

September 22, 2011

Massachusetts Institute of Technology

Department of Physics - Classical Mechanics 8.09 - Fall 2011

Homework set No. 3 (Due: September 30, 2011)

Reading:

1. Goldstein, Chapter 1.3 / 1.4

Problems:

1. (10 points) Determine the boundary conditions along with the choice of generalized coordinates and transformation equations for the following problems:
 - (a) (2 points) A cylinder is rolling down an inclined plane with slipping (Figure 1).
 - (b) (2 points) A straight wire is rotating with a freely moving pearl in the (x, y) -plane with constant angular velocity ω (Figure 2).
 - (c) (2 points) The attachment point of a pendulum is performing harmonic, horizontal oscillations (Figure 3).
 - (d) (2 points) Spherical pendulum (Figure 4).
 - (e) (2 points) A pearl is slipping down without friction on a wire which has an angle α to the x -axis and is accelerating with constant acceleration b in the positive x -direction (Figure 5).
2. (10 points) Consider a pearl on a parabolic rotating wire (Figure 6). Determine the equation of motion
 - (a) (5 points) using only the 2nd Newton Law and
 - (b) (5 points) using the d'Alembert principle.
3. (10 points) Consider the Atwood machine (Figure 7).
 - (a) (5 points) Determine the boundary conditions.
 - (b) (5 points) Determine the equations of motion using the d'Alembert principle for all four accelerations \ddot{x}_i ignoring all masses and moments of inertia of both rolls.
4. (10 points) Consider the double inclined plane (Figure 8).
 - (a) (5 points) Determine the boundary conditions.
 - (b) (5 points) Determine the equation of motion using the d'Alembert principle.

5. (10 points) Consider the double pendulum (Figure 9).
- (a) (5 points) Determine the boundary conditions.
 - (b) (5 points) Determine the equations of motion using the d'Alembert principle for both masses.

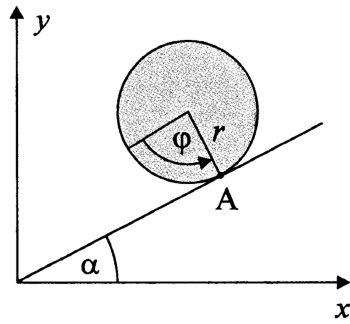


Figure 1: Cylinder rolling down an inclined plane with slipping.

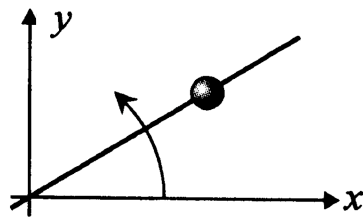


Figure 2: Straight wire is rotating with a freely moving pearl in the (x, y) -plane with constant angular velocity ω .

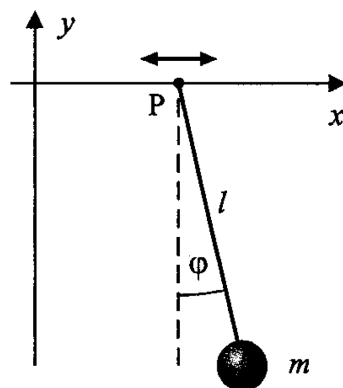


Figure 3: Attachment point of a pendulum is performing harmonic, horizontal oscillations.

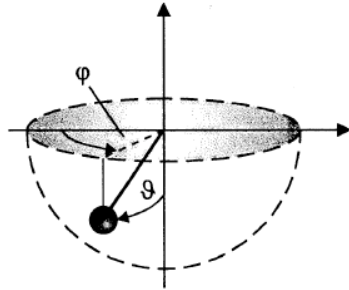


Figure 4: Spherical pendulum.

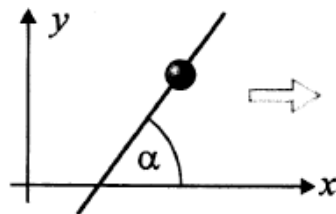


Figure 5: Pearl is slipping down without friction on a wire which has an angle α to the x -axis and is accelerating with constant acceleration b in the positive x -direction.

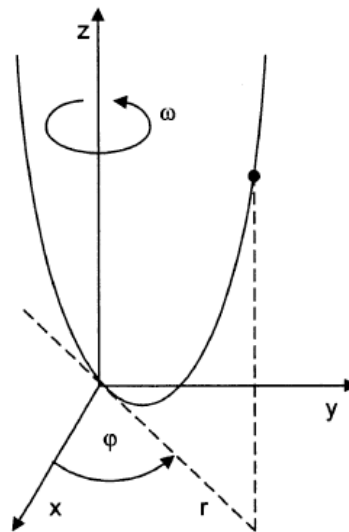


Figure 6: Pearl on a parabolic rotating wire.

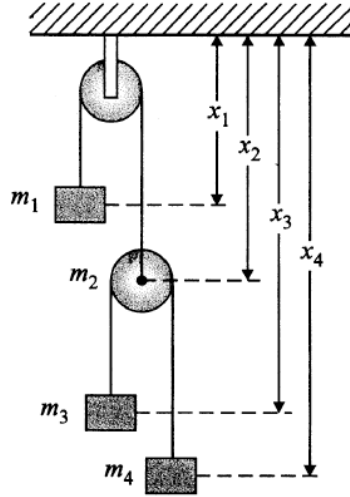


Figure 7: Atwood machine.

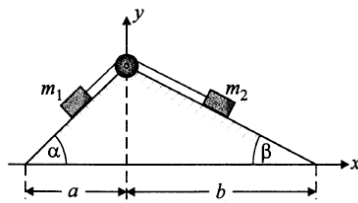


Figure 8: Double inclined plane.

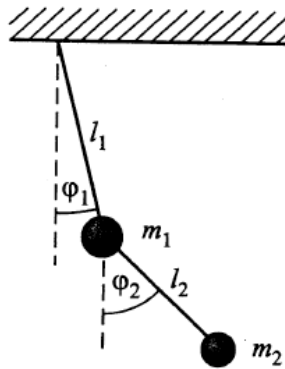


Figure 9: Double pendulum.