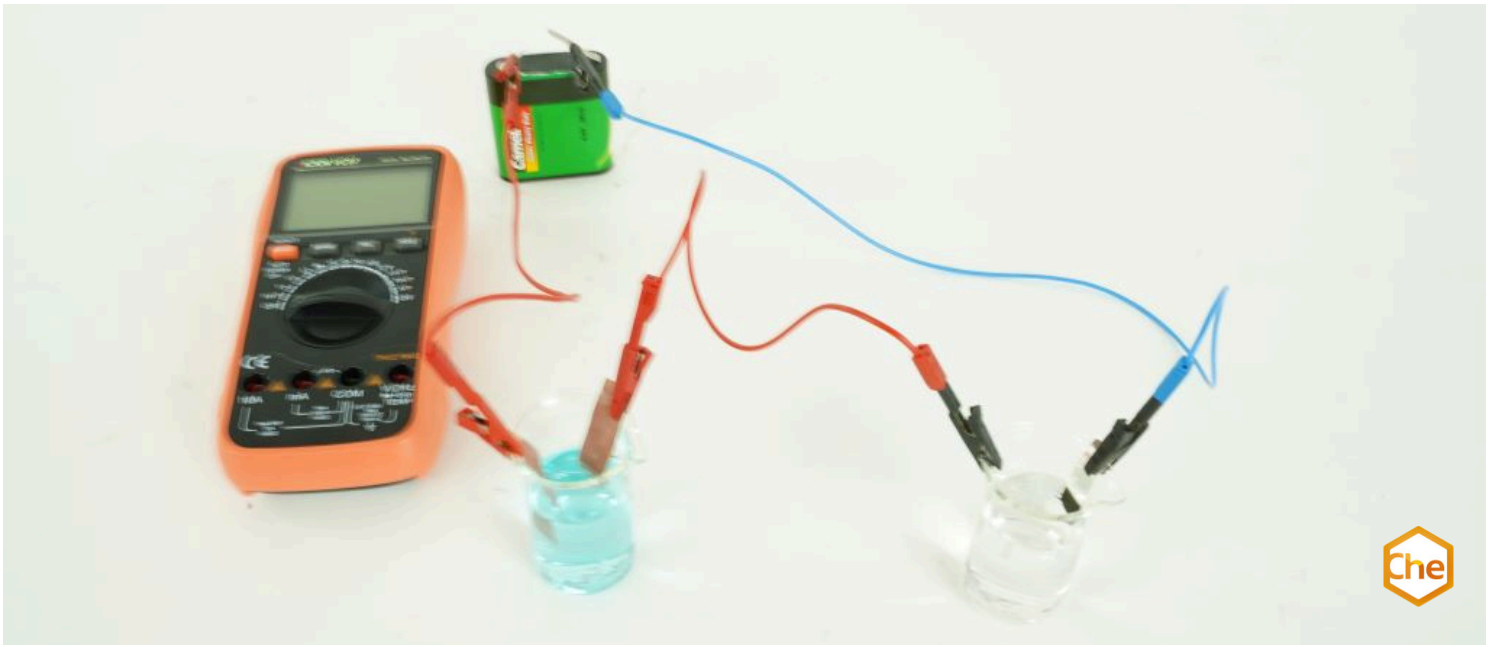
Second law of Faraday



Students learn about Faraday's second law experimentally and prove its correctness.

Chemistry > Physical chemistry > Electrochemistry > Electrolysis

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/61a8e13322e1e50003a26ea4

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Teacher information

Application

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Experiment setup

Faraday's laws are also called the basic laws of electrolysis and describe the process in this.

In this experiment, students use electrolysis to learn the principle of Faraday's 2nd Law, which states that the mass of an element deposited by a given amount of charge is proportional to the atomic mass of the deposited element and inversely proportional to its valence.

(Source: Michael Faraday: Experimental Researches in Electricity. Seventh Series. In: Philosophical Transactions of the Royal Society of London. Ribbon 124, January 1834, S. 77-122)

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Other teacher information (1/2)

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Previous 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. In addition, they should already have a basic theoretical knowledge of Faraday's laws.

Scientific Principle

Faraday's second law, published by Michael Faraday in 1834, states that the mass of an element deposited by a given amount of charge is proportional to the atomic mass of the deposited element, and inversely proportional to its valence (that is, to the number of monovalent atoms that can combine with that element). (Source: Michael Faraday: Experimental Researches in Electricity. Seventh Series. In: Philosophical Transactions of the Royal Society of London. Ribbon 124, January 1834, S. 77-122)

Other teacher information (2/2)

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Learning objective

Students learn about Faraday's second law experimentally and prove its correctness.

Tasks

Students perform electrolysis with two cells connected in series by determining the amount of deposition on a copper and silver cell and comparing the amount of deposition on each electrode.

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Safety instructions

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- Wear protective goggles and gloves.
- For the H- and P-phrases please refer to the corresponding safety data sheets.
- The general instructions for safe experimentation in science lessons apply to this experiment.

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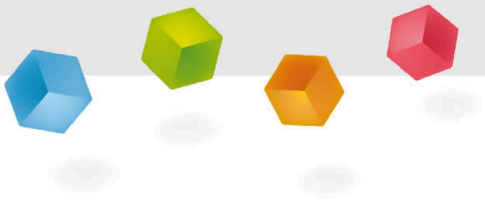

Student Information

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Motivation

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Aluminium beverage can

Faraday's laws were discovered and described by Michael Faraday in 1834. They form the basis for the electrolysis we know today.

Faraday's laws describe the relationship between the energy supplied and the amount of material deposited during electrolysis. The second Faraday law describes the relationship between the quantity deposited and its valency. The deposition quantity is inversely proportional to the valence.

In order to demonstrate this principle, monovalent silver and bivalent copper (or solutions) are electrolyzed simultaneously in this experiment.

Tasks

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1. Investigate the electrolysis of metals or metal salt solutions of different values.
2. Perform electrolysis with two cells connected in series (the first cell with two copper electrodes, the second cell with two silver electrodes).
3. Weigh all electrodes before and after electrolysis and compare the values.
4. What is the relationship between the amount of material deposited and the valency of the metal (or metal salt solution).

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Equipment

Position	Material	Item No.	Quantity
1	Protecting glasses, clear glass	39316-00	1
2	Digital multimeter, 750V AC/DC, 10A AC/DC, 40MΩ, 100mF, 30 MHz, -20...1000°C, Auto range	07123-12	1
3	Connecting cord, 2 mm-plug, 5A, 250 mm, red	07355-01	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	Beaker, Borosilicate, tall form, 50 ml	46025-00	2
7	Reducing plug 4mm/2mm socket, 2	11620-27	1
8	Set Strip electrode (Al, Fe, Pb, Zn, Cu)	07856-00	2
9	Silber, Blech, 40x40x0,2 mm, 1 Stk. ca. 3 g pro Blech	CHE-881317792	2
10	Copper-II sulphate,cryst. 250 g	30126-25	1
11	Silver nitrate, cryst. 25 g	30222-04	1

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Preparation

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- Clean the two copper electrodes. If necessary, use steel wool or emery paper and scrub them clean.
- Weigh both the copper and silver electrodes. Mark the same electrodes if necessary.
- If necessary, prepare a copper sulfate solution.
  - Add about 0.4 g copper (II) sulphate pentahydrate ($CuSO_4 \times 5 H_2O$) to 50 ml demineralised water.
  - Stir until the powder has dissolved.
  - The water should have taken on a slightly bluish colour (picture on the right).

The water takes on a bluish tint.

Set-up

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Attachment of the electrode plates to the rim of the beaker.

- Fill 45 ml of copper sulphate solution into the first beaker and 50 ml of silver nitrate solution into the second beaker.
- Fix the copper electrodes in the beaker with the copper sulphate solution using the crocodile clips, and the silver electrodes in the beaker with the silver nitrate solution. **Make sure that neither the electrodes nor the alligator clips touch each other!**
- Set up the rest of the experiment as you see it in the experimental setup figure, with the two cells connected in series. **Don't close the circuit yet!**
- Optionally, you can include a multimeter to measure the voltage or current.

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Procedure (1/2)

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- Close the circuit by clamping the battery into the circuit. Once the circuit is closed, note the reaction time.
- Make sure that you have connected the copper electrodes to the positive pole and the silver electrodes to the negative pole of the battery. If vapours rise, do not inhale them!
- If you have a multimeter connected in between, switch it on (connected in parallel to measure voltage, in series to measure current).

Experimental setup without multimeter connected.

Procedure (2/2)

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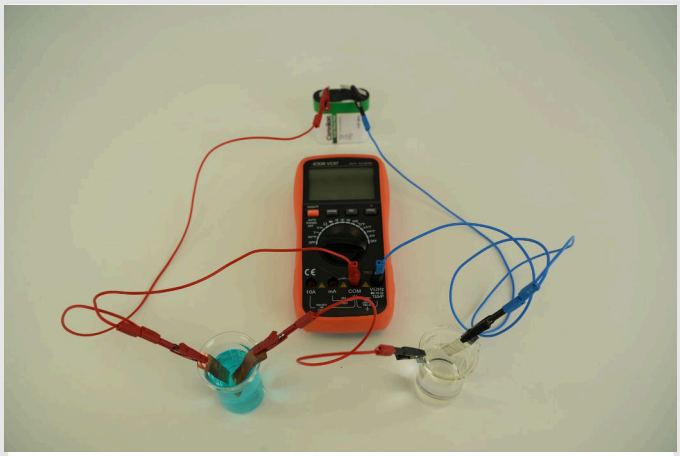
- Let the electrolysis run for 10 minutes.
- Stop electrolysis - Disconnect the battery and wait for the fluids to cool.
- Wash, dry and weigh the four electrodes. Determine the changes in weight. Make sure that the deposited substances adhere only slightly to the electrodes and fall off easily.
- Write down your observations.



Experimental setup with multimeter connected in parallel to measure the voltage.

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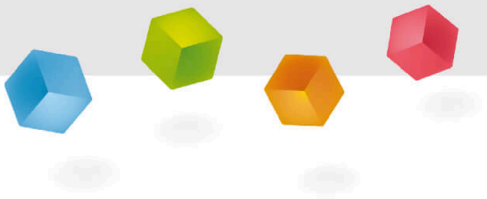

Report

Task 1

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What does Faraday's second law say?

- ○ None of the answers describe Farady's second law.
- ○ Faraday's second law states that the amount of material deposited on an electrode is proportional to the electric charge sent through the electrolyte.
- ○ Faraday's second law states that the mass of an element deposited by a given amount of charge is proportional to the atomic mass of the deposited element and inversely proportional to its valence.

Check

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Task 2

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What results were you able to make?

- [ ] In the case of the silver electrodes, twice as much mass has migrated from one electrode to the other as in the case of the copper electrodes.
- [ ] From each beaker, one electrode has become just as much heavier as the others have become lighter.
- [ ] In the silver electrodes, half as much mass has migrated from one electrode to the other as in the copper electrodes.

Check

Task 3

PHYWE

Mark the correct answers.

- [ ] Electrons move from the cathode to the anode.
- [ ] Electrolysis can be used to produce many metals.
- [ ] The electrode connected to the positive terminal of the battery is called the anode, and the one connected to the negative terminal is called the cathode.
- [ ] The liquid in which the electrodes are placed is called electron liquid.

Check

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Slide	Score / Total
Slide 15: 2. Faraday's law	0/1
Slide 16: Results	0/2
Slide 17: Electrodes	0/2

Total 0 / 5

Solutions Repeat

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