

PHY422/820: Classical Mechanics

FS 2021

Exam Preparation

October 6, 2021

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

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

where r and θ 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 ϵ . 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?

