



Mechanics

Exercise Sheet 1

HS 2026
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Exercise 1: Point mass on wedge

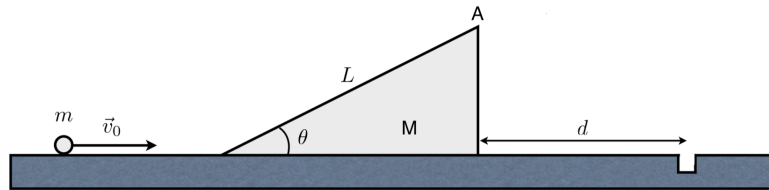


Figure 1: The system in exercise (1).

A wedge of mass M is placed on a smooth horizontal table. The table has a hole at a distance d from the wedge (see Fig. 1). A point-like body of mass m approaches the wedge with velocity $\vec{v}_0$.

- Consider the case where the wedge cannot slide on the table. Assuming the wedge itself to be frictionless, compute the minimal initial velocity v_{min} required for the body to reach the highest point of the wedge, A , as a function of L, θ .
How does the situation change if the wedge has a dynamical friction coefficient $\mu > 0$? Compute the corresponding v_{min} .
- Set $\mu = 0$. For a given $v_0 > v_{min}$, write the horizontal and vertical components of the velocity of m in A . For which value of v_0 does it fall in the hole? Compute it as a function of L, θ, d .
- Now suppose that the wedge is free to slide on the table. Compute again v_{min} as in (a) in absence of friction.

Exercise 2: Elastic collision

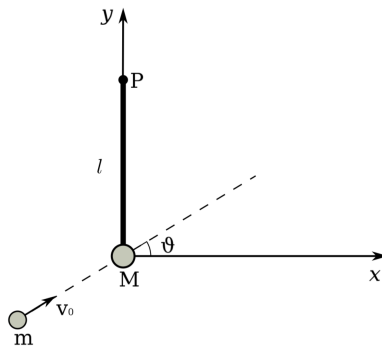


Figure 2: The system in exercise (2).

Consider a body of mass M attached to a rod of length l and negligible mass. The rod is pivoted in P and can rotate without friction in the horizontal xy plane. M is initially at rest. A second body of mass m , also moving in the xy plane, collides with M . The velocity of m before the collision has modulus v_0 and forms an angle θ with respect to the x axis, as shown in figure 2. Assume the angle θ to remain the same before and after the collision.

- Which quantities are conserved in the collision? Why? Write the corresponding conservation laws.
- Write the expressions for the velocity v of m and the angular velocity ω of M immediately after the collision. Discuss the limit cases $\theta = 0$ and $\theta = \pi/2$, and check that for $M > m$ the body of mass m always bounces back.

Exercise 3: Transformation properties of the force.

Consider Newton's second law for a point like mass

$$\vec{F} := m \frac{d^2}{dt^2} \vec{x}. \quad (3.1)$$

- How does the force $\vec{F}$ transform under a general Galilei transformation?
- One example of a non Galilei transformation is a transformation to a rotating reference frame $\vec{x}' = \mathbf{U}(t)\vec{x}$. How does the force $\vec{F}$ transform in this case?