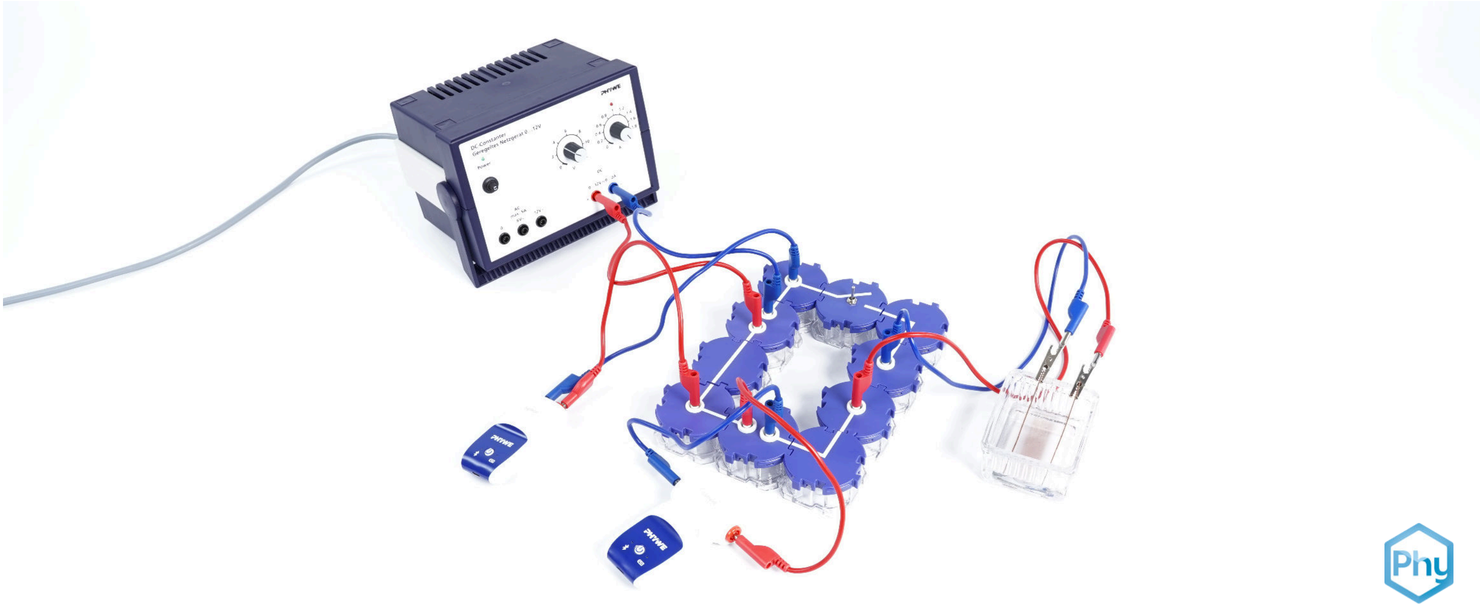
Relationship between voltage and current in conduction processes in liquids with Cobra SMARTsense



In the experiment, the students should find out whether Ohm's law applies to aqueous solutions.

Physics | Electricity & Magnetism | Electric current & its effects

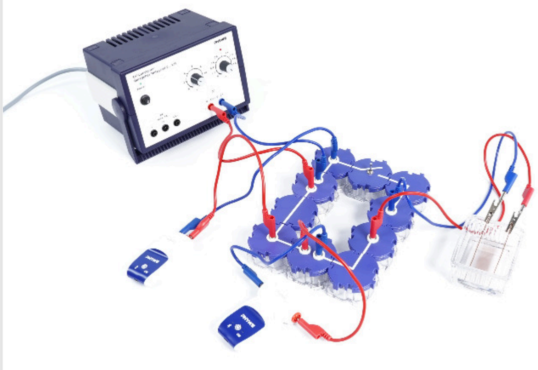
Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

https://www.curriculab.de/c/680f3dc7f6968f00021f9cec

Teacher information

Application



Experimental setup

Salts, acids and bases are electrolytes. In their purest form, they (almost) do not conduct electricity because they then contain no (or only very few) freely mobile ions.

Electrolytes dissolved in water decompose (dissociate) into positive and negative ions.

Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Other teacher information (1/2)

PHYWE

Prior knowledge

For this experiment, the students should be familiar with the fact that aqueous solutions conduct electricity.

Principle

If a voltage is applied to two electrodes immersed in the aqueous solution of an electrolyte, the ions move in the direction of the electrode with the opposite electrical polarity. Aqueous solutions of electrolytes are therefore electrically conductive.

Other teacher information (2/2)

PHYWE

Learning objective

In the experiment, the students should find out whether Ohm's law applies to aqueous solutions.

Tasks

Prepare an aqueous solution of copper sulphate and investigate the relationship between voltage and current strength as the current passes through the solution.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Safety instructions

- Diluted sulphuric acid and sodium hydroxide solutions are highly corrosive to skin, eyes and mucous membranes. Spray mist irritates the respiratory organs.
- Put on safety goggles and wear protective gloves.

Student information

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Motivation

You often hear that you shouldn't take a bath or shower during thunderstorms - but why? The reason is that water can conduct electricity. When lightning strikes, the current spreads through the water and can be dangerous. This everyday example shows that liquids can also conduct electricity - at least if certain conditions are met.

But what exactly is the behaviour of current and voltage? Does Ohm's law also apply here? This is exactly what we want to investigate in this experiment.

Lightning over the sea.

Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Material

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Current - Sensor for measuring electrical current	12902-01	1
2	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage	12901-01	1
3	Straight connector module, SB	05601-01	1
4	Angled connector module, SB	05601-02	2
5	Interrupted connector module with sockets, SB	05601-04	2
6	Junction module, SB	05601-10	2
7	Angled connector module with socket, SB	05601-12	2
8	On-off switch module, SB	05602-01	1
9	Trough, grooved, w/o lid	34568-01	1
10	Copper electrode, 76 mm x 40 mm	45212-00	2
11	Alligator clips, bare, 10 pcs	07274-03	1
12	Connecting cord, 32 A, 250 mm, red	07360-01	2
13	Connecting cord, 32 A, 250 mm, blue	07360-04	2
14	Connecting cord, 32 A, 500 mm, red	07361-01	2
15	Connecting cord, 32 A, 500 mm, blue	07361-04	2
16	PHYWE Power supply, 230 V,DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
17	Water, distilled 5 l	31246-81	1
18	Emery paper, medium	01605-00	1
19	Copper-II sulphate,cryst. 250 g	30126-25	1
20	Spoon, with spatula end, 180 mm, plastic	38833-00	1
21	measureAPP - the free measurement software for all devices a	14581-61	1

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Setup (1/3)

PHYWE

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.

iOS

Android

Windows

Setup (2/3)

PHYWE

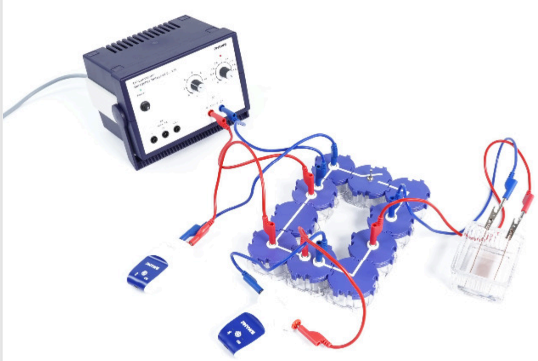


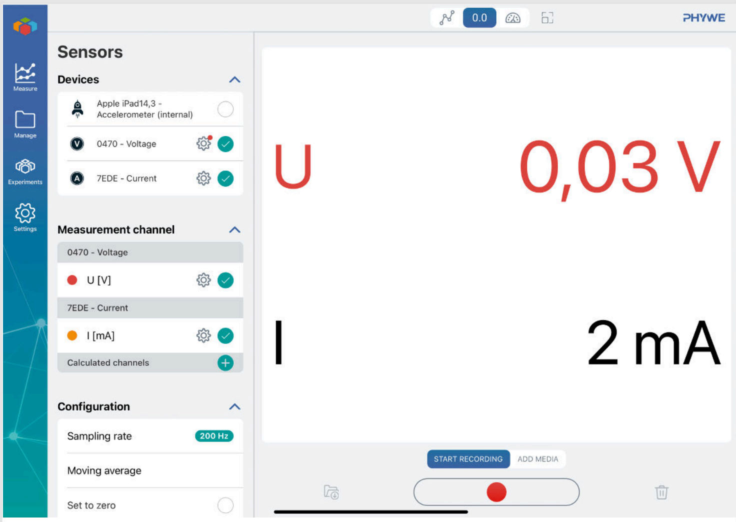
Fig. 1

- Set up the experiment as shown in Fig. 1, initially with the switch open. If you press the blue button, you will see a close-up of the circuit.
- Carefully clean the grooved trough and the copper electrodes if necessary. Then insert the electrodes into the trough with maximum spacing and connect them to the (short) connecting cables using the crocodile clips.
- Fill the grooved trough about halfway with distilled water, add half a spoonful of copper sulphate to the water, and stir until the salt is completely dissolved.

PHYWE Robert-Bosch-Breite 10 37079 Göttingen Tel.: 0551 604 - 0 Fax: 0551 604 - 107 info@phywe.de www.phywe.de

Setup (3/3)

PHYWE



Screenshot of the app without power supply switched on

- Start the two 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. Set the display to show the measured values as numbers by clicking on "0.0" at the top of the app. You can see an example of what this looks like on the left-hand side.

Procedure (1/2)

PHYWE

- Set the power supply unit to $0\ \mathrm{V}$ and switch it on.
- Increase the voltage in steps of $2\ \mathrm{V}$, measure the respective current and note the measured value in Table 1 in the protocol.
- Now set a voltage of $4\ \mathrm{V}$, open the switch and roughly halve the distance between the electrodes.
- Close the switch, measure the current and note the measured value.

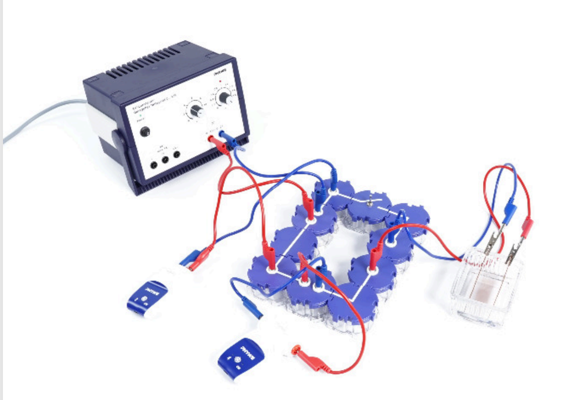


Fig. 2

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Procedure (2/2)

PHYWE

- Open the switch and restore the previous electrode gap.
- Sprinkle some more copper sulphate into the solution, stir it, and once everything has dissolved, close the switch again.
- Measure the current (again at $4\ \mathrm{V}$) and note the measured value.
- Then set the power supply unit to $0\ \mathrm{V}$ and switch it off.
- Dry the electrodes, dispose of the aqueous solution properly, clean the grooved tray, and wash your hands thoroughly with soap.

PHYWE

Report

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

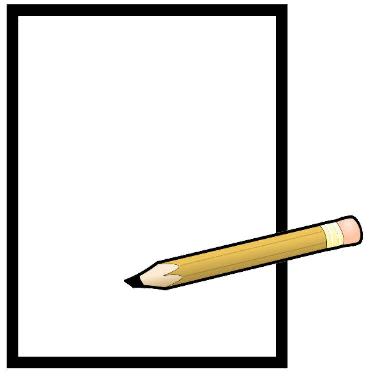
Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Observation (1/2)

Voltage U $[\mathrm{V}]$	Current I $[\mathrm{mA}]$	Resistance R $[\Omega]$
2		
4		
6		
8		
10		

Plot the current as a function of the voltage.



Observation (2/2)

Voltage U $[\mathrm{V}]$	Current I $[\mathrm{mA}]$	Resistance R $[\Omega]$
4 (with reduced electrode gap)		
4 (with increased concentration)		

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Task (1/3)

PHYWE

What is the relationship between current and voltage?

- There is exponential growth between current and voltage.
- There is antiproportional growth between current and voltage.
- There is linear growth between current and voltage.
- There is a constant relationship between current and voltage.

Task (2/3)

PHYWE

Compare the current in line 2 of Table 1 with the currents that you measured at the same voltage but under different conditions (lines 6 and 7 of Table 1). What follows from this comparison with regard to the resistance of aqueous solutions of electrolytes?

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Task (3/3)

PHYWE

What other conditions influence the resistance of a conductive liquid?

The ______ of the ions is hindered by collisions with the other particles in the liquid. The higher the ______ of the liquid, the more the ions are hindered. In the process, ______ is converted into thermal energy. This ______ is released into the environment in the form of heat.

- temperature
- directional movement
- electrical energy
- thermal energy

Check

Slide	Score / Total
Slide 17: Current-voltage ratio	0/1
Slide 19: Influencing the resistance	0/4

Total score 0 / 5

Show solutions · Repeat · Export text

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de