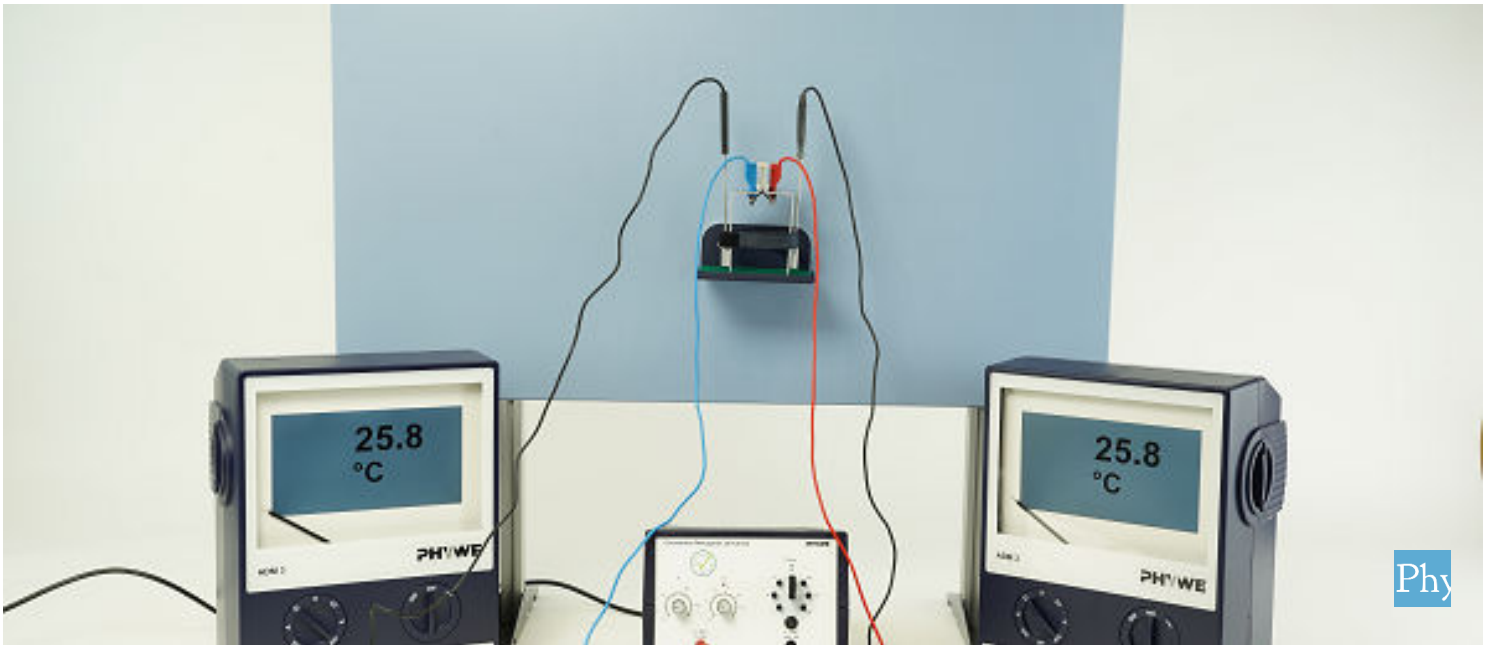
The Peltier effect with ADM3



Physics | Energy | Energy forms, conversion & conservation

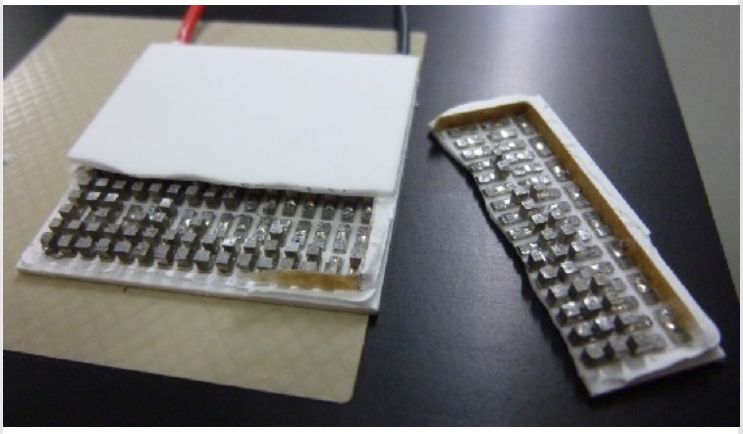
Difficulty level	Group size	Preparation time	Execution time
medium	1	10 minutes	20 minutes

Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

General information

Application

Broken Peltier element



Source photo: wikipedia

Peltier effect: refrigerating machine

Peltier elements are used in many areas for cooling, e.g. in cool boxes or for electronic devices.

They are always useful when normal cooling units take up too much space or are not profitable for small cooling capacities.

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Other information (1/2)

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Previous

A Peltier element and a thermogenerator are the same in structure, but they are used for different purposes. The Peltier element consists of a block with many thermocouples that are electrically connected in series and thermally connected in parallel so that their thermoelectric voltages add up.

Principle

If one side of a thermocouple is colder than the other, an electrical voltage is generated. If a voltage is applied to the other side, a current flows through the element and a temperature difference occurs: one side becomes colder, the other warmer. This effect is called the Peltier effect.

Other information (2/2)

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Learning

In the experiment, the Petier effect is to be illustrated and understood. In addition, an understanding of polarization is to be gained.

Tasks

The thermogenerator is to record the heating and cooling with normal polarity as well as reverse polarity with the two temperature sensors.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

For H- and P-phrases please refer to the safety data sheet of the respective chemical.

Theory

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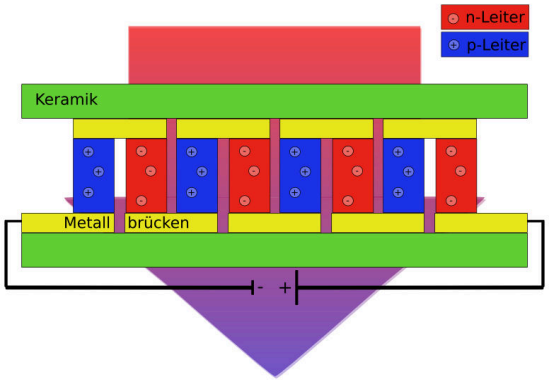

Source: wikipedia

The basis for the Peltier effect is the contact of two semiconductors which have a different energy level (either p- or n-conducting) of the conduction bands.

If a current is passed through two successive contact points of these materials, thermal energy must be absorbed at one of the contact points in order for the electron to reach the energetically higher conduction band of the neighbouring semiconductor material, resulting in cooling.

At the other contact point, the electron falls from a higher to a lower energy level, so that energy is released here in the form of heat.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	2
3	PHYWE Power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13504-93	1
4	Thermogenerator, Peltier element	04374-00	1
5	Heat insulating sheet, felt, 100 mm x 135 mm	04375-00	1
6	Apparatus carrier w. fix. magnet	45525-00	1
7	Beaker, Borosilicate, low-form, 400 ml	46055-00	2
8	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
9	Connecting cord, 32 A, 750 mm, red	07362-01	1
10	Connecting cord, 32 A, 750 mm, blue	07362-04	1

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Structure and implementation

Set-up

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- Set up the circuit according to the illustration.
- Place the thermal insulation plate on the equipment support and place the thermogenerator on it.
- The thermogenerator is connected to the DC output of the power supply unit.
- Insert the two temperature sensors into the holes provided in the thermogenerator. T1 should be the temperature of the leg with the blue socket.

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Procedure (1/2)

Time [min]	Temperature Blue	Temperature Red
1		
2		
3		

Normal polarity

- Set a voltage of 2 V- on the scale of the power supply unit.
- Turn on the power supply and record the heating and cooling readings every minute.
- Stop measurement after 4 minutes and switch off the power supply.
- To cool the thermogenerator, fill the two 400 ml beakers with cold water, immerse both sides.
- Wait for temperature equalization.

Procedure (2/2)

Time [min]	Temperature Blue	Temperature Red
1		
2		
3		

Reverse polarity

- Dry the thermogenerator.
- Reverse the polarity of the voltage at the thermogenerator.
- Switch on the power supply unit and repeat the measurement accordingly.

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37079 Göttingen
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Evaluation (1/2)

Drag the words into the correct boxes!

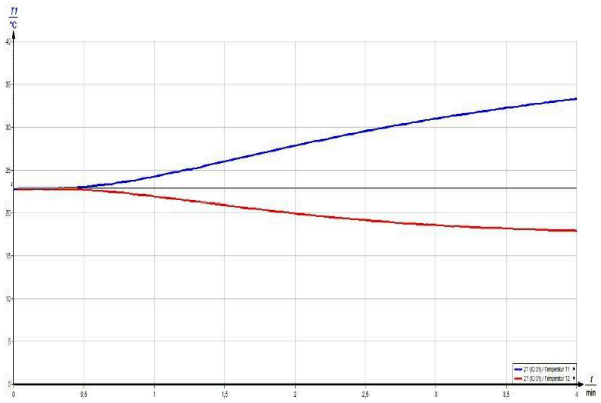
The _____ is greater than the _____ in both cases. This is essentially because the _____ applied causes the whole thermogenerator to heat up. When a _____ is applied to the thermogenerator, one side cools and the other heats. It is always the _____ pole that cools.

heating | cooling | positive | energy | voltage

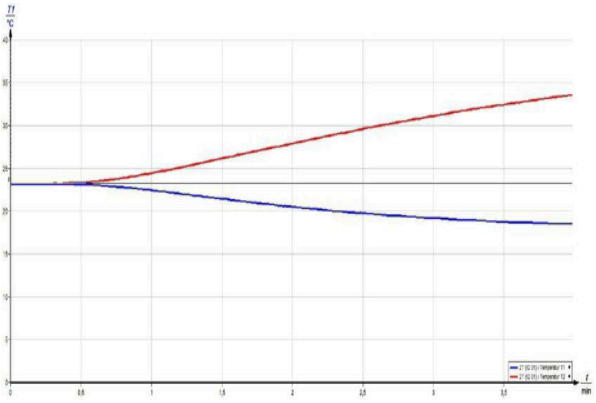
Check

Evaluation (2/2)

Example measurement for normal polarity with horizontal line at the height of the output temperature



Example measurement for reversed polarity with horizontal line at the height of the output temperature



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Slide	Score/Total
Slide 12: Evaluation	0/5

Total score 0/5

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