

**COT6602 Quantum Information Theory**  
**Fall 2019**

**Homework 1**

Out: Tuesday 10/01

Due: will be posted on Webcourses

Type up your solutions using a computer. Do not turn in handwritten notes.

**Problem 1** (Simple pendulum)

A simple pendulum consists of a massless rod of length  $\ell$  with a bob of mass  $m$ . The rod is suspended from the origin  $O$  and moves without any friction. The entire motion is restricted in the  $xy$  plane. The  $y$  axis points downward. Let  $\phi$  denote the angle between the rod and the  $y$  axis.

Write down the Lagrangian  $\mathcal{L}(\phi, \dot{\phi})$  and solve the Euler-Lagrange equation to determine the motion of the simple pendulum. Use <https://www.glowscript.org/> to visualize the motion of the simple pendulum.

There are several examples on this web page that will help you get started.

**Problem 2** (Brachistochrone)

The brachistochrone problem is a famous problem in the calculus of variation: given two points 1 and 2, with 1 higher above the ground, in what shape should we build the track for a frictionless roller coaster so that a car released from point 1 will reach point 2 in the shortest possible time. We cover this problem in class.

Use <https://www.glowscript.org/> simulate how the roller coaster moves along the track. (The roller coaster can be visualized as a simple blob.)