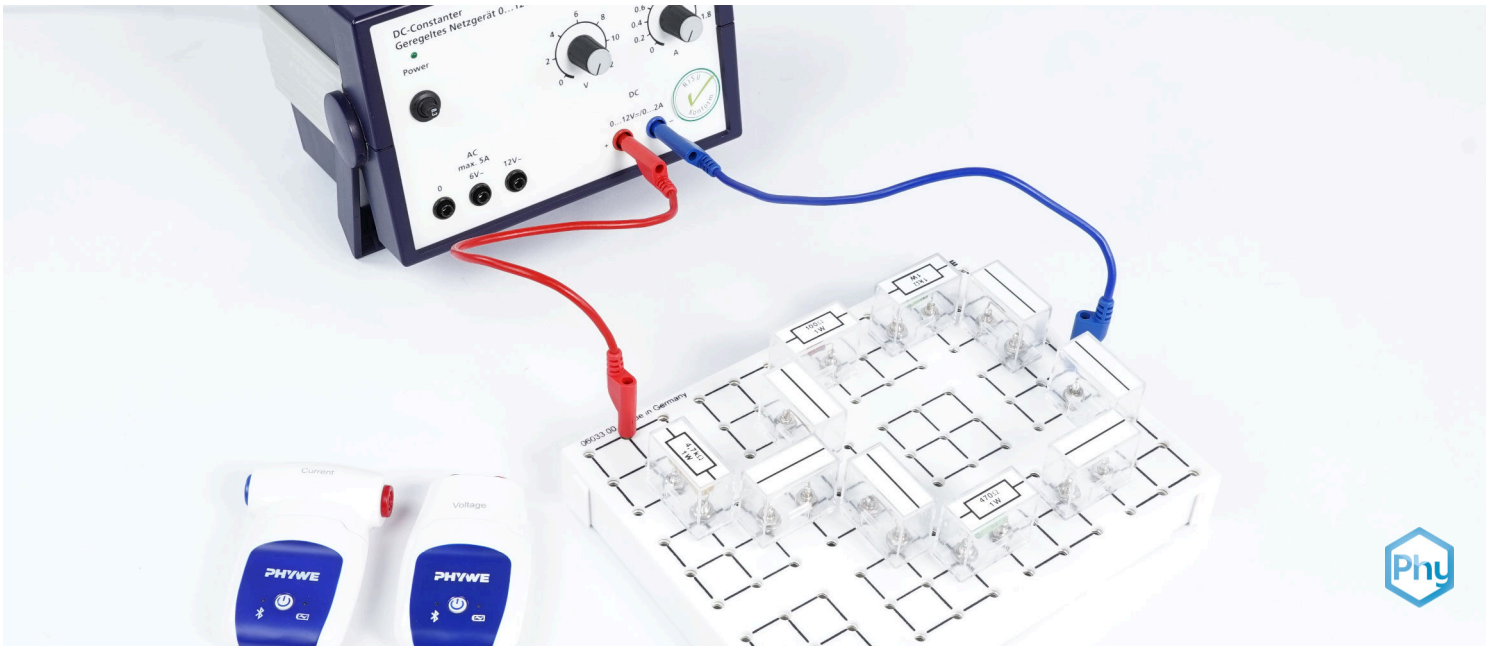
Kirchhoff's laws with Cobra SMARTsense



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

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	20 minutes

This content can also be found online at:

https://www.curriculab.de/c/67aa71a4945666000274bd1e

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Teacher information

Application

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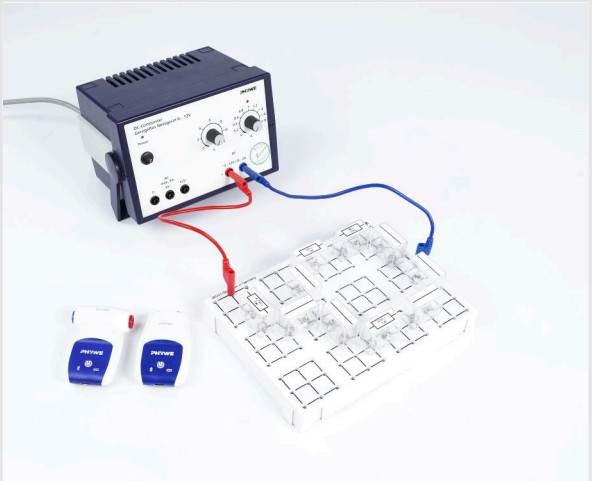

Experimental setup

Kirchhoff's laws are central tools for analysing electrical circuits. The first law, the node rule, states that at every branching point in a circuit, the sum of the incoming currents is equal to the sum of the outgoing currents. It ensures that no charge is lost. The second law, the mesh rule, states that the sum of all voltages in a closed loop is zero.

This makes the energy distribution in a circuit comprehensible. Both laws are essential for calculating and optimising complex networks.

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Other teacher information (1/2)

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Prior knowledge

The students should be able to build a circuit independently. They should also have a basic understanding of electrical quantities such as voltage, current and resistance.

Principle

In the experiment, a circuit is set up in which various resistors are connected in such a way that both the node and the mesh rule can be worked out independently. To do this, the voltage at the individual components and the currents at the node are measured and added or subtracted.

Other teacher information (2/2)

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Learning objective

The aim of the experiment is to learn about the distribution of currents and voltage in an electrical circuit.

Tasks

1. The currents running in and out of the nodes should be measured
2. The voltages at the individual resistors should be measured
3. Kirchhoff's rules are to be derived

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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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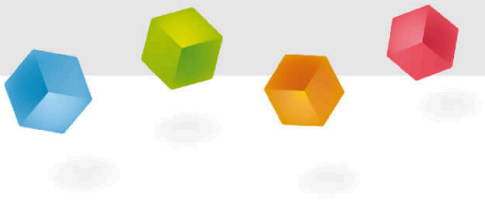

Student information

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Motivation

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Have you ever wondered how electricity really flows through the wires in your house, or how voltage spreads across a circuit? That's exactly what you'll find out in our experiment! Kirchhoff's laws allow us to calculate the current and voltage in any circuit, even if several components are connected to each other.

Understand these laws yourself and find out how current and voltage behave in different circuits. Kirchhoff's laws are much more than just theory - they are the basis for almost every electrical application.

Tasks

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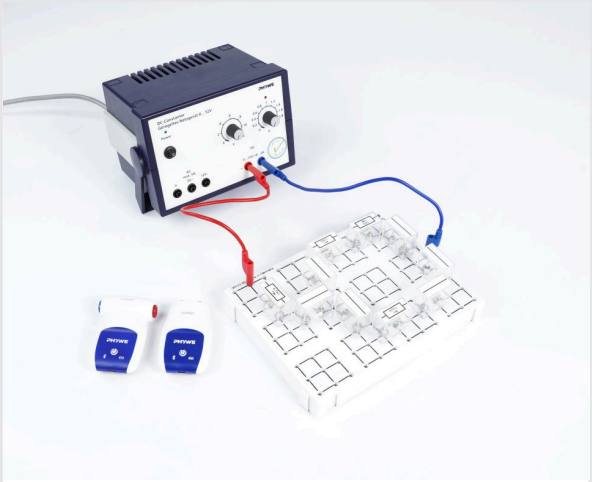

Experimental setup

1. Build a circuit with resistors and junctions.
2. Determine the current before and after a node.
3. Determine the voltage of the individual resistors and the power supply unit.
4. Work out the knot and stitch rules.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage ± 30 V (Bluetooth + USB)	12901-01	1
2	Cobra SMARTsense Current - Sensor for measuring electrical current ± 1 A (Bluetooth + USB)	12902-01	1
3	Plug-in board, for 4 mm plugs	06033-00	1
4	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
5	Resistor 10 Ohm, 1W, G1	39104-01	1
6	Resistor 47 Ohm, 1W, G1	39104-62	1
7	Resistor 100 Ohm, 1W, G1	39104-63	1
8	Resistor 470 Ohm, 1W, G1	39104-15	1
9	Connecting cord, 32 A, 250 mm, red	07360-01	2
10	Connecting cord, 32 A, 250 mm, blue	07360-04	2

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Structure (1/2)

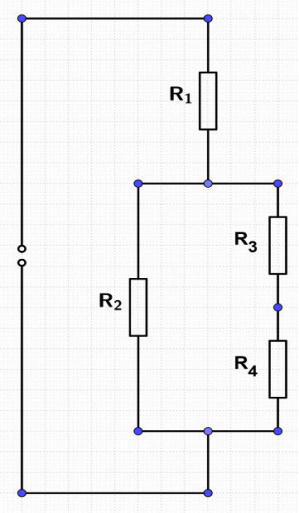
For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check whether your device (smartphone, tablet, desktop PC) is running **Bluetooth activated** is.

iOS

Android

Windows

Structure (2/2)



Experimental setup Circuit diagram

Set up the experiment according to the circuit diagram shown.

Set the power supply unit to approx. 6 V and 1 A and switch it on.

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Procedure (1/3)

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Cobra SMARTsense sensors

Switch on your Cobra SMARTsense Voltage and Cobra SMARTsense Current Sensor by pressing and holding the button on the sensors for 3 seconds.

Open the measureAPP on your tablet or smartphone and make sure that the end device can connect to Bluetooth devices.

Connect both sensors to the app by selecting the Cobra SMART sense Voltage and Cobra SMARTsense Current Sensor under Sensors.

Set the sampling frequency to 10,000 Hz in the measureAPP under Configuration.

Procedure (2/3)

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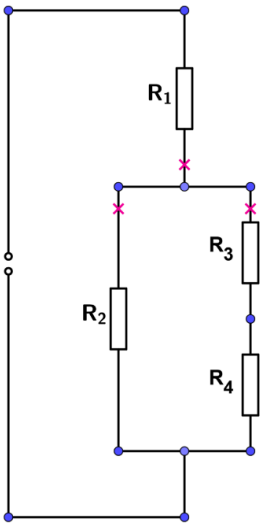

Using the Cobra SMARTsense Current Sensor, measure the current at the points shown as pink crosses.

Use the digital display in the MeasureAPP for this. To do this, click on the centre box above the measurement data, which is labelled 0.0.

Then enter the determined values in the table in the protocol section.

Can you already see how the current behaves at the node?

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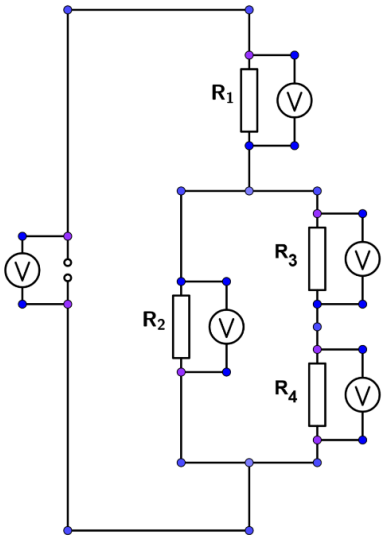
Procedure (3/3)



Now use the Cobra SMARTsense Current Sensor to measure the voltages at all resistors and at the power supply unit. You can also read the results directly from the digital measurement display in the measureAPP.

Enter the measured values in the table in the protocol section.

What correlations can you recognise between the measured values?

Report

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Evaluation (1/4)

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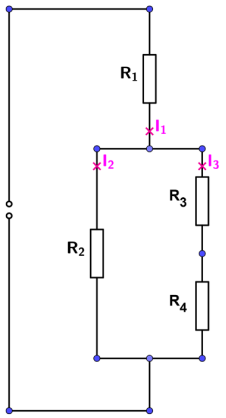
Enter the measured currents in the appropriate boxes. Can you recognise a connection between the values?



$I_1 =$ ☐

$I_2 =$ ☐

$I_3 =$ ☐

Which of the following relationships applies to the currents you have determined? I to?

- $I_1 = I_2 + I_3$
- $(I_2 + I_3)/I_1 = 0$
- $I_1 \cdot I_2 \cdot I3 = 100A$
- $I_1 = I_2 = I_3$

Evaluation (2/4)

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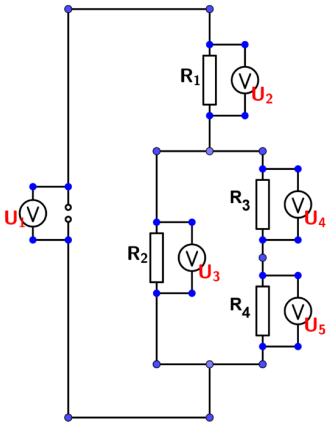
Enter the measured voltage values in the appropriate boxes. Can you recognise a connection between the values?



$U_1 =$ ☐

$U_2 =$ ☐

$U_3 =$ ☐

$U_4 =$ ☐

$U_5 =$ ☐

Which of the following relationships applies to the voltages you have determined? U to?

- $U_1 = U_2 = U_3 = U_4 = U_5$
- $U_1 = U_2 + U_3 = U_2 + U_4 + U_5$
- $U_1 \cdot U_2 = U_3 + U_4 + U_5$
- $U_1 = U_2 + U_3 + U_4 + U_5$

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Evaluation (3/4)

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Fill in the missing words.

Kirchhoff's first law is the node rule. It states that the _____ of all currents flowing into a node (connection point of lines) is equal to the sum of all currents _____. By definition, the current flowing in is _____ and the current flowing out is negative. Therefore, the total sum of the currents at a node is always _____. This means that no electrical charge is generated or destroyed at a node. The law of charge _____ applies.

Check

Evaluation (4/4)

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Drag the words into the correct boxes!

Kirchhoff's second law is the _____. It states that the _____ of all voltages in a mesh (a closed circuit without _____) is equal to _____. The sign of the voltages depends on the selected mesh direction. If the voltage arrows and the mesh direction point in the same direction, the sign is _____; if they point in opposite directions, the sign is _____. The amount of _____ supplied to a voltage source is therefore exactly the same as the amount consumed on the way to the other pole. This corresponds to the law of _____.

- branches
- energy
- negative
- zero
- sum
- positive
- conservation of energy
- mesh rule

Check

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Slide	Score / Total
Slide 16: Current correlations	0/1
Slide 17: Relationships Tensions	0/1
Slide 18: The knot rule	0/5
Slide 19: The mesh rule	0/8

Total amount 0 / 15

Solutions Repeat Export text

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