Current and resistance in a parallel connection

(Item No.: P1381400)

Curricular Relevance

Area of Expertise: Physics

Education Level: Age 14-16

Topic: Electricity

Subtopic: The electrical resistance

Experiment: Current and resistance in a parallel connection

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

Additional Requirements:

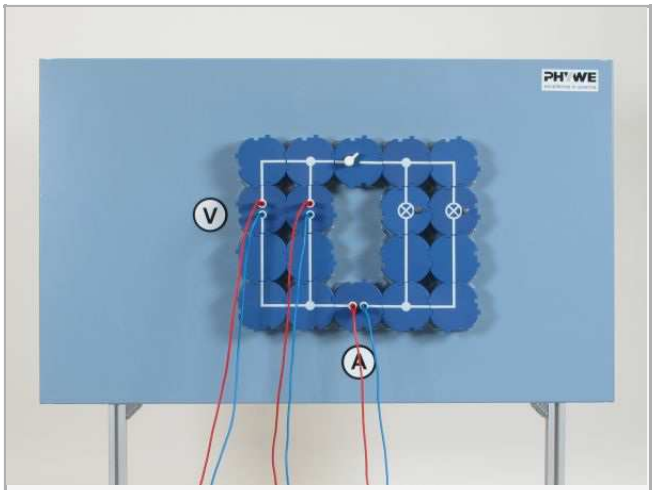
Experiment Variations:

Keywords:

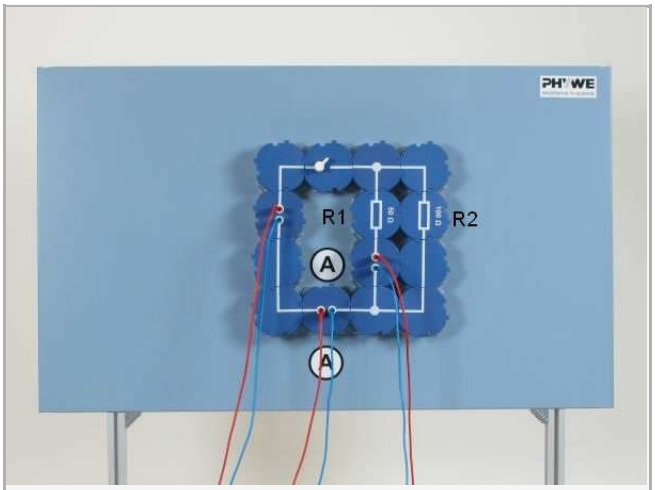
Principle and equipment

Principle

An examination is to be carried out to determine which laws are valid for the current and the resistance in a parallel connection.



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	Switch on/off, module DB	09402-01	1
5	Socket for incandescent lamp E10 ,module DB	09404-00	2
6	Connector interrupted, module DB	09401-04	3
7	Resistor 50 Ohm,module DB	09412-50	1
8	Resistor 100 Ohm,module DB	09413-10	1
9	Electr.symbols f.demo-board,12pcs	02154-03	1
10	Connector, straight, module DB	09401-01	4
11	Connector, angled, module DB	09401-02	4
12	Connector, T-shaped, module DB	09401-03	4
13	Filament lamps 12V/0.1A, E10, 10 pieces	07505-03	1
14	Connecting cord, 32 A, 1000 mm, red	07363-01	3
15	Connecting cord, 32 A, 1000 mm, blue	07363-04	3

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Set-up and procedure

1st. Experiment

- Connect up the circuit as shown in Fig. 1, first only screw in one lamp; select the 30 mV- and 300 mA measurement ranges.
- Switch on the power supply and set the voltage to 12 V.
- Close the switch, observe the ammeter and the lamp, take notice of the deflection and brightness.
- Screw in the second filament lamp and thereby observe the ammeter and the brightness of each lamp (1).

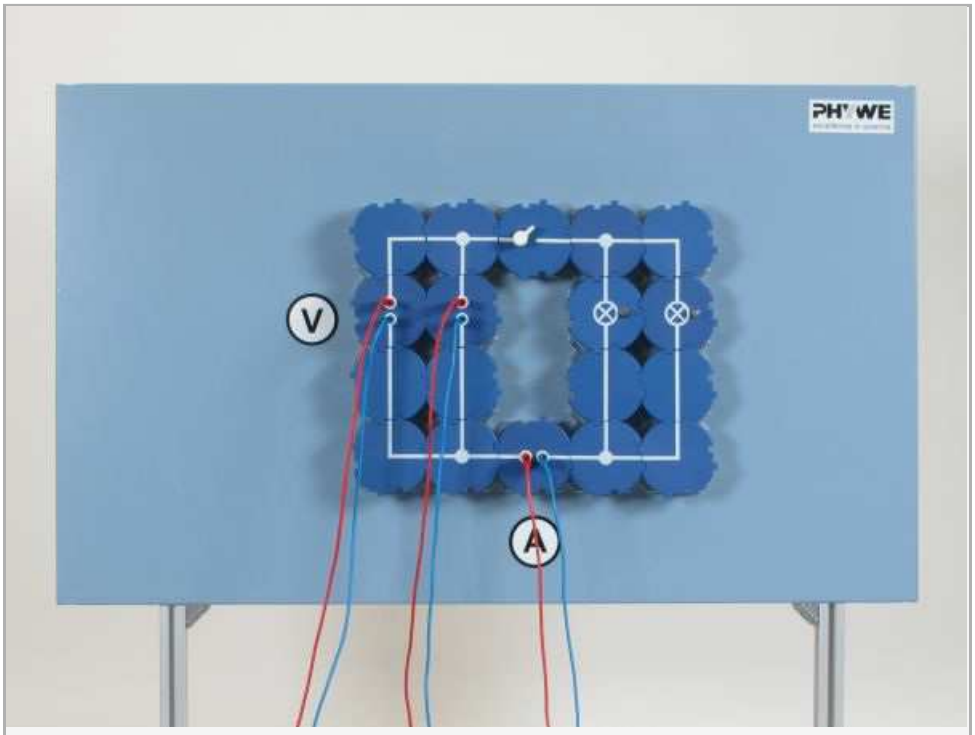

Fig. 1

2nd. Experiment

- Set the power supply to 9 V- and open the switch.
- Change the circuit as shown in Fig. 2; replace the two lamps by the resistors $R_1 = 50\Omega$ and $R_2 = 100\Omega$, and connect the instrument which was in use as voltmeter in the branch with R1, and prepare it for use as an ammeter with 300 mA-measurement range.
- Close the switch, measure the total current I_t in the unbranched part of the circuit, and the partial current I_1; enter the measured values in Table 1.
- Connect the ammeter in the branch with R_2, measure and note the partial current I_2.

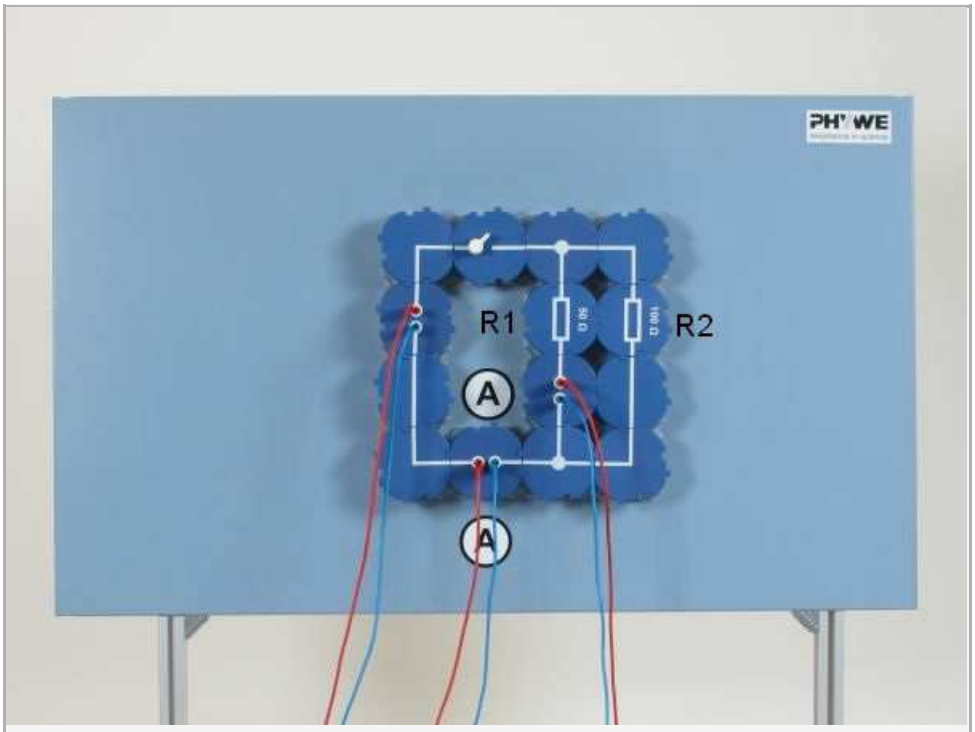

Fig. 2

Observation and evaluation

Observation

1. With two lamps in the circuit, the ammeter shows about twice the value that was found with one lamp. The brightness of the first lamp did not change when the second lamp was connected, and the two lit up with equal brightness.

Evaluation

When an electrical appliance is connected in parallel with one already in the circuit, then the current in the unbranched part of the circuit increases.

It follows from the observations in the first part of the experiment as well as from Table 1, that the total current It is about equal to the sum of the two partial currents I_1 and I_2 . Under consideration of the measurement error, we can say that $I_G = I_1 + I_2$.

The total resistance R_t and the partial resistances R_1 and R_2 can be calculated from the measured values in Table 1.

From the calculated values for the resistances (left side of Table 2) it can be seen that the total resistance is smaller than the smallest partial resistance.

The relationship between R_t, R_1 and R_2 can be derived by using Ohm's law and the equation which has been found for I_t:

It follows from the $I_G = I_1 + I_2$ and $I = U/R$, that

$U_G/R_G = U_1/R_1 + U_2/R_2$ and because $U_G = U_1 + U_2$ that

$1/R_1 G = 1/R_1 + 1/R_{2.}$

In a parallel connection, the reciprocal of the total resistance is equal to the sum of the reciprocals of the partial resistances (see the right side of Table 2). In general, the following relationships are given for current and resistance in parallel connections:

$I_G = I_1 + I_2 + \ldots + I_n$ and

$1/R_G = 1/R_1 + 1/R_{2.} + \ldots + 1/R_{n.}$

Table 1

$\frac{U}{V}$	$\frac{I_G}{mA}$	$\frac{I_1}{mA}$	$\frac{I_2}{mA}$
9	264	173	86

Table 2

$\frac{R_G}{\Omega}$	$\frac{R_1}{\Omega}$	$\frac{R_2}{\Omega}$	$\frac{1/R_G}{1/\Omega}$	$\frac{1/R_1}{1/\Omega}$	$\frac{1/R_2}{1/\Omega}$
34	52	105	0.029	0.019	0.0095

Remarks

The terms "equivalent resistance" and "branch resistance" are more descriptive than the terms "total resistance" and "partial resistance" for parallel connections. We recommend that you use these terms, particularly if they are used in the students textbooks. The set of magnetically adhering electrical symbols for the demonstration board enables circuits to be demonstratively labelled. The set consists of V and A indicators as well as blanks on which whatever is appropriate can be written, e.g. the connections for current and voltage measurements. The blanks can also be used to label the applied voltage or to describe resistances, positions, switch settings etc..

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