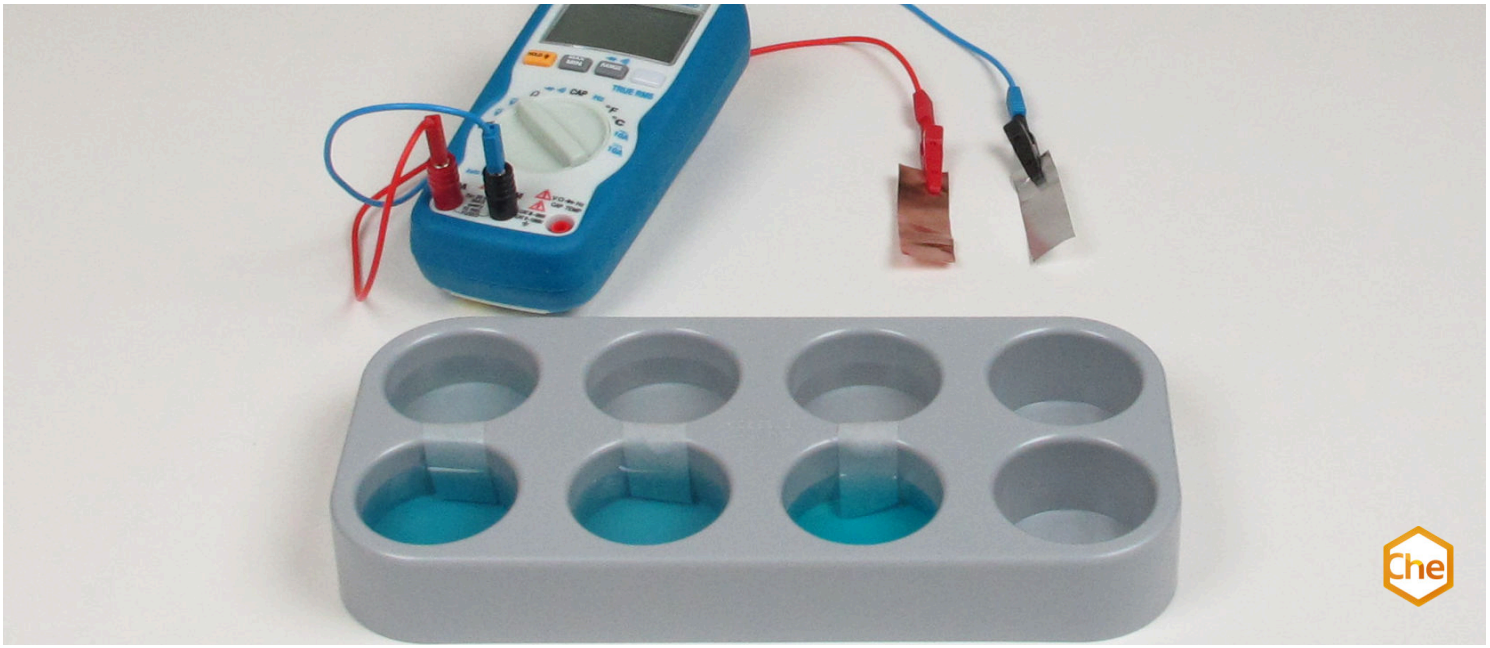
Connection of Daniell cells in series and in parallel



Students have a rough understanding of how a galvanic cell works. In this experiment, students learn how to increase the efficiency of such a galvanic cell.

Chemistry > Physical chemistry > Electrochemistry > Electrochemical voltage series

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/6353c7e230e03500032bd9f8

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Teacher information

Application

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Experimental setup

Two electrodes in a salt solution represent the simplest basic form of a battery. In principle, this structure is an electrical source through which voltage is generated.

The discovery and further development of the so-called galvanic elements, better known as batteries, has a special significance for society. Among other things, this makes the mobile power supply of a wide variety of electrical devices possible. However, a galvanic element can only apply a small amount of voltage, so it is very important to increase the efficiency by connecting several galvanic elements in series or parallel.

Galvanic elements connected in series find practical applications in the operation of portable radios and torches.

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Other teacher information (1/3)

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Prior knowledge

Students should have worked with galvanic elements (Daniell element) in theory and practice.

Principle

The voltage can be increased by connecting several galvanic cells in series, e.g. Daniell elements.

Other teacher information (2/3)

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Learning objective

Students have a rough understanding of how a galvanic cell works. In this experiment, students learn how to increase the efficiency of such a galvanic cell.

Tasks

The students are to make 3 Daniell elements. They are to connect first 2 and then 3 of these in series and measure the voltages.

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Other teacher information (3/3)

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Other information

A galvanic element (Daniell element) consists of two half cells, in this case a copper sulphate solution with copper wire and a zinc sulphate solution with zinc wire. The zinc wire acts as an electrode, which decomposes by releasing electrons. While the other electrode, the copper wire, accepts electrons. As a rule, only a small amount of current or voltage can be generated with a single galvanic element.

The voltage can be increased by connecting several galvanic cells in series, e.g. Daniell elements. The increased voltage corresponds to the sum of the voltages of the individual elements (Kirchhoff's mesh rule). With parallel connection, there is no increase in voltage, but there is an increase in current (Kirchhoff's node rule). The electrolyte solutions of the half-cells are separated by a filter paper strip, which enables a flow of electrons while at the same time preventing diffusion of the electrolyte solutions.

Safety instructions

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- Wear protective goggles and gloves.
- Avoid contact of the chemical with eyes and skin.
- 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

Motivation

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Experimental setup

Transportable electricity is now needed for many things in our everyday lives: Smartphones, watches, video games, pacemakers and hearing aids. Can you imagine what life was like without them?

In addition to the single galvanic elements, the efficiency of the elements can be significantly improved by connecting them in series. In this experiment you will learn how this works.

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Tasks

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Make 3 Daniell elements, of which first two, then three are connected together in series circuits. The voltages of the connected elements are to be measured.

Then 2 elements are connected in parallel and their voltage is compared with the measured values found above.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Digital multimeter, 600V AC/DC, 10A AC/DC, 20 MΩ, 200 µF, 20 kHz, −20°C…760°C	07122-00	1
2	Connecting cord, 2 mm-plug, 5A, 500 mm, red	07356-01	1
3	Connecting cord, 2 mm-plug, 5A, 500 mm, blue	07356-04	1
4	Reducing plug 4mm/2mm socket, 2	11620-27	1
5	Alligator clip, insulated, 2 mm socket, 2 pcs.	07275-00	3
6	Set Strip electrode (Al, Fe, Pb, Zn, Cu)	07856-00	2
7	Emery paper, medium	01605-00	1
8	Beaker, Borosilicate, tall form, 50 ml	46025-00	2
9	Dropping bottle,plastic,50ml	33920-00	1
10	Block with 8 holes, d = 40 mm	37682-00	1
11	Coverage f.cell-meas.bloc,8 piec.	37683-00	1
12	Connecting cord, 2 mm-plug, 5A, 250 mm, red	07355-01	2

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Preparation

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Producing the required solutions

Copper sulphate solution (0.1 mol/l): Add 7.95 g copper sulphate to 250 ml distilled water. Mix well and fill up to 500 ml with distilled water.

Zinc sulphate solution (0.1 mol/l) Add 8.05 g of zinc sulphate to 250 ml of distilled water. Mix well and fill up to 500 ml with distilled water.

Potassium nitrate (1 mol/l): Add 55.5 g potassium nitrate to 250 ml distilled water. Mix well and fill up to 500 ml with distilled water.

Set-up

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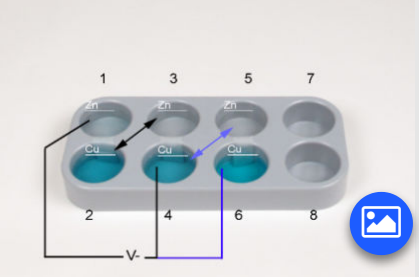
Series connection (1/2)

Fill the measuring cells with the 0.1 molar zinc and copper sulphate solutions (fig. above).

Connect the measuring cell pairs 1/2, ¾ and 5/6 according to the fig. above with current keys made of soaked (potassium nitrate solution 1 mol/l) filter paper strips, put lids on the measuring cells and insert the corresponding bare metal electrodes (copper in copper sulphate solution, zinc in zinc sulphate solution).

Then connect the copper electrode of half cell 2 with the zinc electrode of half cell 3 by means of a short connecting lead (fig. below) and then measure the voltage between zinc electrode 1 and copper electrode 4 (fig. below). The measuring range is to be set at 20 V in the measuring device.



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Procedure

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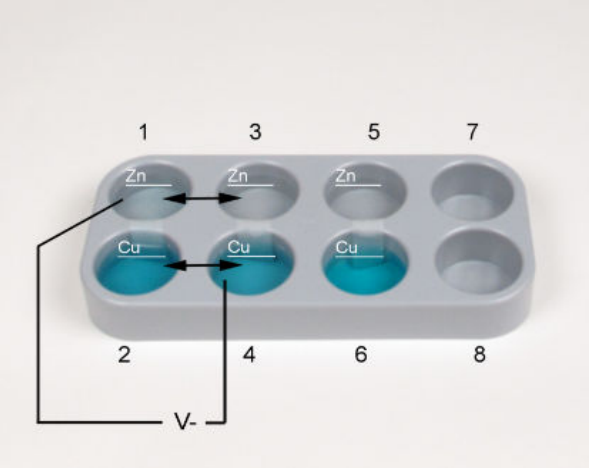
Series connection (2/2)

Now also connect the copper electrode 4 to the zinc electrode 5 via a short connecting lead and then measure the voltage between the zinc electrode 1 and the copper electrode 6.

Parallel connection

Connect the zinc electrodes 1 and 3 (fig. right) and the copper electrodes 2 and 4 each using short connecting leads. Then measure the voltage between electrodes 1 and 4 (or also between 1 and 2 or 3 and 4).



Parallel connection

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Report

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Task 1

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What could be observed when the galvanic elements were connected in series?

- ○ With the series connection, one could observe that the amperage was increased.
- ○ With the series connection, it could be observed that the increased voltage corresponds to the sum of the individual elements.
- ○ With the series connection, it could be observed that the increased voltage corresponds to the product of the individual elements.
- ○ None of the answers is correct.

Check

Task 2

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What could be observed when the galvanic elements were connected in parallel?

- ○ With the parallel connection, a reduction in the current intensity was observed.
- ○ No current could be measured with the parallel connection.
- ○ With the parallel connection, an increase in the current intensity could be detected.
- ○ The same effect was observed with the parallel connection as with the series connection.

Check

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Task 3

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Which KIRCHHOFF rule is used for parallel connection?

- ○ No KIRCHHOFF rule applies.
- ○ KIRCHHOFF's mesh rule, which states that the increased stress here corresponds to the sum of the stresses of the individual elements.
- ○ KIRCHHOFF's node rule. This states that there is no increase in voltage, but an increase in current.

Check

Slide	Score / Total
Slide 15: Series connection	0/1
Slide 16: Parallel connection	0/1
Slide 17: KIRCHHOFF's rule	0/1

Total 0 / 3

Solutions Repeat

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