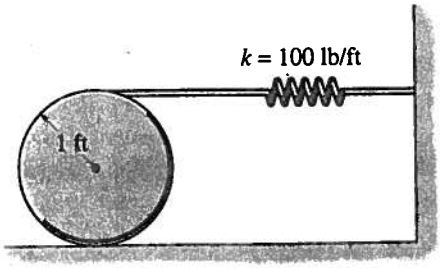
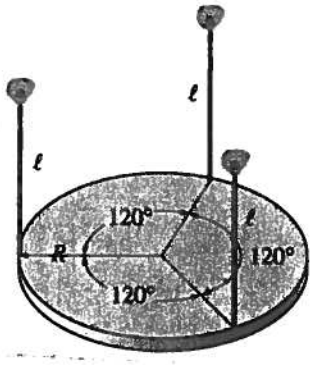
MECH 463 -- Homework 1

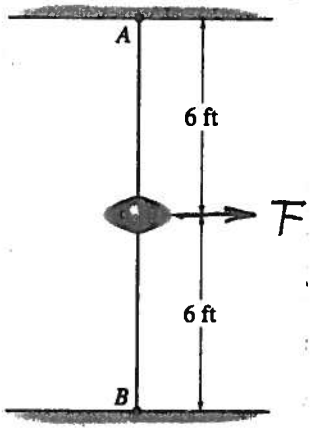
1. A 10 lb disk, radius 1 ft, rolls without slipping on a horizontal surface. A spring of stiffness k = 100 lb/ft is attached to the surface of the disk at a point which is highest when the spring is unstretched. Derive the equation of motion and the natural frequency of vibration.



2. A circular plate, of radius R and mass m, is supported by three symmetrically placed strings of length L. Derive the equation of motion and the natural frequency of vibration.

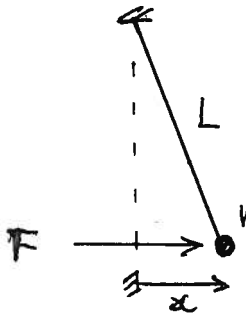


3. A 5 lb weight is supported in the center of a horizontal wire AB that is 12 ft long and under a tension of 20 lb. Derive the equation of motion and the natural frequency of vibration.



4. A constant horizontal force F acts on a simple pendulum of mass m and length L. Determine the effective stiffness k = F/x, where x = displacement from the equilibrium position. (This is a statics question.) By analogy to a mass-spring system, determine the natural frequency of vibration.

5. An oscillating force f(t) of amplitude 0.02 lb and frequency 1 Hz acts on the mass in Q4. Determine the amplitude of vibration.



6. An oscillating force f(t) = F cos wft acts on the end of a spring of stiffness k that is attached to a mass m, as shown in the diagram. Derive a formula for the amplitude of vibration of the mass over a range of frequencies wf. Draw a graph illustrating your results and give physical interpretations of significant features.