Voltage in a series connection (Item No.: P1381600)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Electricity
Subtopic: The electrical resistance
Experiment: Voltage in a series connection

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

Additional Requirements:

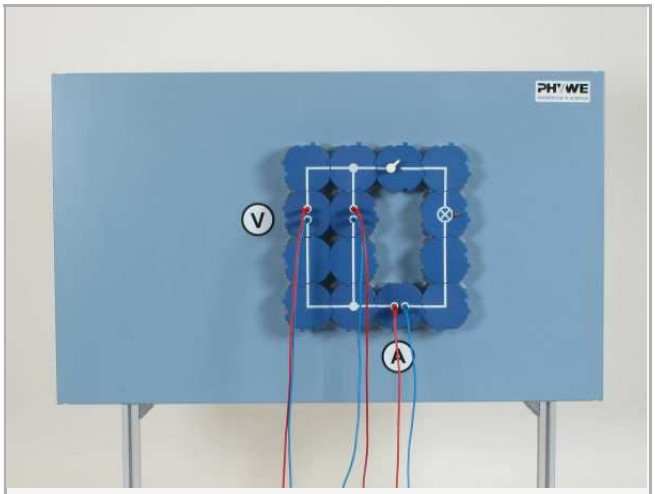
Experiment Variations:

Keywords:

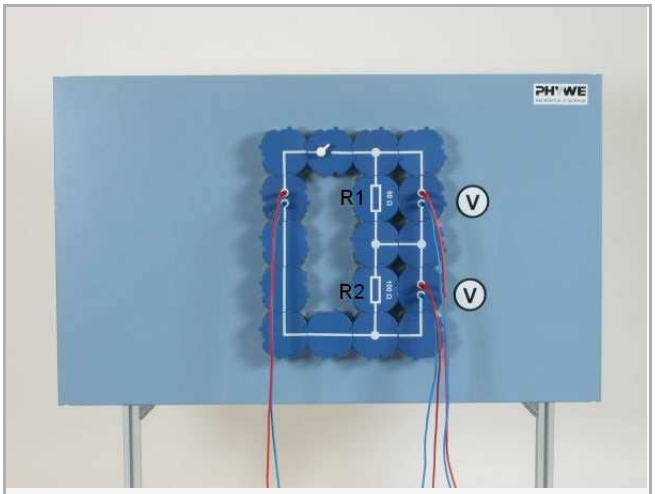
Principle and equipment

Principle

A statement the voltage conditions in an unbranched circuit is to be worked out using a series connection of two electrical devices.



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	1
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	5
11	Connector, angled, module DB	09401-02	4
12	Connector, T-shaped, module DB	09401-03	4
13	Filament lamps 4V/0.04A, E10, 10	06154-03	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; adjust the power supply to 4 V- and select the 10 V- and 100 mA measurement ranges.
- Close the switch; take notice of the brightness of the lamp, measure the current and note it (1).
- Remove the straight connector module 1 from the circuit and replace it by the resistor $R_v = 100\Omega$; observe the brightness of the lamp (2).
- Increase the power supply voltage until the current has again reached its original value, note the voltage required and note it (3).

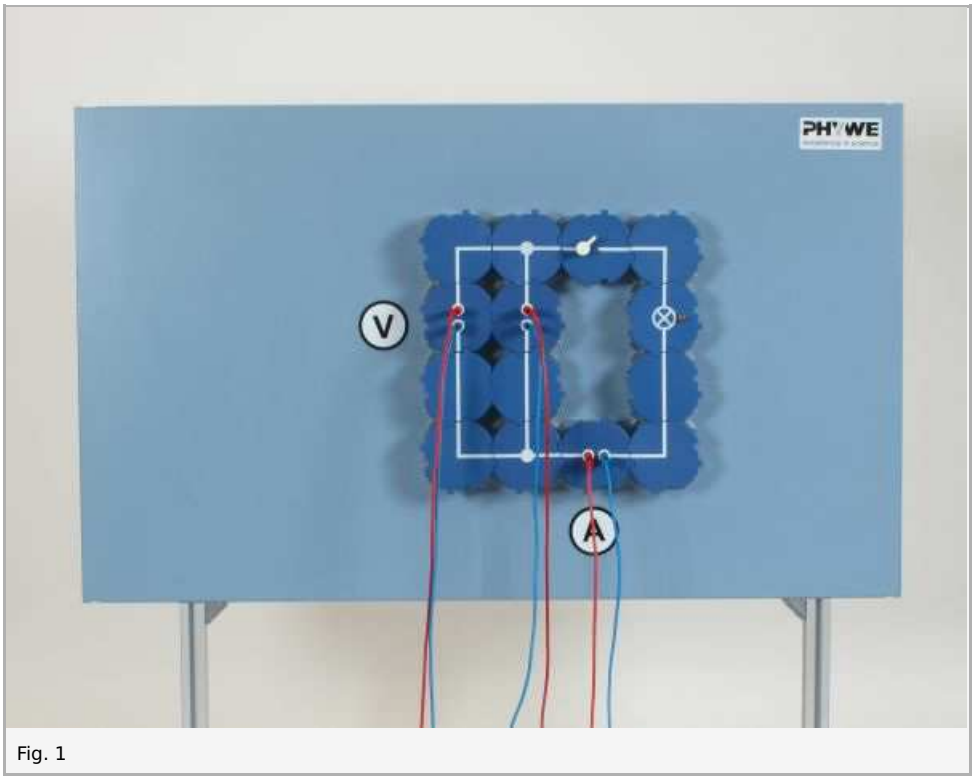

Fig. 1

2nd. Experiment

- Connect up the circuit as shown in Fig. 2; adjust the power supply voltage to 10 V-.
- Close the switch, measure the partial voltages U_1 (across R_1) and U_2 (across R_2); enter the measured values in Table 1.
- Finally, after changing the circuit (broken line in Fig. 2), measure and note the total voltage U_t (across R_1 and R_2).

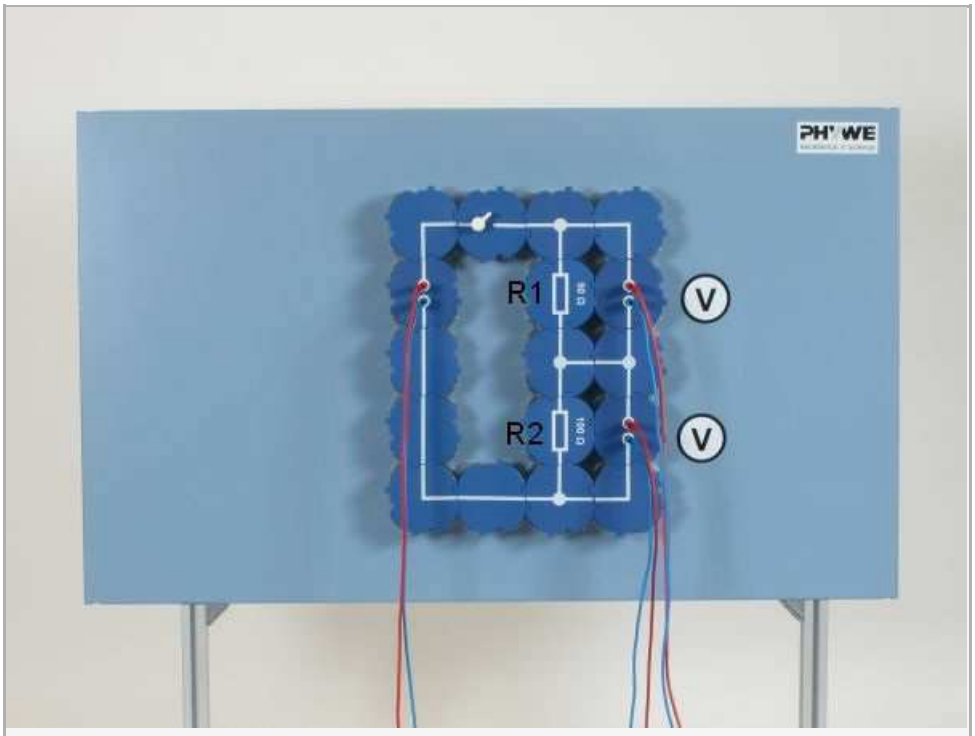

Fig. 2

Observation and evaluation

Observation

1. *I*=0.04 A
2. The brightness of the lamp is much less after connecting the resistor than it was before doing so.
3. A voltage of 8 V is required to bring the lamp back to its original brightness.

Table 1

$\frac{U_1}{V}$	$\frac{U_2}{V}$	$\frac{U_G}{V}$
3.3	6.5	10

Evaluation

As proved in the first experiment, an electrical device can be operated at a higher voltage than its rated voltage by inserting a resistance (series resistance) into the circuit in front of it. A comparison of the voltage values in Table 1 shows, within the limits of measurement error, that:

$U_G = U_1 + U_2$.

In a series connection the total voltage is equal to the sum of the partial voltages. A comparison of the partial voltages with the partial resis- tances shows, within the limits of measurement error, that:

$U_1/U_2 = R_1/R_2$.

In a series connection, the partial voltages behave like the partial resistances. From this we obtain:

$U_1/R_1 = U_2/R_2$

and, takingU_G and R_G into consideration:

$U_G/R_G = U_1/R_1 = U_2/R_2$.

This relationship is synonymous with: $I = I_1 = I_2$, as $U/R = I$.

Remarks

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.. It is also possible to carry out this experiment with just one voltmeter. When several are used, then the instrument errors should compensate each other to the extent that convincing results are obtained. The term total current is deliberately not used, because it could cause confusion.