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Exercise sheet 1
Theoretical physics 1: WS2015/2016
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Exercise 1 (40 points): Soccer ball trajectory

A soccer player is supposed to kick a ball from the top of a mountain of height H down into the valley as far as possible. The mountain's slope is constant and characterized by the angle θ with respect to the horizon. In a very short period of time the player accelerates the ball to the velocity v_0. What is the optimal kickoff angle against the horizon to achieve the maximal distance? Assume the height of the mountain to be sufficiently high for the ball to land on the mountain side.

Exercise 2 (30 points): Adding forces

In between two resting balls of mass $M_1 = M_2$, separated by the distance a, a third ball of mass m moves exactly on the perpendicular bisector. Find those points on the perpendicular bisector, where the small ball is accelerated the least / the most.

Exercise 3 (30 points): Alternative Newton's Laws

Imagine an alternative universe, where point mechanics are not governed by the well-known form of Newton's second law $F = m\ddot{x}$, but by a law of the form $\tilde{F} = m\dddot{x}$ with a „superforce" $\tilde{F}$. Reformulate Newton's laws for that universe.