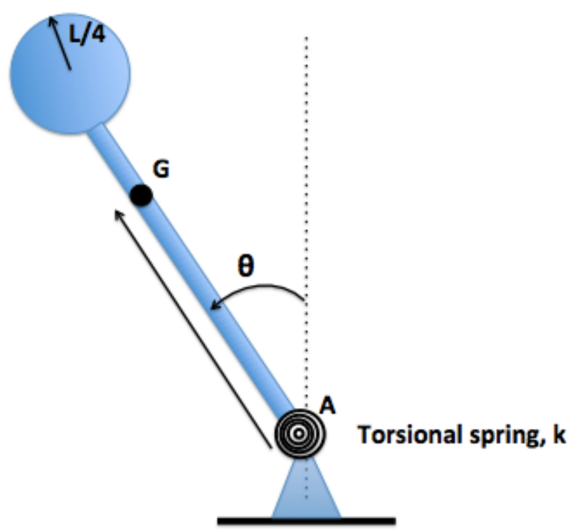
ENGN 0040: Dynamics and Vibrations, Spring 2015

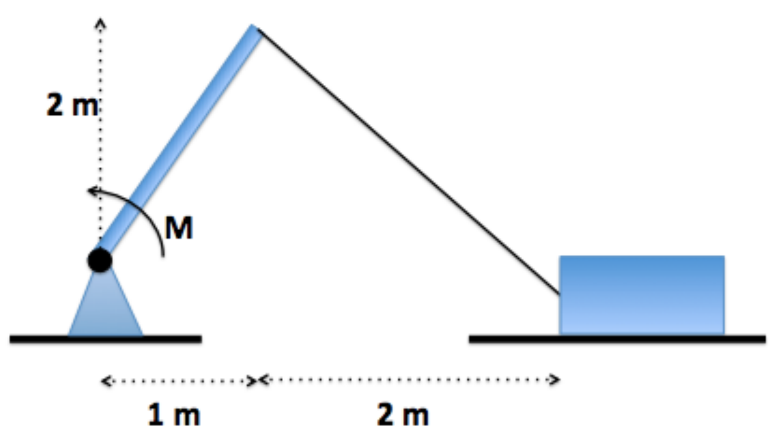
Homework 7: Rigid Body Dynamics
Due Friday April 24th

Problem 1: A thin disk of radius $L/4$ and mass m is rigidly attached to a slender rod of length L and mass m. The system is attached via a torsional spring (constant k), which has a restoring moment in the clockwise direction when perturbed by an angle θ. The center of mass of the system is denoted by point G.



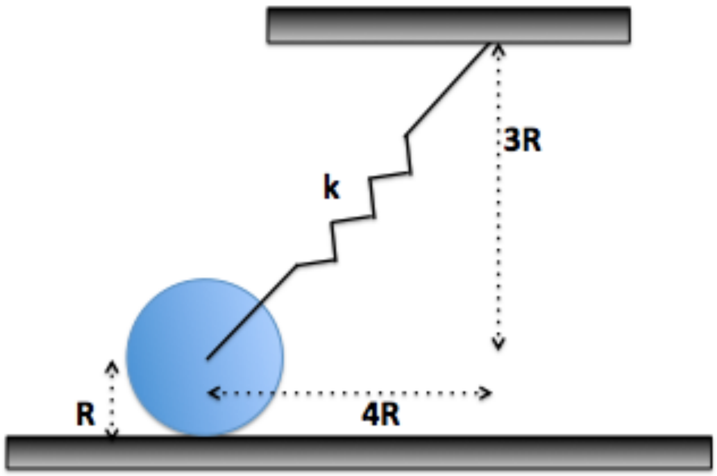
1.1. What is I_A, the mass moment of inertia about point A?
1.2. Draw a FBD and write out the appropriate linear and rotational equations of motions (in terms of I_A).
1.3. Now assuming small values of θ, what is the natural frequency of the system?

Problem 2: The masses of the slender bar and the crate are 9 kg and 36 kg respectively. The crate sits on a frictionless surface. The system is stationary at the instant shown and a counterclockwise moment of 300 Nm is applied to the bar.



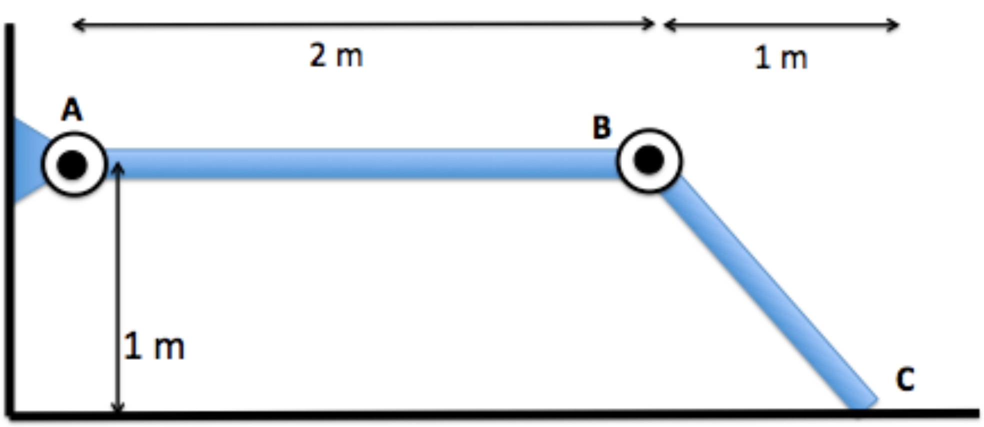
2.1. What is the resulting acceleration vector of the plate?
2.2. Now assume a friction coefficient of 0.2 between the crate and the surface. What is the acceleration of the crate?

Problem 3: The thin disk of mass m and radius R rolls without slipping and is connected to a linear spring (constant k). The unstretched length of the spring is $2R$.



3.1. Starting from rest as shown, what is the angular velocity of the disk when the center has moved a horizontal distance $2R$.

Problem 4: Bar AB has a mass of 5 kg, and bar BC has a mass of 3 kg. If the system is released from rest in the position shown, what are the angular velocities of the two bars at the instant point B hits the floor? Assume point C slides frictionlessly.



Problem 5: The thin disk brake drum is rotating at an angular speed of 10 rad/s at t=0. A force is applied to the thin rigid bar to stop the drum from rotating. How much work must be done on the drum in order to stop its rotation completely?