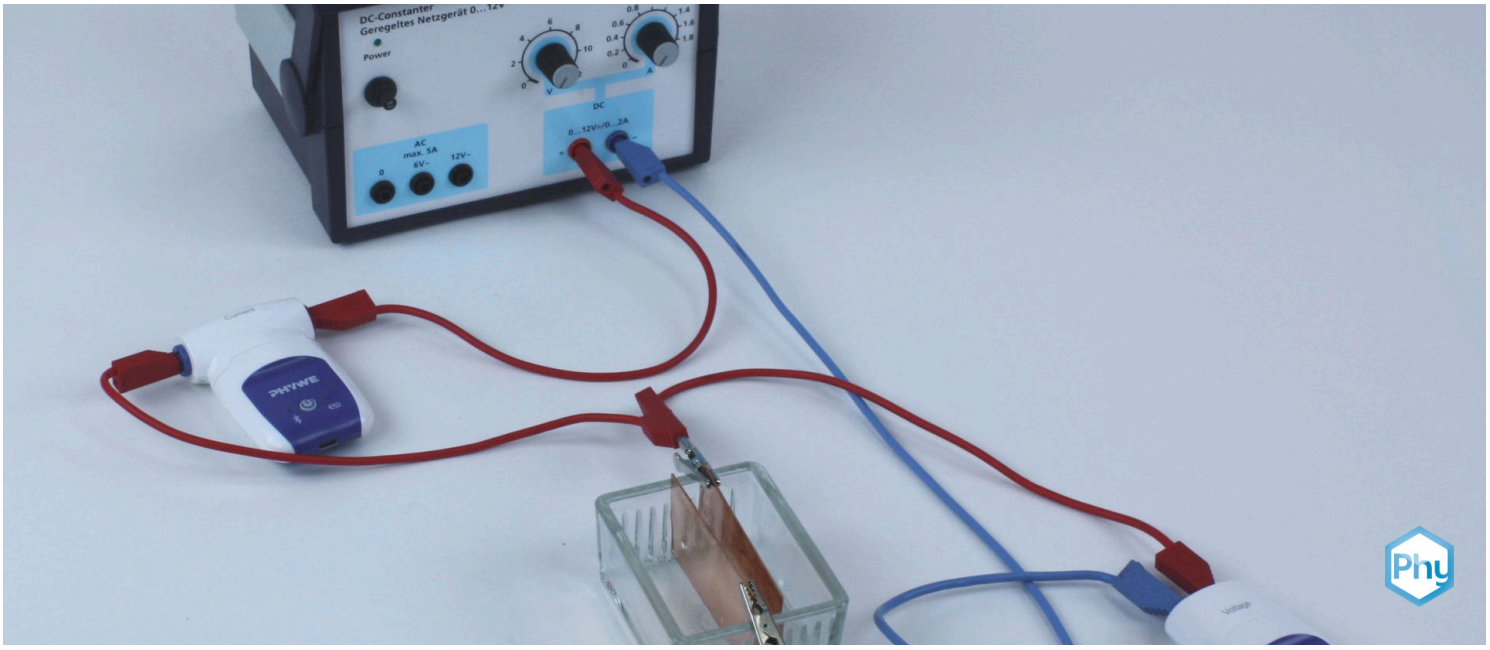
Electrolysis with Cobra SMARTsense



Physics | Electricity & Magnetism | Electric current & its effects

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

This content can also be found online at:

http://localhost:1337/c/638c804e0783cf00038d1561

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Teacher information

Application

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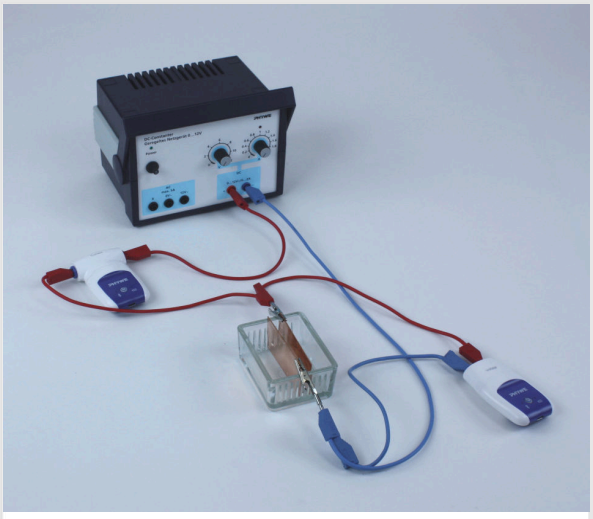

Experimental setup

Electrolysis is the decomposition of chemical compounds by electric current. The cathode serves as an electron donor and the anode as an electron acceptor. When voltage is applied, the electrolyte solution splits as positively charged ions move to the cathode and negatively charged ions move to the anode. Arriving at the respective poles, the ions give up/take up electrons, thus creating a flow of electrons that can be measured. Electrolysis is used to extract metals and to purify waste water. It can also be used for electroplating.

In this experiment, the electrolysis of copper sulphate is investigated.

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Other teacher information (1/3)

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Prior knowledge

The students should be able to construct and understand a simple electric circuit. It is also helpful to discuss the principle of electrolysis before the experiment. In addition, the students should be aware that sodium sulphate in water is converted to sodium ions $2\,Na^{+}$ and sulphate ions SO_4^{2-} .

Principle

In a basin filled with copper sulphate, electrodes are attached at both ends to which a voltage is applied and thus electrolysis is initiated. Copper is formed at the cathode (reduction) and oxygen and sulphuric acid at the anode (oxidation).

Other teacher information (2/3)

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Learning objective

This experiment is designed to teach students about the principle of electrolysis. They know that metallic conductors do not change chemically when an electric current passes through them. This experiment should make them aware that the chemical composition of conductive liquids changes when current passes through them.

Tasks

The students measure the current-voltage characteristic of an electrolysis bath with copper sulphate solution and copper electrodes and observe the visible electrochemical changes of the electrodes and the bath.

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Other teacher information (3/3)

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Additional information

To save time, it is recommended to provide the experiment groups with cleaned troughs as well as perforated cardboard strips

It is also important for this experiment that the teacher centrally organises and supervises the disposal of the aqueous solutions and ensures that the necessary precautions are taken during the experiment.

Disposal

Collect solutions containing heavy metal ions or salts in a designated container and dispose of appropriately.

Safety instructions

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- Wear protective goggles and gloves!
- Copper sulphate is harmful if swallowed, causes skin irritation and severe eye irritation and is very toxic to aquatic organisms with long-term effects.
- R: 22-36/38-50/53
- S: 22-60-61

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Student information

Motivation

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Sewage plant

Electrolysis is a process for the production and purification of metals. Electrolysis is also used for electroplating, i.e. for coating metallic materials.

In addition, electrolysis is used for wastewater treatment. With the help of this process, heavy metals can be separated from the wastewater-sludge mixture and recovered.

In this experiment, you investigate how an aqueous solution of copper sulphate changes chemically during electrolysis.

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Tasks

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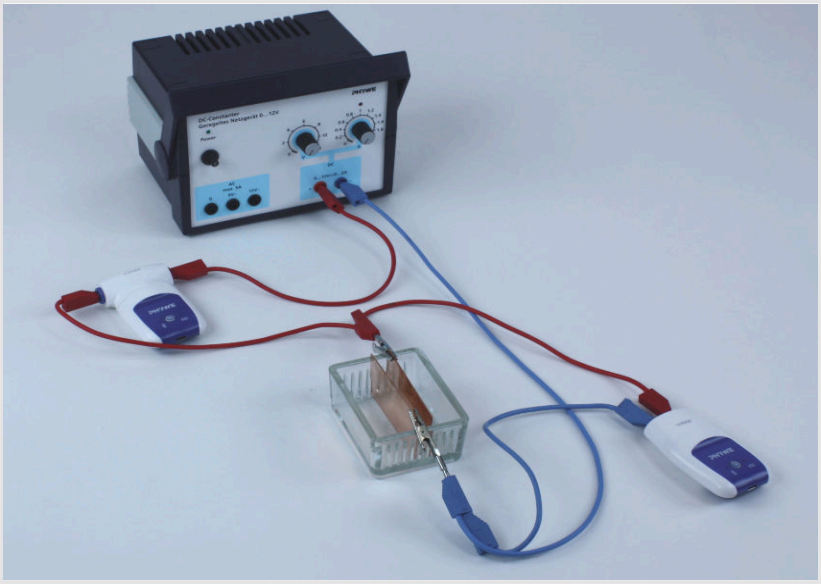
Do the chemical properties of conductive liquids change when current flows through them?

Measure the current-voltage characteristic of an electrolysis bath with copper sulphate solution and copper electrodes. Observe the resulting chemical process.



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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	Trough, grooved, w/o lid	34568-01	1
5	Copper electrode, 76 mm x 40 mm	45212-00	2
6	Sodium sulphate dried 250 g	48344-25	1
7	Glass rod, boro 3.3, l=200mm, d=5mm	40485-03	1
8	Alligator clips, bare, 10 pcs	07274-03	1
9	Connecting cord, 32 A, 250 mm, red	07360-01	2
10	Connecting cord, 32 A, 250 mm, blue	07360-04	1
11	Connecting cord, 32 A, 500 mm, red	07361-01	1
12	Connecting cord, 32 A, 500 mm, blue	07361-04	1
13	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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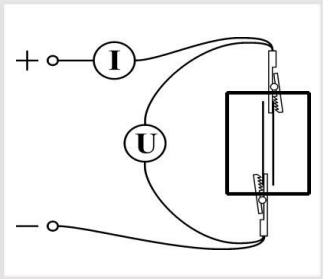
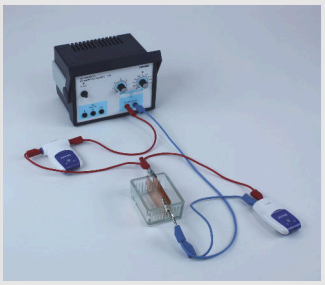
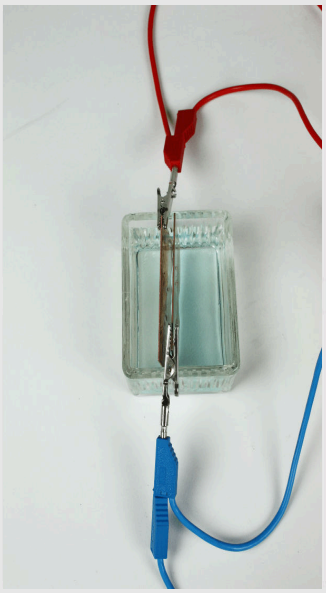
- Set up the experiment according to the circuit diagram and the illustrations.
- Scrub the copper electrodes bare with a cleaning sponge. In stubborn cases, brush with steel or zinc wool.
- Fill the cleaned grooved trough about two-thirds full with distilled water, sprinkle about half a spoonful of sodium sulphate slowly into the water so that no lumps form, and stir.
- Set the voltage regulator on the power supply unit to $0\,V$ set the current limitation to $1\,A$ then switch on the power supply unit.







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Procedure (1/3)

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- 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 connect the sensor under "Measure" > "Sensor" and then select the sensors "Current" and "Voltage" (top left).
- Select a sampling rate of your choice. The higher the sampling rate, the more accurate the measurement.
- Evidence the y-axis with the voltage and the current intensity.
- 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 (2/3)

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- Adjust the voltage in steps of $0,2$ to $0,3\ V$ and increase until $3\ V$ is reached. After each incease wait $20\ s$. This should result in something like the course shown in the illustration.
- Always watch the electrodes!
- End the measurement, save it and open the measured values for further analysis under my measurements. Use the "Zoom" tool to see the current curve clearly.
- Turn the voltage down again.
- Remove the copper plates from the solution and observe them. Write down your observations.

Measuring course

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Procedure (3/3)

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- Now the y-axis with the voltage and the x-axis with the current intensity. Repeat the experiment.
- Then save the data and open it under "Measurements" for further analysis. Look closely at the graph.
- Finally, discard the copper sulphate solution and clean the electrodes and grooved trough - again scrubbing with a sponge - and then wash hands thoroughly.

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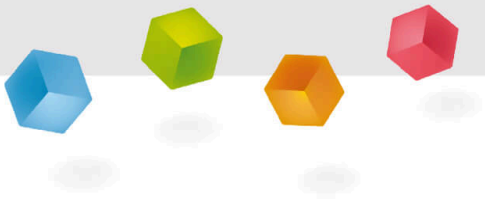

Report

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Task 1

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What can be observed on the ammeter?

- No current flows
- A current flows.

Describe your observations at the anode and cathode.

Task 2

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Explain the process observed at the cathode. Draw the words into the correct boxes!

Na_2SO_4 [ ]: $Na_2SO_4 \rightarrow 2\,Na^+ + SO_4^{2-}$.
Na^+-ions migrate to the [ ] and pick up one [ ] each: $Na^+ + e^- \rightarrow Na$.
Na splits [ ]: $2\,Na + 2\,H_2O \rightarrow 2\,NaOH + H_2 \uparrow$.
The [ ] dissociates: $NaOH \rightarrow Na^+ + (OH)^-$.
The gas bubbles consist of [ ].

- cathode
- water molecules
- electron
- soda lye
- dissociated
- hydrogen

Check

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Task 3

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The solution has visibly changed as...

- ...sodium sulphate has been created by the SO_4-ions recombine with sodium ions.
- ...small flashes of lightning have coloured the solution due to the current.
- ...copper sulphate has been formed by the SO_4-ions have bonded with copper atoms of the anode.

Task 4

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Before an electric current was passed through the aqueous solution, it had the components water & sodium sulphate. What were the components of the solution after the experiment was completed?

- [ ] Sodium sulphate
- [ ] Copper sulphate
- [ ] Water
- [ ] Caustic soda

Check

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Slide	Score / Total
Slide 17: Observation current	0/1
Slide 18: Explanation Observation Cathode	0/6
Slide 19: Colouring of the solution	0/1
Slide 20: Components of the reaction: before - after	0/4

Total 0 / 12

Solutions Repeat Export text

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