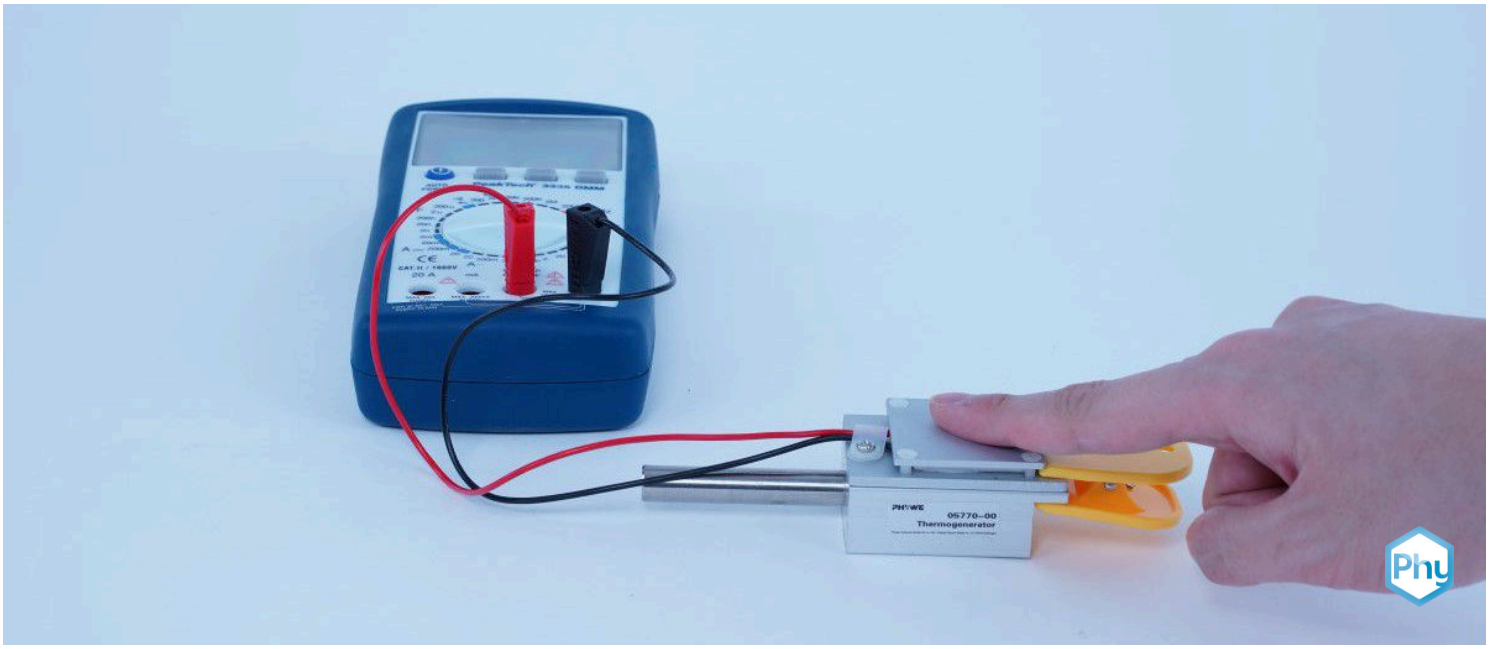
Conversion of thermal energy into electrical energy



Physics | Energy | Energy forms, conversion & conservation

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6167def92d1cf30003518c25

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Teacher information

Application

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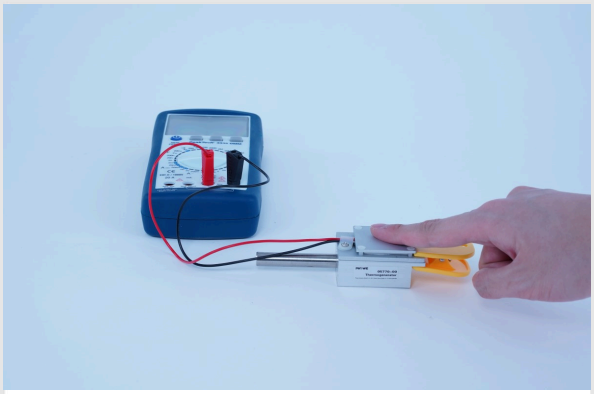

The experimental setup

Peltier elements exploit the thermoelectric effect to generate electrical energy from heat energy, which is extremely useful for humans.

This circumstance is presented in this experiment by generating a measurable current voltage through the body heat of the students.

The laws of this power generation are closely examined in connection with the given temperature difference.

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Other teacher information (1/3)

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Previous

Students should be familiar with the basic forms of energy and the concept that energy can be converted from one form to another.

Principle

By touching the Peltier element, the students generate a measurable voltage and can thus experience how heat energy can be converted into electrical energy. Through this, the students understand how the voltage is related to their body temperature.

Other teacher information (2/3)

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Learning

Students learn that a thermogenerator can generate electrical energy from heat energy.

The thermoelectric voltage thus generated depends on the temperature difference across the element.

Tasks

Induce a temperature difference across the Peltier element by touch and other methods and observe if you can generate an electric current with it.

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Other teacher information (3/3)

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Notes on structure and implementation

- Sufficient time must be allowed between the two experiments for the two sides of the thermogenerator to cool back to room temperature and for the thermoelectric voltage to return to zero.
- Hot water (approx. 60°C) should be provided at the teacher's desk.
- A large accumulator (aluminium block) can keep the temperature difference stable (and therefore higher) over a longer period of time and therefore has advantages in energy production.
- The results depend on the ambient temperature, therefore the measured values may deviate from the sample solution. However, the general behaviour of the thermoelectric voltage remains the same.

Safety instructions

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

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Student Information

Motivation

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A thermal power plant

Thermal power plants burn fossil fuels such as coal and petroleum to power electrical generators with the heat they generate. They are an example of how thermal energy can be converted to meet the ever-growing demand for electrical power.

The Peltier element is another such example, which makes it possible to build up a current flow with naturally occurring heat sources. The own body heat is already sufficient to generate a measurable current.

In this experiment you can experience this physical phenomenon yourself.

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Tasks

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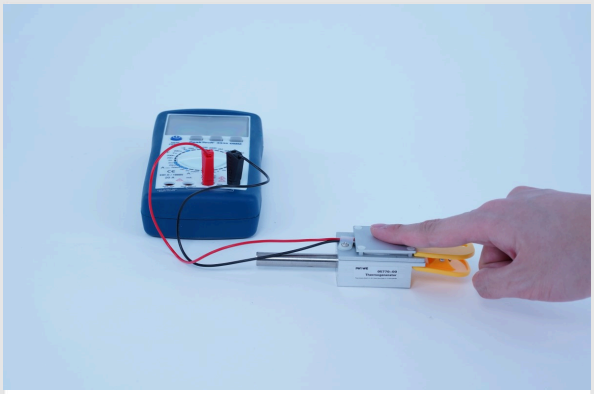

The experimental setup

Is it possible to generate electrical energy with the help of a finger?

To investigate this question, you use a thermocouple. This consists of a so-called "Peltier element", which is mounted between two thin aluminium plates.

What happens when the upper aluminium plate is heated, e.g. by a finger?

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Equipment

Position	Material	Item No.	Quantity
1	Thermal generator for student experiments	05770-00	1
2	Beaker, black	05904-00	1
3	Beaker, Borosilicate, low-form, 400 ml	46055-00	1
4	Digital multimeter, 600V AC/DC, 10A AC/DC, 20 MΩ, 200 µF, 20 kHz, −20°C… 760°C	07122-00	1

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Additional material

- hot water

Structure (1/2)

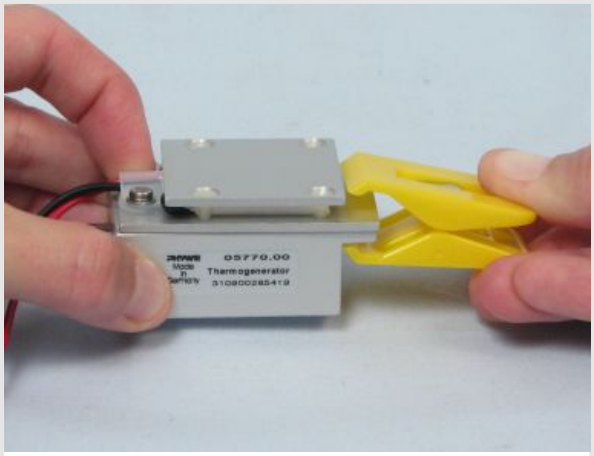

Figure 1

1. The thermogenerator consists of an aluminium block, a yellow clamp and the "Peltier element" (located between two thin aluminum plates).

2. Place the aluminum block on the table with the smaller side facing down. Attach the Peltier element to the aluminum block with the clamp so that its larger side is facing down (Fig. 1).

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Structure (2/2)

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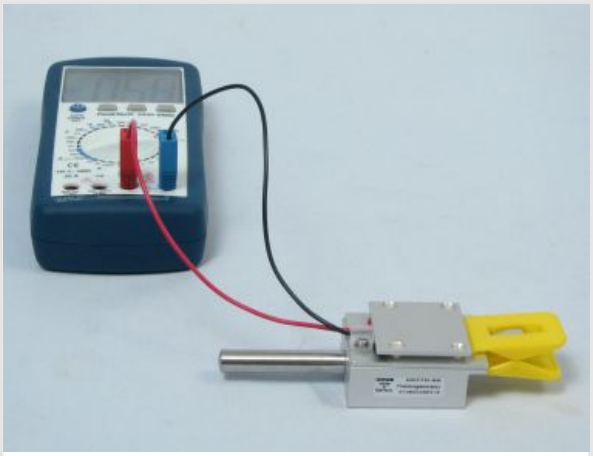

Figure 2

3. Connect the element to the voltage input of the meter (Fig. 2). Select the DC voltage measuring range 2V-.

Procedure (1/2)

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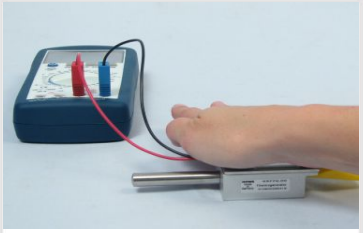

Figure 3

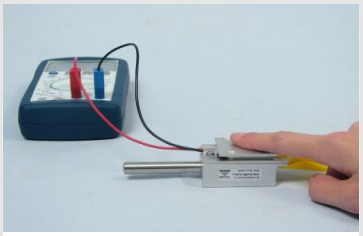

Figure 4

1. Place your hand on the thermogenerator so that there is only contact with the upper aluminium plate (Fig. 3).

2. Read the voltage when it is highest. Enter your result in the results table in task 1.

3. Then you have to wait until the voltage has dropped to 0 V again. You can speed up this process by removing the Peltier element from the aluminium block and placing its top and bottom alternately on the table.

4.Repeat the experiment with your index finger on the thermogenerator (Fig. 4).

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Procedure (2/2)

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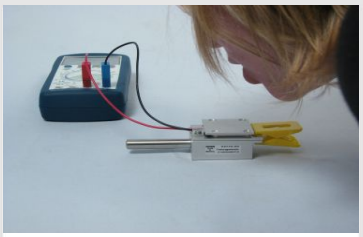

Figure 5

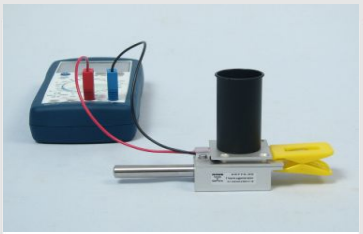

Figure 6

5.Rub your index finger until it gets warm and perform the experiment as before.

6. Repeat the experiment by breathing on the upper aluminium plate (Fig. 5).

7.Fill the black beaker with hot water and place it on the thermogenerator. Carry out the usual experimental procedure (Fig. 6).

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Report

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Task 1

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What tension did you observe in these sections?

Heat source	Voltage U in V
Hand	
Index finger	
grated index finger	
breathe on	
hot water	

Task 2

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How do you explain that the thermocouple produced different voltages?

The voltage generated by the Peltier element is arbitrary.

Since the voltage generated depends on the temperature difference between the plate and the object with which it comes into contact. Accordingly, the different tensions can be explained by the fact that the individual test objects had different temperatures.

The stress generated depends on the pressure applied to the plate. The different stresses can therefore be explained by the fact that the test objects have different weight forces.

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Task 3

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Drag the words into the correct boxes!

The _____ generates an electric current via the thermoelectric effect. For this it needs a _____.
The larger the given temperature difference, the larger the generated _____.
The multimeter shows a _____ of 0 V when the plate is as warm as the room temperature.

- current
- voltage
- temperature difference
- Peltier element

Check

Task 4

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Which of these following statements is true?

- ○ The rubbed finger is cooler than the unrubbed finger because energy is lost to the environment through friction.
- ○ If you cool the plate instead of heating it, a current is created that flows in the opposite direction.
- ○ Since energy conversions are not perfectly efficient, energy was dissipated in this experiment.

Check

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Slide	Score / Total
Slide 18: Voltage	0/1
Slide 19: Temperature difference	0/4
Slide 20: Statements	0/1

Total 0 / 6

Solutions | Repeat | Export text

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