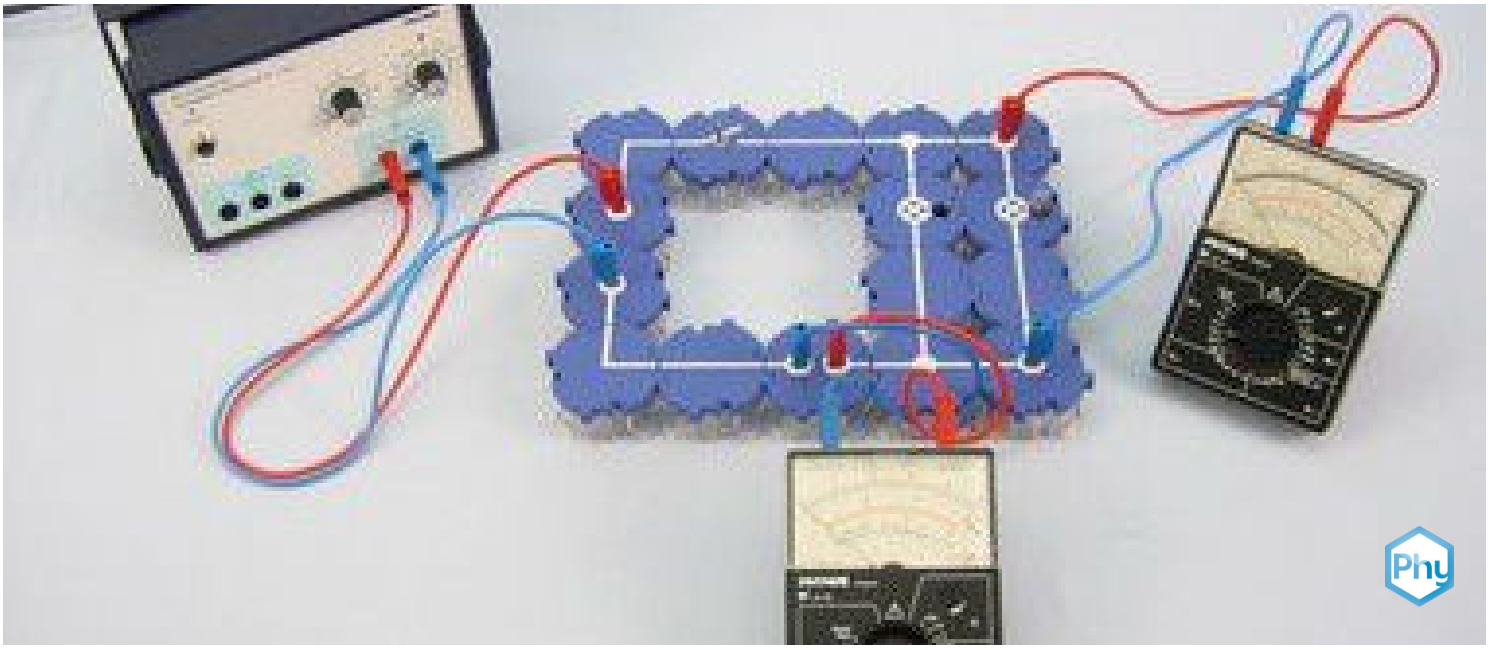
Current and resistance in a parallel connection



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

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

This content can also be found online at:

http://localhost:1337/c/6307b9be0454360003d36593

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

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Teacher information

Application

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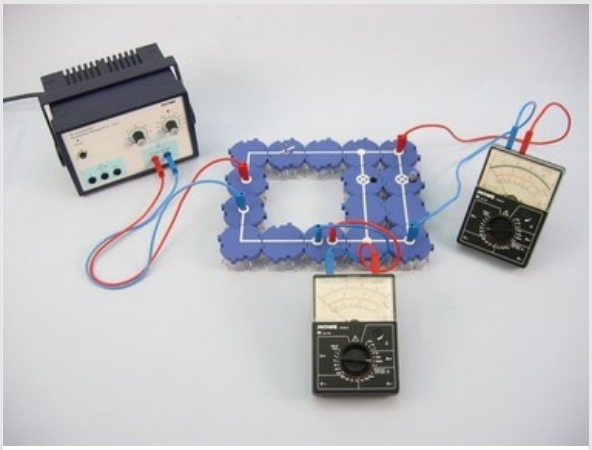

Experimental setup

Parallel circuits are built into almost all electrical devices. However, it is particularly apparent in ceiling lighting with several light bulbs. If one bulb fails, the remaining bulbs remain lit thanks to the parallel circuit.

The total current strength results from the partial current strengths:

$$I_{ges} = I_1 + I_2$$

With $U_{ges} = U_1 = U_2$ follows for the resistance

$$\frac{1}{R_{ges}} = \frac{1}{R_1} + \frac{1}{R_2}$$

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/3)

Prior knowledge

Students should be able to construct a simple circuit and be aware of what voltage and current are. Additionally, the principle of resistance should be understood and the formula $R = U/I$ be known.

Learning objective

Using the measured values they have obtained, the students are to explain the relationship between the partial current strengths I_i of a parallel circuit and the total current I_G. In addition, they should learn the relationship between partial resistances R_i and total resistance R_G in a parallel circuit.

Other teacher information (1/3)

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Robert-Bosch-Breite 10
37079 Göttingen

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info@phywe.de
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Other teacher information (2/3)

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Task

Investigate the relationship between the total amperage I_g and the partial currents I_i and between the total resistance R_g and the partial resistances R_i existing in a parallel connection.

Principle

In the first part of the experiment, the use of light bulbs qualitatively illustrates that a voltage is present and current flows in the branches of the parallel circuit independently of each other.

In the second part of the experiment, the current intensity is measured at various points in the circuit in order to establish the relationship between the total and partial current intensities. In addition, resistors are used to determine the relationship between partial and total resistance.

Other teacher information (3/3)

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Notes

Before this experiment, you can ask the student how the electrical appliances in a household are connected. Generally, some of the students know that there is a parallel connection. Some may also already know the relationship between partial and total current and voltage.

More descriptive than the terms total resistance and partial resistance are the terms equivalent resistance and branch resistance for a parallel circuit. Their use can be recommended especially if they are also common in the students' textbooks.

The results should also be theoretically validated with the equations described in the application.

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37079 Göttingen

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Safety instructions

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

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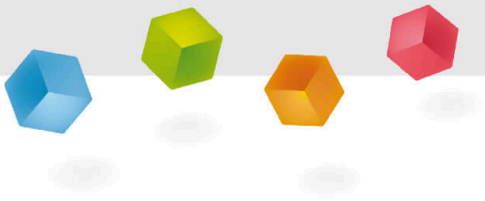

Student information

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Equipment

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

Set-up

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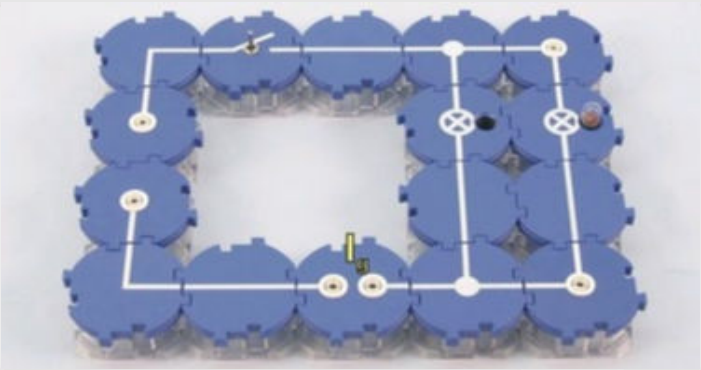
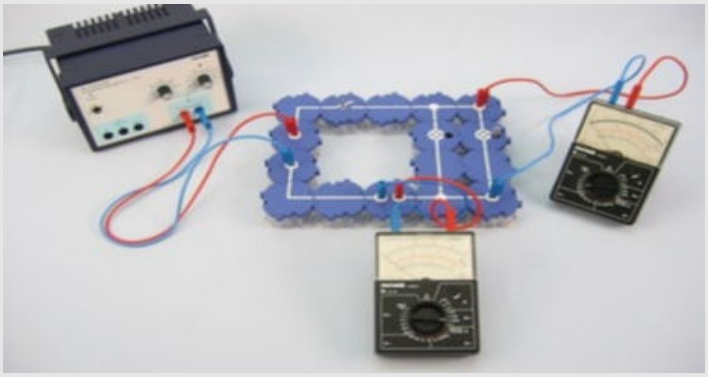
Set up the experiment according to the illustrations.

Screw a bulb into one of the two sockets and leave the other socket empty for the time being. I_G marks the point where you can measure the total current I_G.





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Procedure (1/3)

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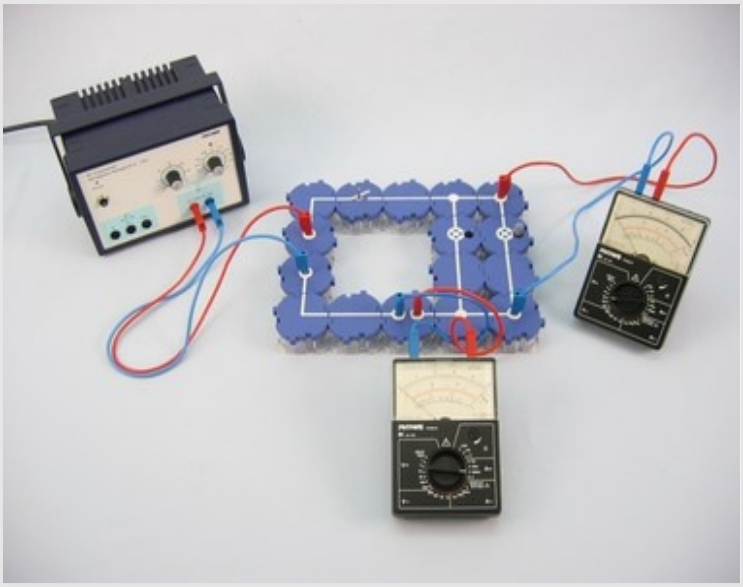

- Set the current limiter to 2 A (right stop). Then switch on the power supply and increase the voltage to 12 V.
- Observe the light bulb. Measure the current and note the reading.
- Now screw in the second bulb.
- Observe both bulbs. Measure the current again and note the reading.

Procedure (2/3)

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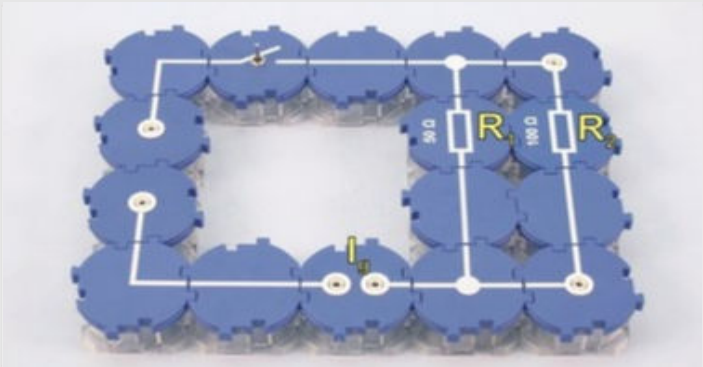
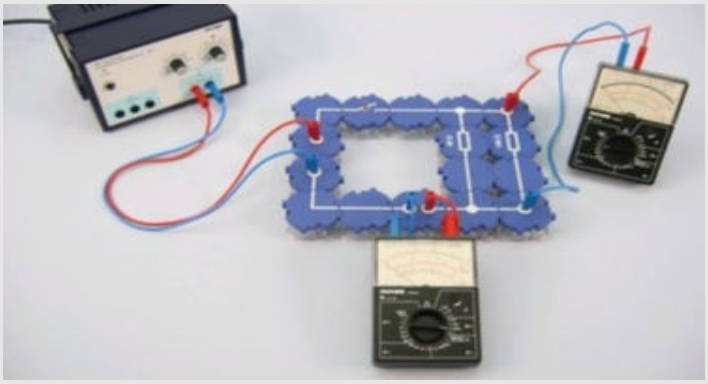
Now replace the lamp sockets with resistors as shown in the illustrations.

Here the values of the resistors are $R_1 = 50\,\Omega$ and $R_2 = 100\,\Omega$





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37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
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Procedure (3/3)

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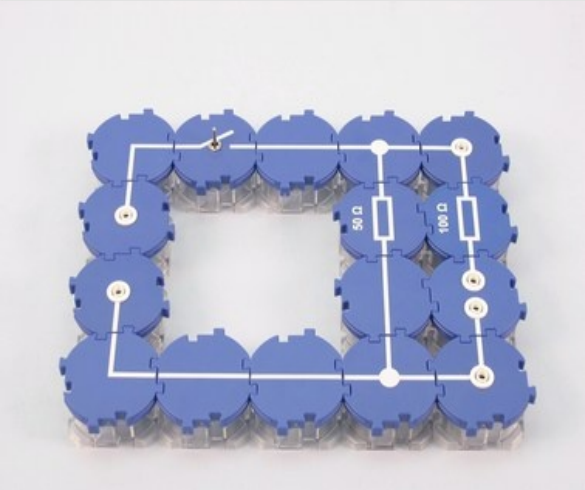

Measurement of the partial currents

- Switch on the power supply unit and set the DC voltage to 8 V.
- Measure the current I_G in the unbranched part of the circuit and record the measured value in the report.
- Replace the straight component in the circuit of $R_2 = 100\,\Omega$with the interrupted component with ammeter connection, as shown in the figure.
- Measure the partial current I_2 in this branch and note the measured value.
- Measure the partial current strength I_1 in which $R_1 = 50\,\Omega$in the same way .
- Then turn off the power supply.

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Report

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Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
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Task 1

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What can be observed during the first attempt after adding the second bulb?

- ○ The measured current intensity decreases.
- ○ The measured current does not change.
- ○ The measured current increases.

Check

After adding the second light bulb...

- ○ ...only the first one remains lit.
- ○ ...no light bulb lights up.
- ○ ...only the second bulb lights up.
- ○ ...both bulbs light up.

Check

Task 2

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Enter the measured values for the different partial currents from the second part of the experiment in the table.

$U\,[V]$	$I_G\,[mA]$	$I_1\,[mA]$	$I_2\,[mA]$
8			

How do the partial currents I_1 and I_2 and the total amperage I_G together?

- $I_G = I_1 \cdot I_1$
- $I_G = I_1 + I_2$
- $I_G = I_1 - I_2$
- $I_1 = \frac{I_1}{I_2}$

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Task 3

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Using the measured values for the current intensity from the table in task 2, calculate the resistances R_G, R_1 and $R_2$and their reciprocals and enter the results in the tables below.

$R_G\ [\Omega]$	$R_1\ [\Omega]$	$R_2\ [\Omega]$

$\frac{1}{R_G}\ [\frac{1}{\Omega}]$	$\frac{1}{R_1}\ [\frac{1}{\Omega}]$	$\frac{1}{R_2}\ [\frac{1}{\Omega}]$

How are the partial resistors R_1 and R_2 and the total resistance R_G related to each other? Keep in mind that measurement errors can occur.

- $\frac{1}{R_G} = \frac{1}{R_1} \cdot \frac{1}{R_2}$
- $\frac{1}{R_G} = \frac{1}{R_1} + \frac{1}{R_2}$
- $\frac{1}{R_G} = \frac{1}{R_1} - \frac{1}{R_2}$
- $\frac{1}{R_G} = \frac{1}{R_1} / \frac{1}{R_2}$

Task 4

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Relationship between partial and total resistance

$$\square = \frac{\square}{\square}$$

- $R_1 + R_2$
- $R_1 \cdot R_2$
- R_G

Check

The equation recognised in task 3 can be rearranged according to the total resistance. Try this on your own. What is the result?

Think about why that has to be.

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37079 Göttingen

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