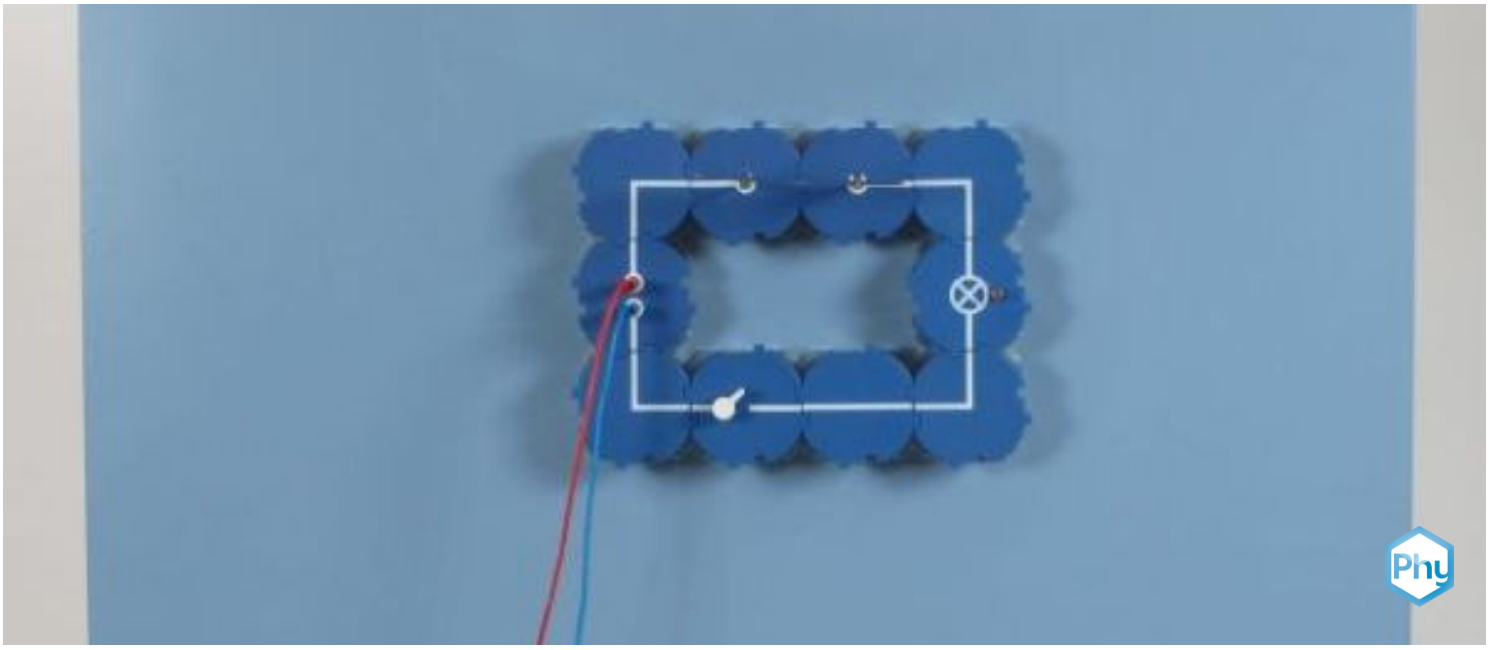
The bimetallic switch



To familiarise students with how a pumice strip works and how the property of different coefficients of thermal expansion affects the curvature of the strip.

Physics > Electricity & Magnetism > Electric current & its effects

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

This content can also be found online at:

http://localhost:1337/c/6474c33721530f000293d893

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

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General information

Application

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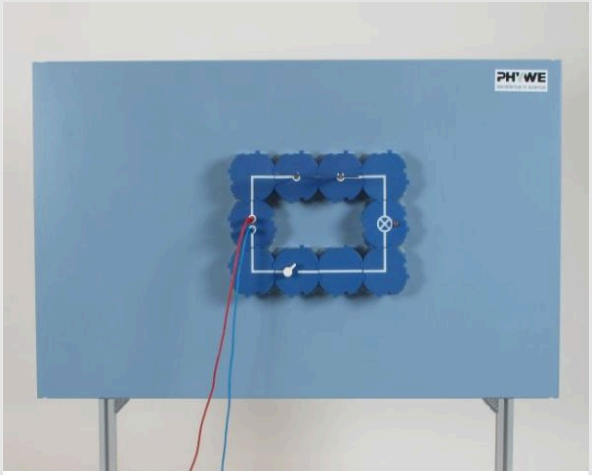

Experimental setup

This experiment is about the investigation of a bimetal switch.

Bimetal strips are used as fuse elements in various devices. For example, the property of opening circuits is exploited as a thermal circuit breaker in electric irons and in power supply devices. In alarm systems, the bimetal strip closes the circuit when the temperature exceeds a permissible maximum value.

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Robert-Bosch-Breite 10
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Other information (1/2)

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Prior knowledge

The students should be familiar with the functioning of the simple electric circuit and know the terms current and voltage.

Principle

Two sheet metal strips with different coefficients of thermal expansion connected to each other form a bimetal strip. When this is heated, a curvature occurs in the direction of the sheet with the lower coefficient of thermal expansion.

Other information (2/2)

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Learning objective

To familiarise students with how a bimetal strip works and how the property of different coefficients of thermal expansion affects the curvature of the strip.

Tasks

First, the experiment is set up according to the circuit diagram and then the bimetal strip is heated with a flame, once in the open circuit and once in the closed circuit.

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Safety instructions

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

Theory

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Fuses prevent impermissibly high currents and thus serve to protect electrical devices and systems. In the worst case, supply lines could heat up so much that a fire occurs. To prevent this, fuses are installed in the circuit as "predetermined breaking points".

In this experiment, the functioning of a bimetal switch is investigated. A bimetallic switch is a bimetallic strip, i.e. a composite of two metals with different coefficients of thermal expansion. If the temperature changes, the length of the metal strips changes. Since different metals expand differently at the same temperature, the bimetal strip bends in the direction of the metal with the lower coefficient of linear expansion.

The available bimetal strip reacts so sensitively that a small amount of heating is sufficient for both parts of the experiment. The hint that heating should be done carefully is aimed at ensuring that, despite repeated demonstrations of the switching processes, not too much teaching time elapses until the bimetallic strip has stretched again in each case.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Connector, straight, module DB	09401-01	1
3	Connector, angled, module DB	09401-02	4
4	Connector interrupted, module DB	09401-04	1
5	Junction, module DB	09401-10	2
6	Switch on/off, module DB	09402-01	1
7	Socket for incandescent lamp E10 ,module DB	09404-00	1
8	Bimetal strip	05913-00	1
9	Alligator clips, bare, 10 pcs	07274-03	1
10	Connecting plug, 2 pcs.	07278-05	1
11	Connecting cord, 32 A, 1000 mm, red	07363-01	1
12	Connecting cord, 32 A, 1000 mm, blue	07363-04	1
13	PHYWE Power supply, universal, analog display DC: 18 V, 5 A / AC: 15 V, 5 A	13503-93	1
14	Filament lamps 12V/0.1A, E10, 10 pieces	07505-03	1
15	Electr.symbols f.demo-board,12pcs	02154-03	1
16	G-clamp	02014-01	2

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Set-up and Procedure

Set-up

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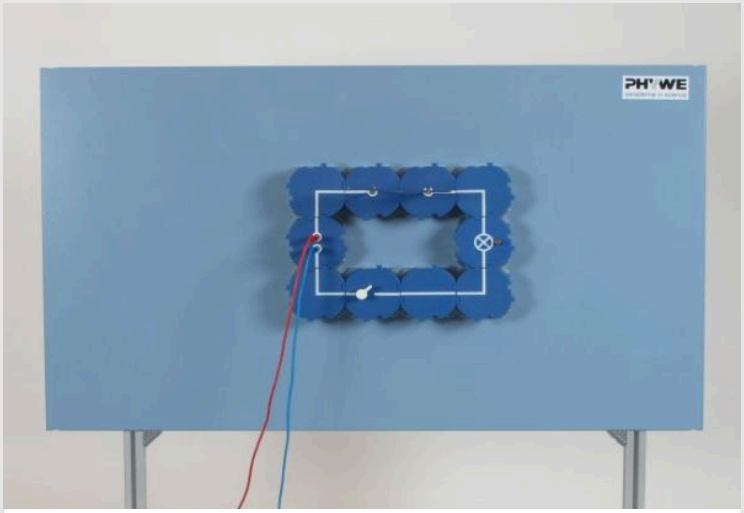

Experimental setup

- Set up the experiment according to the illustration on the left.
- Place the alligator clips on the two connection modules using the connecting plugs and clamp the bimetal strip with the right alligator clip so that the printed surface is facing downwards.
- Switch on the power supply unit and set the nominal voltage to $12V$.

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Procedure

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- With the switch open, turn the right alligator clip so that the bimetal strip touches the left clip from above.
- Close the switch and then gently heat the bimetal strip near its pinched end with a flame and let it cool; observe the bimetal strip and bulb. (Repeat the process if necessary)
- With the switch open, place the bimetal strip so that its free end is about $1cm$ is below the left alligator clips; printed area still facing down.
- Close the switch and proceed as in the first part of the experiment.

Evaluation (1/3)

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Fill in the blanks based on the observations:

To the first part of the experiment: When the bimetal strip is heated, it _____ away from the left alligator clip; the circuit is broken and the light bulb _____. When it cools down, it _____ again and closes the circuit, so that the lamp _____ again.
For the second part of the experiment: When the bimetal strip is heated, it bends towards the alligator clip; the circuit is closed and the lamp _____. When it cools down, it stretches and breaks the circuit again; the light bulb _____.

stretches
goes out
curves
lights
goes out
lights

Check

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Evaluation (2/3)

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Which statement is correct?

- ○ When heated, it curves towards the sheet that has the greater coefficient of thermal expansion.
- ○ A bimetallic strip consists of two sheet metal strips with the same coefficient of thermal expansion connected to each other over their entire surface.
- ○ When heated, it curves towards the sheet metal, which has the lower coefficient of thermal expansion.

Check

Evaluation (3/3)

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Where are bimetal switches used?

- ☐ In light switches.
- ☐ As a heat protection switch in electric irons.
- ☐ In power supply units.
- ☐ In alarm systems.

Check

Why is the use of a bimetal switch useful or necessary in these examples?

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Slide	Score / Total
Slide 11: Behaviour of the bimetallic strip when heated	0/6
Slide 12: Property of the bimetal strip	0/1
Slide 13: Use bimetal switch	0/3

Total score 0 / 10

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