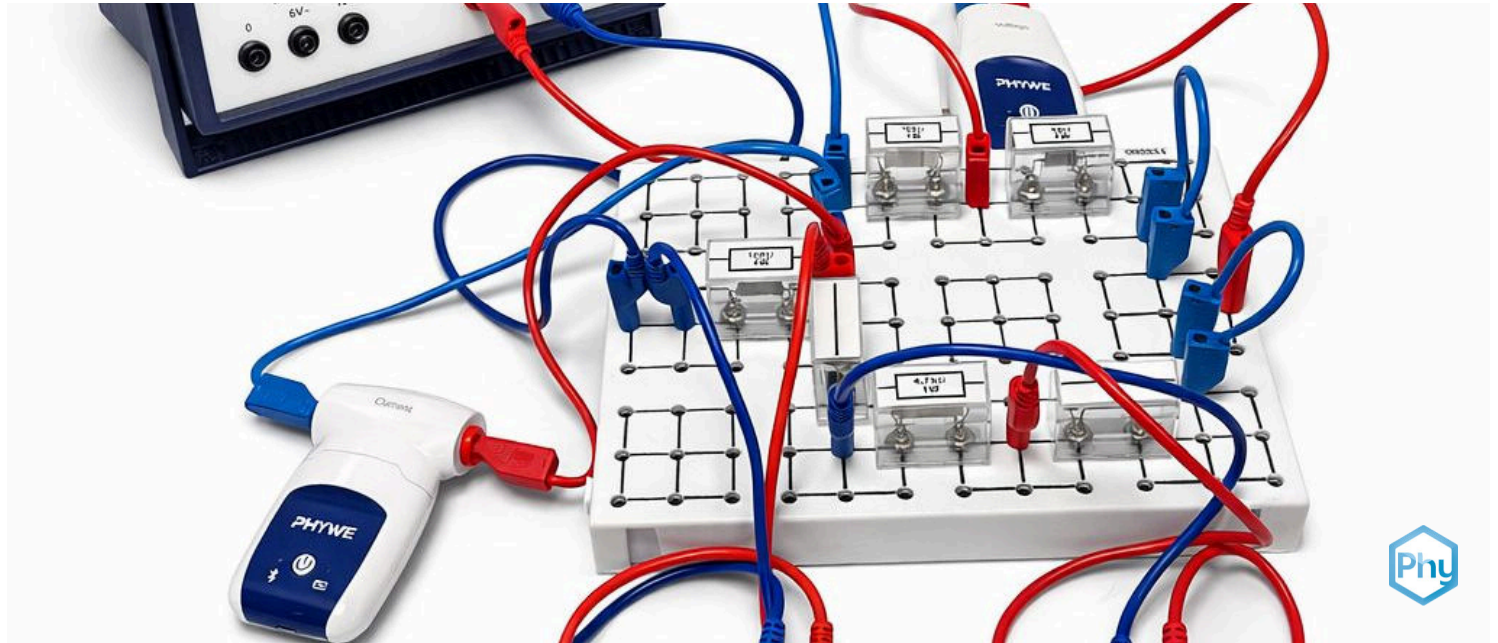


# Kirchhoff's Laws: Kirchhoff's Voltage Law with Cobra SMARTsense



Physics

Electricity &amp; Magnetism

Simple circuits, resistors &amp; capacitors



Difficulty level

easy



Group size

-



Preparation time

10 minutes



Execution time

20 minutes

This content can also be found online at:

<https://www.curriculab.de/c/6983567a4ea2f00002082944>

PHYWE

## Teacher information



## Application

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Experimental setup

Kirchhoff's laws are central tools for analysing electrical circuits. The first law, the current law, states that at every branching point in a circuit, the sum of the incoming currents is equal to the sum of the outgoing currents. No charge is lost. The 2nd law, the voltage law, 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.

In this experiment, the current law is developed.

## 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 the voltage law can be derived independently. To do this, the voltage at the individual components is added or subtracted.

## Other teacher information (2/2)

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### Learning objective



The aim of the experiment is to learn how voltage is distributed in an electrical circuit.

### Tasks



In this experiment, the voltages at the individual resistors are measured first. Then a current is measured at a single resistor and the voltage is determined by calculation. Finally, Kirchhoff's voltage law is to be derived on the basis of these measurement results.

## Safety instructions

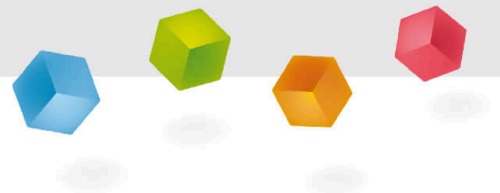
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The general instructions for safe experimentation in science lessons apply to this experiment.

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## Student information



## Motivation

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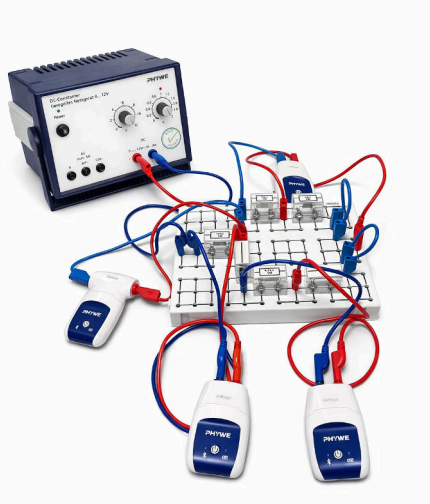
Have you ever wondered how voltage spreads across a circuit? That's exactly what you'll find out in our experiment! Kirchhoff's voltage law allows us to calculate the voltage in any circuit, even if several components are connected to each other.

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

In this experiment you will derive the voltage law yourself.

## Tasks

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Experimental setup

1. Build a circuit with resistors and junctions.
2. Determine the voltage of the individual resistors and the power supply unit.
3. Determine the current at a point in the circuit and calculate the voltage.
4. Work out the voltage law.

## Equipment

Position	Material	Item No.	Quantity
1	Plug-in board, for 4 mm plugs	06033-00	1
2	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage $\pm 30$ V (Bluetooth + USB)	12901-02	3
3	Cobra SMARTsense Current - Sensor for measuring electrical current $\pm 1$ A (Bluetooth + USB)	12902-02	2
4	PHYWE Power supply, 230 V,DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
5	Connecting cord, 32 A, 250 mm, red	07360-01	6
6	Connecting cord, 32 A, 250 mm, blue	07360-04	6
7	Resistor 10 kOhm, 1W, G1	39104-30	1
8	Resistor 4.7 kOhm, 1W, G1	39104-27	1
9	Resistor 1 kOhm, 1W, G1	39104-19	1
10	Resistor 100 Ohm, 1W, G1	39104-63	1
11	Wire building block, housing G1	39120-00	3

## Setup (1/2)

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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



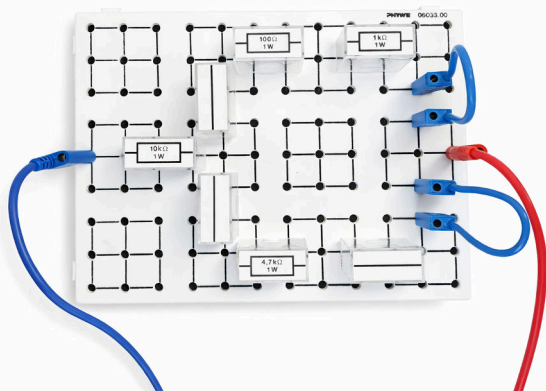
Android



Windows

## Setup (2/2)

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Experimental setup

- Set up the experiment according to the picture shown.
- Set the power supply unit to approx.  $6\text{ V}$  and  $1\text{ A}$  and switch it on.

## Procedure (1/3)

PHYWE

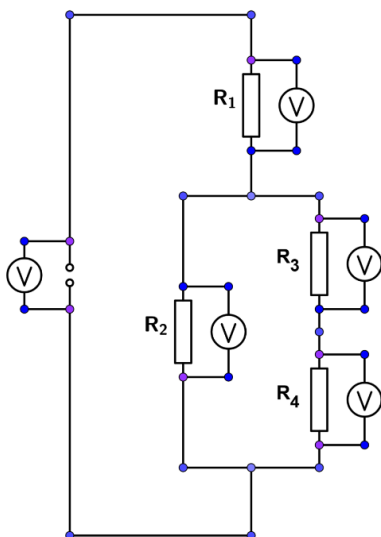



Cobra SMARTsense sensors

- Switch on your Cobra SMARTsense Voltage and Cobra SMARTsense Current sensors 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 all sensors to the app by selecting the Cobra SMART sense Voltage and Cobra SMARTsense Current sensors under Sensors.
- Set the sampling frequency to 10,000 Hz in the measureAPP under Configuration.

## Procedure (2/3)

PHYWE

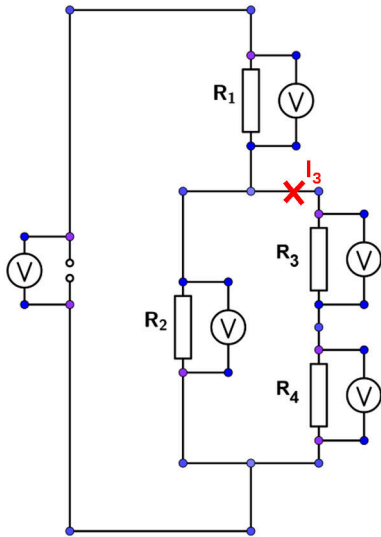


- Using the Cobra SMARTsense voltage sensors, measure the voltage at all resistors and at the power supply unit. To do this, you need to switch the sensors positions once.
- Use the digital display in the MeasureAPP for this. To do this, click on the centre box above the measurement data, which is labelled 0.0.
  - 
- Then enter the values determined under task (1/3) in the log section.
- What correlations can you recognise between the measured values?



## Procedure (3/3)

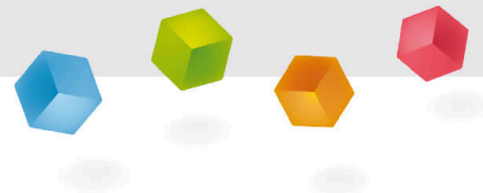
PHYWE



- Now use the Cobra SMARTsense Current Sensor to measure the current  $I_3$  at the marked point.
- Then enter the value determined under task (3/3) in the log section.

PHYWE

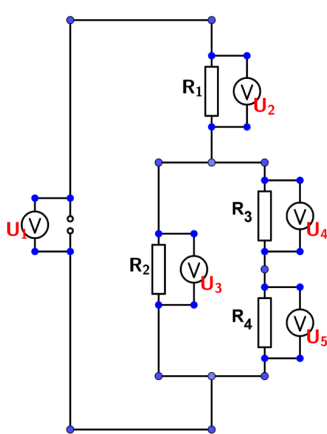
## Report



## Task (1/3)

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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  $U$  you have measured?

$$U_1 = U_2 + U_3 + U_4 + U_5$$

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

$$U_1 = U_2 + U_3 = U_2 + U_4 + U_5$$

$$U_1 = U_2 = U_3 = U_4 = U_5$$

## Task (2/3)

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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

negative

sum

positive

conservation of energy

zero

energy

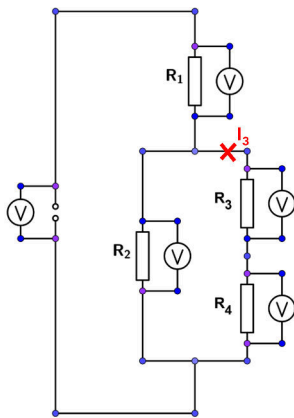
voltage law

✓ Check

## Task (3/3)

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Enter the measured current value  $I_3$  into the appropriate box.  
Calculated the voltage using Ohm's law.



$$I_3 = \boxed{\phantom{000}}$$

$$U_{cal.} = \boxed{\phantom{000}}$$

How does the calculated voltage value differ from the measured value? Why?

Slide

Score/Total

Slide 16: Relationships Tensions

0/1

Slide 17: The mesh rule

0/8

Total amount

 0/9

Solutions

Repeat

Export text