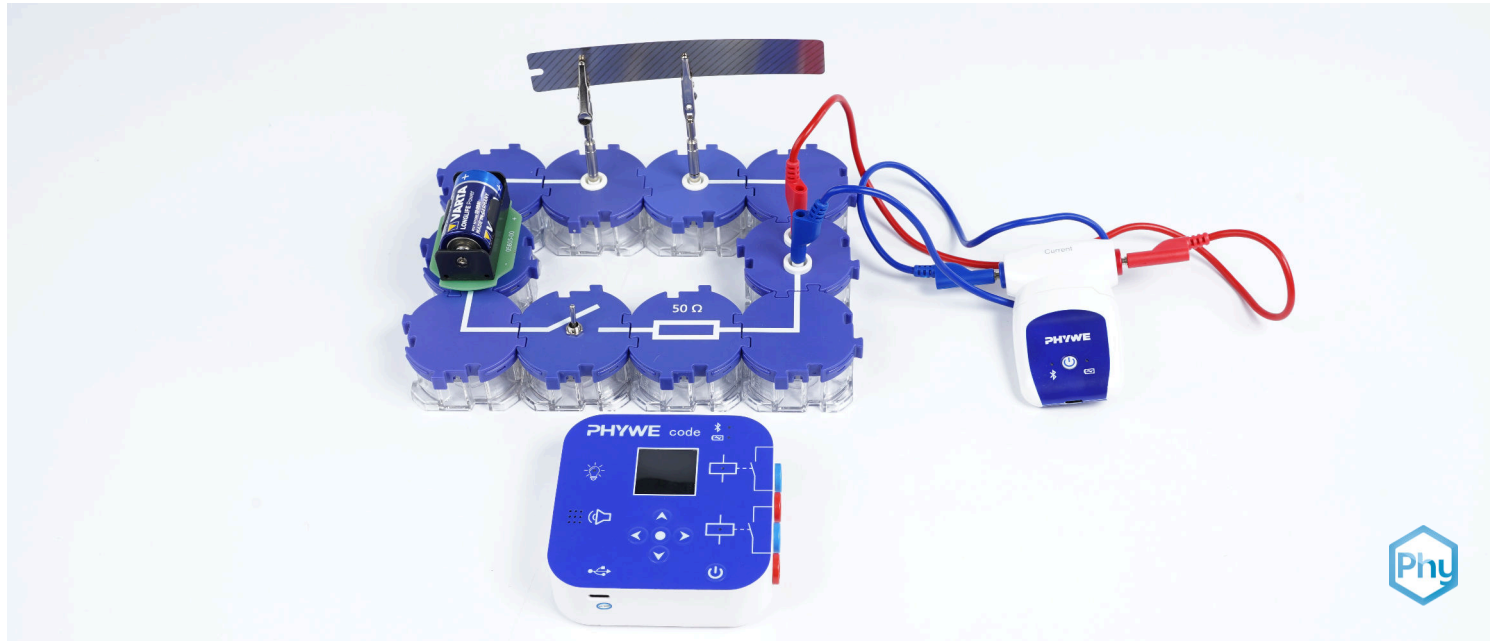# The bimetallic switch with Cobra SMARTsense Code

Physics	Electricity & Magnetism	Simple circuits, resistors & capacitors

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

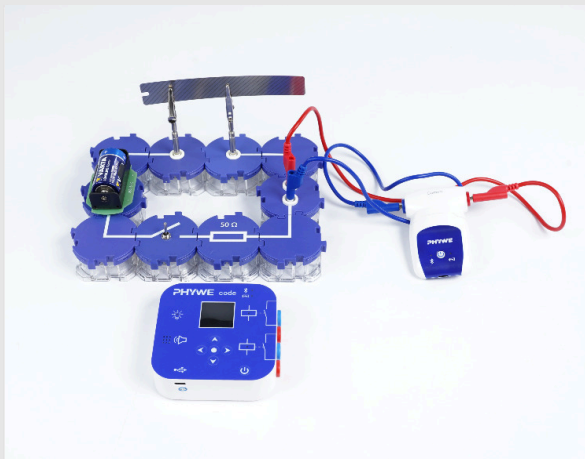https://www.curriculab.de/c/67f789cd5b74d900024e8eae

PHYWE

Teacher information

Application

PHYWE

Experimental setup

A bimetallic strip, which consists of two sheet metal strips with different coefficients of thermal expansion joined together, bends towards the side of the metal with the lower coefficient of thermal expansion when heated.

This makes the bimetallic strip suitable for opening circuits (e.g., in circuit breakers or as a thermal cut-out in electric irons or power supply devices) or closing circuits (e.g., in alarm systems) if the ambient temperature exceeds a maximum permissible value.

Today, temperature-dependent semiconductor sensors perform its functions in many devices and systems.

Other teacher information (1/3)   **PHYWE**

Prior knowledge	The students should be able to set up and understand a simple electrical circuit.
Principle	A bimetallic strip is a metal strip made of two adjacent metals with different coefficients of thermal expansion. When the bimetal is heated, it bends to one side. This means that bimetals can also be used as switches. A programmable actuator can be used to indicate when a bimetal switch closes or opens the circuit.

Other teacher information (2/3)

Learning objective	The students should use the experiment to understand the principle and function of a bimetallic switch. They also learn how to program an actuator with simple "If... then..." logic operations.
Tasks	Experiment 1: The bimetallic strip is clamped so that it lightly touches the second terminal. When heated, it bends and interrupts the contact. Experiment 2: The strip is positioned at a distance from the second terminal. When heated, it bends and makes contact. In both cases, a programmed actuator symbolically indicates whether current is flowing or not.

Other teacher information (3/3)   **PHYWE**

Notes

The test setup is not complicated. The available bimetal switch reacts so sensitively that slight heating is sufficient for both parts of the experiment. Therefore, it is important to point out that heating should be applied carefully to avoid excessive loss of teaching time while waiting for the bimetal strip to return to its original position after repeated trials.

Safety instructions   **PHYWE**

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

PHYWE

Student information

Motivation
PHYWE

The bimetallic strip is used in electric irons, among other applications, to set a desired temperature and to provide protection against overheating. Bimetallic strips are also installed in fire alarms based on a similar principle. These alarms are triggered when the ambient temperature exceeds a permissible maximum value.

In this experiment, you will learn how the bimetallic strip performs these functions.

Tasks

Experimental setup

1. Build a bimetal switch into a circuit consisting of a current sensor and resistor so that it can open or close the circuit.

2. Program the code so that a sad smiley appears as soon as the bimetal switch bends due to heat.

Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Code - Output device for switching relays, LEDs, display	12953-00	1
2	Cobra SMARTsense Current - Sensor for measuring electrical current ± 1 A (Bluetooth + USB)	12902-01	1
3	Connecting cord, 32 A, 250 mm, red	07360-01	1
4	Connecting cord, 32 A, 250 mm, blue	07360-04	1
5	Resistor 50 Ohm,module DB	09412-50	1
6	Angled connector module, SB	05601-02	4
7	Interrupted connector module with sockets, SB	05601-04	2
8	Junction module, SB	05601-10	2
9	On-off switch module, SB	05602-01	1
10	Battery holder module (C type), SB	05605-00	1
11	Bimetal strip	05913-00	1
12	Alligator clips, bare, 10 pcs	07274-03	1
13	Connecting plug, 2 pcs.	07278-05	1
14	Battery Type C 1.5 V - Pack of 2 pieces	07400-00	1
15	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

Additional material

PHYWE

Position	Equipment	Quantity
1	Heat source (e.g. matches)	1

Setup (1/5)

PHYWE

To measure with the **Cobra SMARTsense sensors**, the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the respective app store (QR codes below). Please check that **Bluetooth is enabled** on your device (smartphone, tablet, desktop PC) before starting the app.
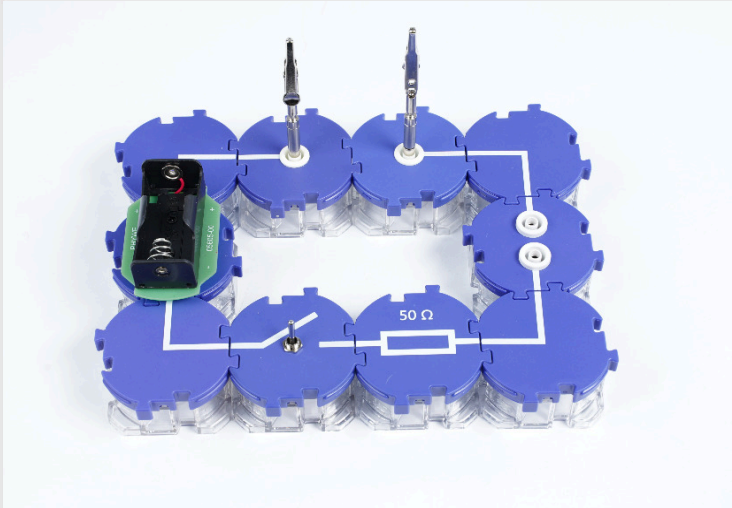
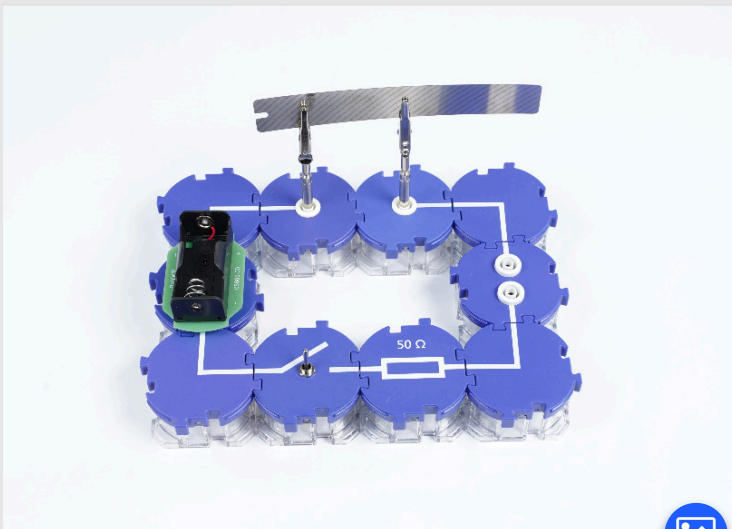| iOS	Android	Windows

Setup (2/5)

PHYWE

Circuit without further connections

- Build the circuit shown and connect the crocodile clips to the two connection modules using the double plugs.

Setup (3/5)

PHYWE

Inserting the bimetal

- Insert the bimetal strip into the center of the right crocodile clip so that the patterned side is facing you, as shown in the illustration. The bimetal strip must touch the left crocodile clip from behind — it must not be clamped or pinched. You can see exactly how this should look by pressing the blue button on the left-hand side.

- You can also slightly adjust the position of the right crocodile clip if this helps the bimetal strip make better contact with the left clip.
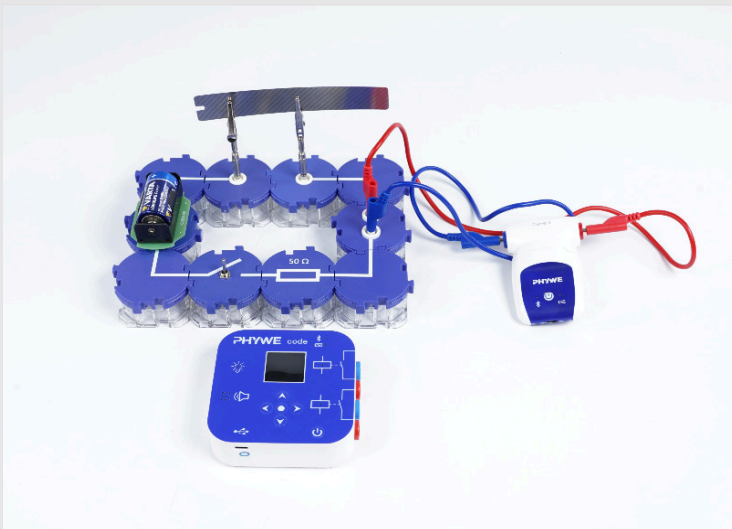
Setup (4/5)

PHYWE
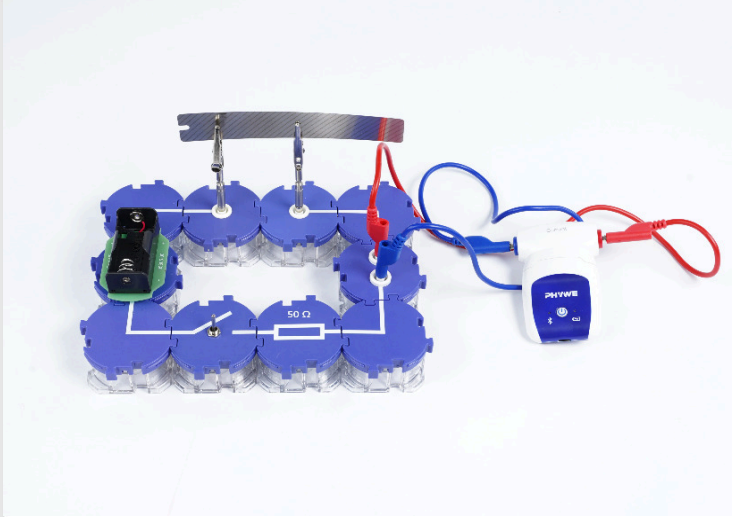
Inserting the bimetal

- Connect the Cobra SMARTSense Current so that you can measure the current of the circuit.
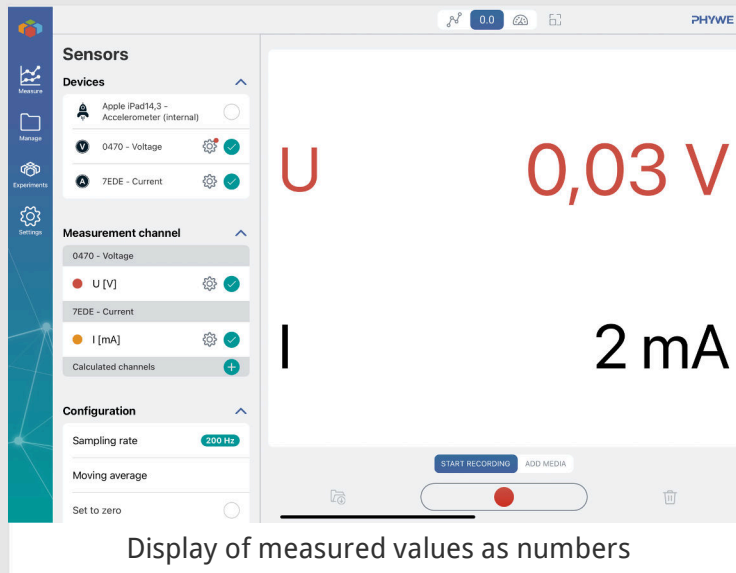
Setup (5/5)

PHYWE

Inserting the battery

- Insert the battery into the battery holder on the left-hand side. Make sure that the normal switch is off so that no current can flow.

Procedure (1/7)

PHYWE

Display of measured values as numbers

○ Start the Cobra SMARTSense Current and the Cobra SMARTSense Code by pressing and holding the on/off button for three seconds.

○ Launch the measureAPP and connect to both devices. Switch to the digital measurement view. On the left-hand side, you will see a screenshot of the app with the standard switch turned off.

○ The current may fluctuate slightly due to background noise, even when no current is applied. Note the highest current measured, while the standard switch interrupts the current flow.
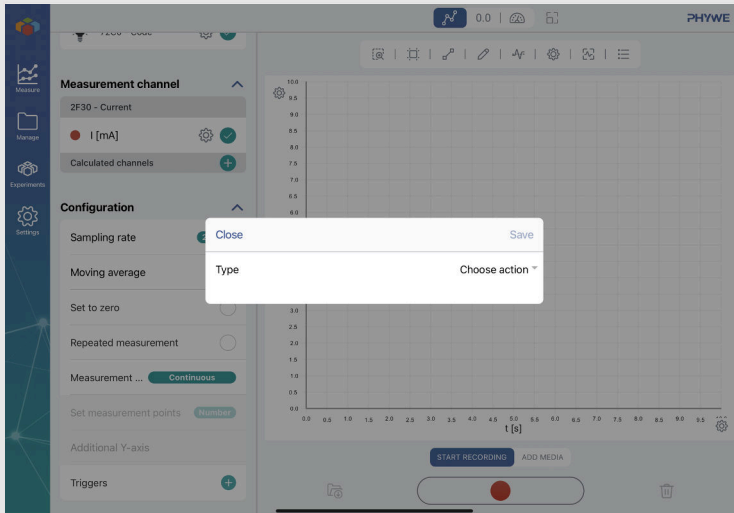
Procedure (2/7)

PHYWE

Adding a trigger
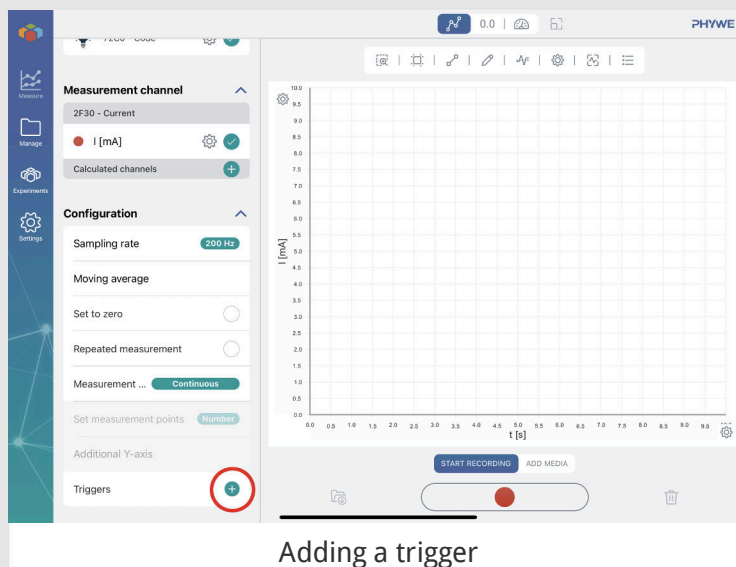
○ Now programme the Cobra SMARTsense code.

○ To do this, add a trigger for the SMARTsense code by pressing the plus button provided.

○ If you set a trigger, this means that the Cobra SMARTsense code triggers a specific action as soon as a measured value fulfils a condition that you define.

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
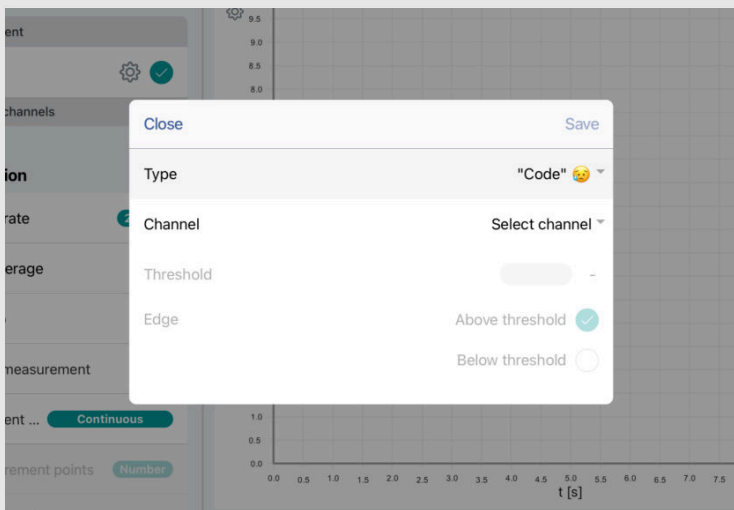www.phywe.de

Procedure (3/7)

PHYWE

Adding an action

- A window will now appear in which you can select an action that you want to trigger. For our first trigger, we want the SMARTsense code to display a sad smiley. Therefore, select this action by clicking on "Select action".
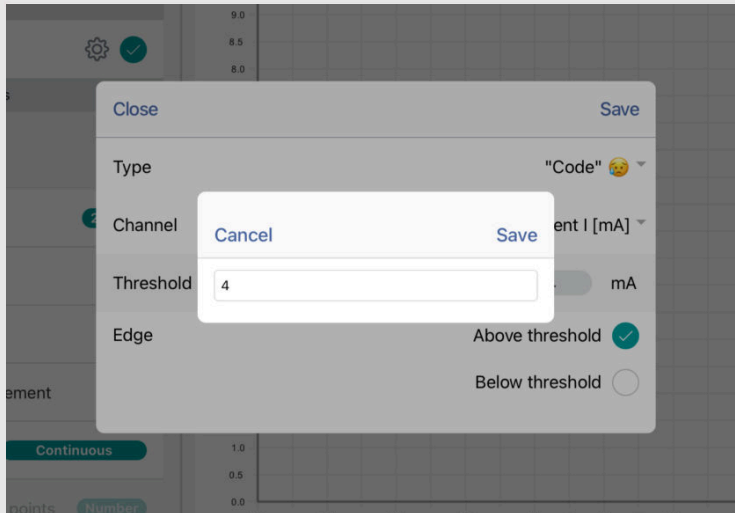
Procedure (4/7)

PHYWE

Adding an action

- Now you have to set which measurement should be taken into account. This will later be the measured variable that should fulfil a certain condition. In our case, this is the current. Therefore, select the corresponding measurement channel.

Procedure (5/7)

PHYWE

Adding a threshold value

- There are two options for when the action is triggered: Either it is triggered as soon as the threshold value is exceeded or when it falls below it. In the next step, you select which of the two cases applies to this trigger. Now you must first define exactly how high the threshold value is by clicking on the corresponding text field.

- To do this, look back at the value that was measured when no current was applied. Add a few mA and enter this value as the threshold value. This ensures that the background noise of the sensor does not trigger the action.

Procedure (6/7)

PHYWE
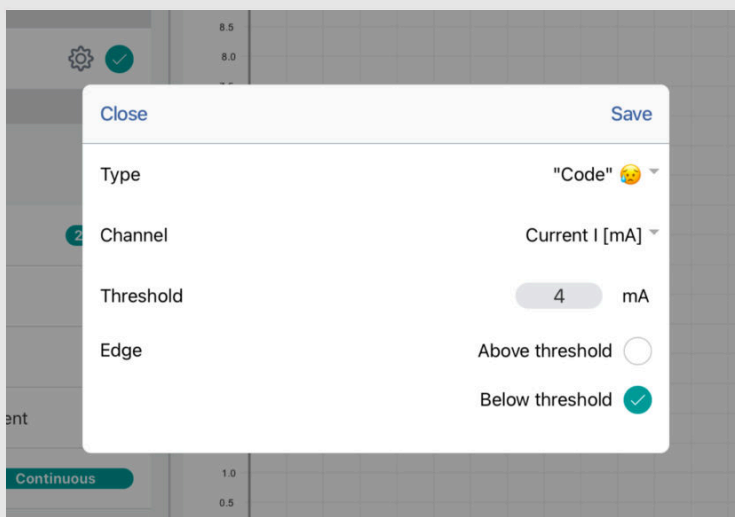
Adding a trigger

- You can now select whether the action should be executed when the current exceeds or falls below the threshold value. For this trigger, the action should be triggered when the current rises above a threshold value.

- Then click on save.

- If you like, create more triggers in which you play around with the properties a little.

Procedure (7/7)

PHYWE

- Close the switch. Then **carefully** heat the bimetal strip near the clamped end using a match flame, and allow it to cool down afterward.

- Observe both the bimetal strip and the SMARTSense Code, and record your observations in the log. If necessary, reheat the bimetal strip to repeat the process.

- Next, open the switch. Adjust the position of the bimetal strip on the left terminal (once it has cooled down) so that it sits in front of the terminal with a distance of approximately 2 mm (the patterned side of the strip should be facing forward, as in the initial setup).

- Close the switch again and proceed as in the first part of the experiment. Record your observations in the log once more.

PHYWE

Report
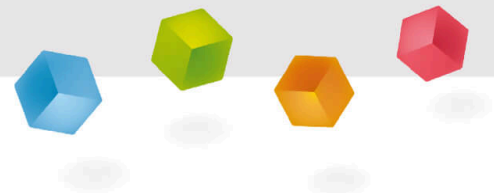
Observations

PHYWE

Observations of the first test section

Observations of the second test section

Task 1

PHYWE

What is the function of this bimetallic switch in the first part of the experiment?

Closing the circuit by closing the switch.

The bimetal switch has no function in the first test section as it already connects both contacts.

Disconnecting the circuit by opening the switch.

Task 2

PHYWE

Drag the words into the correct boxes!

A bimetallic strip can be used as a [_____] switch in [_____] and alarm systems, such as [_____]. In irons, the bimetal switch works by [_____] at a certain temperature, thus [_____] the circuit and preventing the iron from heating up further. In a fire alarm, the bimetal strip [_____] the circuit at high temperatures and thus triggers the alarm.

| heat protection |
| interrupting |
| irons |
| fire alarms |
| closes |
| opening |

✓ Check

Task 3

PHYWE

Drag the words into the correct boxes!

The bimetallic strip consists of two [_____] that are connected to each other over a large area and that [_____] to different degrees when exposed to [_____]. Depending on how the bimetal switch is installed in the [_____], it can [_____] or close the circuit due to its [_____].

Not required: [_____]

| contract |
| heat |
| expand |
| circuit |
| curvature |
| sheet metal strips |
| open |

✓ Check

Slide	Score / Total
Slide 26: Bimetal strip function	**0/2**
Slide 27: Bimetal strip application	**0/6**
Slide 28: Bimetal switch principle	**0/7**

Total amount ⭐ **0/15**

👁 Solutions   🔄 Repeat   📄 Export text