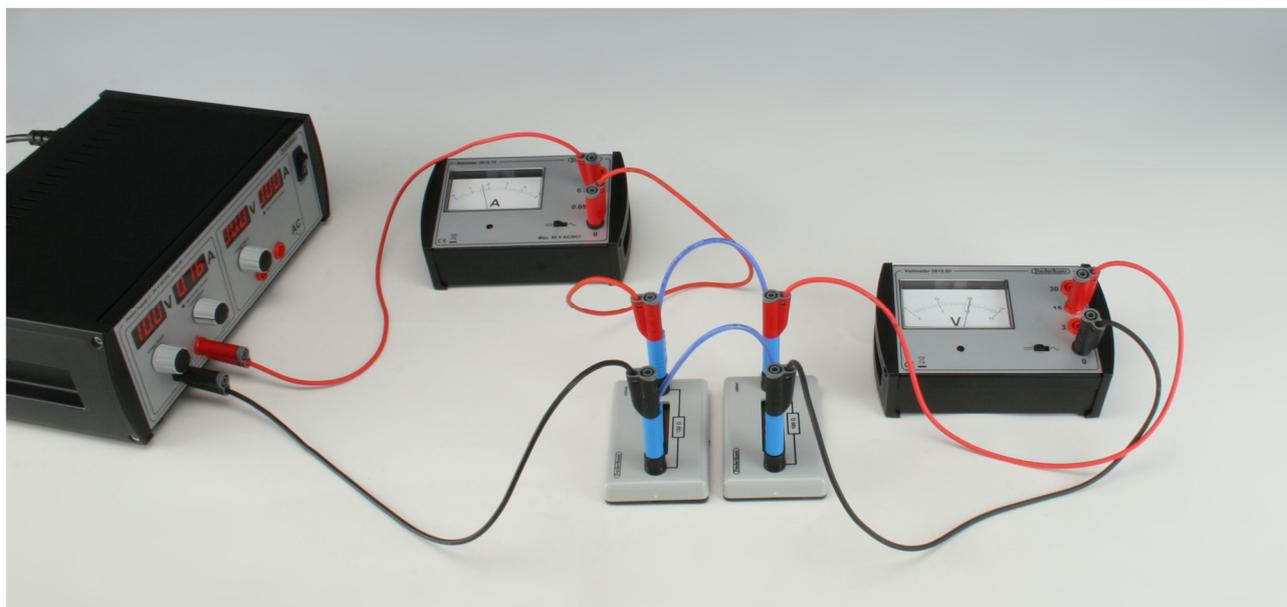


Experiment number	136030-EN	Topic	Electricity		
Version	2017-06-07 / HS	Type	Student exercise	Suggested for	grade 7-9
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## Objective

To investigate the behaviour of current, voltage and resistance in series and parallel circuits with two resistors. The formulae for the total resistance in these two cases are validated.

## Principle

Current and voltage are measured with two analog instruments. The resistance is found using Ohm's law – both for the two resistors individually and for the series and parallel circuits.

## Equipment

(Detailed list on page 4.)

Resistor 100  $\Omega$ , 1 %, 10 W

Resistor 150  $\Omega$ , 1 %, 10 W

Voltmeter

Ammeter

Power supply

Lab leads

## Resistors

Wires, filaments, resistors in electronics – and most other things – conducts a current when connected to a voltage difference. If it takes a large voltage to drive a current through a component, we say it has a high resistance.

Resistors used in electronic devices come in many different shapes. The smallest are the size of grains of salt (0.4 x 0.2 x 0.25 mm) – the largest are so heavy and bulky that they must be secured by bolts.



## Procedure

The voltmeter can use the 15 V range in all 3 parts of the experiment. The current through the voltmeter can be considered as zero.

Use the ammeter in the 0.5 A range in part 1 and 3. In part 2, it is best to use the 0.05 A range.

### 1 – A single resistor

See schematics to the right

*Start with* the 100  $\Omega$  resistor and build the circuit for the current (shown with thick black lines): From the power supply to the ammeter, next to the resistor, and finally back to the power supply.

*Then* add the last two wires to the voltmeter (shown with grey lines).

Adjust the power supply to put 15 V across the resistor. (If the power supply only goes to 12 V, use 12 V.) Write down the voltage.

Measure the current through the resistor. (Remember to write down all measurements.)

Turn the power supply down and

Turn down the power supply and change the resistor to 150  $\Omega$ .

Take again a current reading with 15 V (or 12 V) across the resistor. (Use save voltage as before!)

Turn down the power supply afterwards

### 2 – Series circuit

Connect the two resistors in series – see schematics to the right.

Every time the circuit is rebuilt: Remove the voltmeter completely, build the circuit for the current, and finally add the voltmeter again.

Adjust the voltage across the series connected resistors to 10 V.

Measure the current through the resistors – **do not** turn down the power supply yet – more measurements follow with the same current:

Move the wires to the voltmeter in order to measure the voltage across the 100  $\Omega$  resistor alone. Draw the schematics of the circuit after this change.

Move the wires to the voltmeter in order to measure the voltage across the 150  $\Omega$  resistor alone. Draw the schematics of the circuit as it looks now.

(Remember to write down all measurements.)

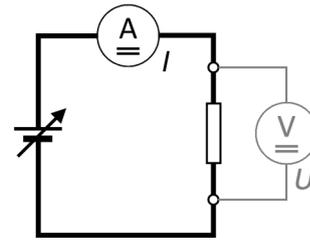
### 3 – Parallel circuit

Connect the two resistors in parallel – see schematics to the right.

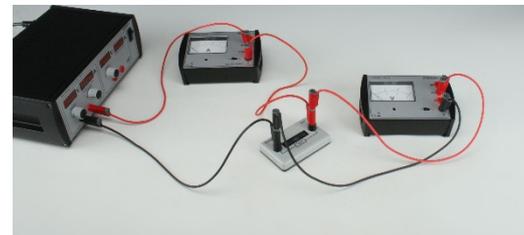
Adjust the voltage across the parallel connected resistors to 15 V. (Or 12 V – the same as in part 1.)

Measure the current running through the parallel circuit. (Write down...)

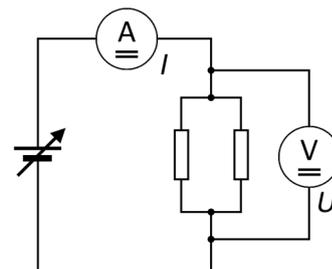
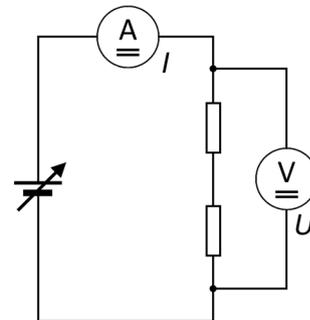
Finally, turn the power supply down.



a ...



b ...



## Theory

Ohm's law – in three equivalent forms:

$$U = R \cdot I \quad I = \frac{U}{R} \quad R = \frac{U}{I}$$

Two resistors  $R_1$  and  $R_2$  in a series circuit can be substituted by a single resistor with the resistance

$$R_S = R_1 + R_2$$

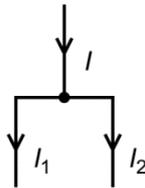
Two resistors  $R_1$  and  $R_2$  in a parallel circuit can be substituted by a single resistor with the resistance

$$R_P = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

Kirchhoff's current law:

The total current flowing into a node is equal to the total current flowing out of the node:

$$I = I_1 + I_2$$



## Calculations

Use the measured values of voltage and current together with Ohm's law to determine the resistance of the two individual resistors.

Likewise, determine the resistance of the series circuit and the parallel circuit from the measured voltages and currents.

Calculate the theoretical value of the resistance of the series circuit and the parallel circuit. Use the nominal resistances of the two resistors.

## Discussion and evaluation

How well do your experimentally determined resistance values match the nominal (printed) values of the two resistors?

How well do the experimentally determined resistances match the theoretical resistance values for the series and the parallel circuits?

Explain how Kirchhoff's current law can be used on the parallel circuit. Do the measured currents agree with Kirchhoff's current law?

Consider the three voltages measured on the series circuit. Try to formulate a rule for voltage drops in a series connection.

## Teacher's notes

### Concepts used

Voltage  
Current  
Series circuits  
Parallel circuits  
Ohm's law  
Kirchhoff's current law

### Mathematical skills

Simple expression evaluation

### About the equipment

The instruments 381560 and 381570 are overload protected. They also tolerate reverse polarity, although only positive values can be measured.

It is possible to read the current on a built-in ammeter on the power supply if you don't want to use an external instrument.

It is not possible to complete these measurements without an external voltmeter.

## Detailed equipment list

### Specifically for the experiment

381560 Voltmeter  
381570 Ammeter  
420541 Resistor 100  $\Omega$ , 1 %, 10 W  
420546 Resistor 150  $\Omega$ , 1 %, 10 W

### Standard lab equipment

364000 Power supply  
(Alternative power supplies: 362510, 361600)  
105720 Safety cable 50 cm, black (qty. 2)  
105721 Safety cable 50 cm, red (qty. 3)  
105713 Safety cable 25 cm, blue (qty. 2)