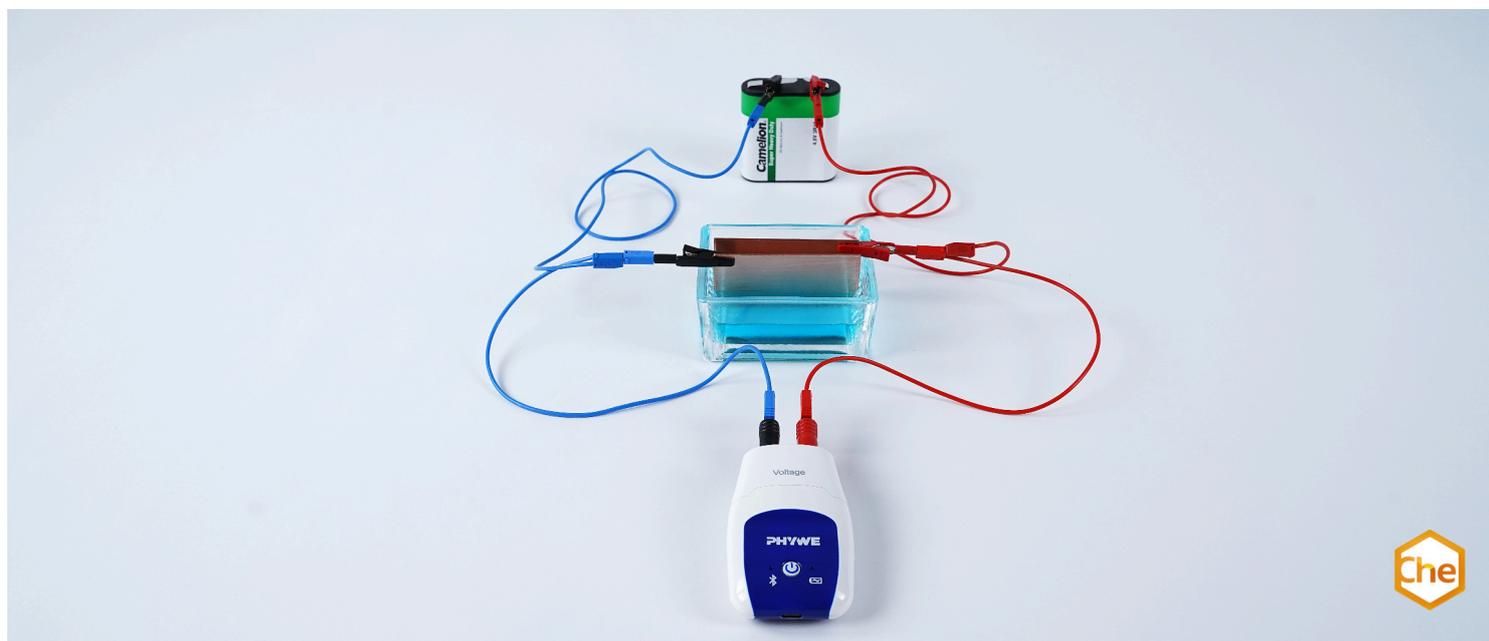


# Electrolysis with a grooved trough with Cobra SMARTsense



In this experiment, the pupils investigate the process of electrolysis.

Chemistry

Physical chemistry

Electrochemistry

Electrolysis



Difficulty level

easy



Group size

1



Preparation time

10 minutes



Execution time

10 minutes

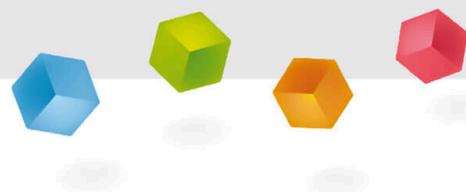
This content can also be found online at:



<https://www.curriculab.de/c/68f5ec9a2d93de00022cc976>

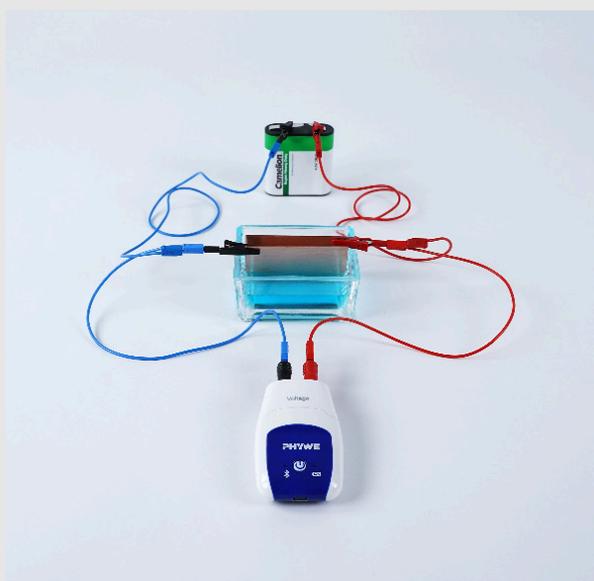
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## Teacher information



## Application

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Electrolysis is a key process for the production of many metals, such as copper or alkali metals. It is a forced redox reaction that takes place through the supply of electrical energy. A simple electrolysis apparatus consists of a DC voltage source, two electrodes and an electrolyte.

In this experiment, electrolysis is investigated using copper as an example. To do this, the students immerse two metallic copper electrodes in a copper sulphate solution (electrolyte) and connect them to a DC voltage source.

## Other teacher information (1/4)

PHYWE

### Prior knowledge



The students should already be familiar with the principle of electrolysis. They should also already be familiar with charge transport, current strength and conductivity.

### Principle



Electrolysis is a forced redox reaction in which chemical compounds are broken down into their components using electrical energy. An electric current flows through an electrolyte solution or a melt. The electrons flow from the anode to the cathode. The cations from the electrolyte migrate to the anode and take up electrons there, while the anions migrate to the cathode and release electrons.

## Other teacher information (2/4)

PHYWE

### Learning objective



This experiment is designed to give pupils an impression of the various processes involved in charge transport by dissolved ions.

### Tasks



The students carry out the electrolysis with the grooved trough. The electrolysis bath consists of copper sulfate solution and copper electrodes. They observe visible electrochemical changes in the electrodes and the bath.

## Other teacher information (3/4)

PHYWE

During electrolysis, the **positive electrode (anode)** a change in the surface can be recognised, while on the **negative electrode (cathode)** metallic copper is deposited.

Copper atoms are oxidised to copper ions at the anode:  $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ . At the cathode, the copper ions are reduced back to elemental copper:  $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ .

If the **Voltage source** (e.g. a battery) is switched off, the finely distributed, deposited copper easily detaches from the electrode.

## Other teacher information (4/4)

PHYWE

**The solutions can be produced for everyone to save chemicals!**

- **Copper sulfate solution (0,05 mol/l):** Add 6,2 g Copper sulfate to 250 ml distilled water. Mix well and fill up to 500 ml with distilled water.

When using this approach variable, a 600 ml beaker can be used. You can find this in the PHYWE webshop.

## Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.
- All persons in the room must wear safety goggles during the experiment!
- For H and P phrases, please refer to the safety data sheet of the respective chemical.

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## Student information



## Motivation

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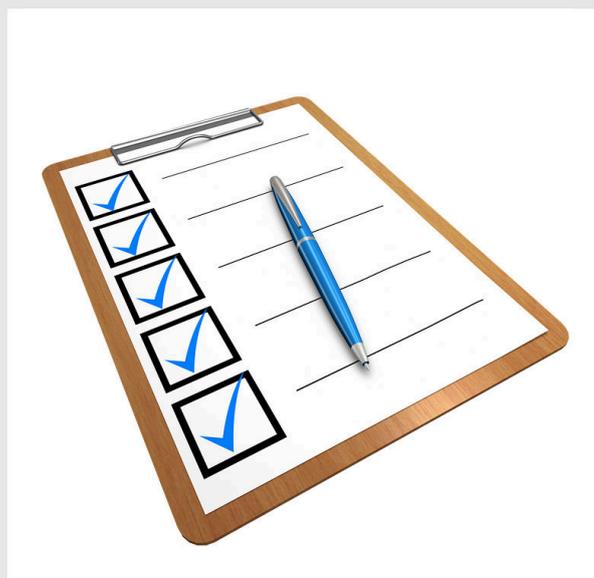


You come across metals everywhere in everyday life, in drinks cans, computer circuit boards or on galvanised garden gates. But have you ever wondered how these metals are actually extracted?

An important procedure for this is the **Electrolysis**. It is used to extract many metals from their compounds, for example **Aluminium**, a light and stable metal that is used in cars, aeroplanes and everyday objects. Due to the so-called **Molten flux electrolysis** the ore **Bauxite** aluminium oxide is converted into pure aluminium.

## Tasks

PHYWE



How can a metal be deposited using an electric current?

1. Set up an electrolysis apparatus and start the electrolysis.
2. Measure the voltage and observe what happens at the two electrodes.
3. Stop the electrolysis and examine the electrodes. What has changed?
4. Note your observations.

## Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage $\pm 30$ V (Bluetooth + USB)	12901-01	1
2	Connecting cord, 2 mm-plug, 5A, 25 cm, red	07355-01	1
3	Connecting cord, 2 mm-plug, 5A, 250 mm, blue	07355-04	1
4	Connecting cord, 2 mm-plug, 5A, 500 mm, red	07356-01	1
5	Connecting cord, 2 mm-plug, 5A, 500 mm, blue	07356-04	1
6	Copper electrode, 76 mm x 40 mm	45212-00	2
7	Trough, grooved, w/o lid	34568-01	1
8	Flat battery, 4.5 V	07496-01	1
9	Reducing plug 4mm/2mm socket, 2	11620-27	1
10	Alligator clip, insulated, 2 mm socket, 2 pcs.	07275-00	2
11	Copper-II sulphate,cryst. 250 g	30126-25	1
12	Connecting cord, 2 mm-plug, 5A, 25 cm, red	07355-01	1
13	Water, demineralized, pure, 10000 ml	CHE-882041145	1
14	Protecting glasses, clear glass	39316-00	1
15	Sulphuric acid,0.5M 1000 ml	48462-70	1

## Setup (1/5)

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 (2/5)

PHYWE

**The solutions can be produced for everyone to save chemicals!**

- **Copper sulfate solution** ( $\approx 0,05 \text{ mol/l}$ ): Add 1 g Copper sulfate to 50 ml distilled water. Mix well and fill up to 100 ml with distilled water.

## Setup (3/5)

PHYWE

1. Look at the two copper electrodes: If the metal has oxidised due to storage, use a piece of sandpaper to remove the oxide layer.
2. Mix your electrolyte. Add approx. 85 ml Copper sulfate solution and then 15 ml Sulphuric acid (0, 5 mol/L) into the grooved trough.
3. Place the copper electrodes without them touching each other (see illustration).

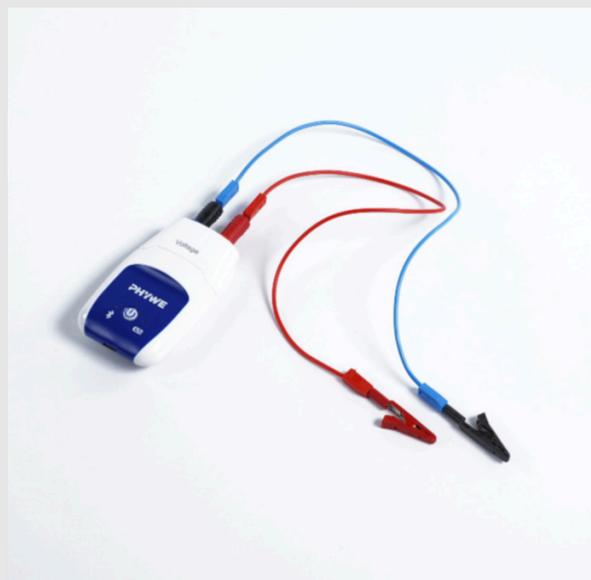


## Setup (4/5)

PHYWE

*Note the colour of the connections below: blue (negative pole) always to blue (black) and red (positive pole) always to red!*

Connect the cables to the Cobra SMARTsense Voltage Sensor using a reducing plug.



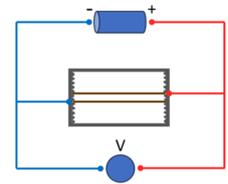
## Setup (5/5)

PHYWE

Now set up the electrolysis apparatus as shown in the illustration on the right.

1. Connect the Cobra SMARTsense Voltage Sensor to the copper electrodes using the crocodile clips.
2. Attach another connecting cable to the crocodile clips on the electrodes and also attach a crocodile clip to the free end of the cable.

Do **not** connect the crocodile clips with the battery yet.



## Procedure (1/3)

PHYWE

- Start the measureAPP on a mobile device.
- Press the start button on the sensor for approx. 3 seconds.
- Connect the sensor by tapping  next to the description of the sensor in the measureAPP.
- Set the measured value display by tapping **0.0** above the diagram.



**Devices** 

-  Apple iPad13,16 - Accelerometer (internal)  
-  4885 - Voltage

**Measurement channel** 

**Configuration** 

 4885 - Voltage  

**Measurement channel** 

Voltage

 U [V]  

Calculated channels 

U 0,00 V

## Procedure (2/3)

PHYWE

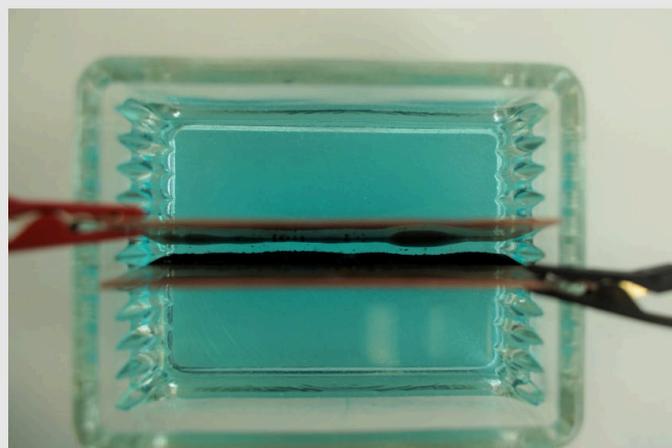
1. Now connect the crocodile clips to the battery. *Blue (negative pole) always to blue (black) and red (positive pole) always to red!*
2. Make sure that you note which electrode, i.e. which copper plate, is connected to the positive terminal and which to the negative terminal of the battery. *If vapours rise, do not inhale them!*
3. Let the electrolysis run for 10 minutes and note the value displayed by the voltmeter.
4. Check whether the temperature of the solution has changed by feeling the groove trough.



## Procedure (3/3)

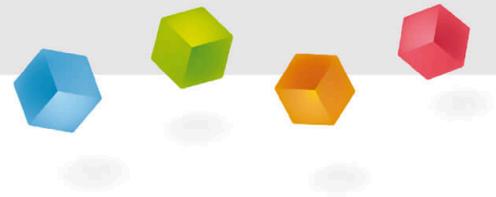
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1. Stop the electrolysis and wait until the water has cooled down.
2. Wash the two electrodes, dry them and take a close look at them. What can you see?
3. Make a note of your observations.



If you look closely, you should see the first gas bubbles between the electrodes.

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# Report

## Task 1

PHYWE

Which statements correspond to your observations?

- The liquid has become warm during the test.
- Both electrodes shine and are absolutely clean.
- One electrode has darkened in colour after the experiment, the other has become lighter.
- During the experiment, air bubbles rose between the two electrodes.

✓ Check

## Task 2

PHYWE

What is electrolysis used for?

- In addition to the extraction of metals, electrolysis is also used in mining to dig for ore.
- None of the answers are correct.
- Electrolysis is used to extract metals such as aluminium or copper.
- Electrolysis is used to melt metals and mould them into new shapes.

✓ Check

## Task 3

PHYWE

What exactly happens during electrolysis?

- During electrolysis, electrons move through the electrolyte from the cathode to the anode.
- Anions from the electrolyte migrate to the positively charged anode.
- None of the answers are correct.
- Cations from the electrolyte migrate to the negatively charged cathode.
- During electrolysis, electrons move through the electrolyte from the anode to the cathode.

✓ Check

Slide	Score / Total
Slide 21: Observations	0/3
Slide 22: Application of electrolysis	0/1
Slide 23: Electrolysis	0/3

Total amount  0/7

 Solutions

 Repeat