The resistance of wires - dependence on length and cross-sectional area (Item No.: P1372500)

Curricular Relevance

Area of Expertise: Physik

Education Level: Klasse 7-10

Topic: Elektrizitätslehre

Subtopic: Der elektrische Widerstand

Experiment: Der Widerstand von Drähten - Abhängigkeit von Länge und Querschnitt

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

Additional Requirements:

- Ruler (approx. 30 cm)

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

Working out the equation $R = \rho\ l/A$ takes some time. The relationships $R \sim l$ und $R \sim 1/A$ should first be recognized. We recommend that each group of students only carry out one of the experiments, and following this, gain the knowledge that $R \sim l/A$ in a joint evaluation

Notes on setup and procedure

When inserting the wires, take particular care to ensure that the fixed wire does not sag, but is also not too taut. When the shortest wires are inserted, small differences in length result in large changes in current, so that the results of the various groups can differ.
The voltage measurement is made directly across the wire, and not across the voltage source. The measurement range of the amperemeter must not be changed, as then the internal resistance would change and influence the current and voltage measurements.
In the second experiment, the largest length is used, so that the length can be more easily kept constant when inserting the various wires.

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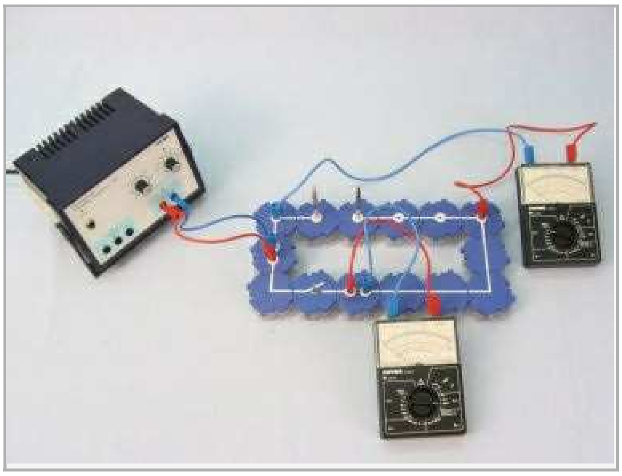
Task and equipment

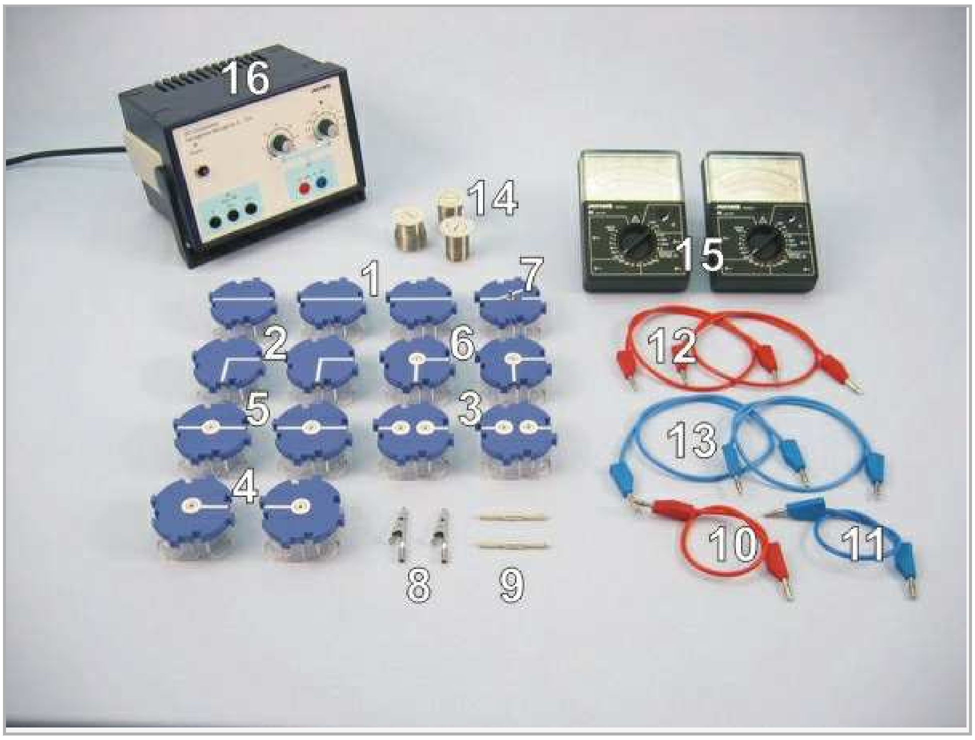
Task

How do the length and cross-sectional area of a wire influence the value of its resistance?

Determine the relationship between the resistance of a wire and its length and cross-sectional area.



Equipment



Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	3
2	Angled connector module, SB	05601-02	2
3	Interrupted connector module, SB	05601-04	2
4	Junction module, SB	05601-10	2
5	Straight connector module with socket, SB	05601-11	2
6	Angled connector module with socket, SB	05601-12	2
7	On-off switch module, SB	05602-01	1
8	Alligator clips, bare, 10 pcs	07274-03	1
9	Connecting plug, 2 pcs.	07278-05	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	Constantan wire, 15.6 Ohm/m, d = 0.2 mm, l = 100 m	06100-00	1
14	Constantan wire, 6.9 Ohm/m, d = 0.3 mm, l = 100 m	06101-00	1
14	Constantan wire, 4 Ohm/m, d = 0.4 mm, l = 50 m	06102-00	1
15	Multi-range meter, analogue	07028-01	2
16	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
Additional material			
	Ruler (approx. 30 cm)		

Set-up and procedure

Set-up

Set up the circuit as shown in Fig. 1. and Fig. 2. Use the two crocodile clips (on connecting plugs) to hold approx. 20 cm of constantan wire between them (Fig. 3). The right crocodile clip should be at position a.

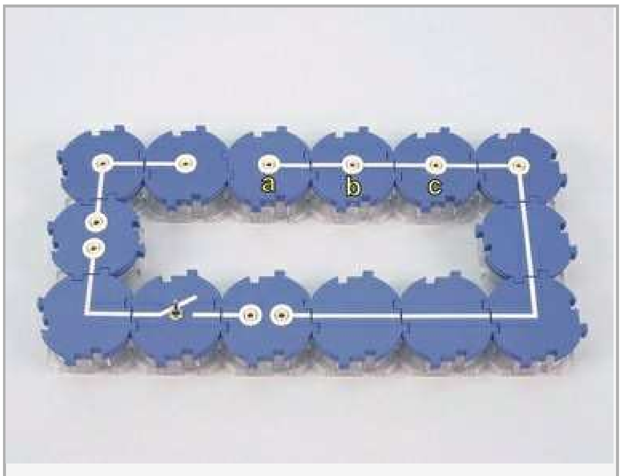


Fig. 1

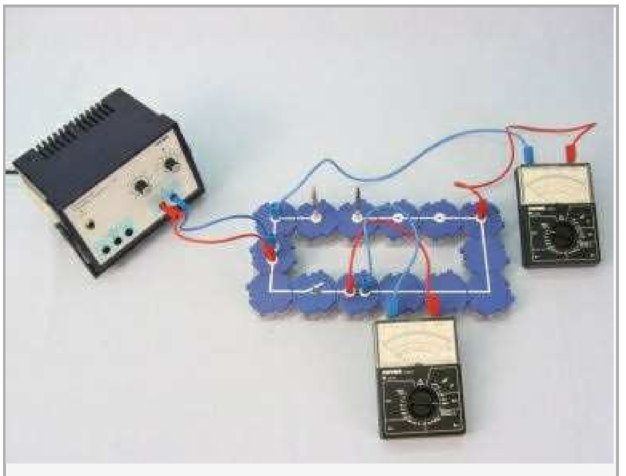


Fig. 2

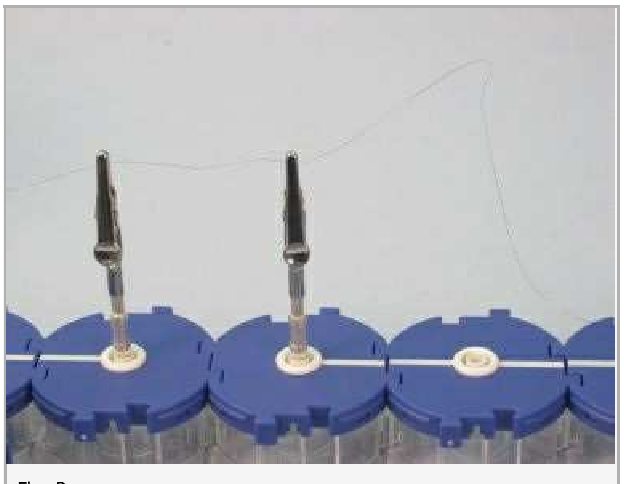


Fig. 3

Procedure

First experiment

- Measure the length l of the part of the wire that is between the crocodile clips and enter the measured value in table 1 in the report.
- Select the 1 V− and 300 mA− measurement ranges.
- Set the power to 0 V, then switch it on.
- Carefully increase the power supply voltage until the voltmeter shows 0.25 V−.
- Read the value of the current and note it in Table 1.
- Set the power supply back to 0 V.
- Release the constantan wire from the right hand crocodile clip.
- Move this clip from position a to position b.
- Fix the constantan wire back in the clip.
- Measure the length l of the part of the wire that is now between the clips. Enter the value in table 1.
- Again set the power supply to 0.25 V− and measure the current. Enter the value in table 1.
- Set the voltage to 0, move the right hand crocodile clip to position c. Proceed as above to fill in the third line of table 1.

Second experiment

- Keep the right hand crocodile clip in position c. Keep the d = 0.2 mm constantan wire between the clips.
- Select the 1 V− and 300 mA− measurement ranges.
- Set the power supply to 0 V, then switch it on.
- Carefully increase the power supply voltage until the amperemeter shows a current of 250 mA−. Read the voltage and enter it in table 2 in the report.
- Replace the wire of d = 0.2 mm with a piece of d = 0.3 mm wire. Carry out the same procedure as above and note the voltage at a current of I = 250 mA−.
- Replace the 0.3 mm wire with a wire of 0.4 mm diameter. Again measure and note the voltage at a current of I = 250 mA− as above.
- Switch off the power supply.

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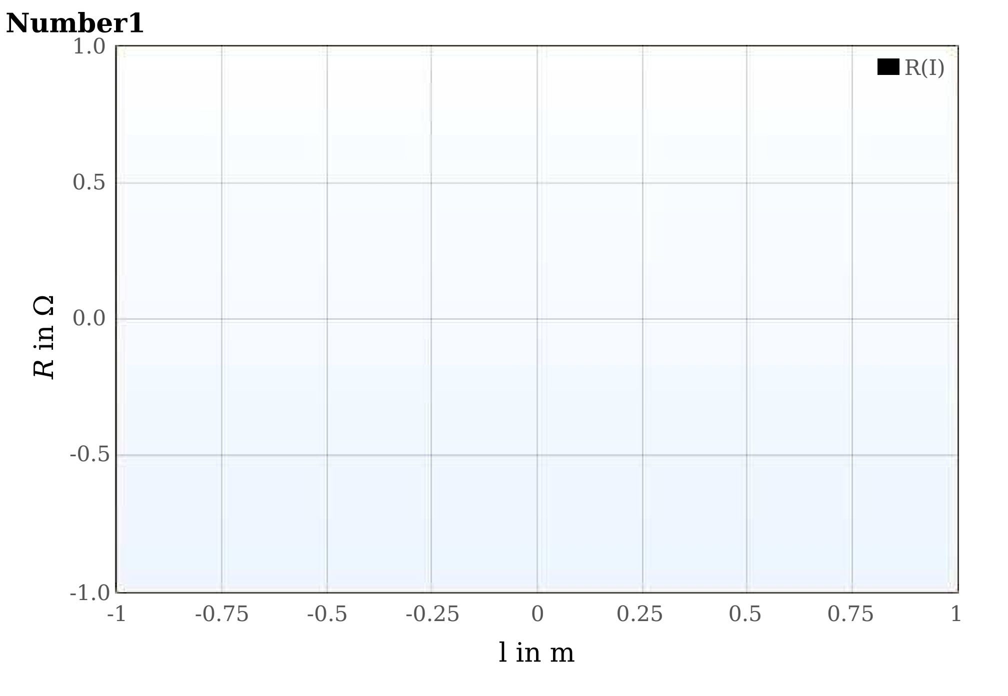
Report: The resistance of wires - dependence on length and cross-sectional area

Result – Table 1

Note down your observations during the first experiment. Calculate the value of the resistance *R* = *U*/*I* for each separate length of wire and enter them into the corresponding columns of table. Calculate the the quotients *R*/*l* and enter them into the last column of the table.

U in V	*I* in A	*l* in m	*R* in Ω	*R*/*l* in Ω/m
0.25	1	1	1	1
0.25	1	1	1	1
0.25	1	1	1	1



Result – Table 2

Note down your observations during the second experiment. Calculate the values of the resistance *R* = *U*/*I* and the corresponding cross-sectional areas of wire $A = (\pi/4)\, d^2$ and enter them into the corresponding columns of table 2. Calculate the products *R* x *A* and record the values in the last column of table.

d in mm	*I* in A	*U* in V	*R* in Ω	*A* in mm^2	*R* x *A* in Ωmm^2
0.2	0.25	1	1	1	1
0.3	0.25	1	1	1	1
0.4	0.25	1	1	1	1

Evaluation – Question 1

Look at the graph which is generated from table 1. Which relationship between resistance *R* and wire length *l* can be presumed?

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Evaluation – Question 2

To check your presumption, contemplate the quotients R / l in table 1. What can you establish from there?

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Evaluation – Question 3

Which relationship can be presumed between the values of the resistance R and the corresponding cross-sectional areas A?

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Evaluation – Question 4

What can you conclude from the products *R* x *A*?