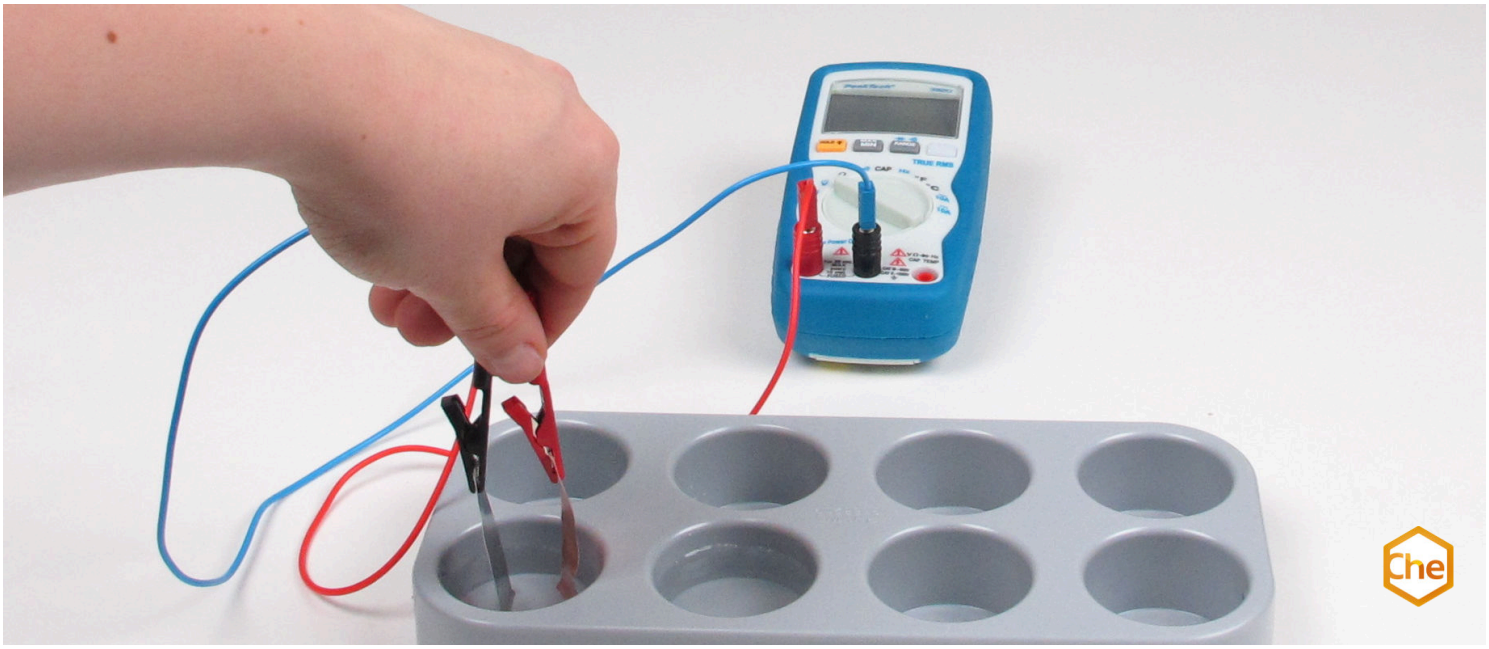
Electric voltage from a salt solution



The students deepen their understanding of basic electrochemical processes. This experiment explains how to generate DC voltage in a salt solution through two electrodes.

Chemistry > Physical chemistry > Electrochemistry > Electrochemical measurement set

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6349997b0379bd0003f7897b

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Teacher information

Application

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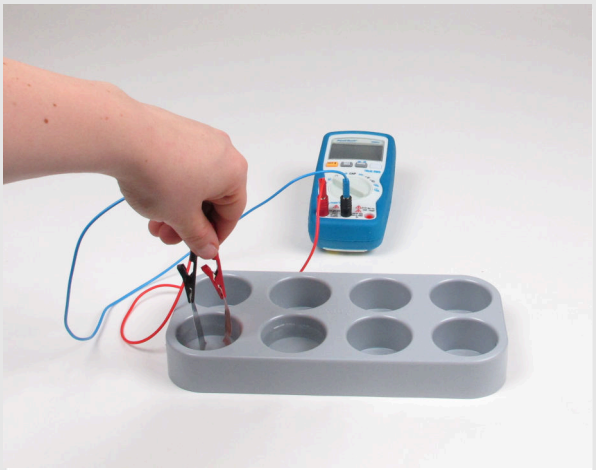

Experimental setup

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 been particularly important for society.

This makes it possible, among other things, to have a mobile power supply for a wide range of electrical appliances, which has a significant impact on our standard of living today.

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Other teacher information (1/3)

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Prior knowledge

Students should already know what an electrolyte solution is and what electrodes are for. They should also know the basics of "voltage", such as the units and the methods of measurement.

Principle

If you put sheets of two different metals, e.g. zinc and copper, into an electrolyte or salt solution, you can detect an electrical voltage on these two metals with a measuring instrument.

Other teacher information (2/3)

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Learning objective

The students should deepen their understanding of basic electrochemical processes. To illustrate this, this experiment explains how DC voltage can be generated in a salt solution by two electrodes. The term voltage is also explained in more detail.

Tasks

The students are to measure a DC electrical voltage in a salt solution between a copper and a zinc sheet.

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Other teacher information (3/3)

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In the electrolyte or salt solution, the less noble metal (here: zinc) gives off electrons to the more noble metal (here: copper). The metal wires used act as so-called electrodes. As the zinc slowly dissolves, ions are released and pass into the solution. Due to the electrons remaining in the wire, the zinc wire has a negative charge. The positively charged ions distribute themselves in the solution and multiply around the negatively charged electrode. The more noble copper wire, on the other hand, is deprived of electrons, making it positively charged. The copper wire generates hydrogen. If the wires are now connected with a connecting line, electrons or current flow from the negative pole (zinc) to the positive pole (copper). This results in the discharge of the poles, whereby the effort to equalise the charge is defined as an electrical voltage U. The unit of electrical voltage is volts. The unit of electrical voltage is volts (V). Physically speaking, U is the difference in potential electrical energy between two points (here: between the electrodes).

(minus) pole (zinc electrode) **(plus) pole (copper electrode)**

Safety instructions

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- Potassium chloride solutions c = 1.0 mol/l have an irritating effect. Protect eyes and skin. Avoid contact of the chemical with eyes and skin.
- Wear protective gloves and goggles.
- For the H and P phrases, please refer to the relevant safety data sheets.
- The general instructions for safe experimentation in science lessons apply to this experiment.

Preparation: Prepare the salt solutions:

1. **1 M potassium nitrate solution**: Add 50.5 g potassium nitrate to 250 ml distilled water. Mix well and make up to 500 ml with distilled water.
2. **1 M potassium chloride solution**: Add 37 g potassium chloride to 250 ml distilled water. Mix well and make up to 500 ml with distilled water.

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Student information

Motivation

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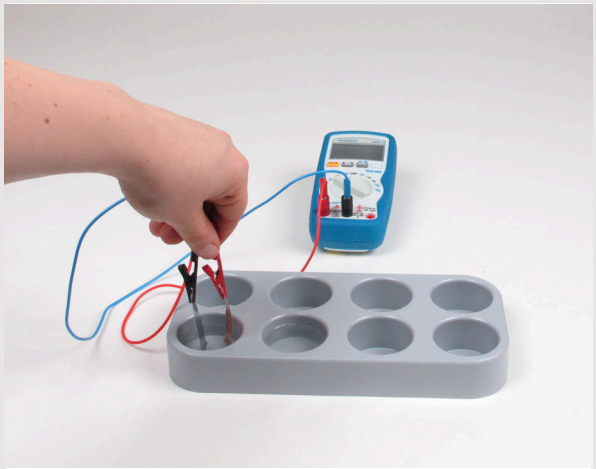

Experimental setup

Can you imagine recreating a battery in its simplest form with just a salt solution and some sheet copper and zinc?

The discovery and further development of the so-called galvanic elements, better known as batteries, has been particularly important for society.

This makes it possible, among other things, to have a mobile power supply for a wide range of electrical appliances, which has a significant impact on our standard of living today.

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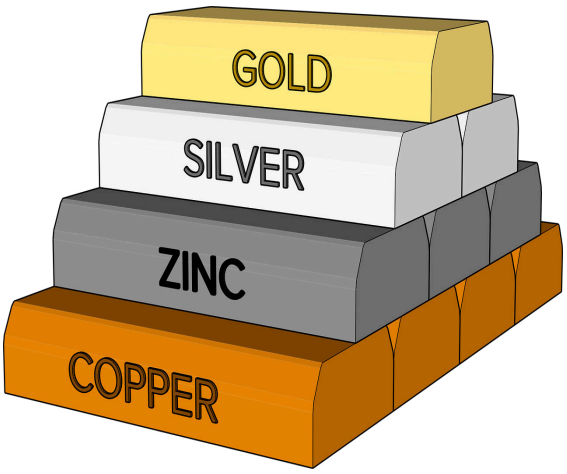
Tasks



If you immerse a copper and a zinc sheet in a salt solution, you can measure a DC electrical voltage between these sheets. Verify this statement using two different salt solutions.

Then answer the questions in the report section.

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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	1
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	Block with 8 holes, d = 40 mm	37682-00	1

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Set-up

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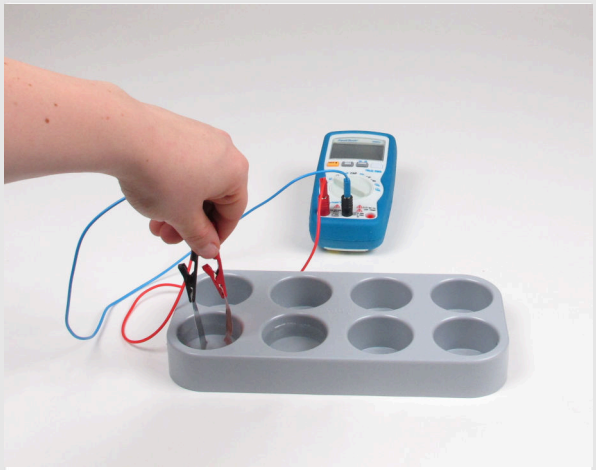

Experimental setup

Cut a 15 mm x 40 mm electrode from each of the copper and zinc sheets. If the copper has oxidised due to storage, use a piece of emery cloth to clean it.

Connect the electrodes with the alligator clips to the connecting leads and the leads in turn to the hand-held multimeter using rerductor plugs (See **Figure** "**Experimental setup**" on the slide "**Motivation**").

Blue=zinc (negative pole) on **Ground socket** (via transition plug) and red=copper (positive pole) to "V" (**V=Volt socket**) in the measuring device.

Procedure

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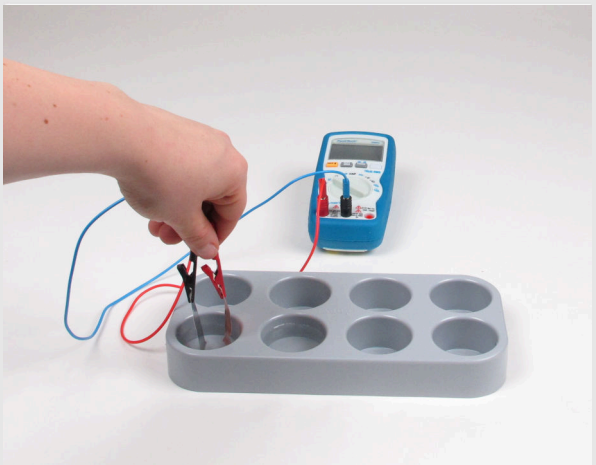
Set the current type DC voltage and the measuring range 2 V on the measuring instrument and press the on switch.

Now fill one well each of the measuring cell block with the salt solutions (the wells will simply be called "measuring cells" in the following experiment descriptions), and then dip the two electrode plates into one of the salt solutions.

Make sure that the two sheets of metal **do not** touch each other.

Then rinse the electrodes with tap water and clean at least the surface of the copper electrode with emery cloth. Insert the electrode plates into the second salt solution in the same way.



Experimental setup

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Report

Task 1

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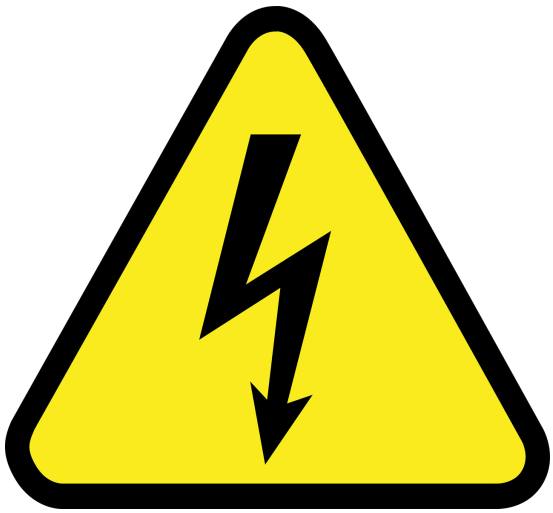
What is the general unit for electrical voltage?

- ○ Electrical voltage is generally expressed in volts (V).
- ○ The electrical voltage is generally expressed in watts (W).
- ○ Electrical voltage is generally expressed in amperes (A).

Check



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Task 2

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Where does the energy that manifests itself here in the formation of an electrical voltage come from? Does it come from the salt solution? Does it come from the metals?

- ○ The power comes from the flow of electrons. The "nobler" metal gives up electrons to the "less noble" metal. The salt solution serves as an electrolyte and conducts the current.
- ○ From the salt solution. A force pushes salt molecules from one electrode to the other. The resulting kinetic energy is the origin of the energy measured here.
- ○ The power comes from the flow of electrons. The "less noble" metal gives up electrons to the "more noble" metal. The salt solution serves as an electrolyte and conducts the current.

Check

Task 3

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Select the definition for electrical voltage.

- ○ The electrical voltage U is defined as the brightness reached by a standard light bulb after 2 hours of burning.
- ○ None of the answers is correct.
- ○ The electrical voltage U is defined as the amount of electrons per unit time in seconds.
- ○ The electrical voltage U is defined as the difference in potential electrical energy between two points.

Check

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Slide	Score / Total
Slide 14: Unit voltage	0/1
Slide 15: Energy source	0/1
Slide 16: Electrical voltage	0/1

Total 0 / 3

Solutions Repeat

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