

# The light-emitting diode (Item No.: P1401100)

## Curricular Relevance



### Difficulty



Difficult

### Preparation Time



10 Minutes

### Execution Time



20 Minutes

### Recommended Group Size



2 Students

### Additional Requirements:

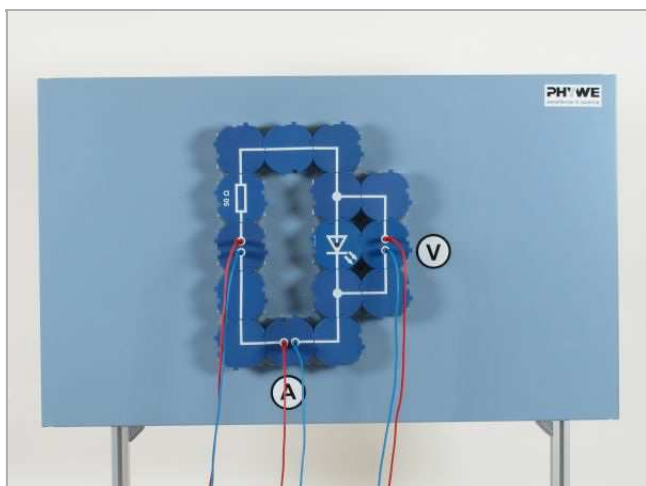
### Experiment Variations:

### Keywords:

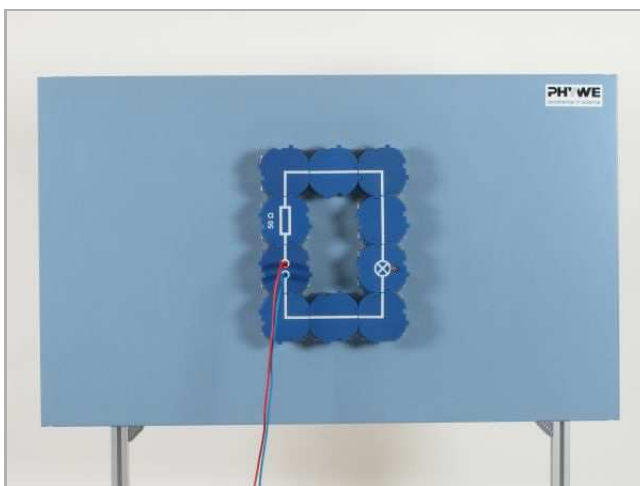
## Principle and equipment

### Principle

The characteristic curve of a light-emitting diode (LED) is to be plotted from measurements of voltage and current. Further, it is to be demonstrated that an LED can be used to help recognize the polarity of a direct current source, and that even a differentiation between direct and alternating current voltages is possible.



Experimental set-up Part 1



Experimental set-up Part 2

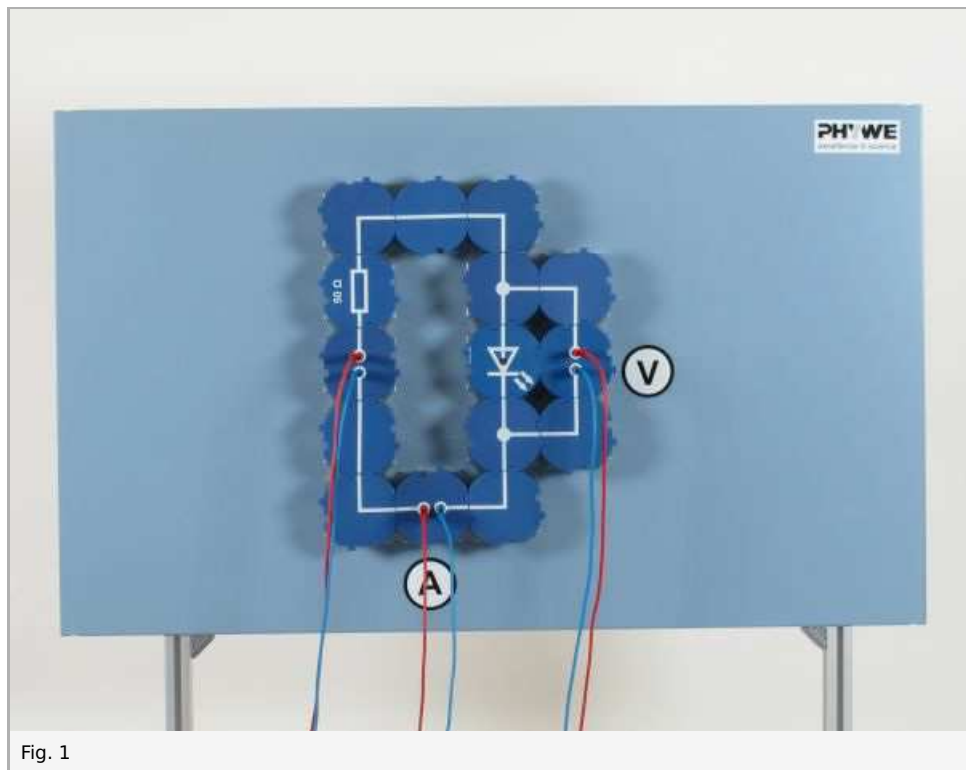
## Equipment

| Position No. | Material  | Order No. | Quantity |
|--------------|---|-----------|----------|
| 1            | Multimeter ADM2, demo., analogue  | 13820-01  | 2        |
| 2            | PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A | 13500-93  | 1        |
| 3            | Demo Physics board with stand   | 02150-00  | 1        |
| 4            | Socket for incandescent lamp E10 ,module DB                                       | 09404-00  | 1        |
| 5            | Connector interrupted, module DB  | 09401-04  | 3        |
| 6            | Light emitt. diode,red,module DB  | 09454-00  | 1        |
| 7            | Resistor 50 Ohm,module DB   | 09412-50  | 1        |
| 8            | Electr.symbols f.demo-board,12pcs   | 02154-03  | 1        |
| 9            | Connector, straight, module DB  | 09401-01  | 2        |
| 10           | Connector, angled, module DB  | 09401-02  | 6        |
| 11           | Connector, T-shaped, module DB  | 09401-03  | 2        |
| 12           | Filament lamps 4V/0.04A, E10, 10  | 06154-03  | 1        |
| 13           | Connecting cord, 32 A, 1000 mm, red   | 07363-01  | 3        |
| 14           | Connecting cord, 32 A, 1000 mm, blue  | 07363-04  | 3        |

## Set-up and procedure

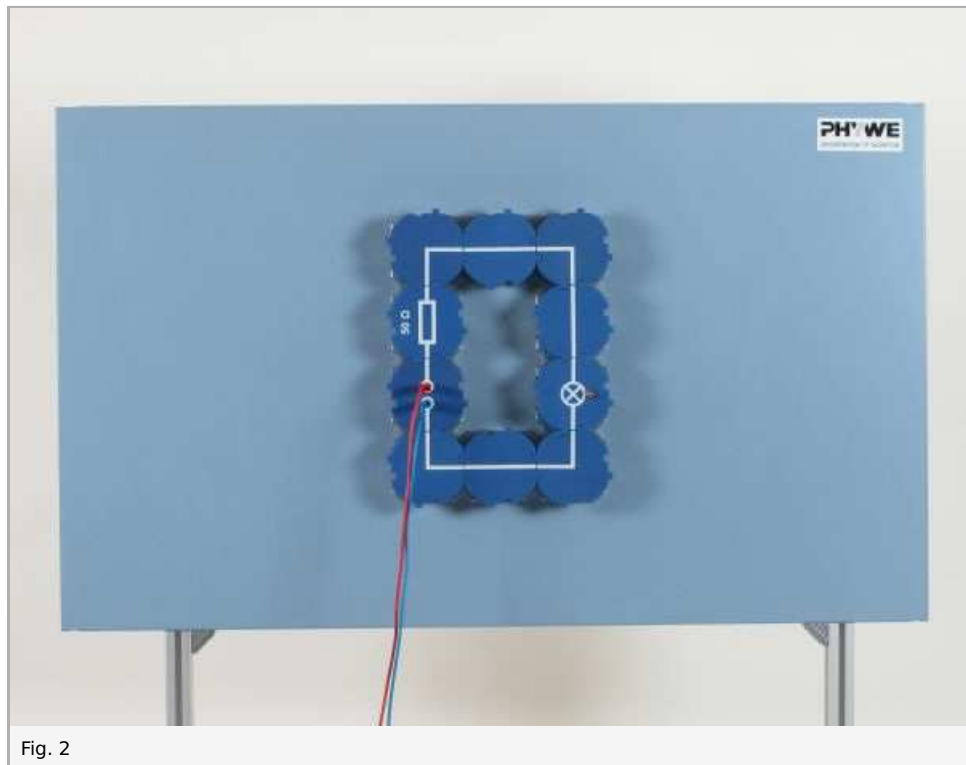
### 1st. Experiment

- Set up the experiment as shown in Fig. 1, with the light-emitting diode polarity for the forward direction
- Select 3 V- for voltage measurement and 1 00 mA- for current measurement
- Starting at 0 V, increase the direct voltage in suitable small steps; read the values of voltage and current and enter them in Table 1; observe the behaviour of the LED (1)
- Reduce the voltage back to 0 V; turn the LED building block through 180° and place it back in position
- Again increase the voltage stepwise and enter the measured values in Table 1



### 2nd. Experiment

- Set up the experiment as shown in Fig. 2
- Apply 6 V direct voltage; observe the filament lamp
- Reverse the connections at the source of direct current and observe the filament lamp
- Replace the direct current source with the alternating current source; set a voltage of 6 V-; observe the filament lamp (2)



## 3rd. Experiment

- Replace the lamp socket by the light-emitting diode; apply 4 V direct voltage, thereby select polarity so that the LED is first in the forward direction and then in the inverse direction
- Observe the behaviour of the LED in the direct current circuit with the different polarities (3)
- Replace the direct current source with the alternating current source; set a voltage of 4 V; observe the behaviour of the LED; reverse the connections to the LED and again observe the behaviour of the LED (4)

## Observation and evaluation

### Observation

Table 1

| $\frac{U}{V}$ | $\frac{I}{mA}$ |
|---------------|----------------|
| 0.0           | 0              |
| 0.5           | 0              |
| 1.0           | 0              |
| 1.5           | 0              |
| 1.7           | 1              |
| 1.8           | 4              |
| 1.9           | 12             |
| 2.0           | 21             |
| 2.1           | 33             |
| 2.2           | 44             |
| -1.0          | 0              |
| -2.0          | 0              |
| -3.0          | 0              |

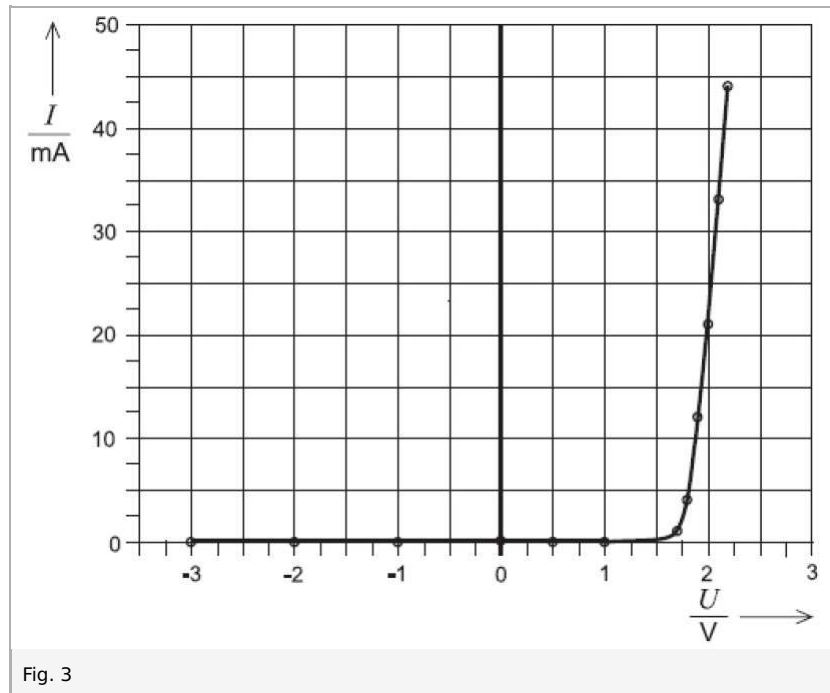
1. At  $U = 1.7 \text{ V}$  the diode begins to light up and its brightness increases with increasing voltage.
2. The filament lamp lights up independently of the direction of the current, or whether direct or alternating current is applied.
3. An LED only lights up in the direct current circuit when its polarity is for the forward direction.
4. On connection to a source of alternating current, a light-emitting diode lights up independently of the choice of connections.

## Evaluation

The characteristic curve of the light-emitting diode is prepared from the measured values (Fig. 3). With light-emitting diode polarity in the forward direction, the U- I characteristic curve is similar to that of a silicon rectifying diode. The breakdown voltage is higher, however, at about 1.7 V.

With polarity in the inverse direction, no current is measurable and the light-emitting diode does not light up. The LED is suitable for determining the polarity of a source of direct current.

As the polarity periodically changes in the alternating current circuit, the LED is poled in the forward direction with half the frequency of the alternating voltage. This effect remains unchanged when the LED is connected to the source of alternating current with its polarity reversed. This behaviour makes it possible to distinguish between an alternating and a direct source of current.



## Remark

Because of the slowness of the eye, on connection of the LED to an alternating current source, the impression is obtained that the LED lights up continuously.