Object of the experiment

1. Demonstrate how electrical energy is converted into thermal energy in an immersion heater
2. Compare the electrical energy and thermal energy

Setup

Settings for Joule and wattmeter:

- Use the *U, I, P* button to set the measured variable to be work, measured in mWs.
- If necessary, press the RANGE button until the red LED LED (AUTO) comes on.
- Press button *t* START/STOP until the red LED comes on.
- If necessary, press the OUTPUT button until the left-hand LED lights up (no voltage at plug socket).

Apparatus

1 Joule and wattmeter	531 831
1 Single-pan suspension balance 610 Tara	315 23
1 Set of 3 extra weights	315 23
1 Demonstration thermometer, -60 ... +160 °C/5 K	382 41
1 Immersion heater	303 25
1 Beaker, Boro 3.3, 2000 ml, squat	602 025
1 Ceramic fibre gauze, 200 x 200 mm	667 100
1 Stand base, V-shaped, small	300 02
1 Stand rod, 47 cm, 12 mm diam.	300 42
1 Leybold multiclamp	301 01
1 Universal clamp, 0...80 mm	666 555

Procedure

- Determine the mass *m* of 2 l of water.
- Read off the water temperature ϑ_0.
- Plug the mains plug of the immersion heater into the earthed socket of the Joule and wattmeter.
- Press the OUTPUT button so that the right-hand LED lights up.
- Observe the digital display of the Joule and wattmeter:
- As soon as the water is boiling, stop the measurement by pressing the *t* START/STOP button and read off the temperature of the water ϑ_1.
- Afterwards, press the OUTPUT button again.
- Read off the electrical work *W* from the Joule and wattmeter.
- Calculate the thermal energy *Q* from the product of *c*, *m* and $\Delta\vartheta$.
- Compare the electrical energy supplied to the immersion heater with the thermal energy it emits.

Measurement results

Temperature ϑ_0 in °C	17.4
Temperature ϑ_1 in °C	100
Temperature difference $\Delta\vartheta$ in K	82.6
Electrical work W in kWs	764
Electrical work W in kWh	0.21
Specific heat capacity *c* in $\frac{kJ}{kg \cdot K}$	4.18

Evaluation

$W = 0.21\ kWh = 0.21 \cdot 3.6 \cdot 10^3\ kJ = 756\ kJ$

$$Q = c \cdot m \cdot \Delta\vartheta = 4{,}18 \frac{kJ}{kg \cdot K} \cdot 2\ kg \cdot 82{,}6\ K = 690\ kJ$$

Energy is the ability of a body to do work or emit heat.

Once it is turned on, the immersion heater does electrical work.

In this experiment, for example, the electrical work *W* = 756 kJ.

At the heating filament of the immersion heater, electrical energy E_{El} is converted into thermal energy E_{Therm}.

The immersion heater transfers an amount of heat *Q* to the water.

In this experiment, for example, the heat emitted *Q* = 690 kJ.

The difference between the electrical energy E_{El} and the thermal energy E_{Therm} for the immersion heater is essentially due to the way the experiment is set up:

The heat supplied to the water can escape unhindered into the surroundings (sides of the beaker, air).

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