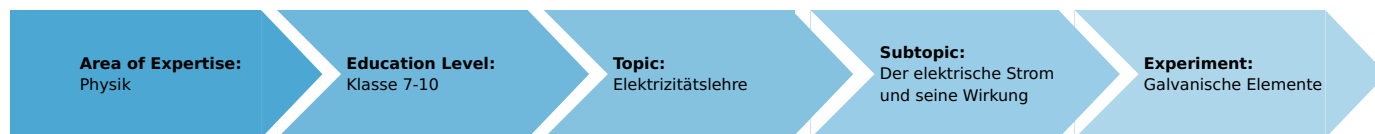


Galvanic cells (Item No.: P1375300)

Curricular Relevance



Difficulty



Intermediate

Preparation Time



10 Minutes

Execution Time



10 Minutes

Recommended Group Size



2 Students

Additional Requirements:

- Cloth or absorbent paper

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

In principle, a galvanic cell consists of two different metallic electrodes which dip into an aqueous solution of an electrolyte. A voltage is generated between the electrodes, whose origin can be explained, in a simplified way, by the passage of positive metal ions from the surface of the electrodes into the solution. Consequently freely mobile electrons are left behind on the electrodes.

As this process occurs to different extents with different metals, the strengths of their negative charges are different. This difference in charge is the source of the voltage.

In this experiment, the students should become acquainted with the construction and mode of action of single cells which are frequently used in practice, but then are more complicated.

Safety measures



R: 36/38/ 61-62-E20/22-33

S: 26/53-37-45

Diluted sulphuric acid is very corrosive to skin, eyes and mucous membranes. Vapour (aerosols) irritates the respiratory organs. Lead is harmful to health. Carry out the cleaning of the lead electrodes in a fume cupboard whenever possible!

Wear protective gloves! Wash your hands thoroughly after the experiment! Wear protective glasses!

Waste disposal

Dilute acid remains with water, neutralise (pH 6-8) and rinse to drain.

Put all lead waste resulting from cleaning the lead electrodes before and after the experiment into the container for heavy metal wastes.

Notes on setup and procedure

Diluted sulphuric acid (approx. 5 %) should be prepared in advance of the experiment. It is important that the students follow all appropriate safety precautions when handling the aqueous solution and the electrodes (lead is poisonous!). The proper waste disposal of the aqueous solutions should be carried out centrally under supervision of the teacher.

Remarks

The measured values given in Table 1 are only to be considered as examples, because the voltages which can be obtained are dependent on the state of the surfaces of the electrodes. For this reason, the lead electrodes in particular should be carefully cleaned prior to their use in the experiment. The suggestion for the succession of the electrode combinations listed in table 1 has been chosen in such a way that the students must reverse the polarity of the voltmeter several times and become orientated towards the "voltage series". Should you wish to avoid the reversal of polarity, change over the positions of the electrodes given in lines 5 and 7 of table 1.

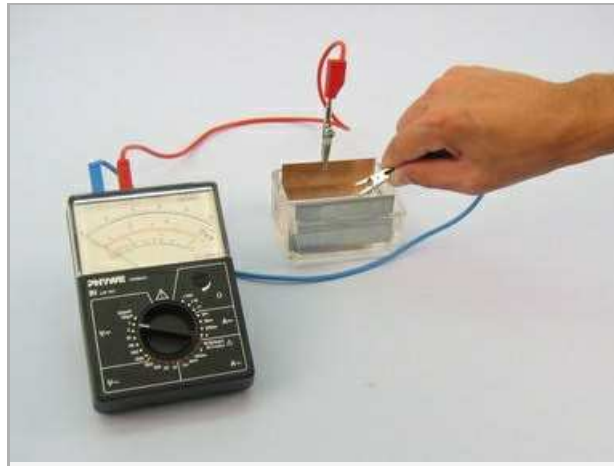
Galvanic cells (Item No.: P1375300)

Task and equipment

Task

How can electric current be generated from chemical processes?

Examine whether voltages are generated between two electrodes of different materials held in an aqueous solution of an electrolyte.



Equipment



Position No.	Material	Order No.	Quantity
1	Trough, grooved, w/o lid	34568-01	1
2	Copper electrode, 76 mm x 40 mm	45212-00	2
3	Iron electrode, 76 x 40 mm	45216-00	1
4	Zinc electrode, 76 mm x 40 mm	45214-00	1
5	Lead electrode, 76 mm x 40 mm	45215-00	1
6	Alligator clips, bare, 10 pcs	07274-03	(2)
7	Connecting cord, 32 A, 500 mm, red	07361-01	1
8	Connecting cord, 32 A, 500 mm, blue	07361-04	1
9	Multi-range meter, analogue	07028-01	1
10	Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
11	Water, distilled 5 l	31246-81	1
12	Emery paper, medium, 5 sheets	01605-02	1
Additional material			
	Cloth or absorbent paper		

Set-up and procedure

Set-up

Safety measures



- Diluted sulphuric acid is very corrosive to skin, eyes and mucous membranes. Vapour (aerosols) irritates the respiratory organs.
- Lead is harmful to health. Carry out the cleaning of the lead electrodes in a fume cupboard whenever possible!
- Wear protective gloves! Wash your hands thoroughly after the experiment! Wear protective glasses!

Setup

Clean the trough and all electrodes. Fill the trough with diluted sulphuric acid (approx. 5 %). Set up the experiment as shown in Fig. 1, first fixing the copper and zinc electrodes in the trough.

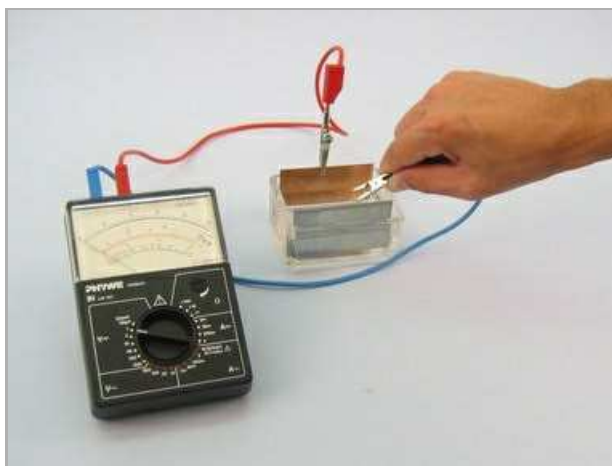


Fig. 1

Procedure

- Select the 1 V- measurement range and connect the (+) input of the voltmeter to the copper electrode, read off the voltage and enter this value in Table 1 in the report.
- Successively replace one of the electrodes by another and - when necessary - reverse the polarity of the voltmeter; in each case, measure the voltage and enter the measured value and the polarities of the electrodes used in table 1.
- Finally, measure the voltage between the copper and zinc electrodes one more time.
- Reduce the areas of the electrodes by lifting them up and thereby observe the voltmeter. Note your observation in the report.
- Reduce the distance between the electrodes and thereby observe the voltmeter. Note your observation in the report.
- Dry the electrodes, properly dispose of the aqueous solution; clean the trough and wash your hands with soap and water.

Report: Galvanic cells

Result - Table 1

Note down your observations and the measured values in table 1.

Electrode at the front		Electrode at the back		Voltage
Material	Polarity	Material	Polarity	U in V
Cu	+	Zn	-	1 ±0
Cu	0 ±0	Pb	0 ±0	1 ±0
Cu	0 ±0	Fe	0 ±0	1 ±0
Cu	1 ±0	Cu	1 ±0	1 ±0
Fe	0 ±0	Pb	0 ±0	1 ±0
Fe	0 ±0	Zn	0 ±0	1 ±0
Zn	0 ±0	Pb	0 ±0	1 ±0

Result - Observations

Note down your observations:

- a) during lifting the electrodes
- b) during reduce the distance between the electrodes

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Evaluation - Question 1

With which electrode combination (apart from Cu-Cu) is the voltage found the highest or lowest?

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Evaluation - Question 2

Attempt to arrange the metals of the electrodes in a series, so that each metal is positive against the one following it:

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Evaluation - Question 3

Which conclusions can be drawn from the noted observations?

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