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

Mechanik (Theoretische Physik 1)

Sommersemester 2018

Abgabe bis Freitag, 01.06.18, 12:00 neben PH 3218.

Übungsblatt Nr. 8 Dieses Blatt wird in den Übungen vom 4.06. - 08.06.18 besprochen.

Aufgabe 1:
Down with Mathematics **4 Punkte**

Consider the slide at TUM's Mathematics and Computer Science department, crudely approximated by two branches of a vertical parabolic tube (see figure 1). Let's assume that the tube constrains the trajectory of the center-of-mass of an infalling person to lie on the parabola that goes along the bottom of the tube. Consider as well that the friction $\mathbf{R}$ is of the Coulomb type,

$$\mathbf{R} = -f|\mathbf{Z}|\frac{\mathbf{v}}{|\mathbf{v}|},$$

with f the friction coefficient and $\mathbf{Z}$ the constraint force.

Compute the equations of motion and calculate the constraint force

1. with the Lagrange equations of the first kind,
2. with the Lagrange equations of the second kind.

For evaluating the constraint force, use the fact that the slide is 13 meters high, each branch covers a horizontal distance of about 15m, and the mass of an average TUM student is 75kg.

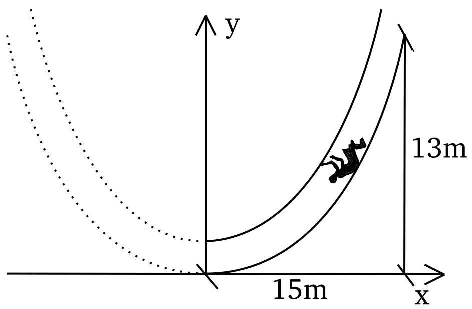
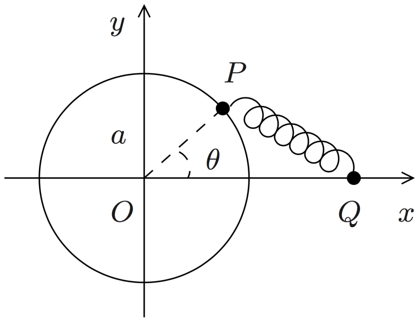


Abbildung 1: Simplified TUM slide. (Not a usage suggestion)

Aufgabe 2:
Equilibrium configurations I **3 Punkte**

Consider the system (see Figure 2) in which a mass m is constrained to move on a circle with radius a while being linked to a spring, the other end of which can slide freely along the x-axis. The system evolves under the influence of a constant gravitational field pointing in the direction of negative y.

Using the Lagrangian formalism of the second kind, find all the possible equilibrium configurations of the system and determine whether the latter are stable or unstable positions.



Simplified TUM slide

Abbildung 2: This figure is actually a hint: remember that the Lagrangian formalism is about finding a suitable set of coordinates!

Aufgabe 3:
Equilibrium configurations II **3 Punkte**

Consider a system consisting of a bead of mass m which can slide without friction on a wire loop of radius a, the latter spinning with angular velocity ω around the z-axis, as in Figure 3. Given that a constant gravitational field in the negative z direction is acting on the system:

1. Use the type two Lagrangian formalism in order to determine all the equilibrium positions for the system, and state which configurations are stable or unstable.
2. Draw a plot showing the behaviour of the equilibrium configurations as a function of the angular velocity ω.

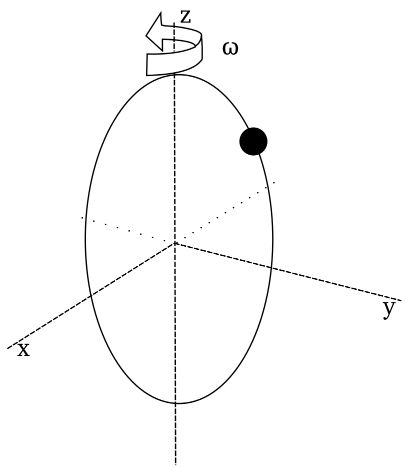


Abbildung 3: Rotating vertical ring