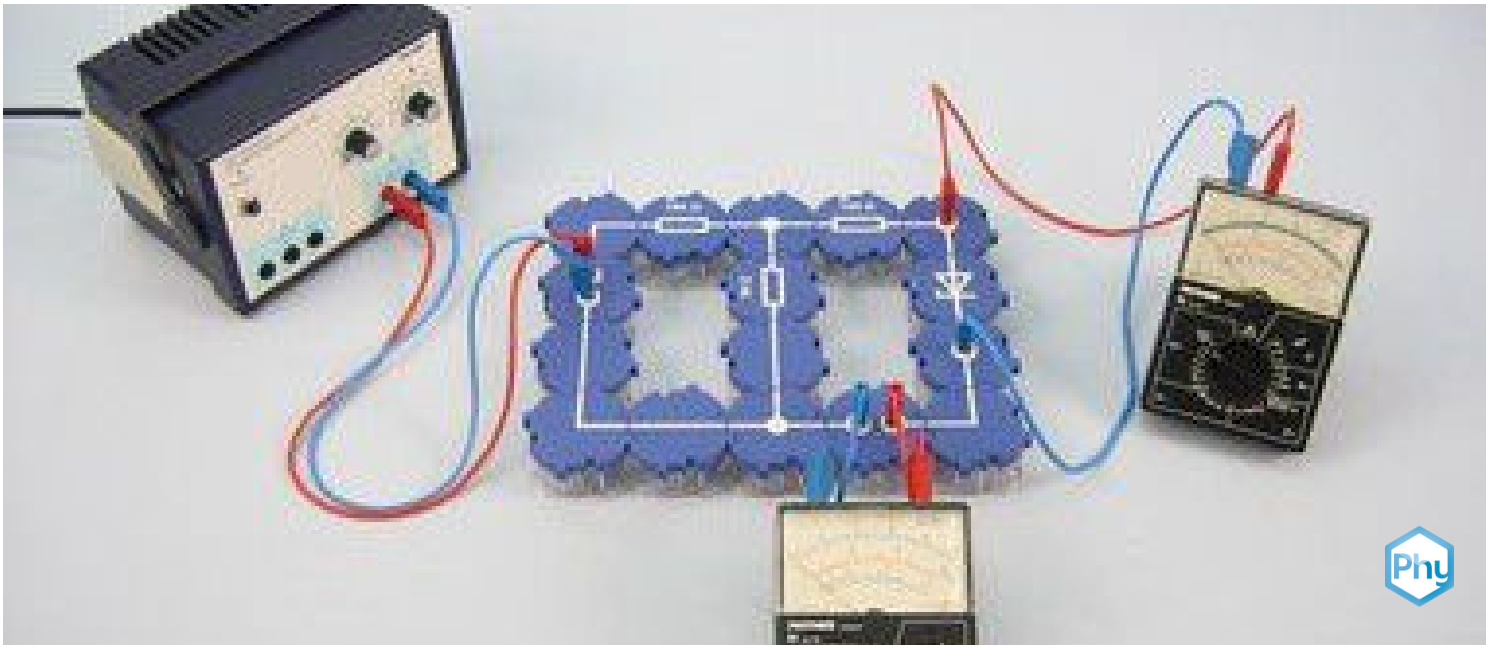
# Characteristic curve of a Zener diode



The students should use the experiment to see how a Z-diode differs from an ordinary rectifier diode.

Physics | Electricity & Magnetism | Electronics

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

This content can also be found online at:

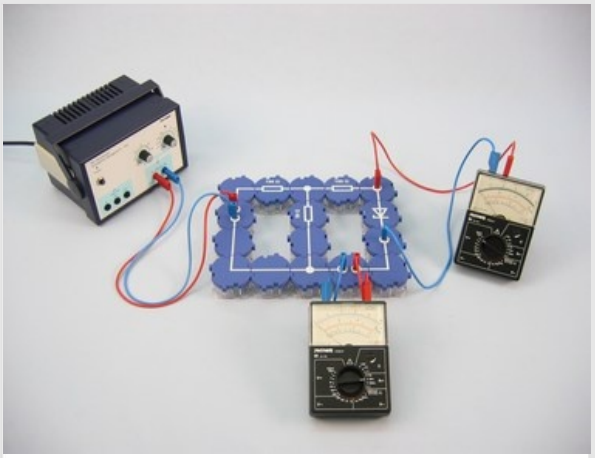
http://localhost:1337/c/63170a3d9ebaee00039a3aee

PHYWE

# Teacher information

## Application

PHYWE



Experimental setup

Z-diodes are silicon diodes with high doping of the p- and n-region. They behave like ordinary Si diodes in the forward direction. When a voltage is applied in the reverse direction, a high electric field strength is generated in the very narrow boundary layer. When a voltage dependent on the selected doping, the breakdown voltage, is exceeded, charge carrier pairs are released under the influence of the electric field, resulting in a strong increase in current intensity. This reduces the diode resistance. If the external voltage is increased further, the diode current rises sharply and produces an increasing voltage drop at the series resistor, while the voltage at the diode rises only very slightly.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

## Other teacher information (1/2)

PHYWE

**Prior knowledge**

Students should be familiar with how an ordinary diode works.

**Principle**

A Z-diode (also Zener diode) is a diode that is designed to be operated permanently in the reverse direction in the breakdown voltage range. The level of this breakdown voltage UBR is the main characteristic of a Z-diode and is specified in the data sheet. This is achieved by a heavily doped p+ and a heavily doped n+ layer. The strong recombination of both layers leads to a very small junction thickness and thus to high field strengths in the junction region.

## Other teacher information (2/2)

PHYWE

**Learning objective**

The students should use the experiment to see how a Z-diode differs from an ordinary rectifier diode.

**Tasks**

Investigate the relationship between current and voltage on a Z-diode in the forward and reverse directions.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

## Safety instructions

PHYWE

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

PHYWE

# Student information



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

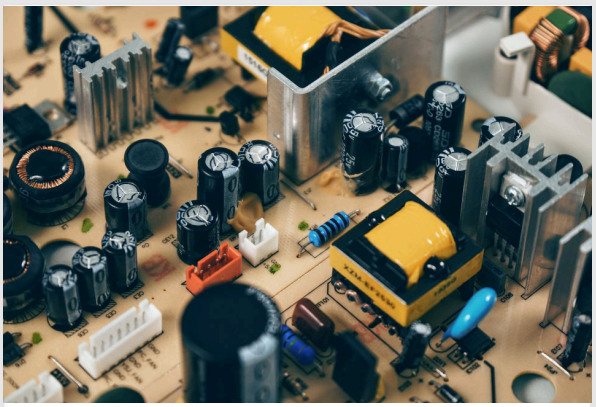
info@phywe.de
www.phywe.de

# Motivation

PHYWE

A diode is an electronic component that allows current to pass in one direction and blocks the flow of current in the other direction.

A Z-diode (also Zener diode) is a diode that is designed to be operated permanently in the reverse direction in the breakdown voltage range. The level of this breakdown voltage UBR is the main characteristic of a Z-diode and is specified in the data sheet. This is achieved by a heavily doped p+ and a heavily doped n+ layer. The strong recombination of both layers leads to a very small junction thickness and thus to high field strengths in the junction region.



Electronic components



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 | Straight connector module, SB | 05601-01 | 3 |
| 2 | Angled connector module, SB | 05601-02 | 3 |
| 3 | T-shaped connector module, SB | 05601-03 | 2 |
| 4 | Interrupted connector module with sockets, SB | 05601-04 | 2 |
| 5 | Straight connector module with socket, SB | 05601-11 | 1 |
| 6 | Angled connector module with socket, SB | 05601-12 | 1 |
| 7 | Resistor module 50 Ohm, SB | 05612-50 | 1 |
| 8 | Resistor module 100 Ohm, SB | 05613-10 | 2 |
| 9 | Z-diode module ZF4.7, SB | 05652-00 | 1 |
| 10 | Connecting cord, 32 A, 250 mm, red | 07360-01 | 1 |
| 11 | Connecting cord, 32 A, 250 mm, blue | 07360-04 | 1 |
| 12 | Connecting cord, 32 A, 500 mm, red | 07361-01 | 2 |
| 13 | Connecting cord, 32 A, 500 mm, blue | 07361-04 | 2 |
| 14 | PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A | 13506-93 | 1 |
| 15 | PHYWE Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection | 07021-11 | 2 |
| 16 | Flashlight, w/o battery,medium | 08164-00 | 1 |
| 17 | Battery Type C 1.5 V - Pack of 2 pieces | 07400-00 | 2 |



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

## Set-up

PHYWE

**1st experiment**

- Set up the circuit as shown in Figs. 1 and 2. Pole the Z-diode in forward direction. Select the measuring range 1 V- and 30 mA-. Pay attention to the correct polarity and the correct connection of the measuring instruments.

**2nd experiment**

- Change the circuit as in fig. 3 and 4.

**Hint:** Pay attention to the changed polarity of the Z-diode! Switch the measuring range for the voltage measurement to 10 V-.

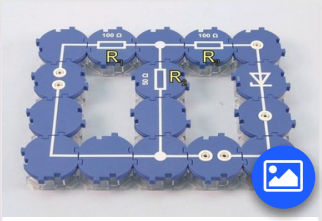


Fig. 1

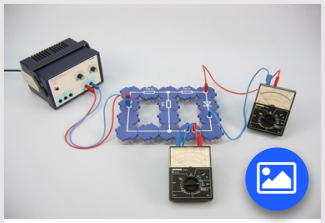


Fig. 2

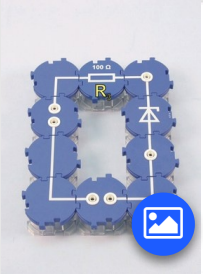


Fig. 3

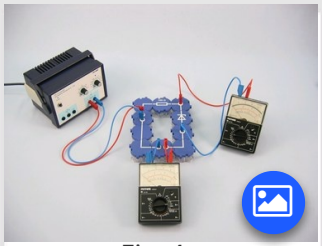


Fig. 4

## Procedure

PHYWE

**1st experiment**

- Switch on the power supply unit. Increase the voltage $U_N$ on the power supply unit in steps of 1 V from 0 V to 10 V. Measure the forward voltage in each case $U_D$ and the forward current $I_D$. Enter the measured values in Table 1 in the report.
- Set the power supply unit to 0 V and then switch it off.

**2nd experiment**

- Switch on the power supply unit. Increase the voltage again $U_N$ in steps of 1 V each from 0 V to 10 V. Measure the blocking voltage in each case $U_{Sp}$ and the reverse current $I_{Sp}$. Due to the changed polarity of the Z-diode, enter the measured values as negative in Table 2.
- Switch off the power supply unit.



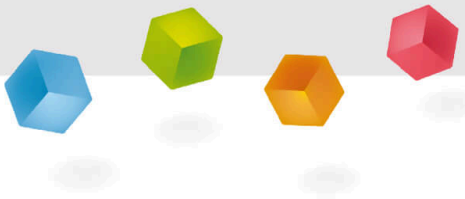
PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

PHYWE



# Report

## Result

PHYWE

| $U_N$ [V] | $U_D$ [V] | $I_D$ [mA] | $U_N$ [V] | $U_D$ [V] | $I_D$ [mA] | $U_N$ [V] | $U_D$ [V] | $I_D$ [mA] | $U_N$ [V] | $U_D$ [V] | $I_D$ [mA] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -10 | | | -4 | | | 2 | | | 8 | | |
| -9 | | | -3 | | | 3 | | | 9 | | |
| -8 | | | -2 | | | 4 | | | 10 | | |
| -7 | | | -1 | | | 5 | | | | | |
| -6 | | | 0 | | | 6 | | | | | |
| -5 | | | 1 | | | 7 | | | | | |



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

## Task (1/4)

PHYWE

Drag the words into the correct boxes!

The Z-diode blocks the circuit and does not allow _____ to flow. This property of the Z-diode only exists until the _____ applied to the _____ exceeds a certain _____. This value is called the _____.

- diode
- current
- breakdown voltage
- value
- voltage

Check

## Task (2/4)

PHYWE

How does a Z-diode differ from an ordinary rectifier diode?



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

## Task (3/4)

PHYWE

Drag the words into the correct boxes!

The _____ is used to keep the _____ below the _____ of the diode. This is necessary because a _____ of the leakage power can lead to damage in the _____ of the diode.

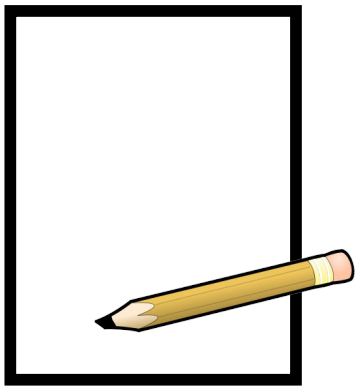
- junction
- rated value
- prior resistor $R_3$
- too high value
- loss power

Check

## Task (4/4)

PHYWE

Graphically plot the values from Table 1.



Read from the characteristic curve how large the change in voltage in the reverse direction is when the current increases from 20 mA to 30 mA. How could this property of the Z-diode be used?



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

| Slide | Score / Total |
| --- | --- |
| Slide 13: How it works | 0/5 |
| Slide 15: Series resistor | 0/5 |

**Total score** 0 / 10

Show 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