Falling feather

More Details

Everyday life and formula – in contradiction?

In everyday life it is absolutely clear: a leaf floats to the ground more slowly than a football that falls from the same height. In contrast, physics describes “free fall” with a single formula – for everything that falls:

$$t = \sqrt{2h/g}$$

This formula states: I only need to know the height h from which an object falls, and this alone will tell me after how many seconds t the object will hit the ground – the acceleration due to gravity g always has the same value. The formula says nothing about the weight or shape of the object – the object does not appear in the formula at all. So, all objects fall equally fast?

There is a catch, as shown in our experiment: in a vacuum, the object does not play a role in free fall, everything falls at the same speed. In air-filled space, the air’s effect becomes clear: it slows down falling objects. With its larger surface area, the feather is slowed down more strongly than the dice. Because air is so normal to us, we often forget that it is there and has a significant effect.

Physical laws should describe fundamental connections and are therefore often formulated for ideal conditions e.g., without the

influence of air. For example, when wanting to calculate the fall of objects in everyday life, you adjust the formula to match the respective objects in order to take into account air resistance.

Air resistance and parachute

Skydivers need air for more than breathing. Why? Let us assume that a skydiver jumps out of an aircraft at an altitude of 3000 metres and wants to fall freely 2000 metres before opening the parachute. The skydiver would then travel at a speed of over 720km/h at that altitude without air resistance. Even worse: without air resistance, even with an open parachute the skydiver would fall from the sky like a rock. In fact, without a parachute, skydivers would not fall faster than approximately 200 km/h because of air resistance. Once the parachute is opened, the speed is only about 20 km/h.

Who discovered this?

Aristotle (384-322 BC) believed that heavier objects fall faster than lighter objects because of their greater weight. Galileo Galilei refuted this in 1590 with a thought experiment that shows a contradiction in Aristotle's thought: if a heavy and a light object are attached to each other, according to Aristotle both objects would have to fall faster together than the heavy object alone since the weight of both objects together is greater than the weight of the heavy object. Having said that, the light object would have to slow down the fall of the heavy object, since according to Aristotle, the light object would have to fall more slowly. So, both objects together would have to fall more slowly than the heavy object alone.

Galileo Galilei could not carry out any free-fall experiments on this thought experiment. In order to measure and compare the rapid fall times one needs precise clocks, which did not exist back then. Not to mention vacuum pumps like in our experiment! Instead, Galileo studied falling processes by rolling balls down an inclined plane,

which slowed down their fall. Among other things, he determined that the falling speed increases over time.