

September 24, 2009

# Massachusetts Institute of Technology

Department of Physics - Classical Mechanics 8.09 - Fall 2009

## Homework set No. 3 (Due: October 01, 2009)

### 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  $\omega$  (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  $\alpha$  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.

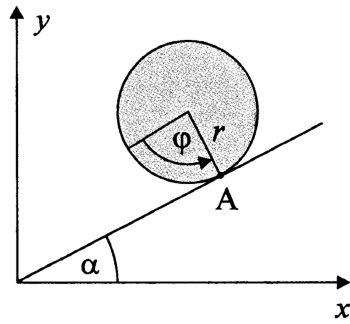


Figure 1: Cylinder rolling down an inclined plane with slipping.

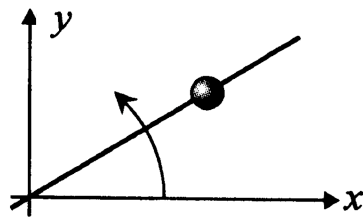


Figure 2: Straight wire is rotating with a freely moving pearl in the  $(x, y)$ -plane with constant angular velocity  $\omega$ .

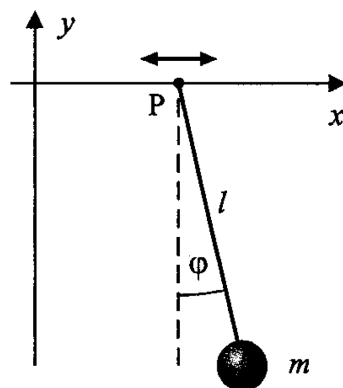


Figure 3: Attachment point of a pendulum is performing harmonic, horizontal oscillations.

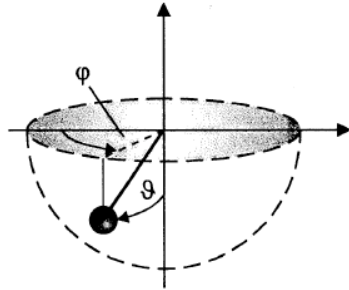


Figure 4: Spherical pendulum.

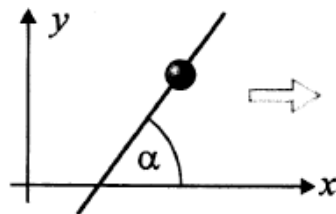


Figure 5: Pearl is slipping down without friction on a wire which has an angle  $\alpha$  to the  $x$ -axis and is accelerating with constant acceleration  $b$  in the positive  $x$ -direction.

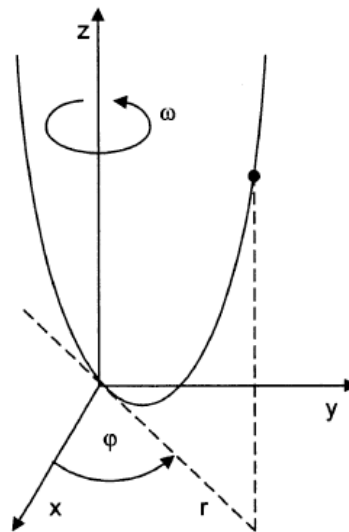


Figure 6: Pearl on a parabolic rotating wire.

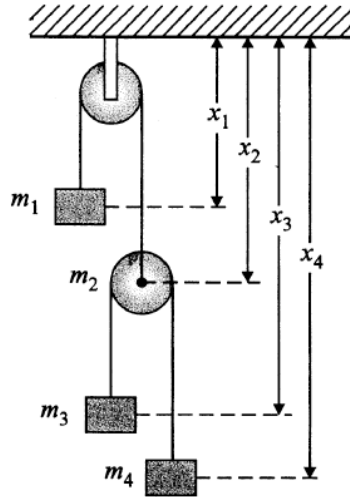


Figure 7: Atwood machine.

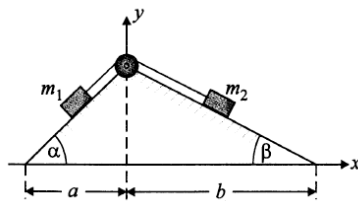


Figure 8: Double inclined plane.

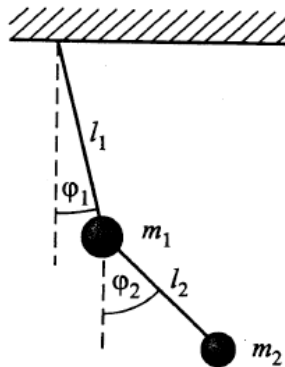


Figure 9: Double pendulum.