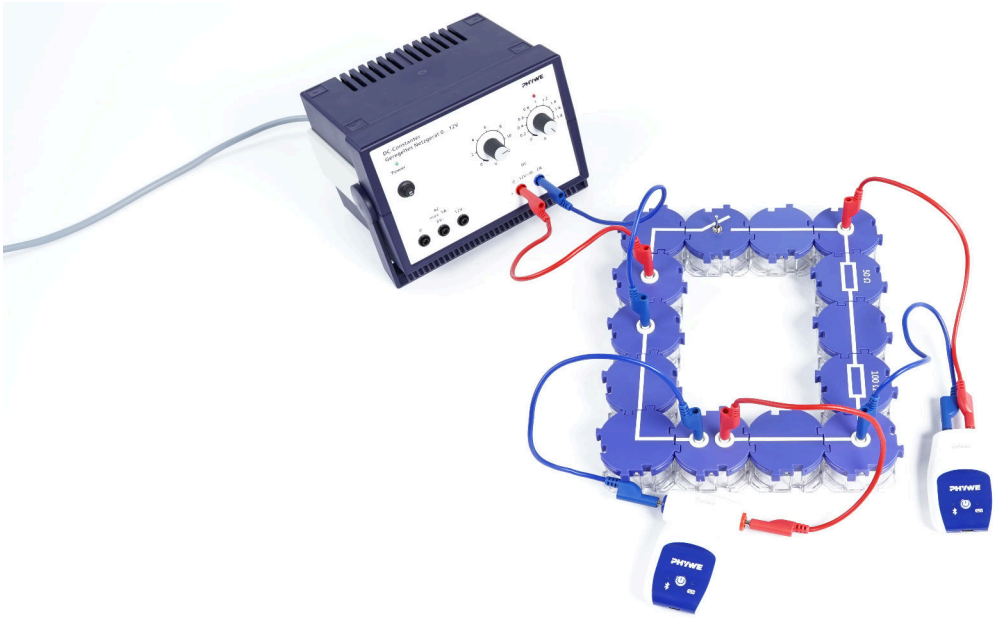
Current and resistance in a series circuit with Cobra SMARTsense



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

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	10 minutes

This content can also be found online at:

https://www.curriculab.de/c/67fe150b6d3a890002ed542d

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Teacher information

Application

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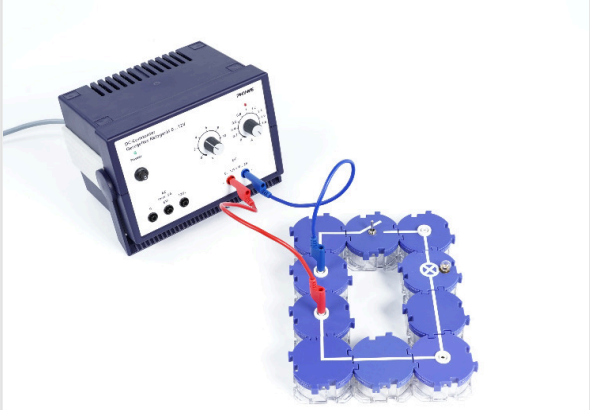

First test setup

Series circuits are used in many electrical devices, but they are particularly illustrative when it comes to fairy lights. In the past, fairy lights were connected in series. However, the disadvantage was that if one bulb failed, the entire chain of lights would go out immediately. For this reason, they are rarely built with a series connection today.

Alarm systems are another example where series circuits are still used.

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Other teacher information (1/3)

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Prior knowledge

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

Principle

In the first part of the experiment, incandescent lamps are added one by one to a series circuit, and qualitative observations of their brightness are made.

In the second part of the experiment, the total current is first measured for two resistors of different sizes, which are then connected in series. Finally, the individual currents are measured before, between, and after the two resistors.

Other teacher information (2/3)

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Learning objective

Using the measured values they have determined, the students should be able to recognise the relationship between the partial currents I_i of a series connection and the total current I_T. In addition, they should learn the relationship between partial resistances R_i and total resistance R_T in a series connection.

Task

Investigate the relationship between the total current strength I_T and the individual currents I_i, as well as between the total resistance R_T and the individual resistances R_i in a series connection.

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Other teacher information (3/3)

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Notes

The first part of the experiment serves as a preliminary investigation to define the problem and to introduce the laws of series circuits in a qualitative manner.

These principles will be quantified in the subsequent parts of the experiment. The fact that in the second part R_1 and R_2 are not immediately connected in series, but that both resistance values are first determined experimentally, has the advantage that the procedure mirrors the first part of the experiment and allows for a comparison between the measured values of R_1 and R_2 and the total resistance R_T.

In the second part of the experiment, the applied voltage must be kept constant. Before each current measurement, students must check the voltage and adjust it to $10\ \mathrm{V}$.

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

Motivation

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Fairy lights - light bulbs connected in series

Series circuits are used in many electrical appliances, but their properties become particularly apparent in fairy lights. In the past, light bulbs were connected in series. However, since the entire chain goes out immediately if one bulb fails, they are no longer commonly installed in series today.

Alarm systems are another example. In this case, the various switching contacts are connected in series and form an "alarm loop." As soon as one contact is interrupted, the alarm is triggered.

In this experiment, you will learn how current and resistance behave in a series circuit.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Voltage, ± 30 V (Bluetooth)	12901-00	1
2	Cobra SMARTsense - Current, ± 1 A (Bluetooth)	12902-00	1
3	Straight connector module, SB	05601-01	2
4	Angled connector module, SB	05601-02	4
5	Interrupted connector module with sockets, SB	05601-04	1
6	Junction module, SB	05601-10	2
7	Straight connector module with socket, SB	05601-11	1
8	Angled connector module with socket, SB	05601-12	2
9	On-off switch module, SB	05602-01	1
10	Socket module for incandescent lamp E10, SB	05604-00	2
11	Resistor module 50 Ohm, SB	05612-50	1
12	Resistor module 100 Ohm, SB	05613-10	2
13	Connecting cord, 32 A, 250 mm, red	07360-01	2
14	Connecting cord, 32 A, 250 mm, blue	07360-04	2
15	Connecting cord, 32 A, 500 mm, red	07361-01	1
16	Connecting cord, 32 A, 500 mm, blue	07361-04	1
17	Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
18	PHYWE Power supply, 230 V,DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
19	measureAPP - the free measurement software for all devices a	14581-61	1

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Setup (1/2)

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To measure with the **Cobra SMARTsense sensors**, the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the respective app store (QR codes below). Please check that **Bluetooth is enabled** on your device (smartphone, tablet, desktop PC) before starting the app.

Android

iOS

Windows 10

Setup (2/2)

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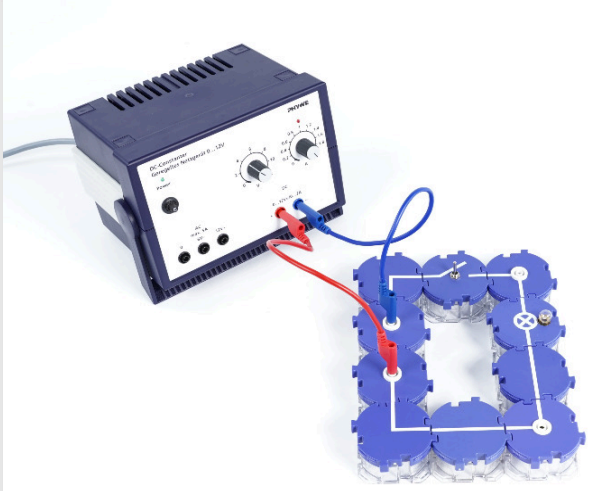

First setup

Experimental part 1:

- First set up the circuit as shown in the illustrations below.
- The switch is initially open. Insert the $4\ \mathrm{V}$ bulb into the bulb holder.

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Procedure

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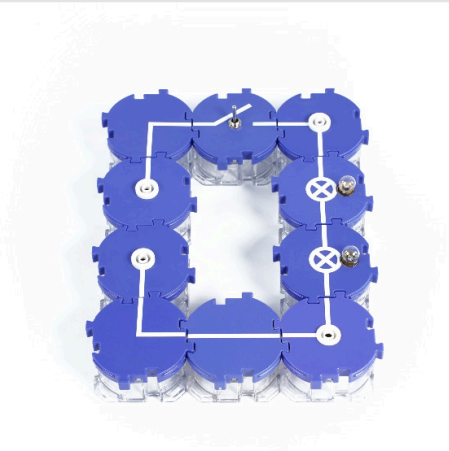
Experimental part 1:

- Set the DC voltage to $4\ \mathrm{V}$ on the power supply unit and set the current limiter to $1\ \mathrm{A}$. Close the switch.
- Observe the brightness of the light bulb.
- Now install a second light bulb in front of the first light bulb, as shown in the illustration on the right.
- Observe the brightness of the light bulbs and compare it with the previous brightness of the individual light bulb.
- Think about how the observations can be justified.



Series connection with two light bulbs

Setup (1/2)

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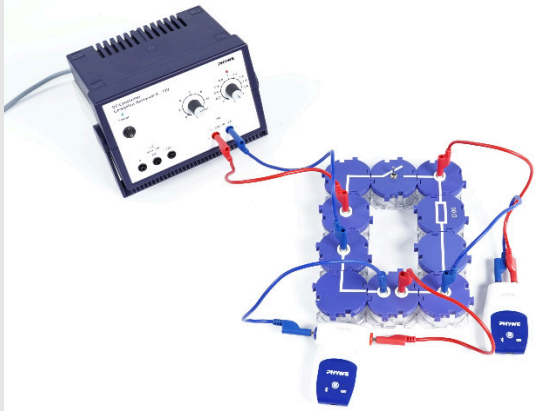

Experimental Setup

Experimental part 2:

- Now build the circuit as shown in the adjacent figure with the resistor $R_1 = 50\,\Omega$ on.
- If you click on the blue button on the left, you will see the setup without connected devices

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Setup (2/2)

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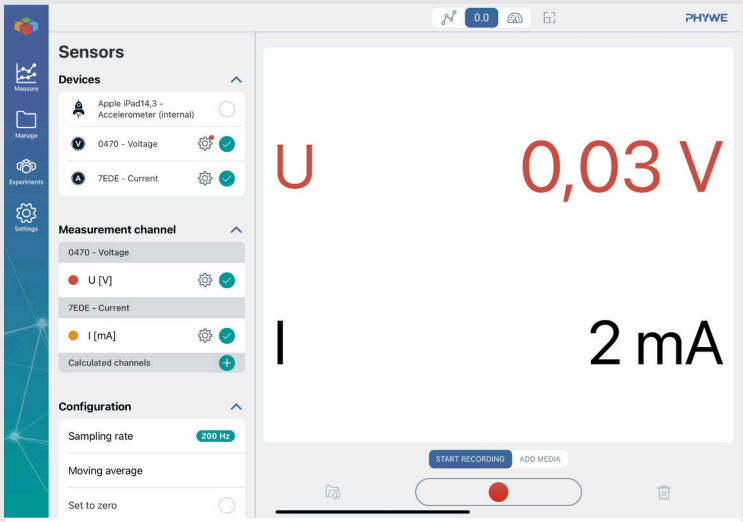

Example screenshot of the app

- Start both Cobra SMARTsense sensors by pressing and holding the on/off button on each device for about three seconds.
- Then open the measureAPP and connect to both sensors. Adjust the display so that the measured values are shown as numbers. To do this, tap on "0.0" at the top of the app. You can see what this looks like on the left-hand side.

Procedure (1/3)

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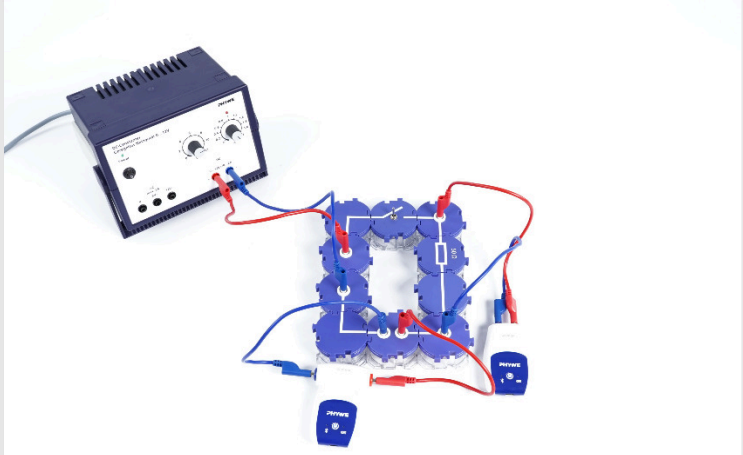

Measurement of U and I with $R = 50\Omega$

Experimental part 2:

- Now switch on the power supply unit and set it to $10\ \mathrm{V}$ and $1\ \mathrm{A}$.
- Measure the measured voltage and current. Note down your measurements.

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Procedure (2/3)

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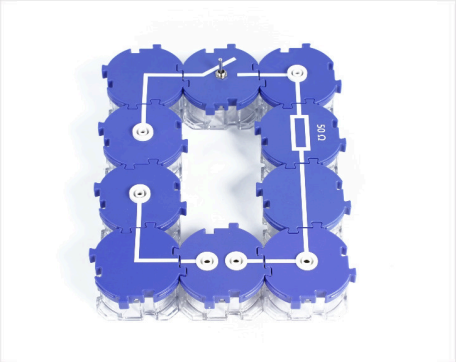
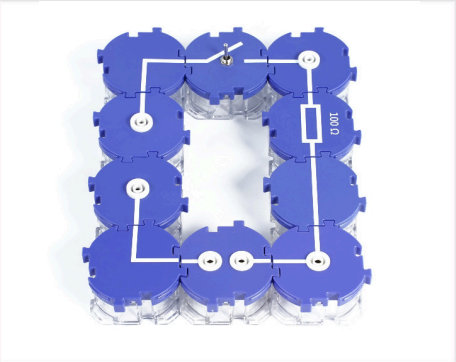
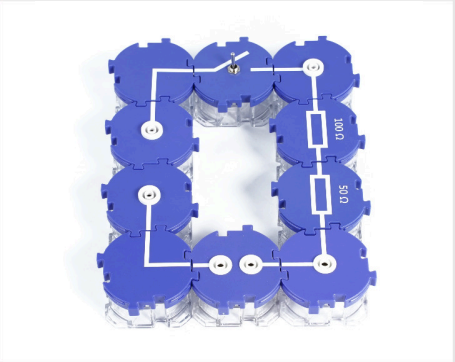
- Replace the resistor with the resistor $R_2 = 100\,\Omega$ (Fig. in the centre). Calibrate the voltage to $10\ \mathrm{V}$ and measure the current.
- Replace the line component in front of the resistor R_2 with the resistor $R_1 = 50\Omega$ (Fig. right), adjust the voltage to $10\ \mathrm{V}$ again and measure the current again. Note both measured values in the log.







Procedure (3/3)

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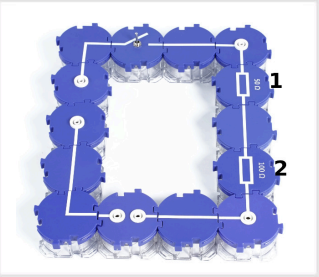
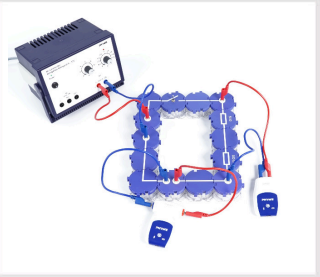
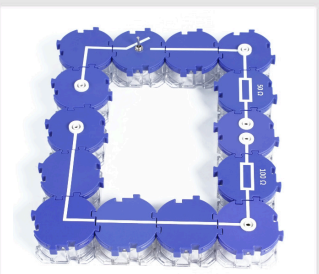
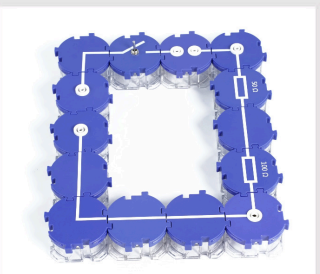
- Change the series connection according to the two figures above.
- Set the DC voltage to $10\ \mathrm{V}$.
- Measure the amperage before R_1, between R_1 and R_2 and behind R_2 and note the values. To do this, after the first measurement, connect the current sensor to the circuit where the power modules 1 and 2 were initially located (Fig. below left, below right).
- Note your measured values in the log and switch off the power supply unit.









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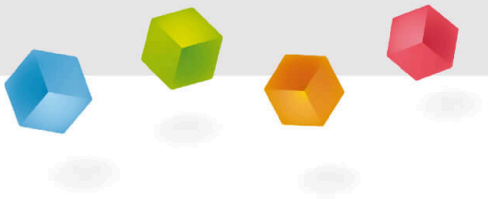

Report

Task 1

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After the second light bulb has been added...

- ...the first light bulb shines brighter than the second.
- ...the second light bulb shines brighter than the first.
- ...both bulbs light up equally brightly.
- ...no light bulb lights up.

After the second light bulb has been added,...

- ...the brightness of the first light bulb has decreased.
- ...the brightness of the first light bulb has increased.
- ...the first light bulb no longer lights up.
- ...the brightness has remained the same.

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Task 2

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Enter the measured values for the second part of the experiment in the table.

Then calculate the values for R from the measured voltages and the resulting currents and enter them in the third column.

Resistors	U [V]	I [A]	R [Ω]
$R_1 = 50\,\Omega$			
$R_2 = 100\,\Omega$			
R_1 & R_2			

What is the relationship between the resistances R_1, R_2 and R_T (R_1 and R_2 in row) in the right-hand column, taking possible measurement errors in account?

- $R_T = R_1 + R_2$
- $R_T = R_1 - R_2$
- $R_T = R_1 \cdot R_2$

Task 3

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Enter the measured currents for the different measuring positions X relative to the resistors R_1 and R_2 in the table.

Position (X)	I [A]
$X - R_1 - R_2$	
$R_1 - X - R_2$	
$R_1 - R_2 - X$	

Which formula can be derived from the measurements for the current in a series circuit? Think about why this is the case.

- $I_T = I_1 \cdot I_2$
- $I_T = I_1 - I_2$
- $I_T = I_1 = I_2$
- $I_T = I_1 + I_2$

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Slide	Score / Total
Slide 19: Multiple tasks	0/2
Slide 20: Relationship between partial and total resistance	0/1
Slide 21: Relationship between current intensity and position	0/1

Total amount 0 / 4

Solutions Repeat Export text

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