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

Mechanik (Theoretische Physik 1)

Sommersemester 2018

Abgabe bis Freitag, 25.05.18, 12:00 neben PH 3218.

Übungsblatt Nr. 7 Dieses Blatt wird in den Übungen vom 28.05. - 01.06.18 besprochen.

Aufgabe 1:
Sliding pendulum **4 Punkte**

Consider a pendulum with a sliding hanging point, as in figure 1.

Obtain the Lagrange equations of the first kind.

Obtain the two bearing forces as a function of the angle φ.

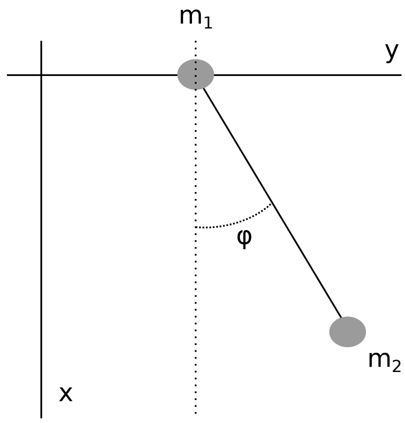

Abbildung 1: Sliding pendulum

Aufgabe 2:
Yo-Yo **3 Punkte**

Two discs are joined by a common axis of radius r. A thread, whose upper end is kept fixed, winds around the axis (see fig. 2). This yo-yo is released while keeping the thread in tension, after which the yo-yo starts to unwind with increasing rotational speed. Once the string becomes unwound, the yo-yo starts to rewind and move up.

1. Compute the string's tension for the case in which part of the thread is wound around the axis, while the hand that holds the upper end of the string remains still.

2. Compute the tension when the string is fully unwound, so that the yo-yo moves near the lowest point of its trajectory, transitioning between unwinding and winding. What can cause the change in tension? How and when does the upper end of the thread has to be moved in order to add energy to the system? (Answer these last two questions qualitatively.)

[Hint: The constraints are different in both cases.]

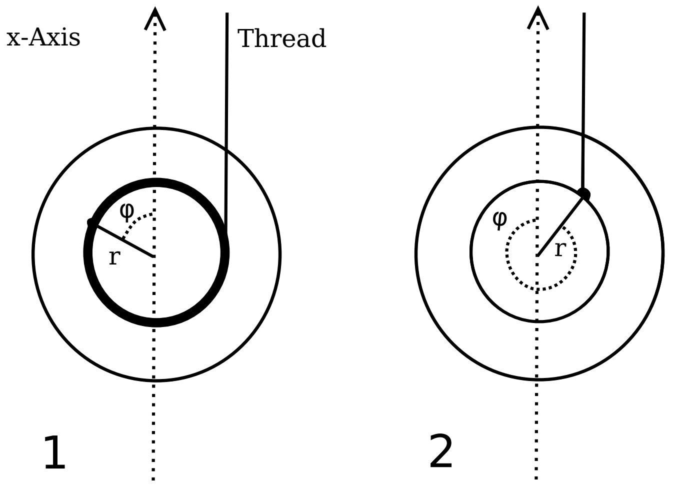

Abbildung 2: Yo-yo

Aufgabe 3:
Scattering on a hard sphere **3 Punkte**

A hard sphere can be represented by the following potential:

$$U(r) = \begin{cases} \infty & r \leq R \\ 0 & r > R. \end{cases}$$

1. Starting from the relation for central potentials,

$$\phi(s) = \int_{r_{min}}^{\infty} dr \cdot \frac{l}{r^2} \cdot \frac{1}{\sqrt{2m\big(E - U(r)\big) - l^2/r^2}},$$

   where m is the mass of an incoming particle, compute the scattering angle of a particle as a function of the impact parameter $\theta = \theta(b)$. Check your solution using basic geometrical considerations.

2. Compute the differential cross section $d\sigma/d\Omega$ and the integrated cross section σ, and comment on your results.

3. The elastic scattering of two billiard balls of mass m and radius a can be represented by the same potential written above, with $R = 2a$. Compute the differential cross section $d\sigma'/d\Omega'$ for the two billiard balls in the frame of reference of the laboratory.