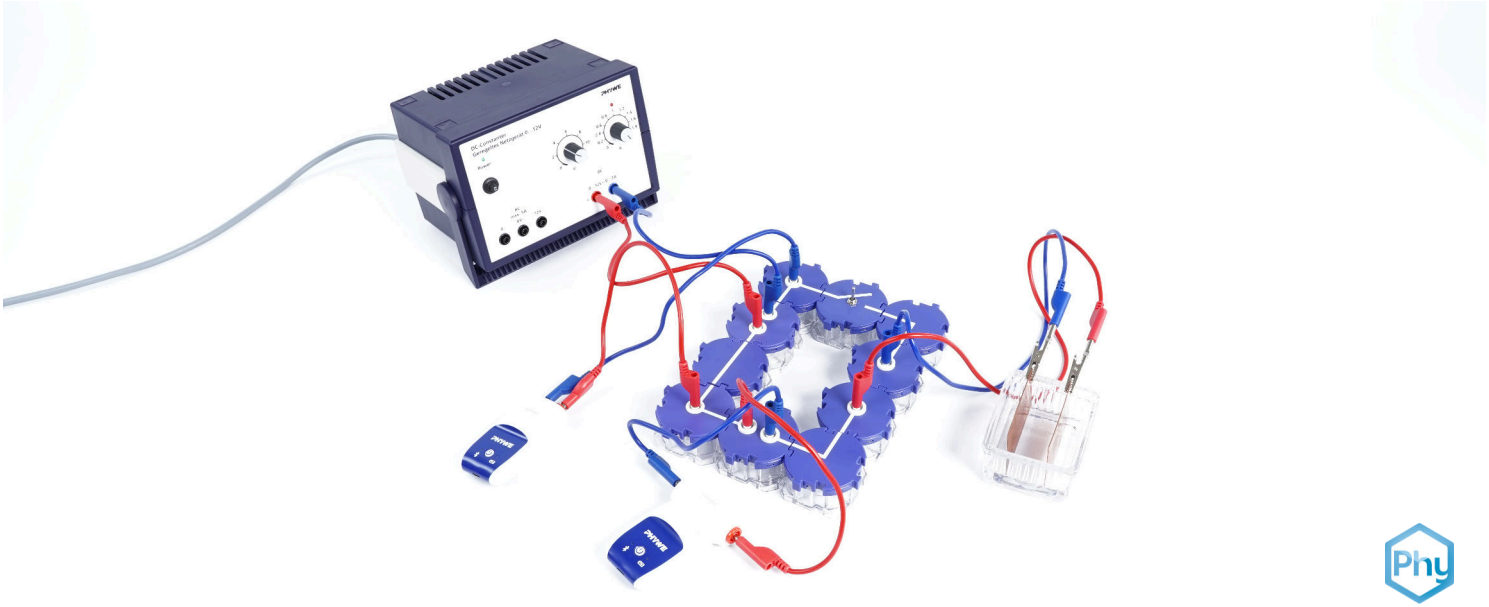
Conductivity of aqueous solutions of electrolytes with Cobra SMARTsenseons of electrolytes



In this experiment, the students should find out why an undissolved (or not melted) electrolyte and distilled water are not or almost not conductive.

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/6808abc33e1f6d00029c34cf

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

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Teacher information

Application

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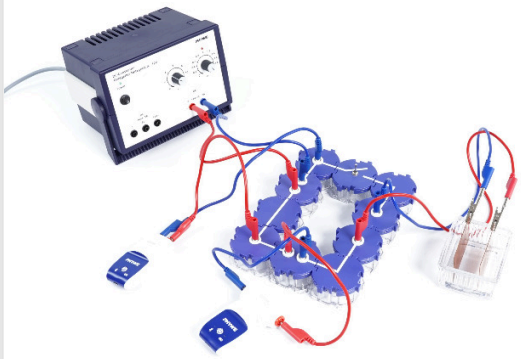

Experimental setup

Salts, acids, and bases are electrolytes. In their pure form, they conduct electricity poorly or not at all, as they contain no — or only very few — freely mobile ions.

When dissolved in water, electrolytes dissociate into positive and negative ions.

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37079 Göttingen

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

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Other teacher information (1/2)

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Prior knowledge

No prior knowledge is required for this experiment.

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)

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Learning objective

In this experiment, the students should find out why an undissolved (or not melted) electrolyte and distilled water are not or almost not conductive.

Tasks

Investigate whether water in which substances are dissolved conducts electricity.

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37079 Göttingen

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

info@phywe.de
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Safety instructions

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- Put on safety goggles!
- Wear gloves!
- Please refer to the relevant safety data sheets for the H and P phrases.
- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student information

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Robert-Bosch-Breite 10
37079 Göttingen

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

info@phywe.de
www.phywe.de

Motivation

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As soon as a thunderstorm approaches, you should leave the pool. It is said that it is also not safe to swim in another body of water when there is thunder and lightning in the air.

But why is it so dangerous to go swimming during a thunderstorm? This experiment investigates the conductivity of substances dissolved in water and thus allows conclusions to be drawn about the answer to this question.

Thunderstorm over the sea

Tasks

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1. Set up the experiment and measure the conductivity of destilled water.
2. Repeat the experiment and determine the conductiviy of several more substances including:
   - salt
   - salt diluted in water
   - drinking water
   - a diluted acid
   - a diluted base

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Tel.: 0551 604 - 0
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Material

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Current - Sensor for measuring electrical current ± 1 A (Bluetooth + USB)	12902-01	1
2	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage ± 30 V (Bluetooth + USB)	12901-01	1
3	Angled connector module, SB	05601-02	2
4	Straight connector module, SB	05601-01	1
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	Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
18	Sodium hydroxide sol.,10%, 1000ml	31630-70	1
19	Water, distilled 5 l	31246-81	1
20	Emery paper, medium	01605-00	1
21	Spoon, with spatula end, 180 mm, plastic	38833-00	1
22	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Setup (1/3)

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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.

iOS

Android

Windows

Setup (2/3)

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- Set up the experiment as shown in Figs. 1 and 2. The switch is open. Clean the grooved trough and the copper electrodes carefully before inserting the electrodes into the outer grooves of the trough.
- Fill the grooved trough about half full with distilled water.

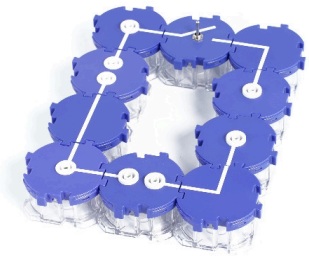
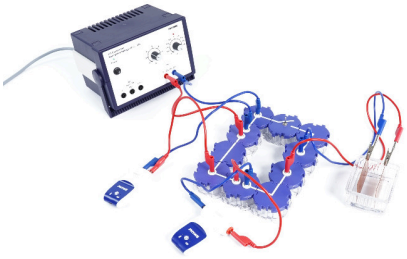


Fig. 1

Fig. 2



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37079 Göttingen

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Setup (3/3)

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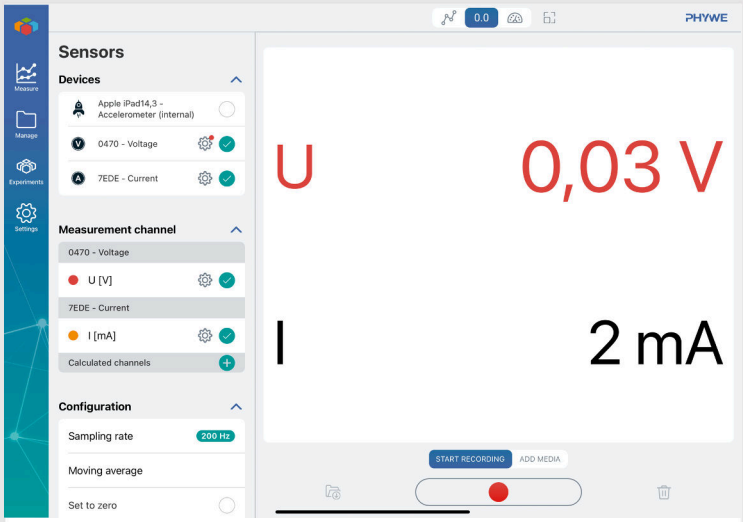

Screenshot of the app without power supply switched on

- Switch on both Cobra SMARTsense sensors by pressing and holding the power button on each device for about three seconds.
- Then open the measureAPP and connect it to both sensors. Adjust the display so that the measured values are shown as numbers. To do this, tap the "0.0" icon at the top of the app. A visual example is shown on the left-hand side of the screen.

Procedure (1/4)

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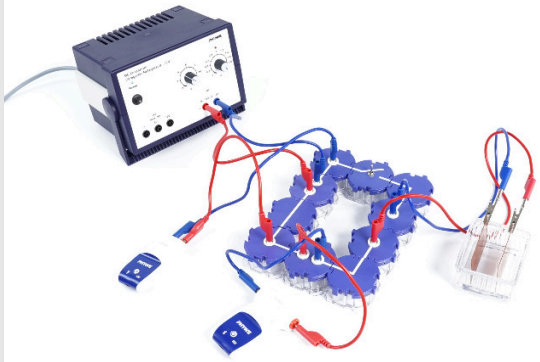
- Set the power supply unit to $0\ \mathrm{V}$ and switch it on.
- Close the switch, increase the voltage at the power supply unit until the measureAPP displays $2\ \mathrm{V}$. Measure the current and note the measured value in Table 1 in the log.
- Open the switch, empty and dry the groove tray.



Experimental setup

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Procedure (2/4)

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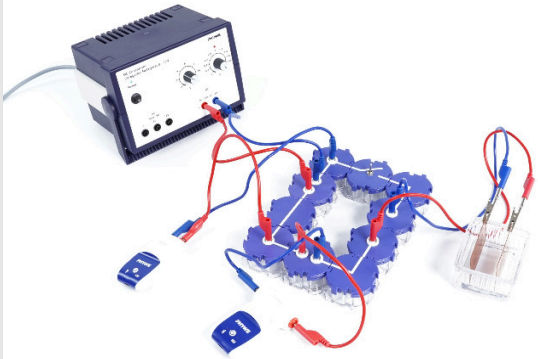
- Place the electrodes back in the grooved trough and fill the trough with a layer of saline salt about $2\ \mathrm{cm}$ high.
- Close the switch and measure the current at $U = 2\ \mathrm{V}$. Note the measured value.
- Pour distilled water slowly onto the salt in the grooved trough and monitor the displayed current values in the measureAPP while doing so.



Experimental setup

Procedure (3/4)

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- Stir the saline solution with the spoon and measure the strength of the current at the end.
- Open the switch and note the measured value for I.
- Empty the groove tray, wash it thoroughly - just like the electrodes - and dry both. Put the electrodes back into the groove tray.
- Fill the grooved trough about half full with drinking water.
- Close the switch and measure the current again at $U = 2\ \mathrm{V}$. Note the measured value.
- Empty the grooved trough with the switch open.
- Close the switch, carefully pour diluted acid into the groove trough, measure the current and make a note of the measured value.

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Robert-Bosch-Breite 10
37079 Göttingen

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

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Procedure (4/4)

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- Open the switch, dispose of the aqueous solution properly, rinse and dry the groove tray and the electrodes with water.
- Proceed in the same way with the diluted base.
- Set the power supply unit to $0\ \mathrm{V}$ and switch it off.
- Dispose of the aqueous solution properly, rinse and dry the groove tray and the electrodes with water and finally wash your hands.

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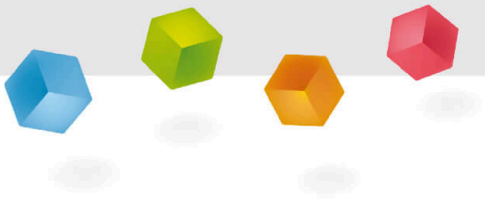

Report

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Robert-Bosch-Breite 10
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Observation

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Test part no.	Substances	Current $I\,[\mathrm{mA}]$
1	Distilled water	
2	Salt	
3	Aqueous solution of a salt	
4	Drinking water	
5	Aqueous solution of an acid	
6	Aqueous solution of a base	

Task (1/4)

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Summarise the results of the individual parts of the experiment in words.

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Task (2/4)

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Drag the words into the correct boxes!

In liquids, a _____ only takes place if freely movable (migratory) _____ are present due to dissociation. When a voltage is applied and thus an _____ is present, the ions move in a directed manner. Electrical energy is converted into _____. A special feature of conduction processes in liquids that is important for applications is that the ions not only transport charges, but also transport substances.

- thermal energy
- electric field
- ions
- conduction process

Check

Task (3/4)

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Why, for example, does table salt not conduct electricity in its solid form? Why does distilled water conduct electricity only poorly — if at all — while ordinary tap water does conduct electricity, even if not very well?

Moving charged particles such as ions are required to conduct electricity. _____ does not have these, which is why it does not conduct electricity. Although _____ consists of electrically charged ions, these are not freely mobile. In contrast, _____ contains small quantities of dissolved salts, which now contribute freely movable ions and thus lead to electrical conductivity.

- Distilled water
- drinking water
- cooking salt

Check

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Robert-Bosch-Breite 10
37079 Göttingen

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Task (4/4)

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In electrical engineering, the ground is often used as a conductor. How can this be explained?

Slide	Score / Total
Slide 20: Functionality	0/4
Slide 21: Reason for conductivity	0/3

Total score 0 / 7

Show solutions | Repeat | Export text

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37079 Göttingen

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