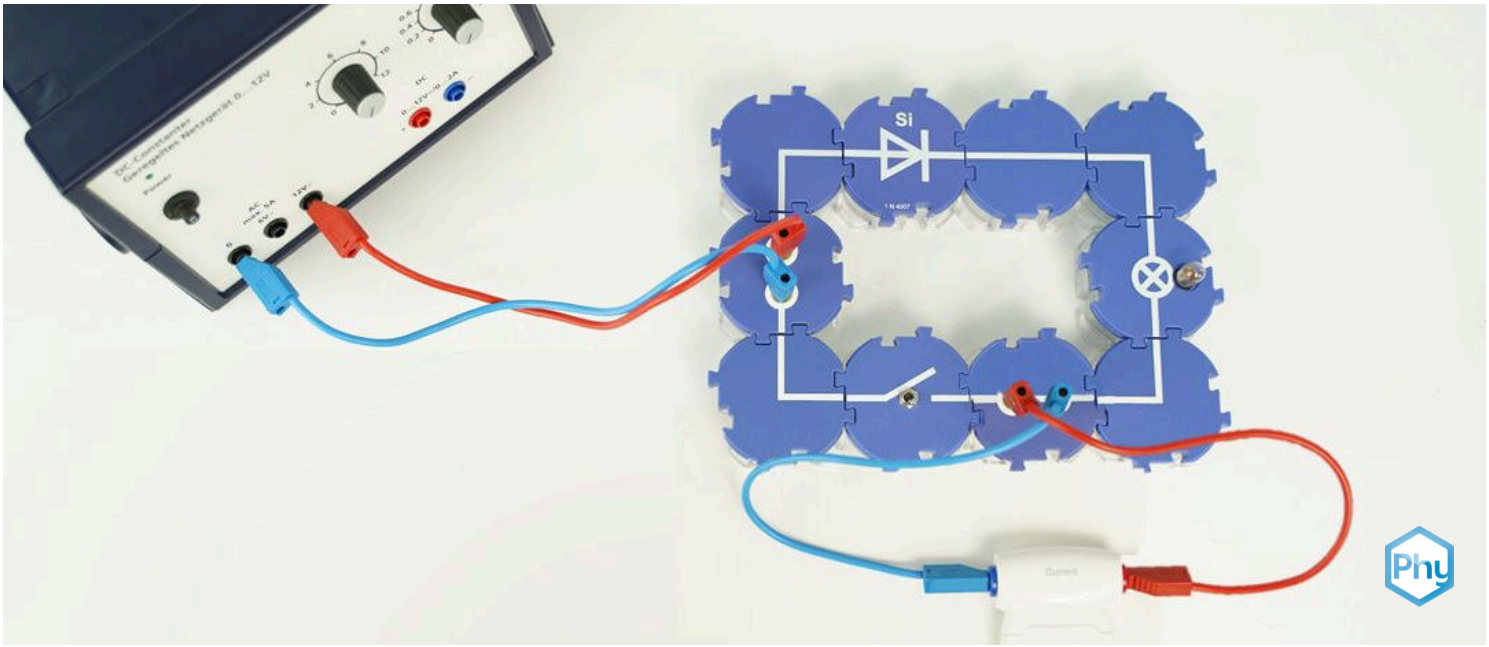
Diodes as rectifiers with Cobra SMARTsense



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:

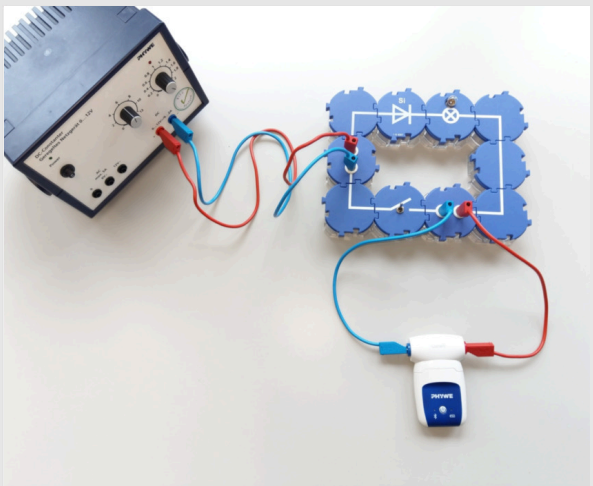
http://localhost:1337/c/638c80330783cf00038d155d

PHYWE

Teacher information

Application

PHYWE



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, students will learn about the property of rectification.

PHYWE

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)

PHYWE

Prior knowledge

The students should be able to construct a simple electric circuit. They should also understand what voltage and current are and explicitly what alternating current is.

Students should additionally be familiar with the principle of the diode (in particular the Vertil effect) and have understood the terms forward direction and reverse direction.

Learning objective

The students should recognise the rectifying effect of a diode.

Other teacher information (2/3)

PHYWE

Task

Investigate the effect of a diode in an alternating current circuit.

For this purpose, the behaviour of the current strength at direct voltage with and without diode in the forward direction is to be measured first. This is then repeated for alternating voltage.

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.

PHYWE

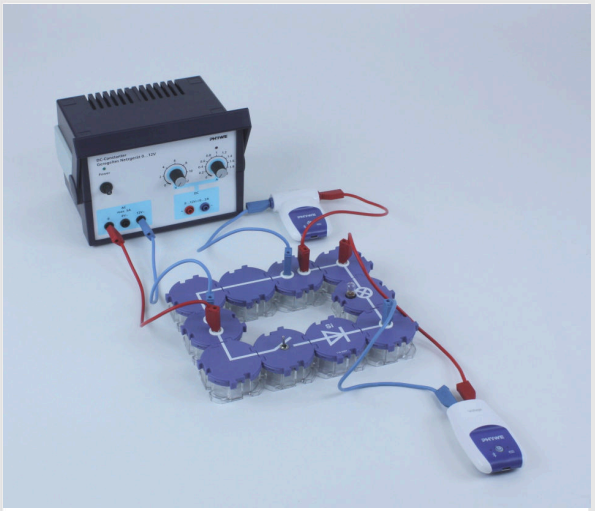
Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Other teacher information (3/3)

PHYWE



Alternative experimental set-up

Notes

The experiment is designed so that, in addition to the rectifying effect of the diode, the students also realise that the diode has a resistance - albeit a relatively small one - in the forward direction.

For further quantitative evaluations, the experimental set-up can be expanded to the effect that the voltage dropping across the incandescent lamp is also measured. This will then show that the resulting voltage at the incandescent lamp in particular is also significantly influenced by the diode.

Safety instructions

PHYWE

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

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

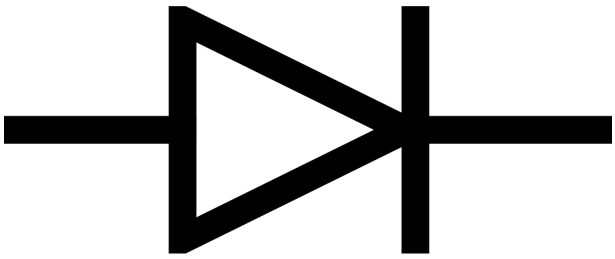
Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

PHYWE

Student information

Motivation



Switching symbol of a diode

Semiconductor diodes are used in many ways in today's technology due to their useful properties. Examples are solar cells or LEDs.

You should already know how a diode behaves at DC voltage; that they have a forward and a reverse direction. In the illustration of the switching symbol, in the forward direction, the left connection wire is for the anode and the right for the cathode.

In this experiment, you will learn how this property can be useful and how a diode behaves with AC voltage.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

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	Cobra SMARTsense - Current, ± 1 A (Bluetooth)	12902-00	1
4	Straight connector module, SB	05601-01	2
5	Angled connector module, SB	05601-02	2
6	Interrupted connector module with sockets, SB	05601-04	1
7	Angled connector module with socket, SB	05601-12	2
8	On-off switch module, SB	05602-01	1
9	Resistor module 500 Ohm, SB	05613-50	1
10	Silicon-diode module 1N4007, SB	05651-00	1
11	Socket module for incandescent lamp E10, SB	05604-00	1
12	Filament lamps 12V/0.1A, E10, 10 pieces	07505-03	1
13	Connecting cord, 32 A, 250 mm, red	07360-01	2
14	Connecting cord, 32 A, 250 mm, blue	07360-04	2
15	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Set-up (1/2)

PHYWE

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

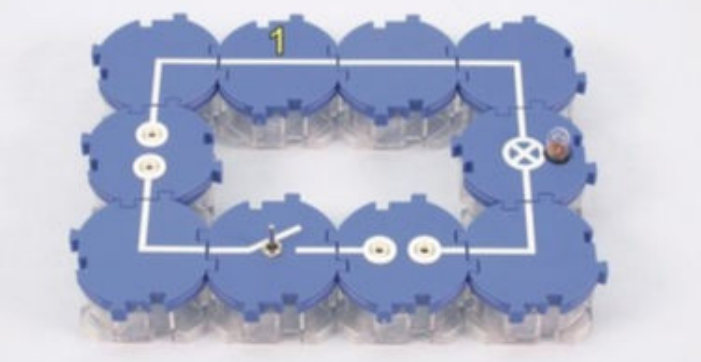
Android

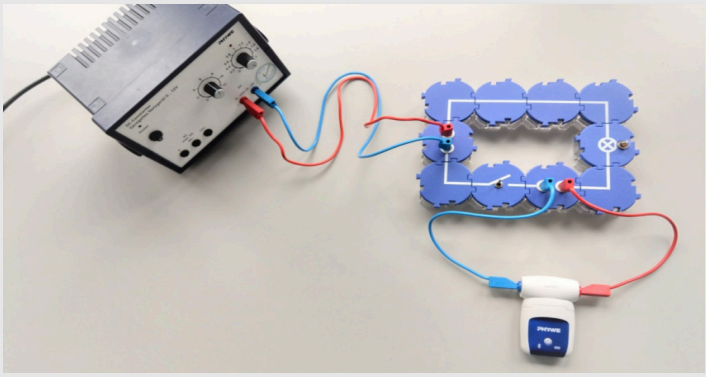
Windows

Set-up (2/2)

PHYWE

Set up a circuit with a light bulb and an ammeter as shown in the illustrations. The switch should be open first.





PHYWE

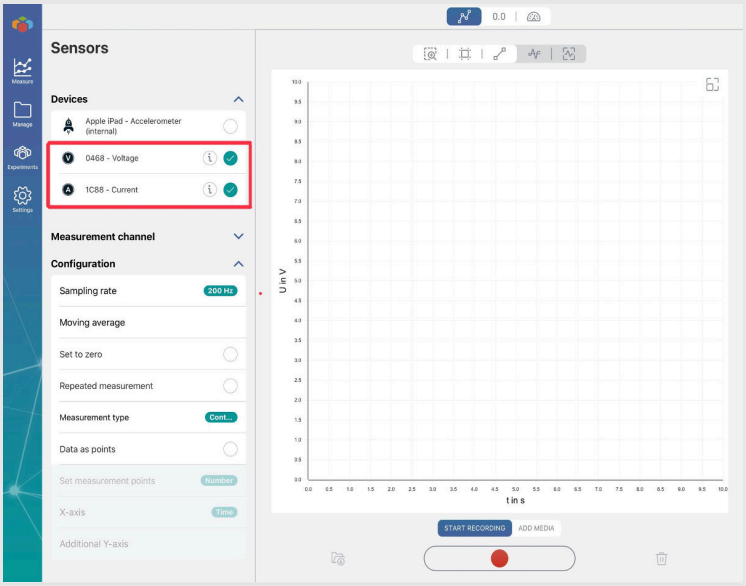
Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Procedure (1/4)

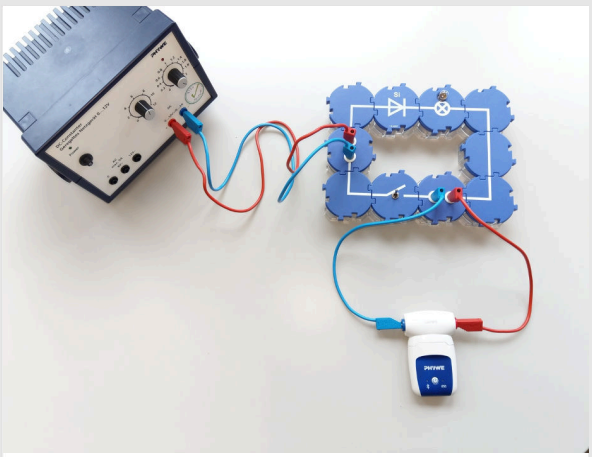
PHYWE



- 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 measure app 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".

Procedure (2/4)

PHYWE



Experimental setup with DC voltage

- Switch on the power supply unit and apply a DC voltage of 12V-. Set the current limiter on the power supply unit to 1 A.
- Close the circuit, start a measurement (about 5-10 seconds) and determine the resulting average value for the current intensity. Note the value in the report.
- Replace the conduction component 1 (see assembly illustration) with the diode in the forward direction (see illustration on the left).
- Start a new measurement and determine the resulting average current again and record it in the report.

PHYWE

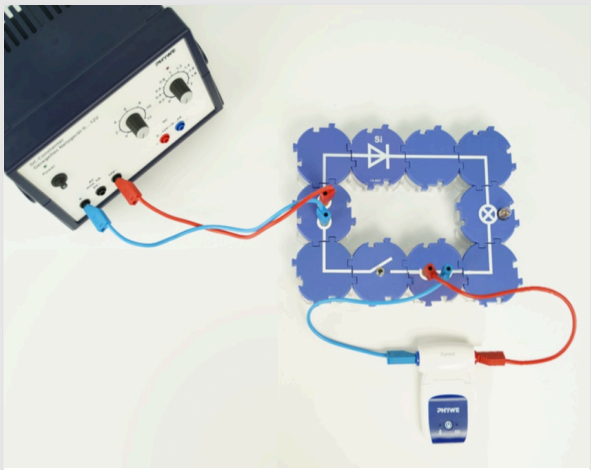
Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Procedure (3/4)

PHYWE

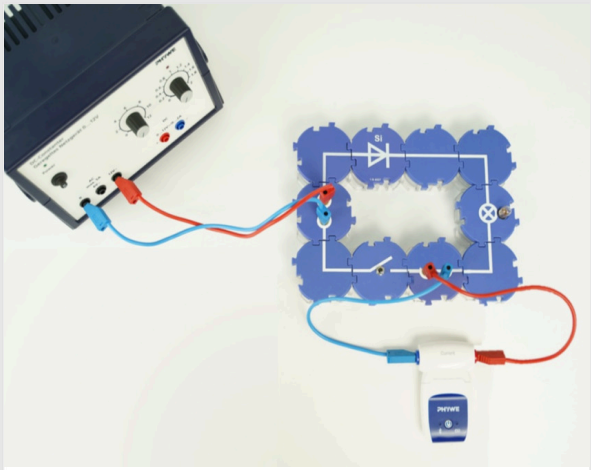


Experimental set-up with alternating voltage

- When the switch is open, replace the diode with a line component (see illustration of structure). Then apply an alternating voltage of 12V~.
- Close the circuit and observe the bulb. Start a new measurement and determine the average current again. Note the result again in the report.
- Note: The AC voltage is according to the mains voltage $50\ Hz$. You can use the zoom function to view the course of the current strength in order to exclude measurement errors. To do this, zoom in to about $0,1\ s$ into the measurement data. A higher sampling rate provides more accurate measured values.

Procedure (4/4)

PHYWE



Experimental set-up with alternating voltage

- Replace the line component 1 again with the diode, start a measurement, determine the average current and note it down.
- Open the switch and turn the diode 180°. Close the switch again, start another measurement and note the resulting average current again.
- Switch off the power supply unit.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

PHYWE

Report

Table

PHYWE

Note down the measured currents for the different set-ups.

	$I\,[mA]$
DC voltage, without diode	
DC voltage, with diode	
AC voltage, without diode	
AC voltage, with diode, measuring range 300mA-.	
AC voltage, with diode in reverse direction	

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Task 1

PHYWE

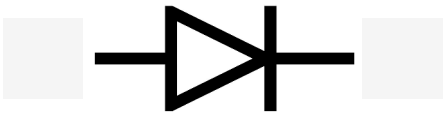
Why is the current somewhat lower when the diode is installed in the DC circuit - in the forward direction - instead of the conductor component?

- This is a measurement error due to the setup. The current should remain constant.
- The diode has a small resistance.
- The voltage drops to zero at the diode, so the current also changes.

Task 2

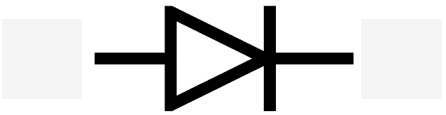
PHYWE

Switch the diode in forward direction!



Check

Switch the diode in the reverse direction!



Check

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Task 3

PHYWE

Which of the following statements are correct for the incandescent lamp in the AC circuit (without diode)?

- [ ] The light bulb shines brightly because the polarity of the current does not matter.
- [ ] The light bulb is on. The average current is only zero because the meter cannot measure fast enough.
- [ ] The current intensity is not permanently zero. The respective current flow causes the luminescence.
- [ ] The current is about zero on average and yet the bulb lights up.

Check

Task 4

PHYWE

Explain why, in the case of the applied AC voltage, the luminosity of the incandescent lamp with the diode inserted is only about half as great as that with the line component inserted, although the average measured current is greater.

Since after inserting the diode only the current flow in forward direction behind the diode is possible, about half of the current is blocked.

The other two statements are false!

The diode is not only an electrical valve, but also an electrical resistor. Thus, the current intensity at the bulb is reduced.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Task 5

PHYWE

Drag the words into the correct gaps.

In a circuit with _____ applied, a diode can be used to generate _____, since current only flows when the polarity is in the _____. Figuratively, the diode acts as a _____ or valve of the current flow, so that the current only flows in one direction. When the polarity is opposite, it is referred to as the _____. This is useful because some electrical components only work with direct current. Diodes thus act as _____ in AC circuits.

- conducting direction
- blocking direction
- DC current
- rectifiers
- AC voltage
- directional filter

Check

Slide	Score / Total
Slide 18: Diode Direct current	0/1
Slide 19: Multiple tasks	0/4
Slide 20: Incandescent lamp in AC circuit	0/3
Slide 21: Current intensity direct current/alternating current	0/1
Slide 22: Generation and application of alternating current	0/6

Total 0 / 15

Solutions Repeat Export text

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de