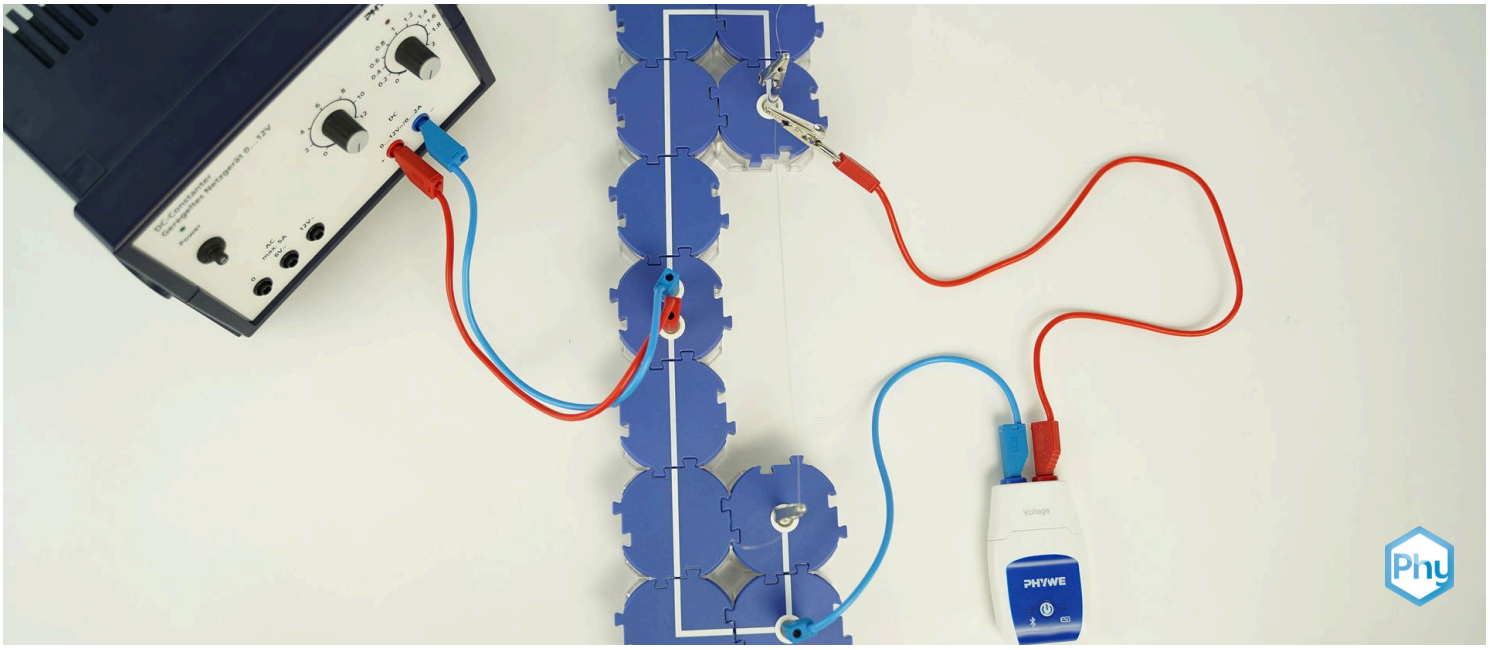
The potentiometer with Cobra SMARTsense



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

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	20 minutes

This content can also be found online at:

http://localhost:1337/c/638c80060783cf00038d1559

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Teacher information

Application

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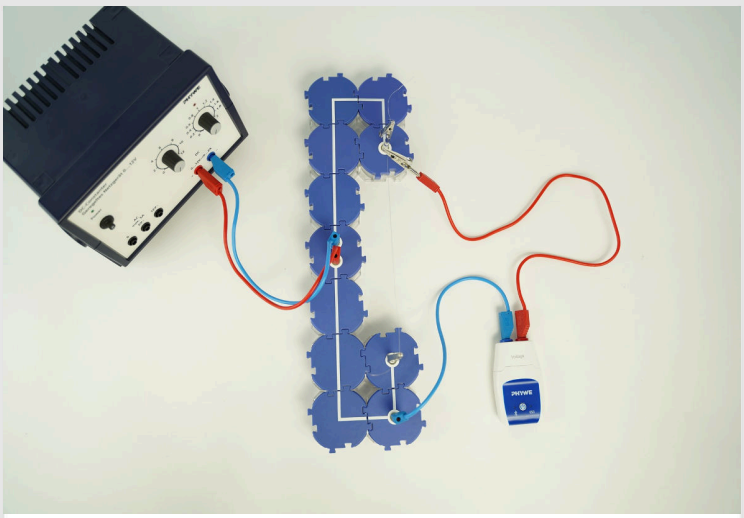

Experimental setup

Potentiometers are electrical resistance components whose resistance values can be changed mechanically (by turning or moving). It has at least three connections (two fixed contacts and a slider) and is mainly used as a continuously adjustable voltage divider. A variable resistance can be tapped via the wiper. Potentiometers are often used to control electronic devices, such as for setting an amplifier, e.g. the volume setting of a sound amplifier, e.g. in a radio or television set.

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Other teacher information (1/3)

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Prior knowledge

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

Learning objective

The students should understand the principle of a potentiometer by means of a model and experience its function in a vivid way with a technical potentiometer.

Other teacher information (2/3)

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Task

Investigate the operating principle of a potentiometer using a potentiometer model. Then vary the brightness of a light bulb with the help of a technical potentiometer.

Principle

A potentiometer represents a voltage divider. If an electrically conductive resistor is tapped at evenly distributed sections with a wiper, it is in principle a series connection of many identical resistors for which applies: $U_1/R_1 = U_2/R_2 = ... = U_n/R_n$. Thus the wiper can change the resistance value and thus also the partial voltage dropping until then almost steplessly.

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Other teacher information (3/3)

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Notes

For a homogeneous wire applies: $I_1/R_1 = I_2/R_2 = ... = I_n/R_n$. When dealing with the potentiometer, one should also use the descriptive term voltage divider.

The choice of lengths l in the first experiment is in itself arbitrary. The measured values for l and U are better comparable with each other if the lengths of the wire pieces are roughly like 4:3:2:1.

In the second experiment, care should be taken that the specified voltage at the power supply unit does not exceed 5 V because of the load capacity of the bulb. Potentiometers whose load is low have a carbon layer instead of resistance wires. If you connect the sliding contact of the potentiometer to one end of the resistance path, you can also use the potentiometer as a variable resistor.

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

Control knobs of a sound mixer

Potentiometers are electrical components whose resistance values can be changed mechanically (by turning or moving). The resistance can be adjusted almost continuously from one end to the contact on the wiper.

Potentiometers are often used to control electronic devices, such as for setting an amplifier, e.g. the volume setting of a sound amplifier, e.g. in a radio, TV set or on a sound mixer.

In this experiment you will learn how exactly a potetiometer works.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
2	Cobra SMARTsense - Voltage, ± 30 V (Bluetooth)	12901-00	1
3	Cobra SMARTsense - Current, ± 1 A (Bluetooth)	12902-00	1
4	Straight connector module, SB	05601-01	4
5	Angled connector module, SB	05601-02	3
6	T-shaped connector module, SB	05601-03	1
7	Interrupted connector module with sockets, SB	05601-04	2
8	Junction module, SB	05601-10	2
9	Straight connector module with socket, SB	05601-11	2
10	Angled connector module with socket, SB	05601-12	2
11	Socket module for incandescent lamp E10, SB	05604-00	1
12	Potentiometer module 250 Ohm, SB	05623-25	1
13	Alligator clips, bare, 10 pcs	07274-03	1
14	Connecting plug, 2 pcs.	07278-05	1
15	Connecting cord, 32 A, 250 mm, red	07360-01	1
16	Connecting cord, 32 A, 250 mm, blue	07360-04	1
17	Connecting cord, 32 A, 500 mm, red	07361-01	2
18	Connecting cord, 32 A, 500 mm, blue	07361-04	2
19	Constantan wire, 15.6 Ohm/m, d = 0.2 mm, l = 100 m	06100-00	1
20	Filament lamps 12V/0.1A, E10, 10 pieces	07505-03	1
21	Filament lamps 1.5V/0.15A,E10,10 pieces	06150-03	1
22	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/2)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is 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 that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Set-up (2/2)

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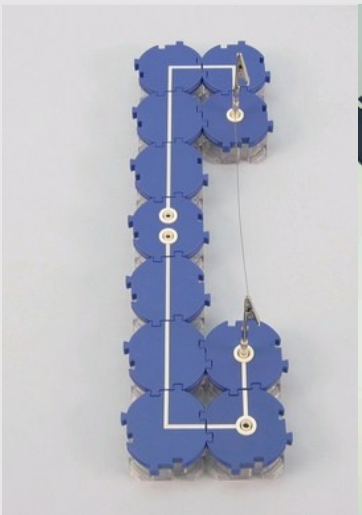
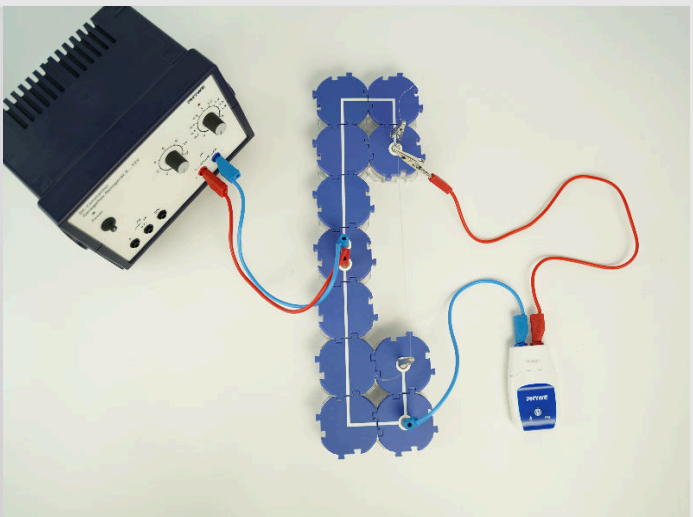
- Set up the experiment according to the photos.
- Clamp the constantan wire between two alligator clips (on connecting plugs) so that it does not sag.
- Connect the voltmeter on one side to the bottom corner of the circuit via a connecting lead.



Circuit



Experimental setup

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Procedure (1/5) Part 1

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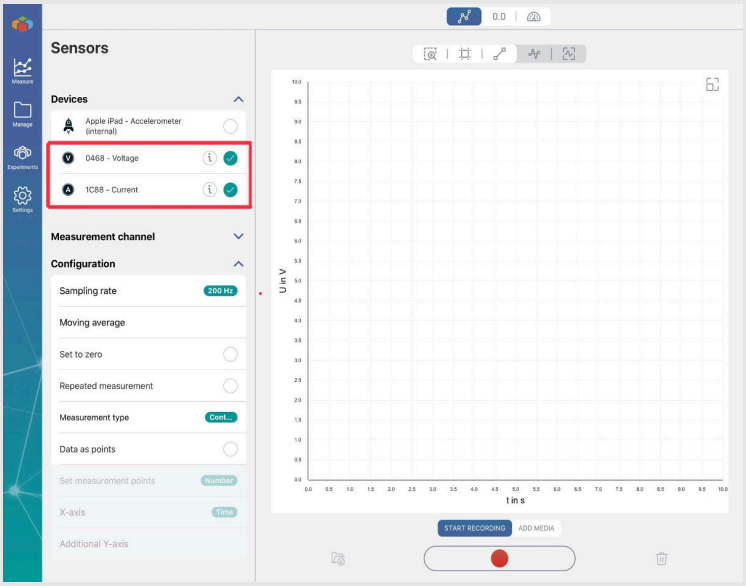

- The SMARTsense Current can be connected in series with the power supply unit if required.
- Turn on both SMARTsense sensors by pressing and holding the power button and make sure the tablet can connect to Bluetooth devices.
- Open the PHYWE measure app and select the sensors "Voltage" and "Current" as shown in the picture.
- After each of the following measurements, the measurement can be saved. For further analysis, the measurement can be opened again at any time under "My measurements".

Procedure (2/5) Part 1

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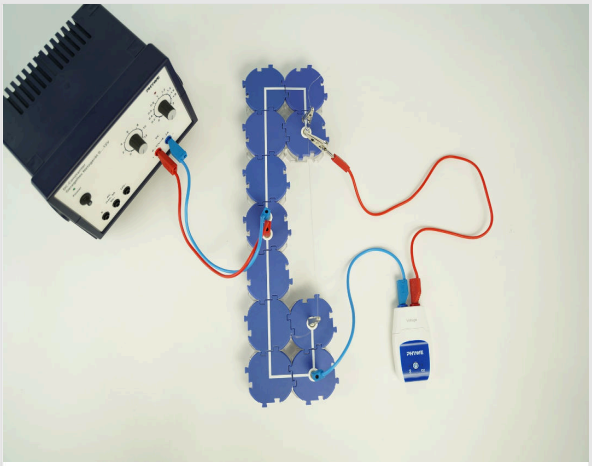

Experimental setup

- Connect a connecting wire with alligator clip to the other side of the voltmeter . First connect this alligator clip to the upper holder of the wire, see figure
- Set the power supply unit to 0V and 2A (right stop) and switch on.
- Carefully increase the voltage at the power supply unit until the voltmeter shows 1V.
- Measure the Length l of the clamped wire and note the measured value.

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Procedure (3/5) Part 1

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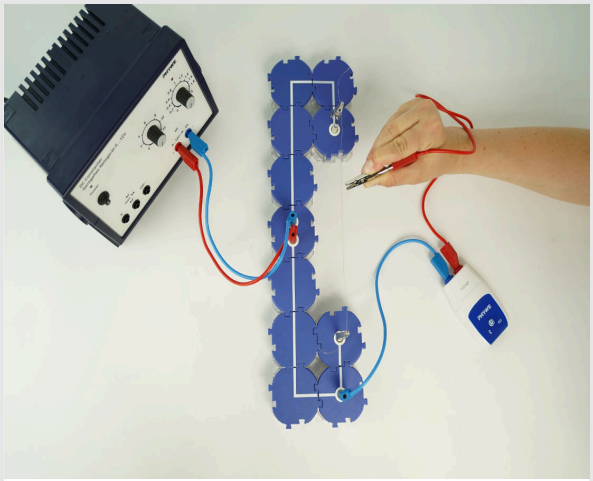

Ex. position for the alligator clip

- Using the alligator clip, connect the voltmeter successively at different points on the wire as shown in the illustration: e.g. at about ¾, ½, ¼ of the wire length.
- Measure the respective tapped length of the wire piece and the voltage across the wire piece. Write down your measured values for l and U in the table in the report.
- Set the power supply unit to 0V and switch it off.

Procedure (4/5) Part 2

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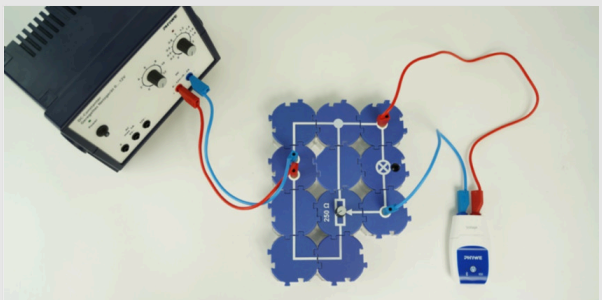

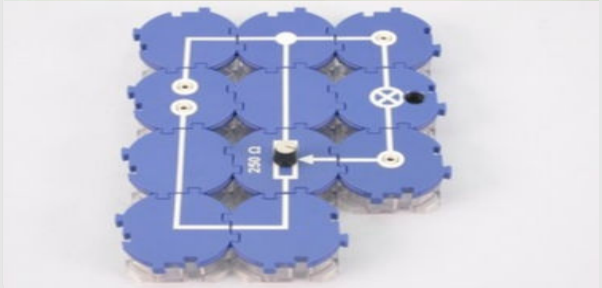

- Now build a circuit as shown in the illustrations opposite.
- Switch on the power supply and set it to about 4V.
- Now slowly turn the knob of the potentiometer clockwise to the right stop and back again.
- Observe the displayed reading for the voltmeter.

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Procedure (5/5) Part 2

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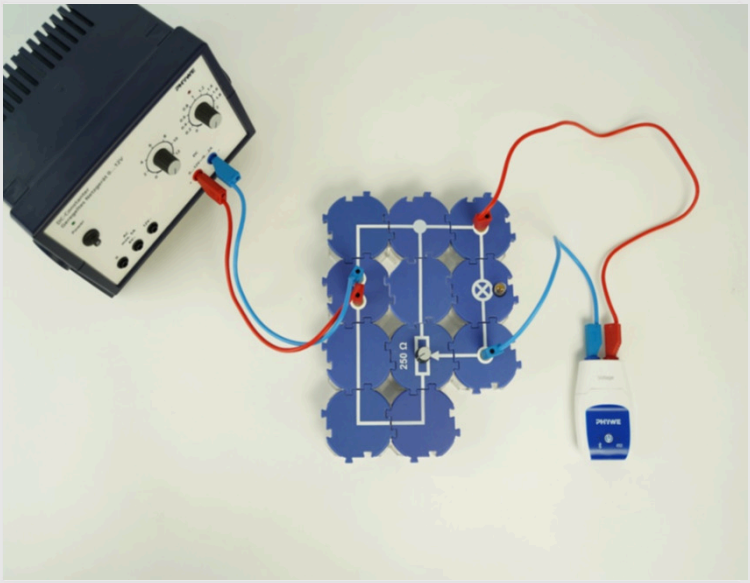

- Complete the circuit by installing the bulb. (see illustration).
- Turn the potentiometer knob slowly from the left stop to the right stop and then back again.
- Observe the brightness of the bulb in particular.
- Set the power supply unit to 0 V and switch it off.

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Report

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Task 1

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Enter the measured values for the different positions of the alligator clip of the execution of the first part of the experiment in the table.

Position	$l\,[m]$	$U\,[V]$	$U/l\,[V/m]$
1			
2			
3			
4			

What is the connection between U and l results from the table?

Tip: Carry U against I as a graph.

- $U \propto 1/l$
- $U \propto l^2$
- $U \propto \sqrt{l}$
- $U \propto l$

Task 2

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Remember the observations made during experiments 1 and 2 and also the connection from task 1. Using the gap fillers, describe how a potentiometer works.

A potentiometer consists of a _____ and (usually) a sliding _____, usually called a slider. For example, in a _____, when you turn the knob, you actuate an electrical contact which moves over this layer. This varies the _____ of the electrically conductive material, so to speak, which in turn changes the value of the _____.

- resistor layer
- length
- electrical resistance
- knob
- contact

Check

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Task 3

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Remember the observations made during experiments 1 and 2 and also the context from task 1. Use the gap fillers to describe what a potentiometer is used for.

A _____ is very suitable for _____ electronic devices. A simple example of this is the _____ of radios or televisions or the _____ of lamps. The _____ also has a potentiometer for adjusting the _____.

volume control
power supply
brightness
output voltage
adjusting
potentiometer

Check

Task 4

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Which of the following statements agree with your observations?

- [ ] Without bulb: If the potentiometer is at the left stop, the highest voltage is displayed.
- [ ] With bulb: If the potentiometer is at the left stop, the bulb lights up brightly.
- [ ] With incandescent lamp: When turning to the right stop, the lamp becomes darker and finally goes out.
- [ ] Without bulb: When turning to the right stop, the voltage goes back to 0 V.

Check

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Slide	Score / Total
Slide 18: Proportionality U and I	0/1
Slide 19: Potentiometer function	0/5
Slide 20: Potentiometer application	0/6
Slide 21: Behaviour of the voltage / bulb	0/4

Total 0 / 16

Solutions | Repeat | Export text

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