

Homework 2 - Newtonian mechanics and Euler-Lagrange formalism

To be handed in: **ETH:** Sun 05-10-09 **UNI:** Wed 07-10-09

1. **Newtonian mechanics: Two masses connected by a spring**

Two different masses m_1 and m_2 are connected by a spring with spring constant D . As illustrated in Fig. 1, this setup is attached to the ceiling by a rope, which we now intend to cut.

- State the time-evolution $z_{\text{cm}}(t)$ of the center of mass coordinate.
- What are the accelerations of m_1 and m_2 immediately after cutting the rope?
- Calculate the frequency ω of the harmonic push-pull oscillation.
- Determine the respective amplitudes A_1 and A_2 .

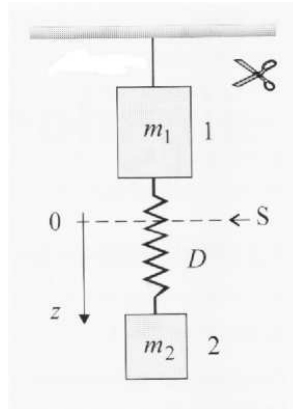


Figure 1: After cutting the rope, both masses are exposed to the gravity field of the earth.

2. **Chopper carrying load on a rope – a pendulum with moving pivot:** Huts in the Swiss mountains have often to be supplied by choppers carrying heavy load on a rope underneath the chopper. How is the motion influenced by the load? We describe this system by a planar pendulum in a homogenous gravitational field of acceleration g . The pivot (chopper) of mass m_1 is moving horizontally (one dimensional motion) and the oscillating mass is m_2 . The length of the pendulum is l .
- (a) Find the Lagrangian of the system.
 - (b) What are the Euler-Lagrange equations?
 - (c) Solve the equations by linearizing assuming small displacements and $m_2 \ll m_1$.
 - (d) What are the forces of constraint in (c)?