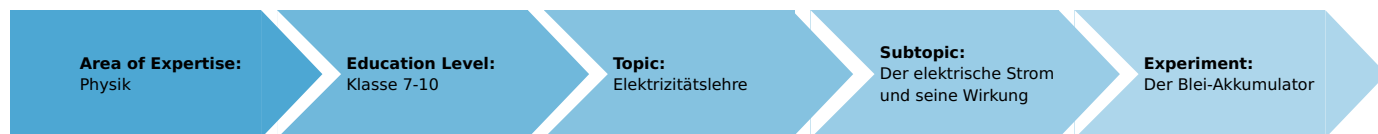


The lead accumulator (Item No.: P1375400)

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

The storage of electrical energy is a significant problem for the supply of energy, particularly as the alternating current made available by power stations cannot be directly stored.

Direct current, however, can be stored by converting the electrical energy into chemical energy. The device which is suitable for this is called an accumulator, or storage battery. In practice, several accumulator cells are connected together in series to a battery.

The students are familiar with such accumulators. This experiment is intended to clearly explain the construction principle and the mode of action of a lead accumulator.

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.

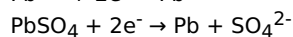
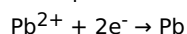
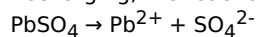
For reasons of safety, the teacher himself should pour the required amount of diluted sulphuric acid into the troughs of each group of students.
The proper waste disposal of the aqueous solutions should be carried out centrally under supervision of the teacher.

Remarks

The process of repeatedly recharging and discharging a new accumulator is called forming.
The chemical reactions which take place during recharging and discharging are indeed complicated, but can be treated presumed the students have sufficient knowledge:

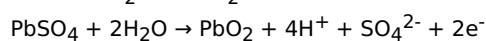
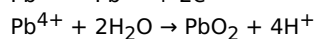
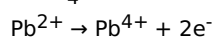
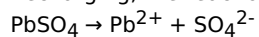
Before voltage is applied, the two lead electrodes coated themselves with lead sulphate (PbSO_4), after they were dipped in the aqueous solution in which sulphuric acid was dissociated ($\text{H}_2\text{SO}_4 \rightarrow 2\text{H}^+ + \text{SO}_4^{2-}$).

Recharging, the reactions at the cathode:



The cathode takes up electrons, its surface is reduced to pure lead.

Recharging, the reactions at the anode:



The anode donates electrons and binds oxygen; lead oxide is formed from lead sulphate at its surface.
The reverse reactions occur during discharging.

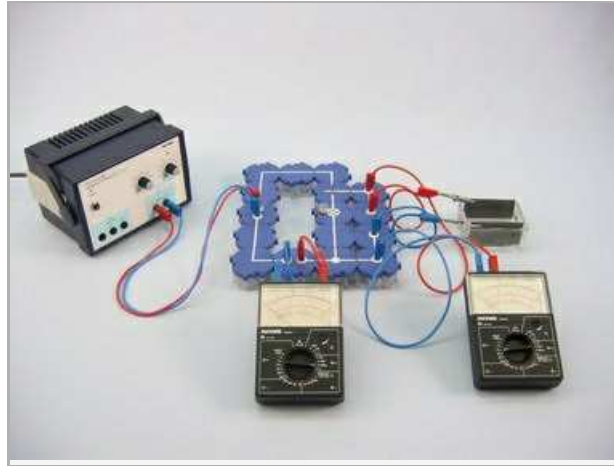
The lead accumulator (Item No.: P1375400)

Task and equipment

Task

How does a lead accumulator function?

Demonstrate how electrical energy can be stored chemically by using, as example, a model of a lead accumulator.



Equipment



Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	3
2	Angled connector module, SB	05601-02	3
3	T-shaped connector module, SB	05601-03	1
4	Interrupted connector module, SB	05601-04	2
5	Junction module, SB	05601-10	2
6	Angled connector module with socket, SB	05601-12	2
7	Change-over switch module, SB	05602-02	1
8	Socket module for incandescent lamp E10, SB	05604-00	2
9	Trough, grooved, w/o lid	34568-01	1
10	Lead electrode, 76 mm x 40 mm	45215-00	2
11	Alligator clips, bare, 10 pcs	07274-03	(2)
12	Connecting cord, 32 A, 250 mm, red	07360-01	2
13	Connecting cord, 32 A, 250 mm, blue	07360-04	2
14	Connecting cord, 32 A, 500 mm, red	07361-01	2
15	Connecting cord, 32 A, 500 mm, blue	07361-04	2
16	Filament lamps 4V/0.04A, E10, 10 pcs	06154-03	(2)
17	PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
18	Multi-range meter, analogue	07028-01	2
19	Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
20	Water, distilled 5 l	31246-81	1
21	Emery paper, medium, 5 sheets	01605-02	(1)
Additional material			
	Stop watch, digital, 24h, 1/100 s and 1 s	24025-00	1
	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

Fill the trough with diluted sulphuric acid (approx. 5 %) and fit the lead electrodes in the trough after having cleaned them with emery cloth.

Set up the experiment as shown in Fig. 1, Fig. 2 and Fig. 3, with the changeover switch at 1 ("load" = recharge); select the 300 mA- and 10 V- measurement ranges.

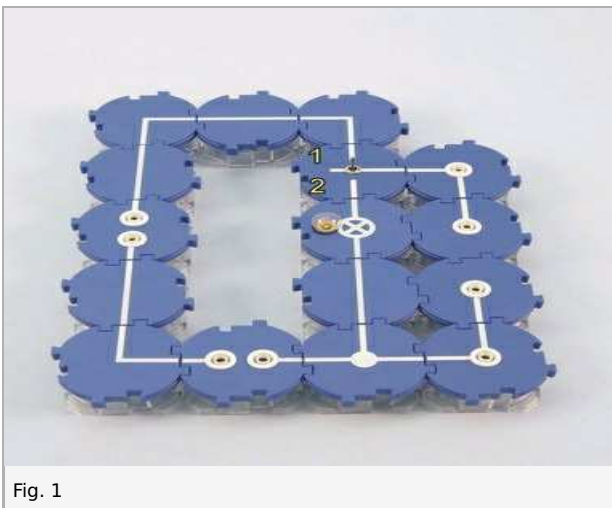


Fig. 1

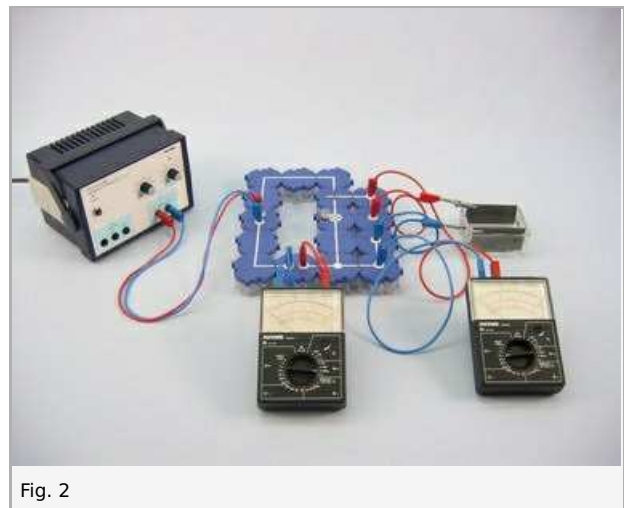


Fig. 2

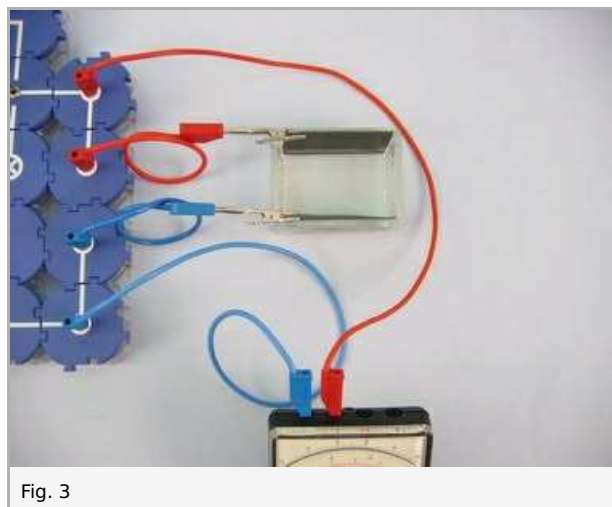


Fig. 3

Procedure

- Set the power supply to 0 V and switch it on.
- Adjust the power supply voltage so that the ammeter shows about 200 mA.
- After about 0.5 minutes, flip the changeover switch to position 2 ("empty" = discharge), observe the lamp and measure the voltage (for this, temporarily select the 3 V- measurement range); note the measured value in the report.
- Observe the voltmeter and lamp for some minutes, note your observations in the report.
- Again select the 10 V measurement range, flip the changeover switch to 1; adjust the (recharging) current to approx. 200 mA.
- After about 0.5 minutes, flip the changeover switch to 2, select the 3 V- measurement range and observe the lamp and voltmeter for some minutes.
- Compare your observations in the Results page and note your realisation in the report, too.
- Set the power supply to 0 V and switch it off.
- Remove the electrodes from the solution, rinse them with water and visually inspect them; note any changes in the electrodes in the report.
- Properly dispose of the aqueous solution; clean the trough and wash your hands with soap and water.

Report: The lead accumulator

Result - Observations 1

Note down your observations during the first part of the experiment. How high is the voltage level between the electrodes?

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Result - Observations 2

Note down your observations during the second part of the experiment. Compare the observations with the first part of experiment.

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Result - Observations 3

Note down your observations to the electrodes.

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Evaluation - Question 1

Use your observations to describe the construction and mode of action of a lead accumulator cell.

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Evaluation - Question 2

The ability of an accumulator to store electrical energy is called its capacity. It is measured in ampere-hours (Ah). How can the highest possible capacity of a new lead accumulator be reached?

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