Ohm's law (Item No.: P1372400)

Curricular Relevance

Area of Expertise: Physik
Education Level: Klasse 7-10
Topic: Elektrizitätslehre
Subtopic: Der elektrische Widerstand
Experiment: Das ohmsche Gesetz

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

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

The students should first derive Ohm's law $I \sim U$ from their measured values. Then they should find out that R = const. is the condition for the validity of this law. To avoid confusion between the words "resistor" (the electrical component) and "resistance" (the physical term), the modules are first referred to as the 50 Ω and the 100 Ω module.

Notes on setup and procedure

The resistance values and the voltage settings have been chosen so that the measurement range 10 V− and 300 mA− can be adhered to during the measurements.
Prior to switching the power supply on, the students must be instructed on the correct connection of measurement instruments and the setting of the required measurement ranges.

Remarks

One can confirm the relationship $I \sim 1/R$ for U = constant by comparing the values for I and R line by line in table 1. It can be seen from the first sample result chart that the smaller the resistance is, the steeper the graph.
The condition for validity of Ohm's law, R = constant, is equivalent to the condition that ϑ = constant for pure metals. Certain alloys, e.g. constantan, have a constant resistance over a relatively large temperature range.

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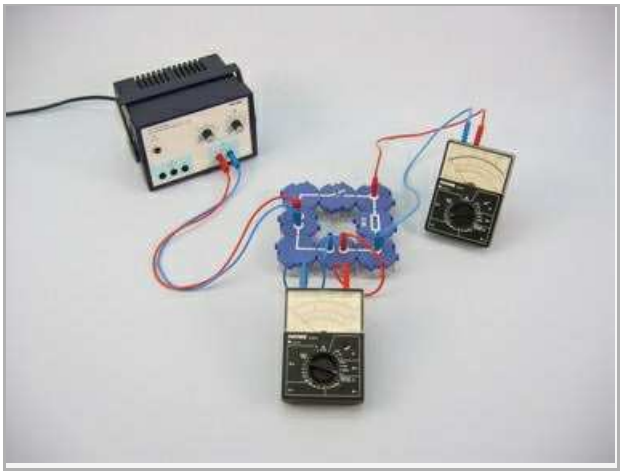
Task and equipment

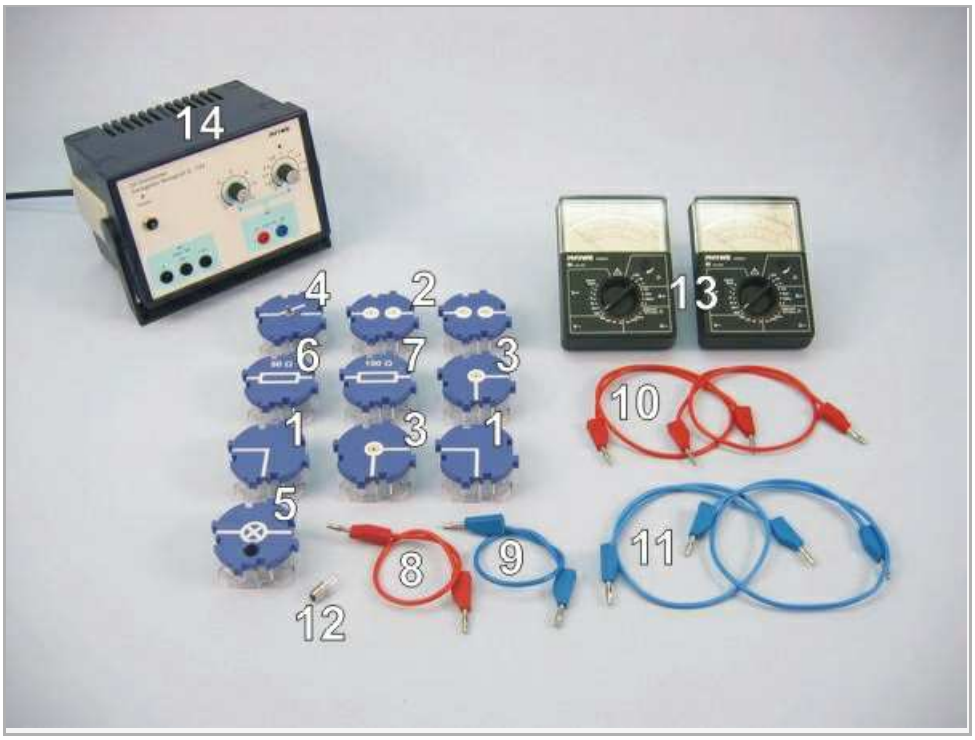
Task

What is the relationship between voltage and current?

Take a series of pairs of voltage and current measurements in a circuit and use these to determine the relationship between *U* and *I*.



Equipment



Position No.	Material	Order No.	Quantity
1	Angled connector module, SB	05601-02	2
2	Interrupted connector module, 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	07505-03	1
13	Multi-range meter, analogue	07028-01	2
14	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

Set-up and procedure

Set-up

First experiment

- Set up the circuit according to the schematic diagram as shown in Fig. 1 and Fig. 2; first using the 50 Ω module.

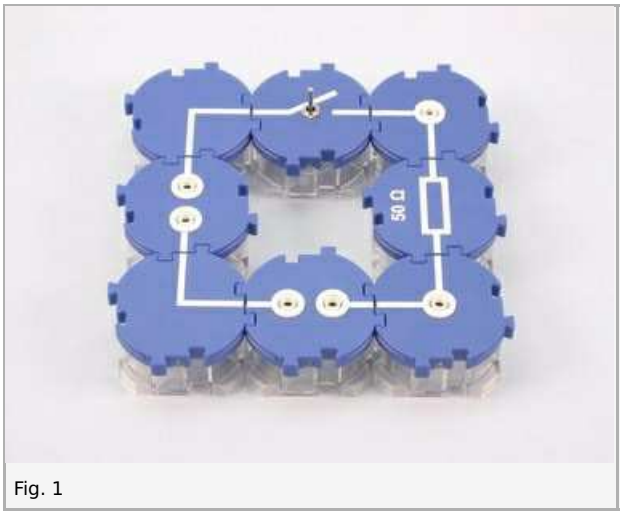


Fig. 1

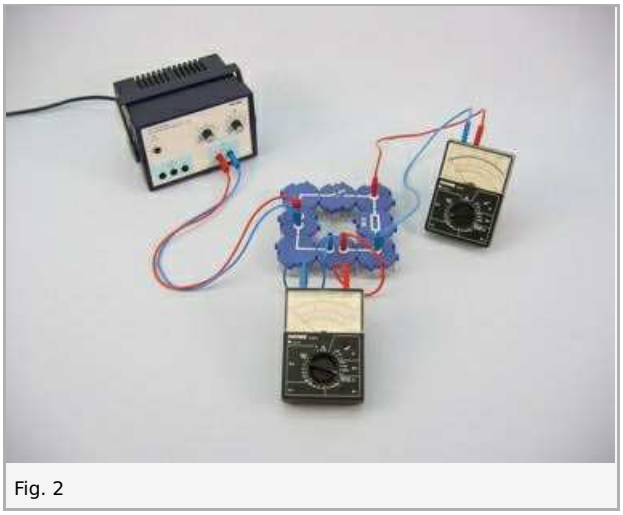


Fig. 2

Second experiment

- Change the experimental setup by connecting a filament lamp in the circuit instead of the 100 Ω module (Fig. 3). Connect the power supply and the multi range meters as before (Fig. 4).

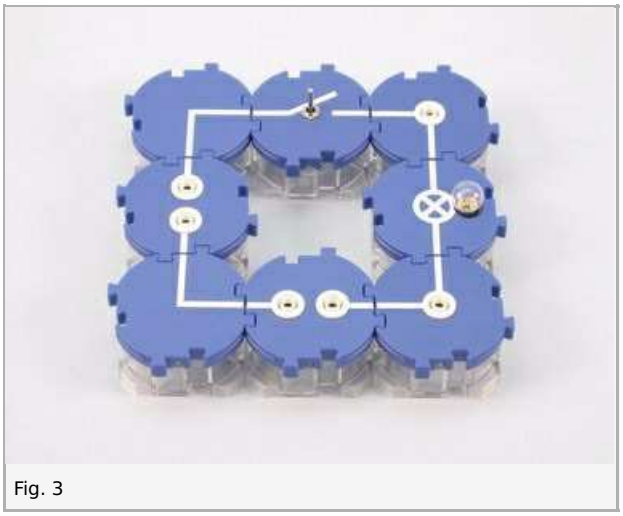


Fig. 3

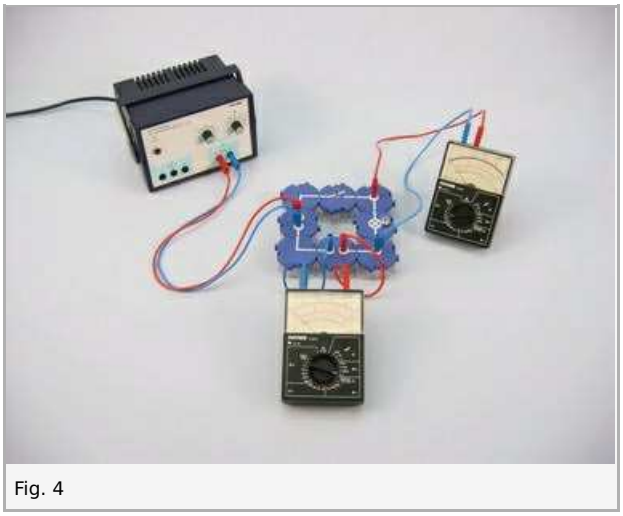


Fig. 4

Procedure

First experiment

- Select the 10 V− measurement range on the voltmeter and the 300 mA− measurement range on the amperemeter (cp. Schematic).
- Close the switch, set the power supply to 0 V and switch it on.
- Starting from 0 V, increase the voltage in steps of 2 V− up to 10 V−. At each step measure the current *I* and enter the measured values in table 1 in the report.
- Turn the voltage back to 0 V, open the switch and replace the 50 Ω module with the 100 Ω module.
- Close the switch and again increase the voltage in steps of 2 V− up to 10 V−; at each step measure the current *I* and enter the measured values in table 1.
- Open the switch, set the power supply back to 0 V and switch it off.

Second experiment

- Leave the measurement ranges of the multi meters as in the first experiment and close the switch.
- Switch on the power supply and again increase the voltage in steps of 2 V−, starting at 0 V. Measure the current *I* at each step and enter the measured value in table 2 in the report.
- During the experiment, observe the lamp and note its brightness in the report.
- Open the switch, switch off the power supply.

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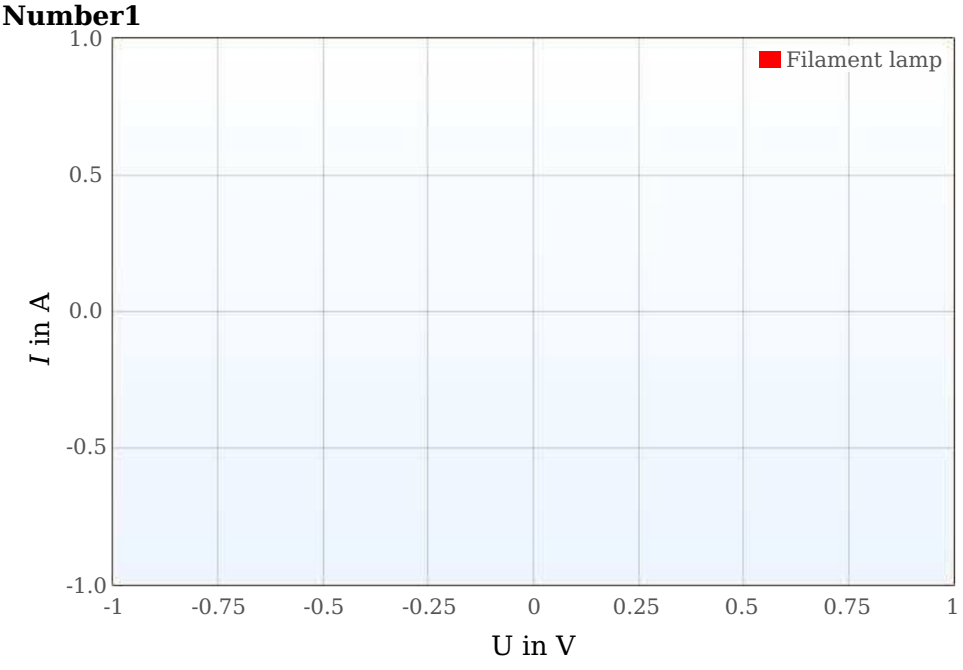
Report: Ohm's law

Result – Table 1

Record all the measured values of the second experiment. Calculate the quotient *U*/*I* for each pair of values.

U in V	*I* in A	*U*/*I* in V/A
0	0 ±0	0 ±0
2	1 ±0	0 ±0
4	1 ±0	1 ±0
6	1 ±0	1 ±0
8	1 ±0	1 ±0
10	1 ±0	1 ±0

Number1



Result – Observations

Note down your observations of the brightness of the lamp during the second experiment.

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Evaluation – Question 1

The graph for the measurements of the first experiment (Diagram 1) is shown in 'Evaluation - Table 1'.

Which relationship is apparently given between the current *I* and the voltage *U* for each of the modules?

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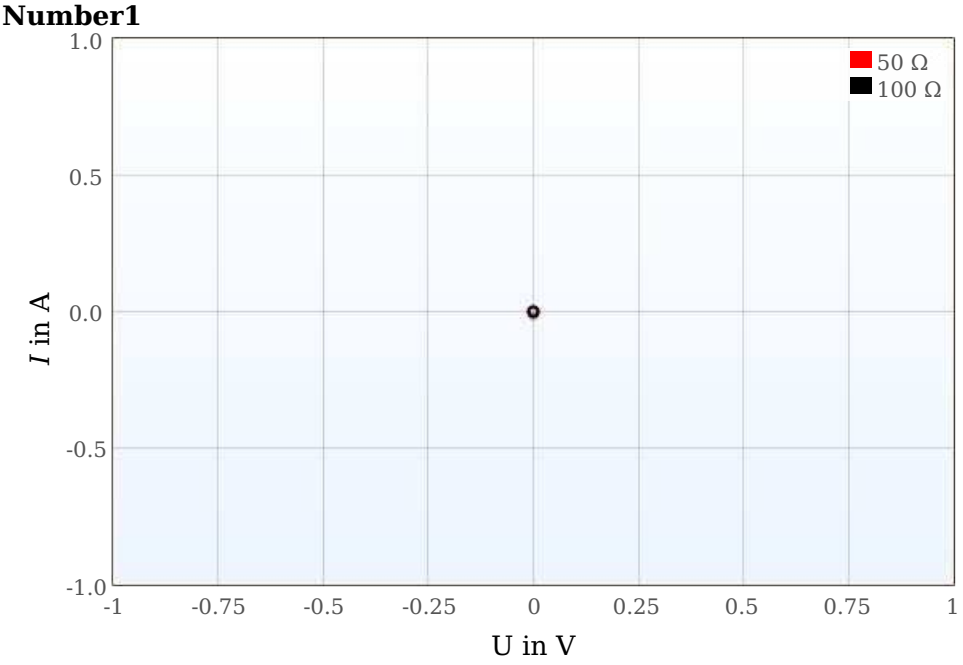
Evaluation – Table 2

Record all the measured values of the first experiment.

Calculate the quotient *U*/*I* for each pair of values and record the results in the table.

U in V	*I* in A		Quotient *U*/*I* in V/A	
	with 50 Ω module	with 100 Ω module	with 50 Ω module	with 100 Ω module
0	0	0	–	–
2	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$
4	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$
6	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$
8	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$
10	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$	$\frac{1}{\pm 0}$



Evaluation – Question 2

Check your supposition by calculating the quotient U/I for the paired measurements and adding the values to table 2. What becomes apparent?

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Evaluation – Question 3

For the first 50 Ω module, the value of U/I is about half of the value for the second 100 Ω module. It therefore makes sense to regard the quotient U/I as a constant with respect to the resistance R, and to define it as $U/I = R$. The unit of resistance is 1 V/A = 1 Ω.

Calculate the average value of $R = U/I$ for the two modules. Compare them with the values printed on the modules. Usually, there are small differences. How can you explain them?

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Evaluation – Question 4

Examine Diagram for the measurements of the second experiment and the quotient U/I, which is shown on the Results-Table 2 page.

With this information, answer the following question: Is Ohm's Law also valid for filament lamps? Give reasons for your answer

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Evaluation – Question 5

While the defining equation $R = U/I$ always holds true (as long as $I \neq 0$), Ohm's Law is only valid under a certain condition. Which condition is that? (Hint: The brightness of the filament lamp is linked to the temperature of the metal filament.)

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Evaluation – Question 6

Take a close look at the resistors that are built into the modules and describe them.

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