

# PHY422/820: Classical Mechanics

FS 2020

Exam Preparation

December 1, 2020

## Problem P1 – Two Masses, One Swinging

Two equal masses  $m$  that are connected by a massless string of length  $l$  hang over two ideal massless and frictionless pulleys. The left mass is guided and can only move in a vertical line, but the right mass can swing.

1. Show that the Lagrangian of the system is given by

$$L = mr^2 + \frac{1}{2}mr^2\dot{\theta}^2 - mgr(1 - \cos\theta), \quad (1)$$

where  $r$  and  $\theta$  are defined as shown in the figure.

2. Derive the equations of motion.
3. Assume the left mass starts at rest, and the right mass is undergoing oscillations with a small amplitude  $\epsilon$ . What is the average acceleration  $\ddot{r}$  over a few periods of the oscillation, and what does this imply for the motion of the left mass?

