

## PHY 305, I-Semester 2020/21, Tutorial 3

Work in the same teams as for assignments. Do “Stages” in the order below. Discuss via online (video or audio) conference on a subchannel for your group.

**Stage 1** (*Variational techniques*) Discuss:

- (i) What is a functional? Try to invent some new functionals with physical meaning that were not examples in the lecture (no need for equations, just concepts).
- (ii) Explain the problem statement of finding an extremal point of a functional using variational techniques.
- (iii) Identify the critical tricks in practically solving the problem.

**Stage 2** (*Lagrangian mechanics*) Discuss:

- (i) How come we suddenly have a completely new formalism for mechanics?
- (ii) List the primary strengths of Lagrangian mechanics. In which cases or why is it more powerful than Newtonian?
- (iii) What is the procedure of solving a problem in the Lagrangian approach? Where do you have to be careful?

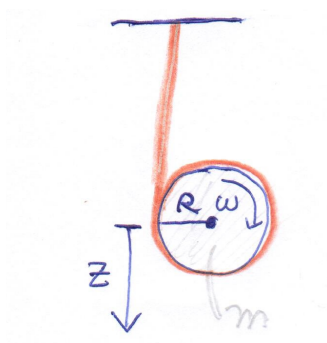


Figure 1: Sketch of yoyo in a simple model. A string (brown) is held with your finger and wound around a cylinder (grey) of mass  $m$  with radius  $R$ . The yoyo can move down by unwinding the string while rotating, and up by winding up the string through rotation.

**Stage 3** (*Applications*) Solve whichever you want first:

- (i) Figure 1 shows a sketch of a “yoyo” toy, see caption. Discuss the constraints, write down the Lagrangian in some suitable generalized coordinate and derive the Euler Lagrange equations.
- (ii) Find a function  $y(x)$  that makes the functional

$$S[y] = \int_0^1 \sqrt{1 + x + y'(x)^2} dx \quad (1)$$

with  $y(0) = 0$ ,  $y(1) = 1$  stationary.