Calorimeter

04401.00

Operating Instructions

1. PURPOSE AND DESCRIPTION

Calorimeter 04401.00 is a water calorimeter with which the specific heat of solids or liquids can be determined. Conversion energies, such as the melting energy of ice, can also be determined.

The unit is fitted with an electric heating system to heat up the contents. Power is supplied to the heating resistor over two 4 mm sockets in the lid. The lid has an orifice (d = 10 mm) to introduce a thermometer or a temperature probe. An agitator with a yoke handle, which can be lifted, passes through two smaller orifices in the lid. The calorimeter is designed to stand temperatures up to 100 °C.

2. HANDLING

The handling is explained taking the determination of specific thermal capacities as an example. In the case of solids, the mixing method is used, for liquids, energy is added by means of the electric heating element.

In order to accelerate thermal equilibrium in the calorimeter, the agitator should be continuously moved during the experiment. It may, however, not be lifted to the point where water is splashed onto the styrofoam lining of the lid.

2.1 Mixing metod

To determine the specific heat of solids according to the mixing method, a sample body of known temperature and mass is brought into thermal contact with a quantity of water of known temperature and thermal capacity inside the calorimeter. The specific heat of the sample is calculated from the temperature of the mixture after thermal equilibrium is reached.

Carrying out of experiment:

- An adequate quantity of liquid (200 ml or more) is weighed and filled into the calorimeter.
- The sample body is hanged from a support by means of a fishing thread and heated in a sufficiently stationary water bath, e. g. in boiling water to 100 °C. A gauze bag may be used to carry several small samples.
- The temperature of the heated sample (temperature of the bath) and the temperature of the water in the calorimeter are read as precisely as possible from the corresponding thermometers immediately before immersing the sample in the calorimeter.
- When one is certain the sample body has reached the temperature of the bath, it is immersed as fast as possible in the calorimeter. The calorimeter lid is closed at once and agitation starts.
- When temperature in the calorimeter begins to drop due to thermal release to the environment, maximum temperature is read as temperature of the mixture.

2.2 Electric heating method

To determine the specific heat of liquids, a quantity of liquid of known mass and temperature is filled into the calorimeter and heated by the electric heating element. The specific heat of the liquid is calculated from energy input and temperature increase.

Next to water, only such liquids may be filled into the calorimeter, which do not attack aluminium, nickel or styrofoam, e. g. all types of alcohol. Only alternating current should be used, to avoid corrosion of the heating element. It is furthermore recommended to use highly purified (distilled) water.

The heating element can only be operated when it is completely immersed in the liquid. A filling quantity of 200 ml is sufficient for this.
The amount of added electric energy is determined measuring current intensity, voltage and heating time. Adequate current intensities: 3 ... 5 A. Adjustment of the supply voltage should be determined in a preliminary experiment, so that the required heating energy will be immediately available during the main experiment.

Carrying out the experiment:

- An adequate amount of liquid (200 ml or more) are weighed and filled into the calorimeter.
- Initial temperature is read; voltage supply and chronometer are switched on; continuous agitation is assured.
- After temperature has increased by 5 - 10 °C for example, voltage supply and chronometer are switched off simultaneously and the maximum value displayed by the thermometer, before temperature stops increasing, is read.

To obtain a more precise measurement, thermal energy released by the calorimeter to the environment must be taken into account. This is achieved by means of a correction of the read final temperature:

- a second experiment is carried out with the same calorimeter contents, during which the drop of temperature ε is measured at the average heating up temperature during a period of time which corresponds to the total heating time during the main experiment. Calculation is now repeated with the final temperature increased by ε.

3. EXPERIMENTING REFERENCE LITERATURE

Physik in Schülerversuchen, Ausgabe A/B	01130.01
Physik in Demonstrationsversuchen, Ausgabe A/B, Elektrik	01141.31
Physik in Demonstrationsversuchen, Ausgabe A/B, Wärme	01141.51
Physik in Demonstrationsversuchen, Ausgabe C, Teil 1	01146.01
Physik in Demonstrationsversuchen, Ausgabe C, Teil 2	01146.11
University laboratory experiments	00067.72

4. TECHNICAL SPECIFICATIONS

Type	Water calorimeter
Exterior dimensions	d = 134 mm; h = 160 mm
Thermal insulation	Styrofoam
Calorimetric capacity	approx. 70 J/°C
Calorimeter vessel	
Material	aluminium
Capacity	500 ml
Dimensions	d = 88 mm, h = 92 mm
Heating element	
Material	Canthal
Resistance	2.4 Ω ± 0.2 Ω
Max. power	
in water	60 W (12 V/5 A)
in air	10 W (5 V/2 A)
Operating power	alternating voltage