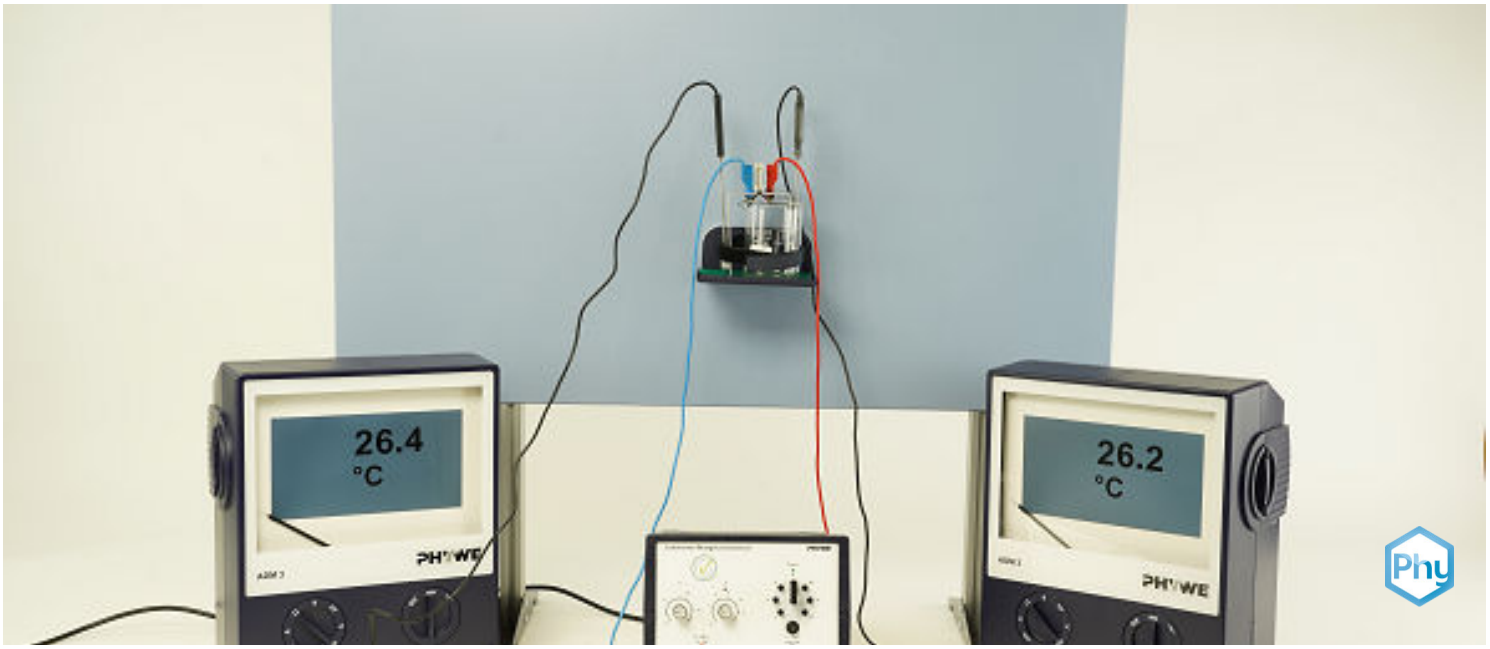
Model test for the use of ambient heat with the Peltier heat pump with ADM3



Physics > Thermodynamics > Conversion of heat, entropy

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

This content can also be found online at:

http://localhost:1337/c/64a66f3374522a0002db8859

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General information

Application

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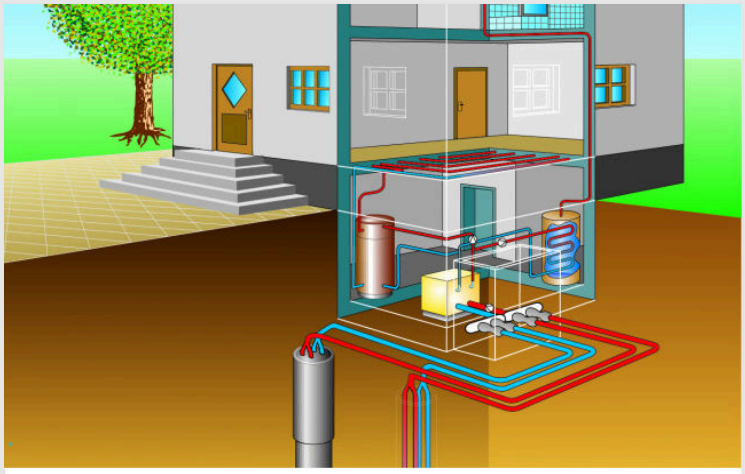

Source Photo: Federal Environment Agency

Model experiment on the use of ambient heat with the Peltier heat pump

Chillers or heat pumps work particularly effectively when the hot or cold side is kept at a constant temperature with the help of a large storage tank.

These can be, for example, water reservoirs or earth reservoirs.

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Other information (1/2)

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Prior

If a direct current flows through a Peltier element, one side heats up and the other cools down. The temperature of the warm side influences that of the cold side and vice versa.

Principle

If the warm side is kept at a constant temperature by a large storage tank, e.g. of water, the cold side cools down more than without a storage tank.

Other information (2/2)

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Note

The current intensity in this experiment should not be higher her than 1 A. At higher amperages, the Peltier element heats up too much, so that the temperature on the warm side rises despite the water bath. The differences in cooling without and with storage are thus smaller.

Tasks

In this experiment, temperatures are measured during operation of the thermogenerator without and with "water storage" on the warm side in dependence of the time.

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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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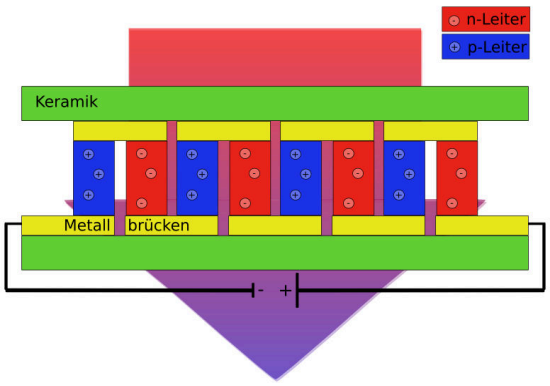

Source: wikipedia

The basis for the Peltier effect is the contact of two semiconductors that 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 contact point so that the electron reaches the energetically higher conduction band of the neighbouring semiconductor material; consequently, cooling occurs.

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, analog display DC: 18 V, 5 A / AC: 15 V, 5 A	13503-93	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, 250 ml	46054-00	1
8	Beaker, Borosilicate, low-form, 400 ml	46055-00	2
9	Immersion probe NiCr-Ni, steel, -50...400 °C	13615-03	2
10	Connecting cord, 32 A, 750 mm, red	07362-01	1
11	Connecting cord, 32 A, 750 mm, blue	07362-04	1
12	G-clamp	02014-01	2

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Setup and procedure

Structure (1/2)

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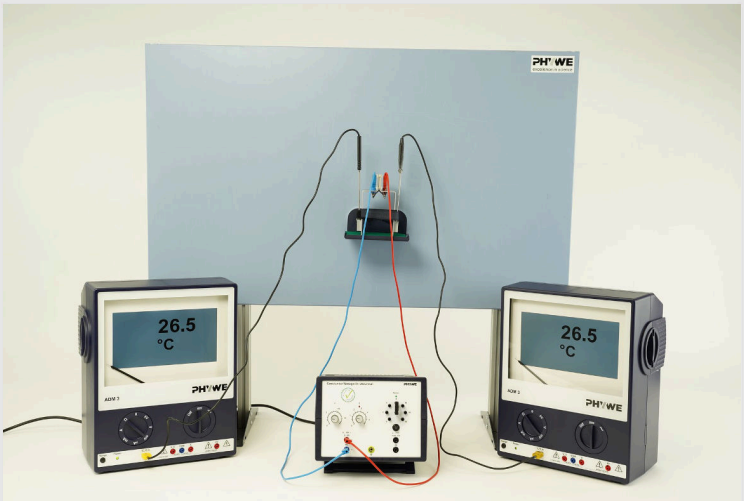

Structure without water reservoir

- Set up the experiment according to the illustration.
- Place the thermal insulation plate on the unit support and place the thermogenerator on it.
- Connect the thermogenerator to the DC output of the power supply unit.

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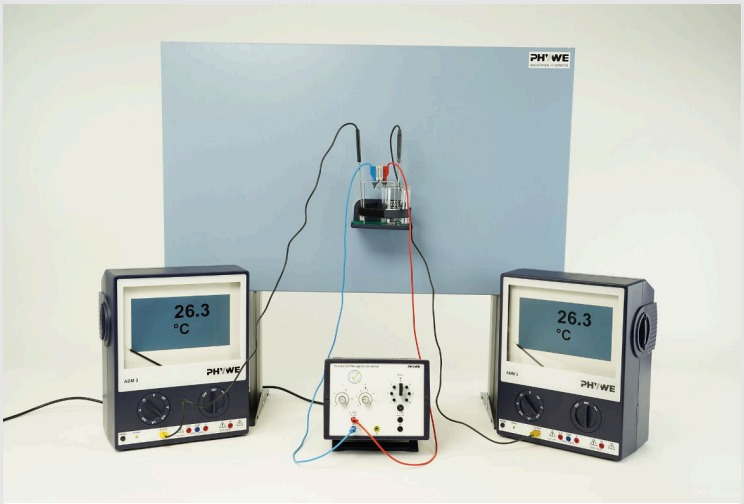
Structure (2/2)



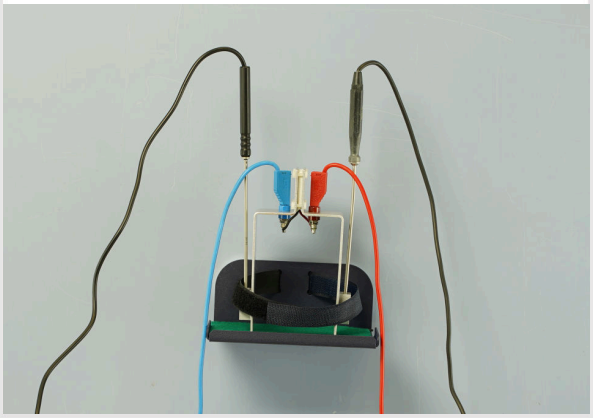
Structure with water reservoir

- Connect the two temperature sensors to the ADM3 multimeters and insert them into the holes provided on the thermogenerator.
- Fill the 250 ml beaker and the two 400 ml beakers each to the top mark with water and have them ready.

Implementation (1/4)

Test part 1

Thermogenerator without water reservoir



- Set a current of 1 A- and a voltage of approx. 3 V- on the scale of the power supply unit.
- Switch on the mains unit.
- Take a reading from both temperature sensors every 30 seconds (table on next page).
- Stop the measurement after about 5 minutes when the temperature of the red sensor no longer changes.

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Implementation (2/4)

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- Switch off the mains unit.
- To cool, place the thermogenerator with both sides in the 400 ml beakers filled with water.
- Wait for the temperature to equalise.

Time [min]	Temp. Blue	Temp. Red	Time [min]	Temp. Blue	Temp. Red
0,5			3,0		
1,0			3,5		
1,5			4,0		
2,0			4,5		
2,5			5,0		

Implementation (3/4)

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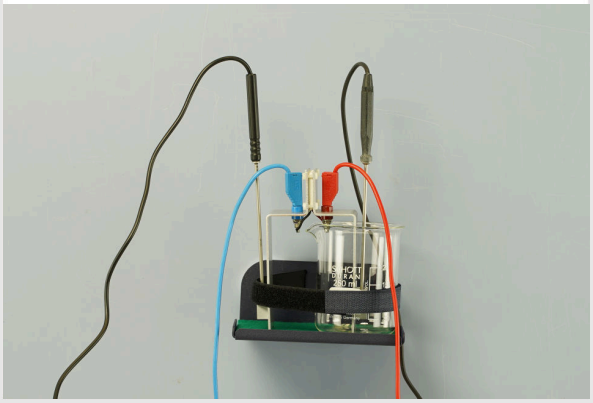
Test part 2

Thermogenerator with a water reservoir on the warm side



- Dry off the thermogenerator.
- Place the 250 ml beaker on the equipment rack.
- Set up the thermogenerator so that the leg with the blue socket is immersed in the beaker.
- Put the two temperature sensors back into the holes of the thermogenerator, the blue socket should be the temperature of the negative pole (blue).

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Procedure (4/4)

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- Switch on the mains unit.
- Repeatedly take readings every 30 seconds.
- After 5 minutes the measurement should be stopped.
- Switch off the mains unit.

Time [min]	Temp. Blue	Temp. Red	Time [min]	Temp. Blue	Temp. Red
0,5			3,0		
1,0			3,5		
1,5			4,0		
2,0			4,5		
2,5			5,0		

Evaluation (1/2)

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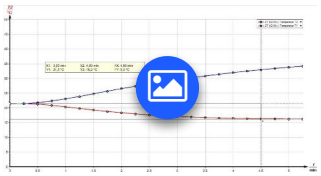

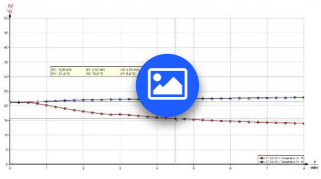

Drag the words into the correct boxes!

When using a water storage tank, the temperature on the _____ side hardly increases at all. The temperature on the _____ side becomes lower than without a storage tank. The upper figure shows that when the thermogenerator is operated _____, the temperature on the cold side remains constant after a certain time. In the second part, _____ the temperature drops even further.

hot | with storage | without storage | cold

Check

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Evaluation (2/2)

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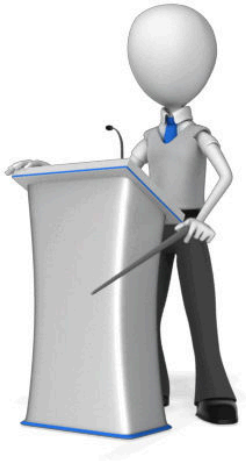
1. Determine the time t_0 up to the temperature minimum when measuring the thermogenerator without storage tank
2. Determine the temperature changes ΔT_1 and ΔT_2 after the time from 1)

$t_0 =$ ☐

$\Delta T_1 =$ ☐ $\Delta T_2 =$ ☐



Slide	Score / Total
Slide 15: Observation temperature	0/4

Total score 0 / 4

Show solutions | Repeat | Export text

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