Heat conduction

Task and equipment

Information for teachers

Additional information

Energy can be transmitted through heat convection, heat radiation or heat conduction. The greater the thermal conductivity of a wall, the higher the temperature of its exterior. This property is used to compare the temperatures and thus the thermal conductivity of aluminum and glass with each other by means of the thermal generator.

Notes on the Set-up and Procedure

For this experiment the teacher should provide approx. 200 ml hot water of at least 50 °C for each student group.

Only when the aluminium mug is filled almost up to the edge with water, and it stands stable, can a thermometer be carefully placed inside.

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Task

Why do people drink mulled wine from glasses?

In order to compare an aluminum beaker with a glass beaker, hot water is poured into an aluminum beaker. In addition, hot water is available in another glass beaker. The temperatures at the bottom of these beakers are compared with each other by means of a thermal generator. The higher the displayed voltage, the higher the temperature.

Student's Sheet

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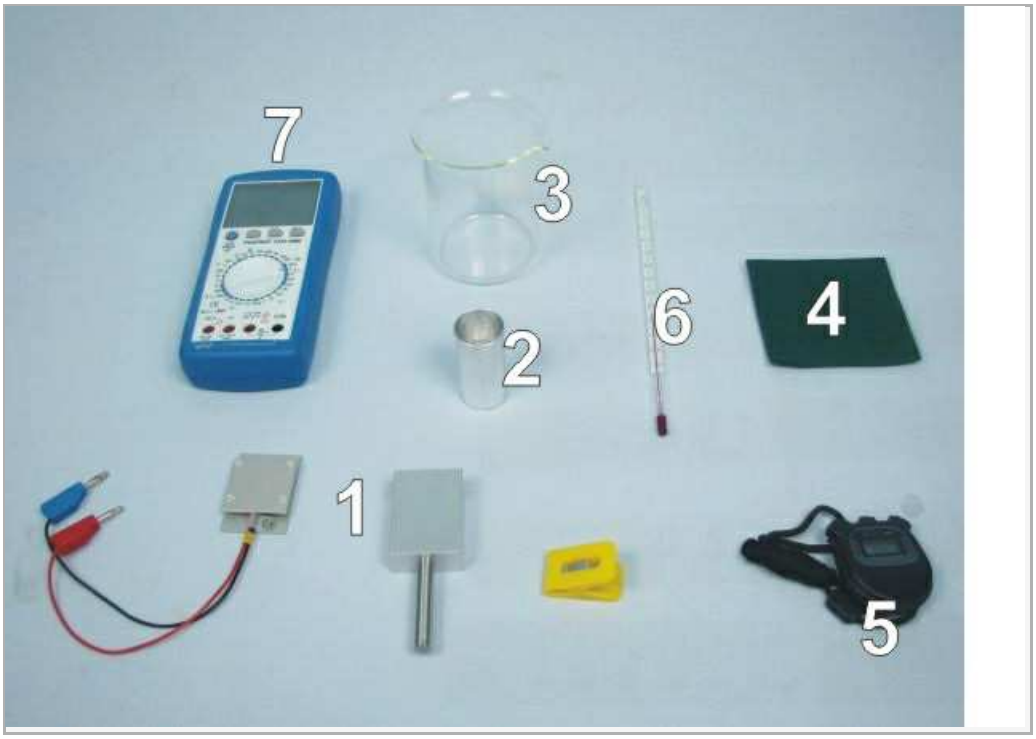
Equipment



Position No.	Material	Order No.	Quantity
1	Thermal generator for student experiments	05770-00	1
2	Beaker, aluminum, polished	05903-00	1
3	Glass beaker DURAN®, short, 400 ml	36014-00	1
4	Felt sheet, 100 x 100 mm	04404-20	1
5	Digital stop watch, 24 h, 1/100 s & 1 s	24025-00	1
6	Lab thermometer,-10..+100 °C	38056-00	1
7	DMM with NiCr-Ni thermo couple	07122-00	1
Additional material			
	Hot water		
	Paper		
	Scissors		

Set-up and procedure

Set-up

Put the Peltier element on the aluminum block of the thermal generator (Fig. 1) and fasten it by means of the yellow clip (Fig. 2).

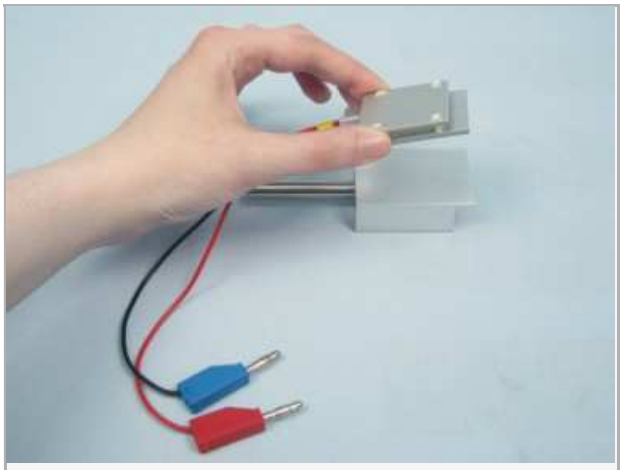


Fig. 1

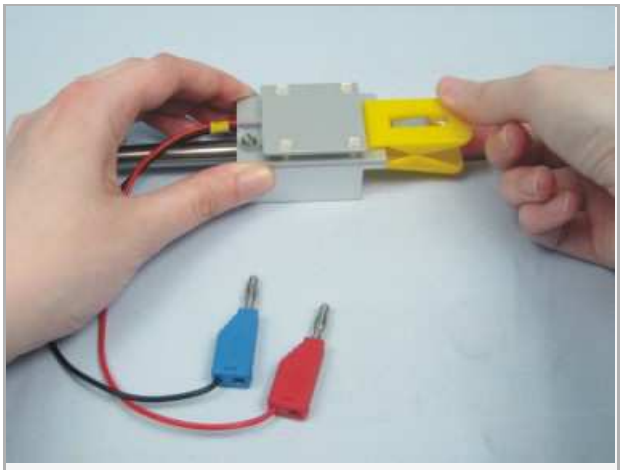


Fig. 2

Connect the Peltier element to the voltage input of the measurement instrument (Fig. 3), select the measuring range of 2 V and switch on the measuring instrument.

Fig. 3

Prepare two protocol sheets according to Table 1 and 2.
Please note that the display .001 on the measuring instrument means 0.001 V = 1 mV.

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Procedure

Let your teacher fill your 400ml glass beaker half-full with hot water of about 50 °C and then place it on the layer of felt.

1st Experiment: Heat conduction of aluminum

Put the aluminium beaker on the Peltier element of the thermo generator.
Pour hot water in the beaker up to approx. 5 mm below the edge of the glass.
Carefully place the thermometer in the beaker and begin the stopwatch (fig. 4).
Read the times entered in Table 1 as well as the voltage U1, and then the water temperature ϑ_1, and enter the values in Table 1 in the report. (The temperature value of t = 0 min is not measurable, because the thermometer does not respond so quickly.)
During the measurement, the 400-ml beaker should stand on the layer of felt, and if possible it should be covered with a piece of paper.

Fig. 4

2nd Experiment: Heat conduction of glass

Before beginning with the next experiment, the Peltier element and the aluminium block must be brought to room temperature.
For this purpose remove the Peltier element from the aluminium block and place on the table with the hot side facing down.
Observe the voltage and wait until it is less than 10 mV. Put the Peltier element back on the aluminium block and wait again until the voltage is close to 0 mV (i.e. between-10 mV and +10 mV) is.
Measure the water temperature ϑ_2 in the 400ml glass beaker and write down this value at t = 0 min on Table 1.
Pour water from the beaker glass until about 50 ml remain in the beaker.
Put the beaker glass on the Peltier element and immediately begin the stopwatch (fig. 5).
Read the times entered in Table 1 as well as the voltage U_2, and then the water temperature ϑ_2, and enter the values in Table 1.

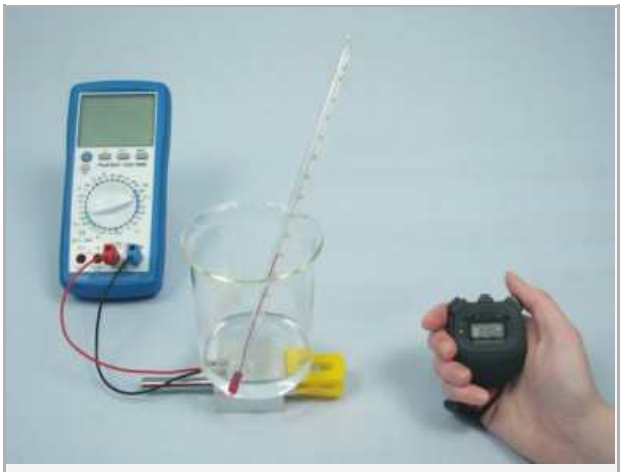

Fig. 5

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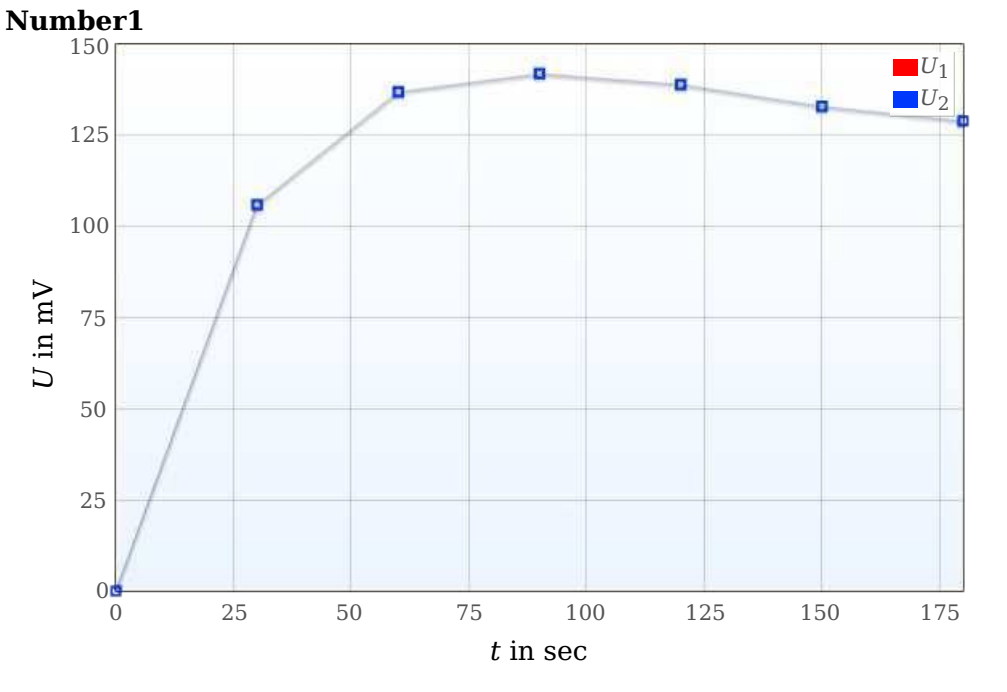
Report: Heat conduction

Result - Table 1

Record your measured values in the table.

t in sec	Aluminium-Beaker		400-ml-Glass Beaker	
	ϑ_1 in °C	U_1 in mV	U_2 in mV	ϑ_2 in °C
0	----		0	49,0 0
30	0	0	106 0	47,5 0
60	0	0	137 0	46,5 0
90	0	0	142 0	46,0 0
120	0	0	139 0	45,0 0
150	0	0	133 0	44,0 0
180	0	0	129 0	43,5 0



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Evaluation - Question 1

Compare the voltages for the beaker made of aluminum and the beaker made of glass. Which beaker conducts the heat best? Explain your answer.

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Evaluation - Question 2

What is the significance of the thermal conductivity of the material in practical use, for example touching the hot beaker, or cooking with such a pot?

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Evaluation - Supplementary problem 1

In the diagram of Table 1 both voltages U_1 and U_2 were applied over time. Describe the progression in time of the voltages.

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