Light-emitting diodes (Item No.: P1378100)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physik	Klasse 10-13	Elektrizitätslehre	Elektronik	Die Leuchtdiode

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

Light-emitting diodes (LEDs) are pn junctions composed of GaAs or GaP. Depending on the desired wavelength of light, the substrates are doped with various elements. When the pn junctions are connected to a current source in the forward direction, electrons and holes flood the barrier layer and recombine there. When they do, the expended energy is released in the form of visible or infra-red light.
In the reverse direction, LEDs behave the same as normal diodes. However, the maximum reverse voltage is quite small. For some LED types, it is even less than 10 V.

Notes on setup and procedure

A voltage divider consisting of R_1 and R_2 is used to make it easier to set the voltage in the forward voltage range, which is about 1 V to 2 V. This makes it possible to vary the voltage on the power supply unit U_P from 0 V to 12 V without overloading the LED in the forward direction or exceeding the maximum reverse voltage. LEDs may only be operated with a multiplier. The resistor limits the forward current to the admissible value, which is I_F, max = 20 mA for the diode type used in this experiment. It can be calculated by using the following formula:

$R_V = (U_N - U_D) / I_{D,max}$.

Remarks

The determination of the type and polarity of a source of current can only be achieved in the way described, when the voltage is at least high enough to light up the diode, but does not exceed the permissible reverse voltage of the diode. When the voltage is too high, it can be adjusted to a voltage which is safe for the diode by using a voltage divider.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

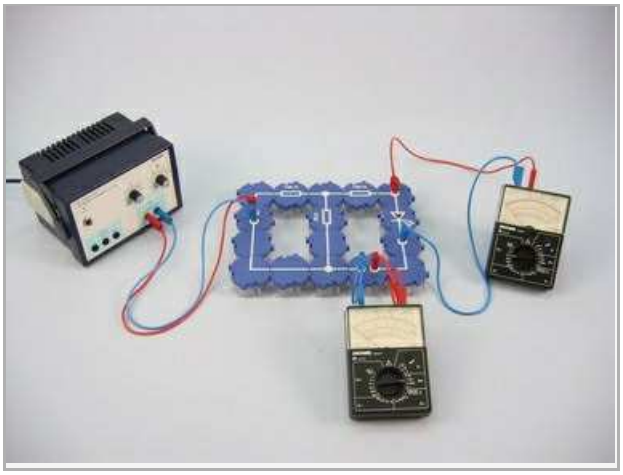
Light-emitting diodes (Item No.: P1378100)

Task and equipment

Task

What are the characteristics of light-emitting diodes and what are they used for?

1. Investigate the relationship between current and voltage for a light-emitting diode in forward and reverse direction as well as the electrical power received by the diode.
2. Test the suitability of light-emitting diodes for determining the type of current and the polarity of the current source.



Equipment

Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	3
2	Angled connector module, SB	05601-02	4
3	T-shaped connector module, SB	05601-03	2
4	Interrupted connector module, 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	Light emitting diode module red , SB	05654-00	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	Multi-range meter, analogue	07028-01	2
15	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Set-up and procedure

Set-up

First experiment

Set up the experiment according to the schematic diagram 1 as shown in Fig. 1 and Fig. 2. Set the measurement ranges to 10 V- and 30 mA-.

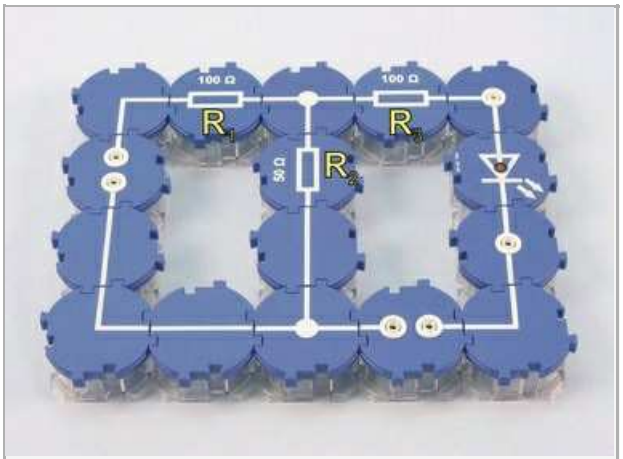


Fig. 1

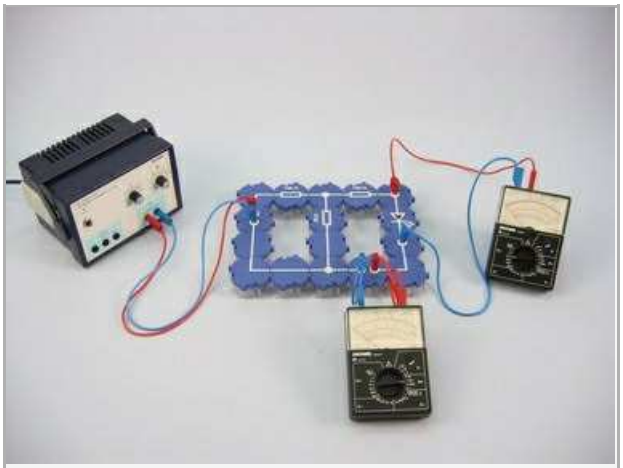


Fig. 2

Second experiment

Set up the experiment according to the schematic diagram 2 as shown in Fig. 3 and Fig. 4.

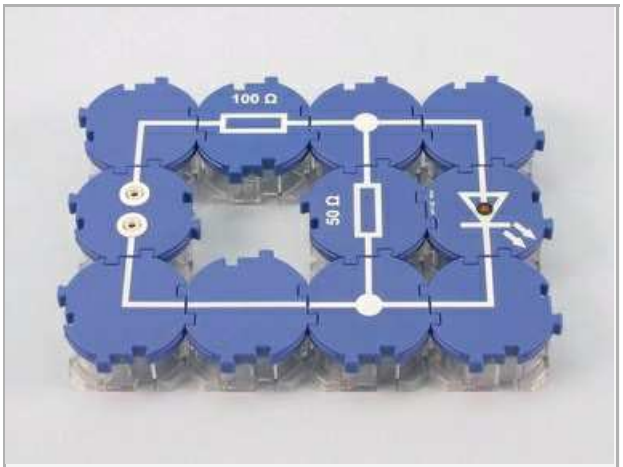


Fig. 3

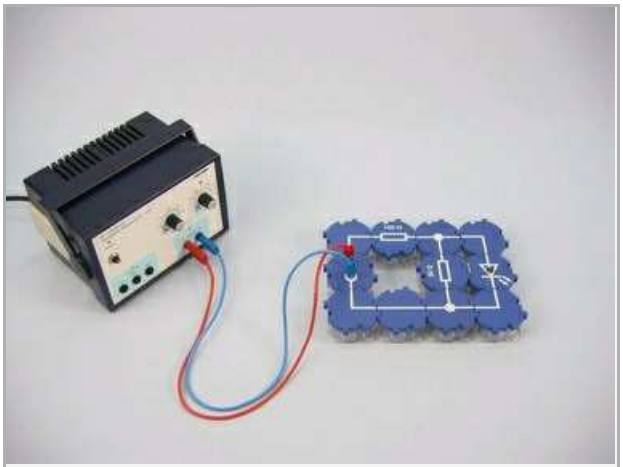


Fig. 4

Procedure

First experiment

- Switch on the power supply unit and gradually increase the direct voltage up to 12 V, starting at 0 V. Enter the measurements for current and diode voltage in Table 1 in the report.
- Switch off the power supply unit. Plug the LED into the circuit with reverse polarity, as shown in Fig. 5 and Fig. 6.
- Switch on the power supply unit and determine measurements for current and voltage as before. Since you inverted the LED polarity, enter the voltage values that you are measuring in the first 12 slots in Table 1 in the report as negative values.
- Switch off the power supply unit.

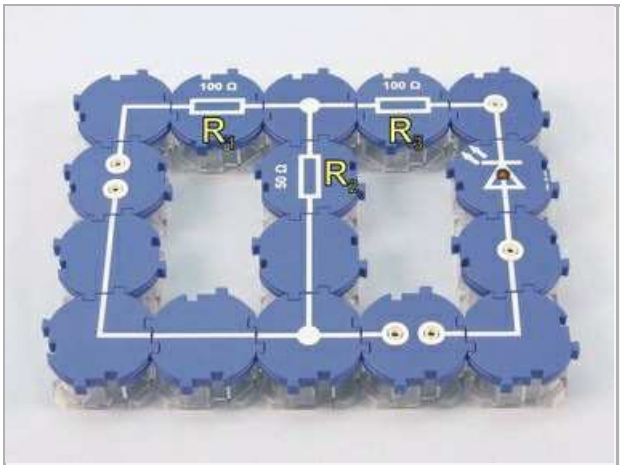


Fig. 5

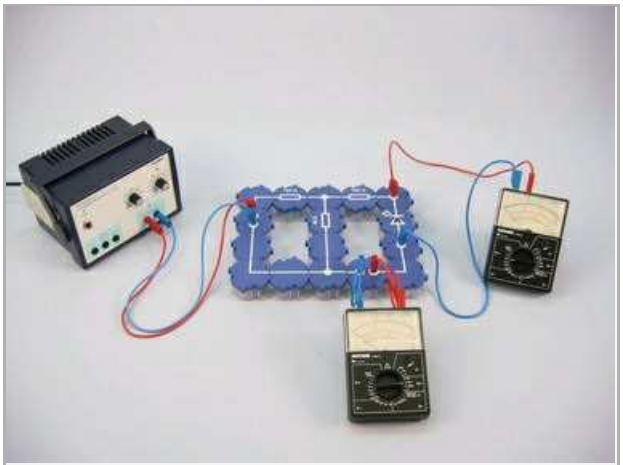


Fig. 6

Second experiment

- Set the power supply to 6 V− (direct voltage) and switch it on.
- Observe the light-emitting diode.
- Then, switch off the power supply and turn the light-emitting diode through 180° (Fig. 7, Fig. 8). Switch on the power supply and again observe the diode; note your observations in both cases under Result - Observations 1 in the report.
- Switch off the power supply and switch the connection cord on the power supply unit from direct voltage over to 6 V alternating voltage.
- Carry out the same observations and replugging of the light-emitting diode as with direct voltage; note your observations under Result - Observations 2.
- Switch off the power supply unit.

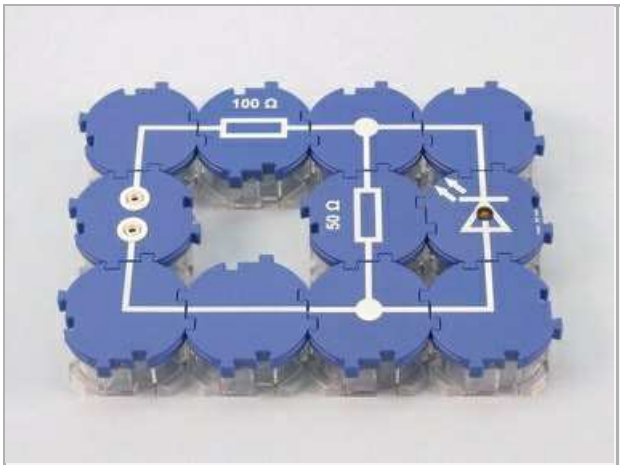


Fig. 7

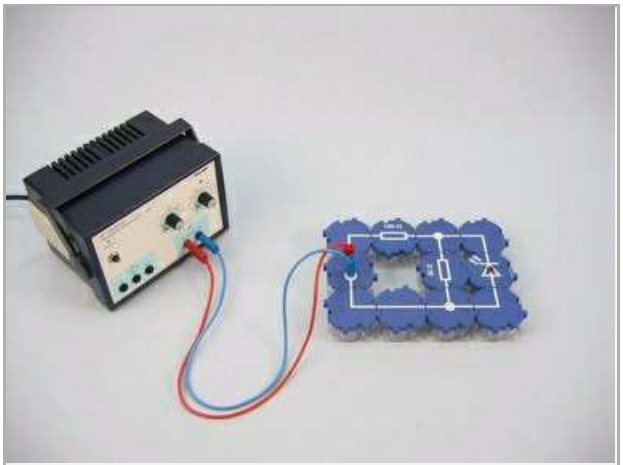


Fig. 8

Robert-Bosch-Breite 10
D - 37079 Göttingen

Tel: +49 551 604 - 0
Fax: +49 551 604 - 107

info@phywe.de
www.phywe.com

Report: Light-emitting diodes

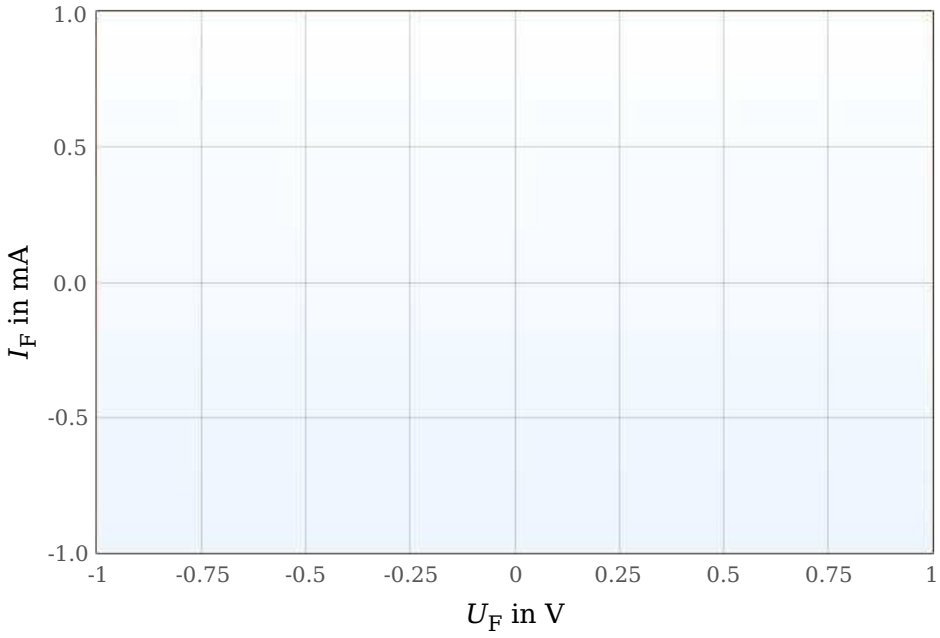
Result - Table 1

Record yout measured values in the table. Note the reverse direction voltage in the first 12 slots of the "Voltage at the LED" column. Do the same for the current.

Set voltage of power supply unit U_P in V	Voltage at the LED U_F in V	Current I_F in mA
12	1 ±0	1 ±0
10	1 ±0	1 ±0
8	1 ±0	1 ±0
6	1 ±0	1 ±0
4	1 ±0	1 ±0
2	1 ±0	1 ±0
0	1 ±0	1 ±0
2	1 ±0	1 ±0
4	1 ±0	1 ±0
6	1 ±0	1 ±0
8	1 ±0	1 ±0
10	1 ±0	1 ±0
12	1 ±0	1 ±0

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

Number1



Result - Observations 1

Note your observations.

.....

.....

.....

.....

Result - Observations 2

Note your observations.

.....

.....

.....

.....

Evaluation - Question 1

Describe the characteristic curve in the chart of Table 1 in general and in relation to the lighting up of the LED. Compare this characteristic curve with that of a normal silicone diode.

Note: The left arm of the graph represents the voltage U_R. The minus signs for this arm are just for the technical realisation of displaying the graph.

.....

.....

.....

.....

Evaluation - Question 2

How high is the maximum electrical power received by the LED? Draw a comparison between this value and the electrical power of a filament lamp for small voltages.

.....

.....

.....

.....

Evaluation - Question 3

Explain the behaviour of the LED when connected to direct voltage (Observations 1).

.....

.....

.....

.....

Evaluation - Question 4

How do you explain Observations 2?

.....

.....

.....

.....

Evaluation - Question 5

How must one proceed, to use a light-emitting diode in order to recognise the type of voltage and − in the case of direct voltage − to additionally determine its polarity?

.....

.....

.....

.....