

# Challenge Problems

## Physics 41

Due Date: None

1. Consider a bob of mass  $m$  attached to a massless rod of length  $L$ . It is attached to the ceiling at the other end is free to swing like a pendulum. Let  $\theta$  be the angle the rod makes with the vertical.
  - (a) Write the equation of motion the angle  $\theta(t)$  satisfies. Do not assume  $\theta$  is small.
  - (b) Approximate that  $\theta$  is small and solve the equations of motion. You may assume that the pendulum is released from rest at an angle  $\theta = \theta_0$  at time  $t = 0$ .
2. Consider two pendulums made up of a thin massless rod attached to the a mass at the one end and free at the other end. The free end of first pendulum is attached to the mass of the second pendulum. The free end of the second pendulum is attached to the ceiling. Both the pendulums are free to swing independently. Assume  $\theta_1$  and the  $\theta_2$  are the angles the two pendulums make with the vertical.
  - (a) Write the equations of motion the angles  $\theta_1(t)$  and  $\theta_2(t)$  satisfies. Do not assume the angles are small.
  - (b) Approximate that  $\theta_1$  and  $\theta_2$  are small and solve the equations of motion. You may assume that the system is released from rest when  $\theta_1 = \alpha$  and  $\theta_2 = 0$ .