# Determining the efficiency of a hand-held mixer

## Questions

- What measurement errors have we made through negligence in the test conditions and evaluation (for example, temperature range and measuring cup)?
- What can be done to optimize the experiment setup?
- We have obviously overlooked the heat capacity of the cup.
  How can we determine this?
- The electrical energy supplied should first be converted completely into mechanical work and then converted completely into heat.
  The following should therefore apply: $k_1 \cdot W_{el} = k_2 \cdot W_{mech} = k_3 \cdot \Delta Q$, where $k_1 = k_2 = k_3 = 1$
  Why can't we verify that with our measurement? How do the differences come about?

## Answers

- Questions 1 and 2: If we have the water exactly at room temperature at the starting point, and if we use a real Dewar flask (vacuum-insulated inner container with reflective coating) and this has an insulated lid, the experiment conditions are optimal. "Optimal" means that heat exchange with the ambient air (through convection and radiation) is minimal.
- In reality, not only the calorimeter but, among other things, its inner wall absorbs heat. The heat capacity of the calorimeter should therefore be determined. It is best to work with the so-called "water value" (W), whereby $C_{Kal} = C_{H2O} \cdot W$. In order to determine the water value, fill the calorimeter with cold tap water (same amount as in our experiment) and wait until the temperature reaches $T_1$ through temperature equalization. Now empty the calorimeter quickly and fill it with hot water at temperature $T_2$. $T_2$ should be higher than the ambient temperature by exactly as much as $T_1$ was below it. We measure the mixed temperature $T_3$ when it stabilizes and evaluate: $W = m \cdot (T_2 - T_3) / (T_3 - T_1)$.
- The variation between the electrical energy input and the amount of heat absorbed by the water is due principally to the efficiency of the electric motor. Due to friction and ohmic losses, the mixer housing heats up and dissipates this heat directly to the ambient air.