TEACHERS´S GUIDE

Experiment:
Rubbing erasers, hands and ice cubes

Central concepts:

- Friction
- Energy transformation
- Phase change

Purpose of the experiment

With this experiment, students have the opportunity to learn more about the phenomenon of friction. Friction is a force that resists the relative motion of two surfaces or objects sliding against each other. Friction often results in the conversion of kinetic energy into thermal energy, which is indicated by increased temperature of the involved surfaces or objects. This is experienced in the cases of the students rubbing their hands together, and when rubbing an eraser against a rough surface, such as a wooden table. In the case of rubbing ice against a table, however, part of the thermal energy is used to melt the ice. In addition, due to heat conduction from the table to the ice cubes, the temperature of the table decreases.

Expected outcome

Against the background of their own experience of rubbing things against each other, students can be expected to predict accurately that their hands or erasers will increase in temperature when they are rubbed against each other. Depending on the age group, the term friction may be introduced to explain the phenomenon. Secondary students can be encouraged to provide underlying microscopic explanations in terms of increased vibrations of involved molecules due to the relative motion. Explaining the decreasing temperature and melting due to rubbing ice cubes is more complex, but the exercise nevertheless provides an aesthetically engaging experience also at lower ages.

Relevant age groups

The exercise is suitable for physics teaching in a broad range of age groups. For instance, in the Swedish year 1-3 science studies curriculum, “Gravity and friction that can be observed during play and movement, such as on swings and slides”, is listed as a core content. In secondary teaching, friction can be introduced in relation to concepts such as force, temperature, and phase changes, by means of the exercises.

Added value of IR cameras

Students at all ages have personal experience of the phenomenon that things get warmer when they are rubbed. When seeing this phenomenon in the screen of an IR camera, they are able to combine their sense of touch with vision, which reinforces and builds on their previous experience. Apart from seeing the increased temperature, they can also follow the subsequent cooling process as heat spreads out in the involved objects. IR cameras can be used to identify increased temperature due to friction also in other experimental set-ups, such as when they run and slide to a stop or at the point of suspension of a pendulum. As teachers, we have often inferred such “heat losses” or conversions from kinetic to thermal energy involved in dissipative processes, but with IR cameras students can actually see them.

Tips and tricks

If many groups do the exercises, it might be good to have parallel sets of erasers, since they get warmed up in the handling. Bring a lot of ice and towels to clean up the melted ice.