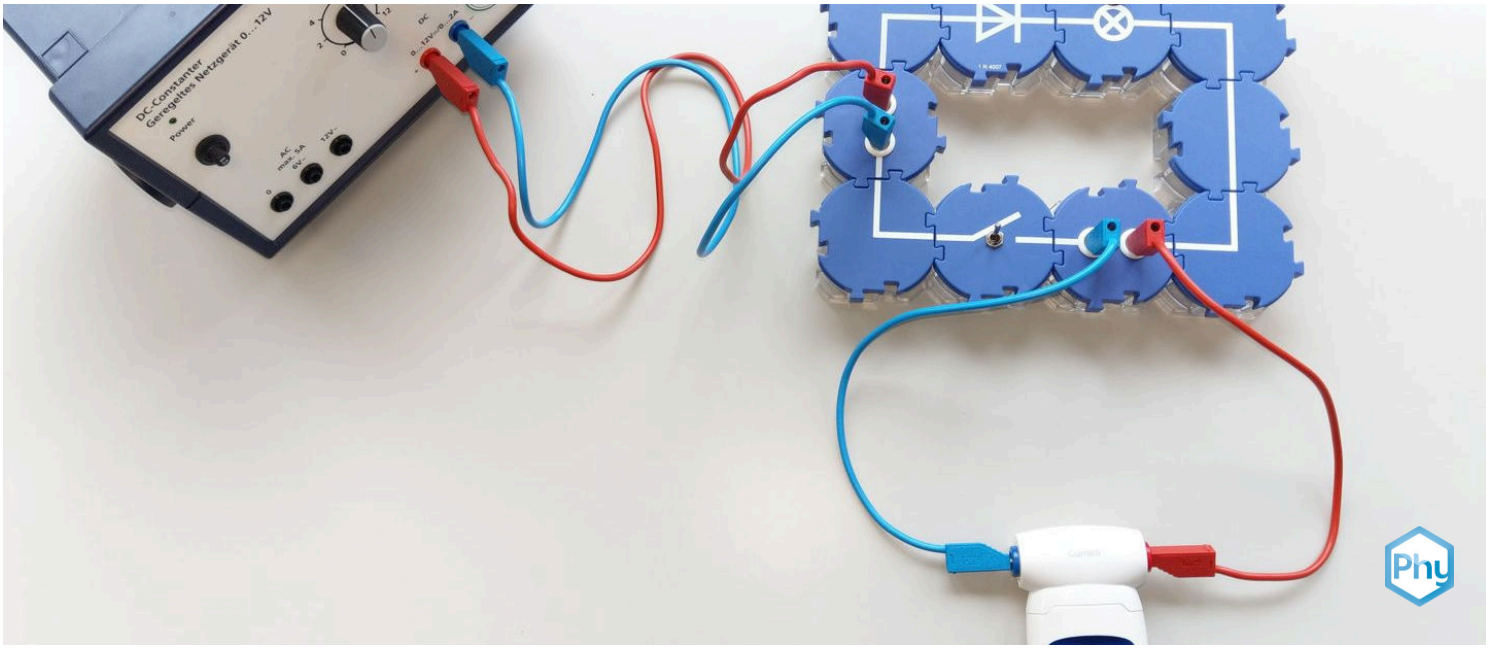
# The diode as an electrical valve with Cobra SMARTsense




Physics > Electricity & Magnetism > Simple circuits, resistors & capacitors

| Difficulty level | Group size | Preparation time | Execution time |
|---|---|---|---|
| easy | 2 | 10 minutes | 20 minutes |

This content can also be found online at:

http://localhost:1337/c/638c801c23a87a0003a273ac

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# Teacher information

## Application

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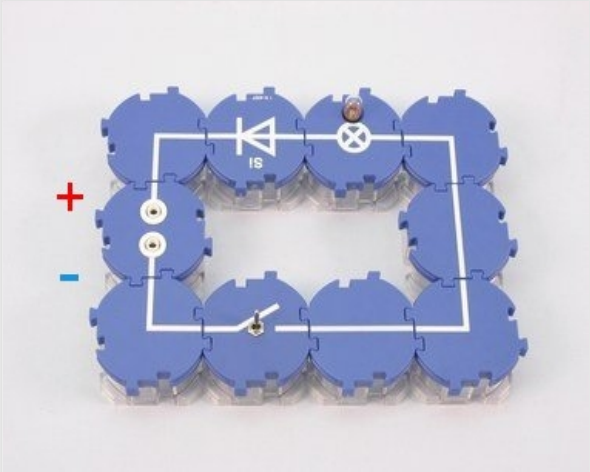

Experimental setup

Nowadays, diodes are used everywhere.

Most obviously as a light source in the form of light-emitting diodes. One of the special features of a diode is that it can be used to block current in a certain direction or, for example, to limit voltages so that a component cannot be destroyed by overvoltage. Diodes are also used to convert alternating voltage into direct voltage. This is referred to as rectification.

In this experiment, we are explicitly concerned with the most important property of the direction of passage.



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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

# Other teacher information (1/3)

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**Prior knowledge**

The students should be able to build a simple electric circuit. They should also understand what voltage and current are.

**Learning objective**

The students should realise that a diode acts like an electric valve.

Note: The measurement of the current intensity is not necessary for the detection of the valve effect because the incandescent lamp indicates the electric current anyway and no reverse current can be detected under the given experimental conditions.

# Other teacher information (2/3)

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**Task**

The students should investigate what happens when a diode is connected in series with an incandescent lamp in a DC circuit. First, the students should realise that the diode only allows one forward direction. Then the students measure the current in the circuit and obtain an additional quantitative result.

**Principle**

The term diode is usually used for semiconductor diodes (usually silicon diodes) that work primarily with a p-n junction. The doped atoms are stationary and form a space charge as ions, whose electrostatic field keeps the two types of charge away from each other and thus prevents recombination. The diffusion voltage arises across the entire space charge zone. This can be compensated by an externally applied voltage - depending on the polarity - in which case the p-n junction becomes conductive, or amplified, in which case it remains blocked.



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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
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## Other teacher information (3/3)

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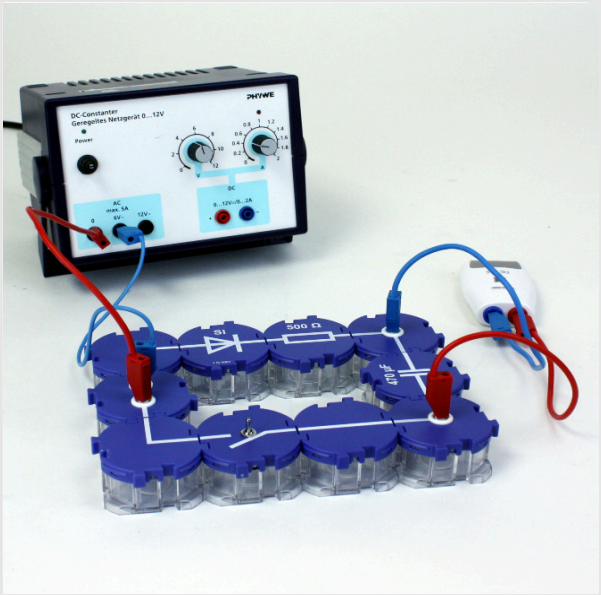

Note: The adjacent figure shows an alternative experimental setup for using the diode as an electric valve. For this purpose, a Cobra SMARTsense Voltage is connected in parallel to a capacitor ($470\ \mu F$) and an alternating voltage is applied.

Attention: The diode may only be connected with an additional resistor ($500\ \Omega$) can be used as a load, which limits the current intensity.

In addition, the resistance delays the charging process of the capacitor. Larger resistance values can make the process even slower and thus more traceable.

## Safety instructions

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



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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

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# Student information

## Motivation

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LED lights of a headlight on a car

Semiconductor diodes are used in many ways in today's technology due to their useful properties. The light-emitting diode (LED) is particularly obvious in its application. Due to their efficiency, these are used, for example, in traffic lights, headlights, torches or as infrared light-emitting diodes in remote controls for signal transmission.

In this experiment, you will learn what properties a diode has, among other things.



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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
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info@phywe.de
www.phywe.de

# Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A | 13506-93 | 1 |
| 2 | Cobra SMARTsense - Voltage, ± 30 V (Bluetooth) | 12901-00 | 1 |
| 3 | Straight connector module, SB | 05601-01 | 2 |
| 4 | Angled connector module, SB | 05601-02 | 2 |
| 5 | Interrupted connector module with sockets, SB | 05601-04 | 1 |
| 6 | Angled connector module with socket, SB | 05601-12 | 2 |
| 7 | On-off switch module, SB | 05602-01 | 1 |
| 8 | Resistor module 500 Ohm, SB | 05613-50 | 1 |
| 9 | Capacitor module 470 µF non-polar electrolytic, SB | 05646-47 | 1 |
| 10 | Silicon-diode module 1N4007, SB | 05651-00 | 1 |
| 11 | Connecting cord, 32 A, 250 mm, red | 07360-01 | 2 |
| 12 | Connecting cord, 32 A, 250 mm, blue | 07360-04 | 2 |
| 13 | measureAPP - the free measurement software for all devices and operating systems | 14581-61 | 1 |



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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
www.phywe.de

## Set-up (1/2)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

## Set-up (2/2)

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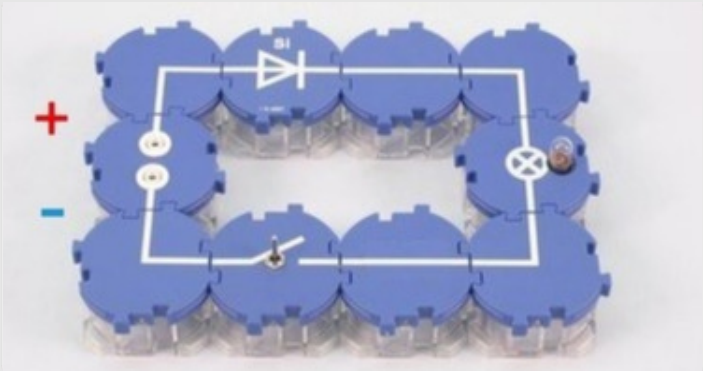
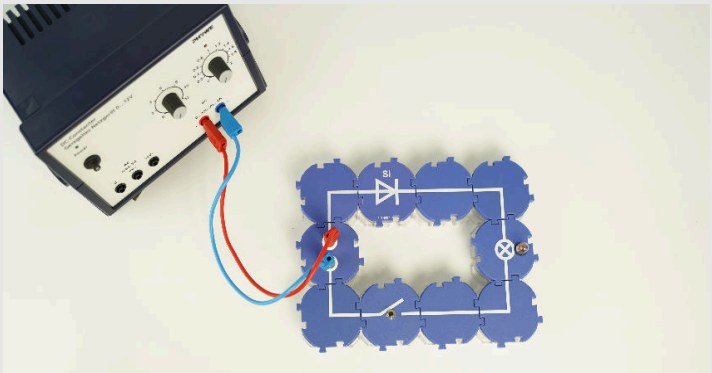
Set up the circuit as shown in the illustrations. The switch should be open at first. The tip of the diode in the printed circuit symbol points in the technical direction of the current (to the negative pole).





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Robert-Bosch-Breite 10
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info@phywe.de
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# Procedure (1/3)

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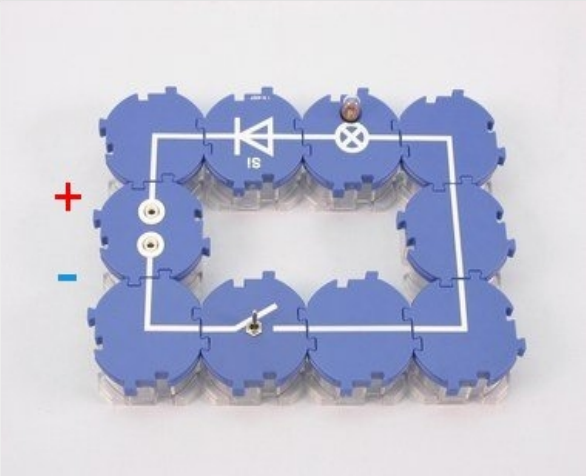


Experimental setup with rotated diode

- Switch on the power supply and set the power supply to a DC voltage of 12 V and the current limiter to 2 A (right stop).
- Close the switch and observe the bulb.
- Turn the diode 180° (see illustration) and observe the bulb while doing so.

# Procedure (2/3)

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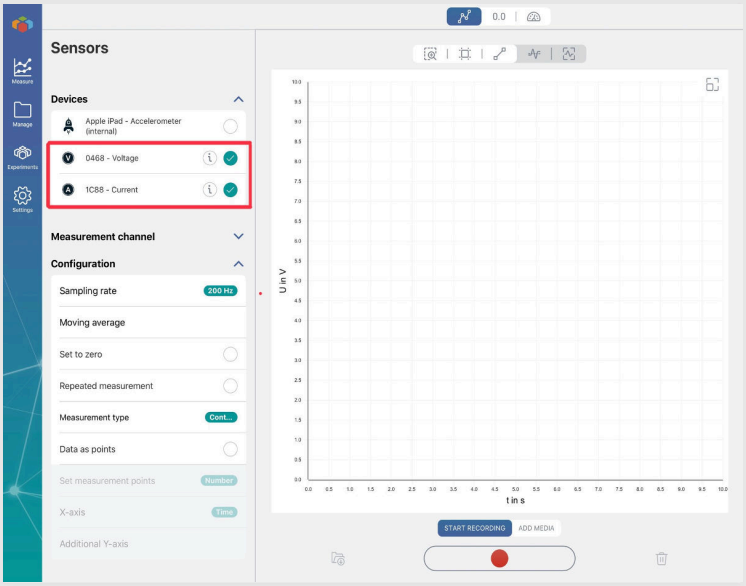


- Turn on the SMARTsense sensor by pressing and holding the power button and make sure the tablet can connect to Bluetooth devices.
- Open the PHYWE measureAPP and select the sensor "Current".
- After each of the following measurements, the measurement can be saved. For further analysis, the measurement can be opened again at any time under "My measurements".



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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 (3/3)

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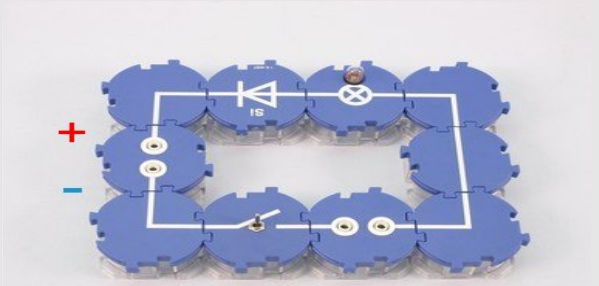


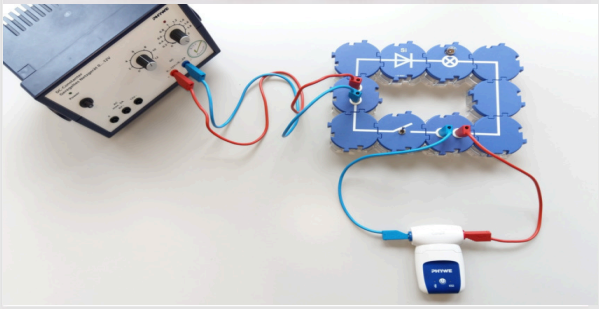

- Remove one of the line modules and replace it with a double socket module with a SMARTsense Current (see illustrations).
- Always set a large measuring range first and, if necessary, adjust the respective measuring range down to the smallest current measuring range.
- Observe the current strength.
- Now set the largest measuring range again and turn the diode component back by 180°.
- Observe the current again.
- Switch off the power supply unit.

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# Report



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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

## Task 1

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What observations could be made when carrying out the experiment?

After turning the diode, the bulb has ...

- ...dimmed.
- ...no longer lit up.
- ...continued to shine unchanged.
- ...shone brighter.

What is the relationship between the current strength and the experiment?

If the tip of the diode points to the positive pole...

- ...the current strength rises sharply.
- ...the current intensity does not change.
- ...the current drops to zero.

## Task 2

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What can be concluded from the observations?

- ○ The diode only allows current to flow in one switching direction.
- ○ The diode generates a current in one direction opposite to the current source.

Check



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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
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# Task 3

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What could the properties of a diode be used for? - Draw the correct word in the gap.

With a diode, you can block the _____ in a certain _____. This can be usefully employed in the _____ of _____ to _____. In this case, the diode only allows the current to flow in one direction (_____) and blocks it in the opposite polarity (_____).

direction
DC voltage
conversion
pass direction
AC voltage
block direction
current

Check

| Slide | Score / Total |
|---|---|
| Slide 16: Multiple tasks | 0/2 |
| Slide 17: Evaluation of the observations | 0/1 |
| Slide 18: Application diodes | 0/7 |

**Total** 0 / 10

Solutions Repeat



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