FYS 3120/4120 Classical Mechanics and Electromagnetism
Spring semester 2006

Problem set 1

Problem 1.1

A double pendulum, with lengths L_1 and L_2, performs oscillations in the vertical

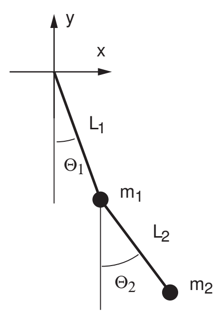

Figure 1: Double pendulum

x,y-plane, as shown in Figure 1. Use the two angles θ_1 and θ_2 as generalized coordinates. Find the Lagrangian $L = T - V$, with T as the total kinetic energy and V as the potential energy, expressed as a function of θ_1, θ_2 and the time derivatives $\dot{\theta}_1$ and $\dot{\theta}_2$.

Problem 1.2

A body with mass m moves frictionlessly on an inclined plane, as shown in Fig-

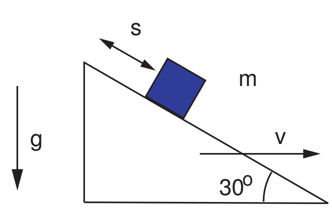

Figure 2: Motion on a moving inclined plane

ure 2. The plane is moving with a constant velocity v in the horizontal direction. Use the distance s that the body moves relative to the inclined plane as generalized coordinate. Show that the body is subject to a time-dependent constraint, in the sense that the position vector of the body depends both on the generalized coordinate s and on time t, $\mathbf{r} = \mathbf{r}(s,t)$. Find the Lagrangian $L = T - V$ as a function of s, $\dot{s}$ and t.

Problem 1.3

An Atwood's fall machine consists of three parts with masses m_1, m_2 and m_3,

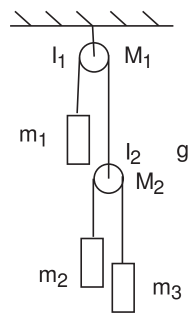

Figure 3: A fall machine

that move vertically, and two rotating pulleys, with moments of inertia about their centers I_1 and I_2. The radii of the pulleys are r_1 and r_2, and their masses M_1 and M_2. Find the number of degrees of freedom of the composite system and choose appropriate generalized coordinates. Find the Lagrangian of the system as functions of the coordinates and their time derivatives. (Friction is neglected.)

Problem 1.4

A rotating top is set into motion on a horizontal floor. Count the number of

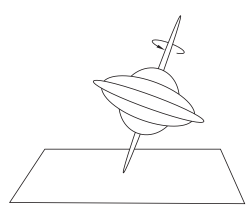

Figure 4: A rotating top

degrees of freedom of the top.