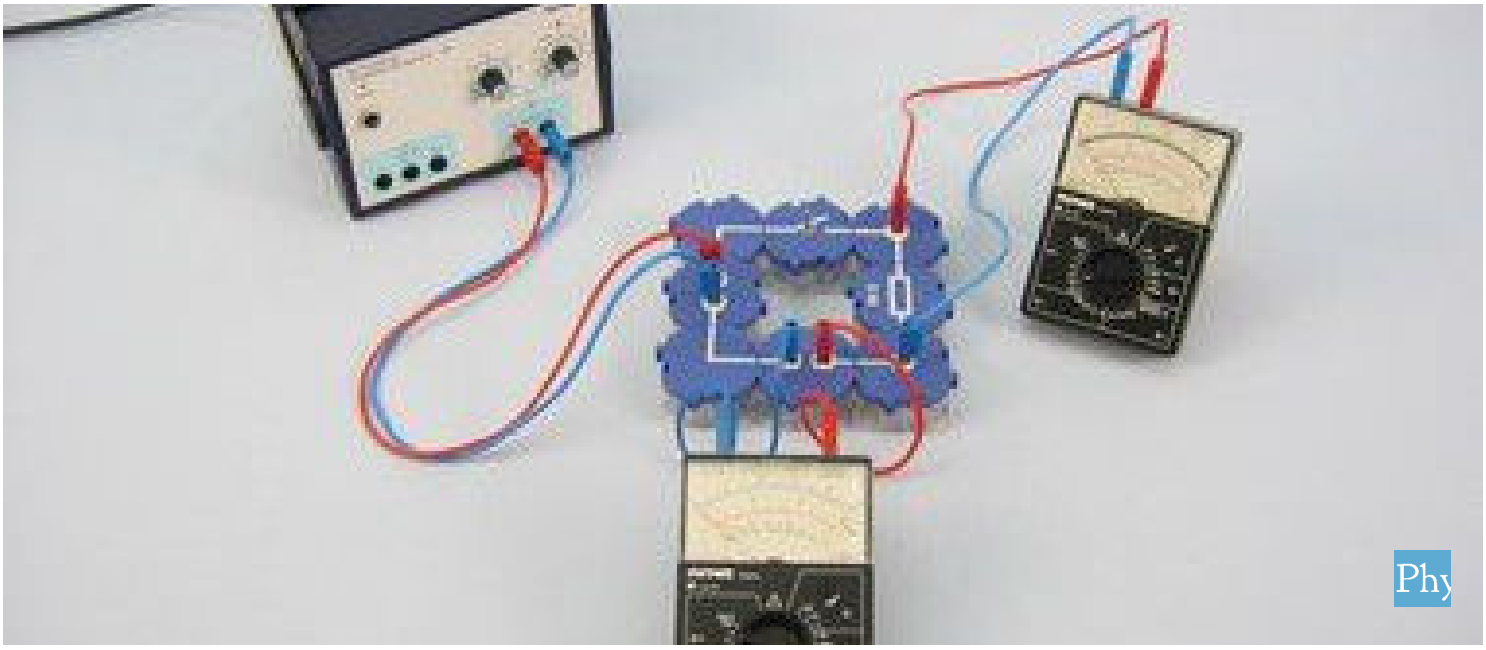
Ohm's law



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

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

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Teacher information

Application

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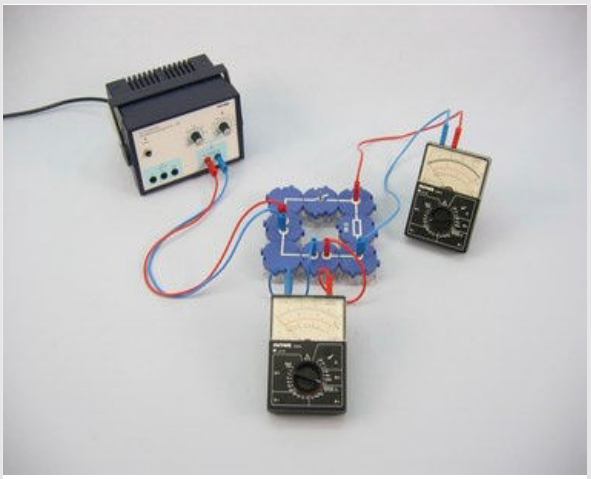

Experiment set-up

Ohm's law is a fundamental law in electrical engineering. With the help of an electrical resistance R the electric current intensity can be I at a given voltage U regulate. Resistors can be found in almost all electrical devices. Without a significant resistance, short circuits occur.

The SI unit of electrical resistance is one ohm (Ω):

$$1\Omega = 1V/A$$

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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 be familiar with terms such as current, voltage and consumers.

Scientific principle

Electrical resistance is a material constant and represents the proportionality factor between voltage and current in an electric circuit.

The acronym 'URI' can be used as an aid to remember Ohm's law, which states

$$U = R \cdot I \quad \Leftrightarrow \quad R = U/I = const.$$

Other teacher information (2/3)

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Learning objective

The students should first use the measured values they have obtained to explain Ohm's law $I \propto U$ confirm.

Subsequently, they should also work to ensure that the condition $R = const.$ applies.

Tasks

The students build a simple circuit with a resistor and measure the voltage U at the resistance R and the current I. Subsequently, the relationship between these variables is examined.

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Other teacher information (3/3)

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The resistance values as well as the voltage values to be set are adjusted in such a way that the measuring ranges 10 V- or 300 mA- can be maintained during the measurements. Before switching on the power supply units, the correct switching of the measuring instruments and the setting of the required measuring ranges must be discussed.

Note:

The validity condition for Ohm's Law, R = const, is equivalent to the condition ϑ = const for pure metals. Certain alloys, e.g. constantan, have a constant resistance within relatively large temperature ranges.

Safety instructions

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

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Student Information

Motivation

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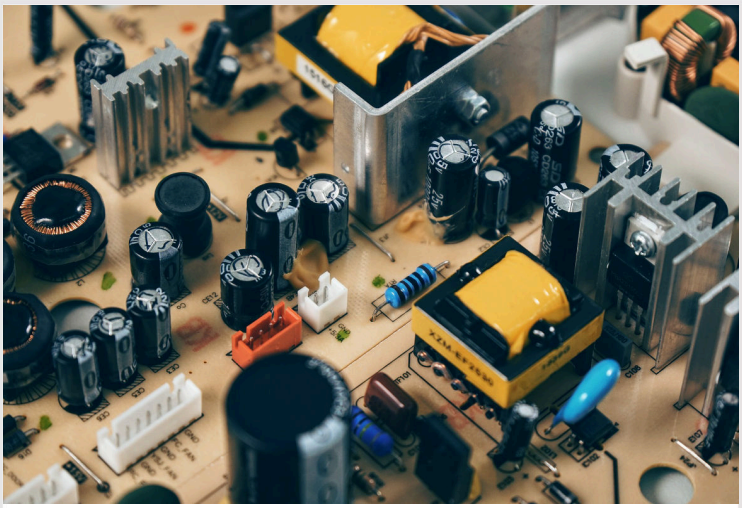

Board

When you charge your mobile phone, only a certain amount of current may flow, otherwise a short circuit would occur and your phone would break down.

For this purpose, the current intensity can be limited with electrical components, the so-called electrical resistors. These are installed in every electrical circuit, on every circuit board and in all electrical devices.

In this experiment you will learn how far the current I at a given voltage U by the electrical resistance R is limited.

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Tasks

What is the relationship between the voltage and the current in an electric circuit?

Determine a series of pairs of measured values for the voltage and current in a circuit and use them to investigate the relationship between the voltage U and the amperage I .

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Equipment

Position	Material	Item No.	Quantity
1	Angled connector module, SB	05601-02	2
2	Interrupted connector module with sockets, SB	05601-04	2
3	Angled connector module with socket, SB	05601-12	2
4	On-off switch module, SB	05602-01	1
5	Socket module for incandescent lamp E10, SB	05604-00	1
6	Resistor module 50 Ohm, SB	05612-50	1
7	Resistor module 100 Ohm, SB	05613-10	1
8	Connecting cord, 32 A, 250 mm, red	07360-01	1
9	Connecting cord, 32 A, 250 mm, blue	07360-04	1
10	Connecting cord, 32 A, 500 mm, red	07361-01	2
11	Connecting cord, 32 A, 500 mm, blue	07361-04	2
12	Filament lamps 12V/0.1A, E10, 10 pieces	07505-03	1
13	Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	2
14	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

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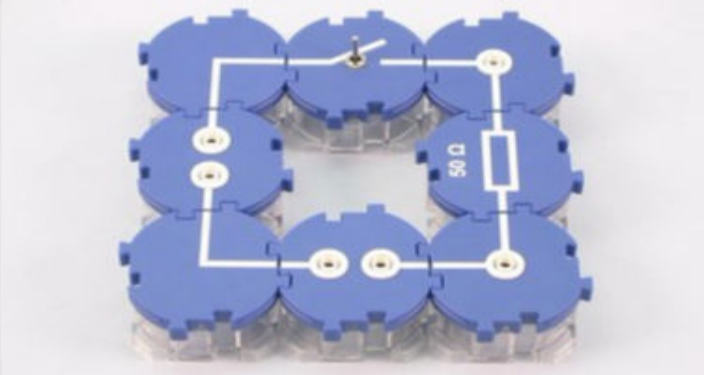
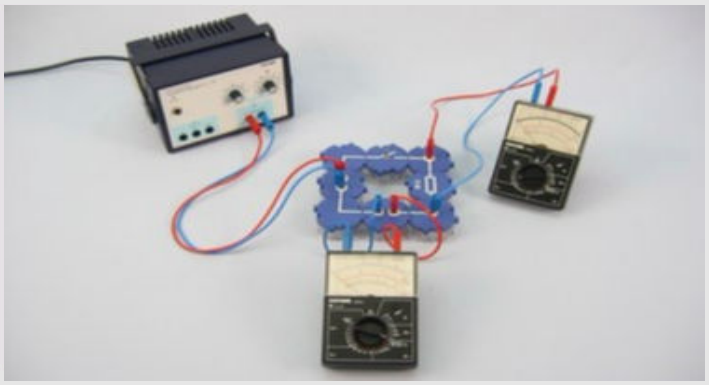
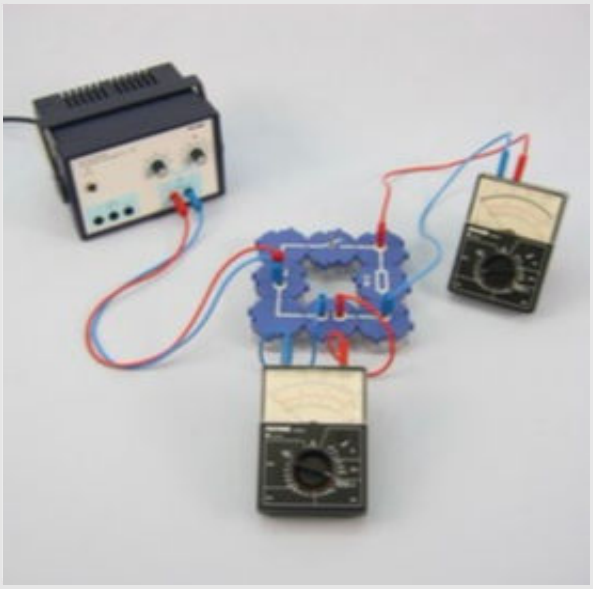
Set-up

- Set up the experiment according to the illustrations and first place the component with the label $50\,\Omega$ one. A switch is connected in series with the resistor.
- Connect the power supply unit and the ammeter to the double sockets, while the voltmeter is connected to the two single sockets next to the resistor.





Procedure (1/2)



- Set the power supply to 0 V and 2 A and close the switch.
- Switch on the power supply unit and increase the voltage in steps of 2 V each. Measure the respective current intensity I and note the measured values in the protocol.
- Reset the voltage to 0 V and replace the 50Ω module with the 100Ω module.
- Now increase the voltage in steps of 2 V as before and note the respective current in the protocol.
- Open the switch.

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Procedure (2/2)

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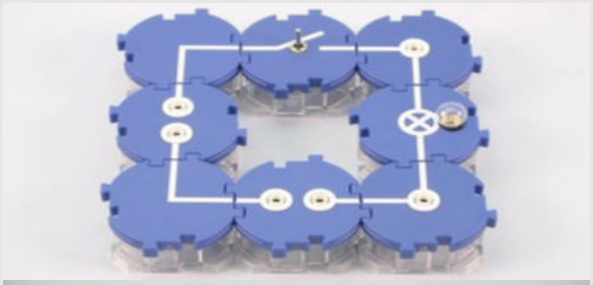

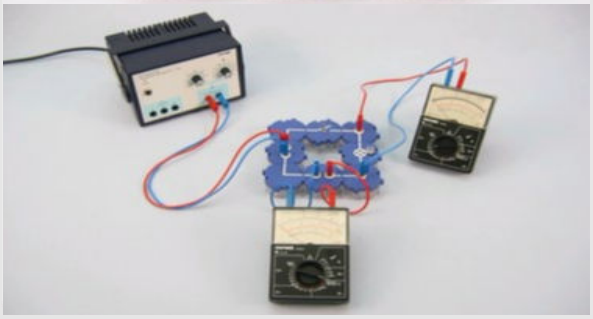

- Now replace the resistor component with the component with the lamp socket and the 12 V bulb used.
- Close the switch and measure the current in steps of 2 V (starting from 0 V) as before and note it in Table 2 in the log.
- During this part of the experiment, pay attention to the brightness of the light bulb and write down your observations in the protocol.
- Open the switch and switch off the power supply unit.

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Report

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Table 1 (1/2)

U [V]	$I\,[A]$		$U/I\,[V/A]$	
	$50\,\Omega$	$100\,\Omega$	$50\,\Omega$	$100\,\Omega$
2				
4				
6				
8				
10				
12				

Enter your measured values from the test part with built-in resistors into the table. Use it to calculate the quotients U/I and enter them in the table as well.

Table 1 (2/2)

For the 50-Ω module, the value for U/I about half the size of the 100Ω module. It is therefore obvious to use the quotient $U/I = const.$ as electrical resistance R (engl.: Resistance): $R = U/I$. The unit of resistance is $1\,\Omega = 1\,V/A$.

Calculate the mean values of U/I for the 50Ω and the 100Ω device and compare them with the imprints on the components used.

Average value for the $50\,\Omega$ Building block

Average value for the $100\,\Omega$ Building block

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Table 2

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U [V]	$I\,[A]$	$U/I\,[V/A]$	Lamp Brightness
2			
4			
6			
8			
10			
12			

Enter your measured values from the test part with built-in bulb into the table. Use it to calculate the quotients U/I and enter them in the table as well. Write down your observation on the lamp brightness.

Task 1

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You have calculated the quotients of the pairs of measured values U/I and their values are entered in Table 1. Check the statements using the quotients.

- ○ U/I is always 1
- ○ U/I is constant.
- ○ U/I is always 0

Check

What is the relationship between the current I and the tension U?

- ○ $I \propto 1/U$
- ○ $I \propto U$
- ○ $I = U$

Check

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Task 2

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Examine your entered values in table 2.

Ohm's law also applies to the light bulb?

○ True ○ Wrong

Check

Paste the words in the right places.

Deviations of the _____ from the printed value result from the _____ when measuring _____ and voltage as well as from the _____ of the resistance values.

mean values | measurement error | current | tolerance

Check

Task 3

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Paste the words in the right places.

The bulb is very _____ at 2 V and very _____ at 12 V. The brightness _____ as the _____ increases, as this also increases the _____: _____

current | falls | increases | strong | voltage | weak

Check

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Task 4

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While the definition equation $R = U/I$ always applies if $I \neq 0$, applies $R = const.$ only under a certain condition. What's that?

(Note: the brightness of the filament lamp is a measure of the temperature of its metallic filament).

- ○ Temperature $\vartheta = 0$.
- ○ Temperature ϑ = constant.

Check

Slide	Score / Total
Slide 18: Multiple tasks	0/2
Slide 19: Multiple tasks	0/5
Slide 20: Brightness of the incandescent lamp	0/6
Slide 21: When does R = const. apply?	0/1

Total amount 0 / 14

Solutions | Repeat | Exporting text

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