Technische Universität München
Physik-Department **B. Garbrecht, C. Tamarit, G. Zattera**

Mechanik (Theoretische Physik 1)

Sommersemester 2018

Abgabe bis Freitag, 6.07.18, 12:00 neben PH 3218.

Übungsblatt Nr. 12 Dieses Blatt wird in den Übungen vom 9.07. - 13.07.18 besprochen.

Aufgabe 1:
Electron inside a capacitor — 2 Punkte

An electron finds itself inside a capacitor with 2 parallel plates and a voltage that grows linearly with time, implying a potential energy of the form

$$V = -Axt, \tag{1}$$

where A is a constant, x is the distance to the grounded plate along the direction perpendicular to the plates, and t is the time.

Obtain the equations of motion in the Lagrangian and Hamiltonian formalism, discuss whether energy will be conserved or not, and confirm the conclusion by solving the dynamical equations.

Aufgabe 2:
Pearl in rotating wire — 2 Punkte

A pearl can slide along a horizontal straight wire, which rotates with constant angular velocity ω.

Are the constraints holonomic, or non-holonomic? Is the energy conserved? And the Hamiltonian? Check the answer by solving the equations of motion.

Aufgabe 3:
Oscillator in motion — 3 Punkte

A wagon moves with constant speed v_0 along horizontal rails. Inside the wagon there is a spring with elastic constant D attached to a mass m (see figure).

1. What are the Lagrangian and Hamiltonian in the static reference frame B of the figure? Is energy conserved, and how can this be understood in qualitative physical terms?

2. In the reference frame B' that moves with the wagon, what is the canonical momentum associated with $\dot{x}'$? Calculate the Lagrangian and Hamiltonian. What happens now with the conservation of either E or H?

3. Obtain the equations of motion in both frames, and check their mutual consistency.

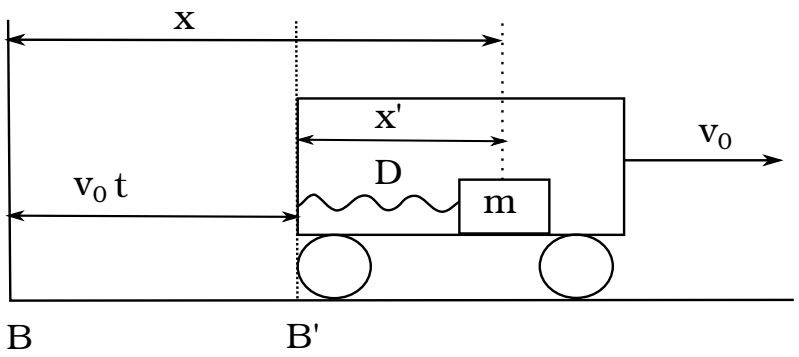

Abbildung 1: Oscillator in motion.

Aufgabe 4:
Rigid bodies race **3 Punkte**

Three rigid bodies are placed on top of a slope of height h and length l, they are initially at rest, and are positioned in such a way that their centres of mass are at the same height. Respectively, the bodies are:

- A hollow spherical shell of mass M with external radius R, and internal radius $R - \frac{R}{5}$
- A ring of mass M with external radius $\frac{3R}{2}$, internal radius R and thickness $R/10$
- A cylinder of mass M with a radius R and height equal to $2R$.

At $t = 0$ the bodies start rolling down the slope: the surface of the slope is characterized by some friction parameter which is big enough to prevent all of the bodies from slipping, so that the motion is purely rolling. Given such a system:

1. Place your bet.
2. Using the Lagrange formalism of the second kind, solve the equations of motion for the three bodies and find out which one crosses first the finish line placed on the slope at a distance l from the starting point.