

## Determining the efficiency of a hand-held mixer – information on the experiment for teachers

### 1 Ideas for teaching

You should make clear to your students that heat was not historically recognized as an energy form, and that the equivalence of energy forms was not always taken for granted. It is true that in 1798 Count Rumford, later Sir Benjamin Thompson, first attempted in Munich to measure, using water, the friction heat generated while boring cannon barrels. However, both his measurements and the underlying concepts were still too imprecise at this stage. It was not until 1843 that James Prescott Joule determined with great precision the mechanical energy equivalent using a rotating paddle immersed in water and driven by descending weights.

A relatively complex apparatus that is not available in every school is needed for determining the exact heat equivalent. For this reason, we propose a comparatively simple freehand experiment that provides a good illustration of the conversion of electrical energy into mechanical energy and then into heat through friction.

### 2 Previous knowledge and qualifications

The following experiments assume knowledge of the following concepts: Current: electric current, voltage, power, electrical energy, heat, and heat measurement.

### 3 Notes on conducting the experiment

#### 3.1 Facilities

The students can conduct this freehand-experiment in any classroom.

#### 3.2 Time required

The experiment can be performed by a group of students or demonstrated by the teacher in accordance with the applicable safety guidelines for your school and requires about 25 minutes in either case.

#### 3.3 Safety aspects

The students may conduct the experiments only in the presence and under the supervision of the teacher. The teacher is to point out to the students that the provided materials may be used only according to the respective instructions.

Observe the applicable safety guidelines for your school concerning the use of electrical devices and electricity.

#### 3.4 Apparatus and materials

Ideally a Dewar flask, but if necessary a plastic cup will do; an electric hand-held mixer; possibly a tripod with holder; a digital thermometer; a scale; an accurate electric power consumption meter.

**Preparation:** The experiment room should be at a temperature of approximately 25 °C. You should leave about one liter of water in a suitable container in the experiment room overnight so that the water is exactly at room temperature at the start of the experiment.

## Teaching Methods

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**Note:** Depending on the students' level of knowledge, teachers should explain the proper use of the hand-held mixer and the electric power consumption meter in advance, demonstrating if necessary. Safety-relevant materials and apparatus must be tested for proper functioning before being handed out to the students.