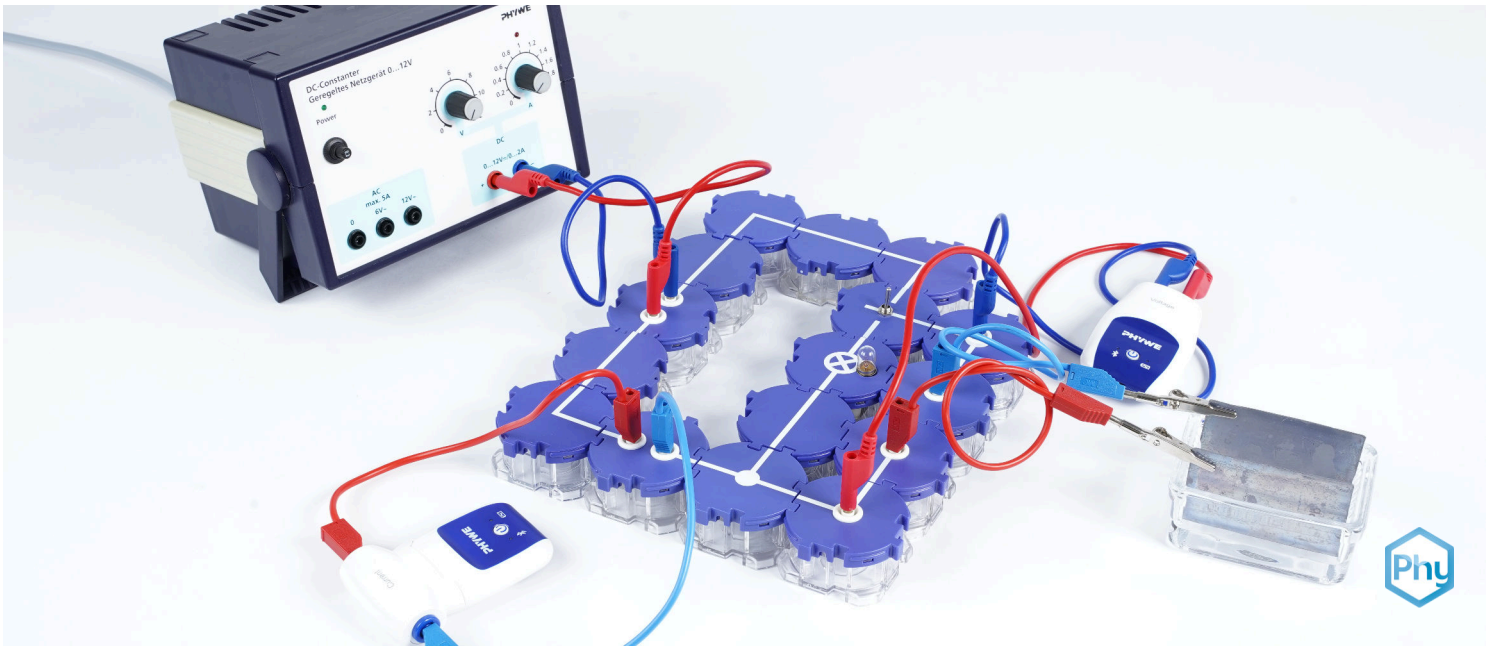
The lead accumulator with Cobra SMARTsense



This experiment is intended to show the students the basic structure and mode of operation of a lead accumulator.

Physics > Electricity & Magnetism > Electric current & its effects

Difficulty level	Group size	Preparation time	Execution time
medium	-	10 minutes	10 minutes

This content can also be found online at:

https://www.curriculab.de/c/67aa6eff945666000274bc5c

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Teacher Information

Application

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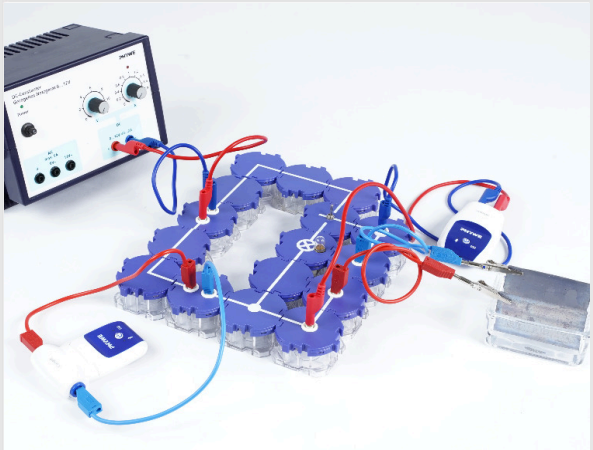

Experimental setup

The storage of electrical energy is a significant problem of energy supply, especially since the energy of alternating current provided in power plants cannot be stored directly.

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

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Other teacher information (1/2)

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Prior knowledge

For this experiment, students should be familiar with the fact that aqueous solutions conduct electricity.

Principle

The chemical reactions that take place during charging and discharging are complicated, but can be covered if the students have the appropriate prior knowledge:

Before a voltage is applied, the two lead electrodes become coated with lead sulphate (PbSO4) after being immersed in the aqueous solution in which sulphuric acid has dissociated $\mathrm{H_2SO_4} \rightarrow 2\mathrm{H^+} + \mathrm{SO_4^{2-}}$

Other teacher information (2/2)

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Learning objective

This experiment is intended to show the students the basic structure and mode of operation of a lead accumulator.

Tasks

Using a lead accumulator model as an example, show how electrical energy can be stored and reused chemically.

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Safety instructions

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- Wear protective gloves and goggles.
- For the H and P phrases, observe 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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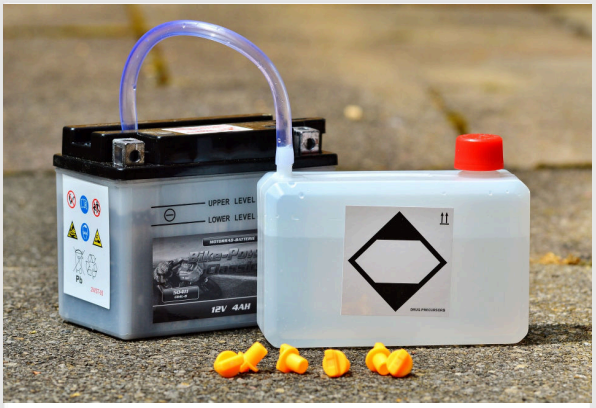
The storage of electrical energy is a significant problem of energy supply, especially since the energy of alternating current provided in power plants cannot be stored directly.

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



In practice, several accumulator cells are generally connected in series to form a battery.

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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module, SB	05601-01	4
2	Angled connector module, SB	05601-02	3
3	T-shaped connector module, SB	05601-03	1
4	Interrupted connector module with sockets, 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	1
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	1
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	06154-03	1
17	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
18	Sulphuric acid, 10%, tech.gr., 1000 ml	31828-70	1
19	Water, distilled 5 l	31246-81	1
20	Emery paper, medium	01605-00	1
21	measureAPP - the free measurement software for all devices and operating systems	14581-61	1
22	Cobra SMARTsense Current - Sensor for measuring electrical current ± 1 A (Bluetooth + USB)	12902-01	1
23	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage ± 30 V (Bluetooth + USB)	12901-01	1

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Set-up and Procedure (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check whether your device (smartphone, tablet, desktop PC) is running **Bluetooth activated** is.

iOS

Android

Windows

Set-up and Procedure (1/3)

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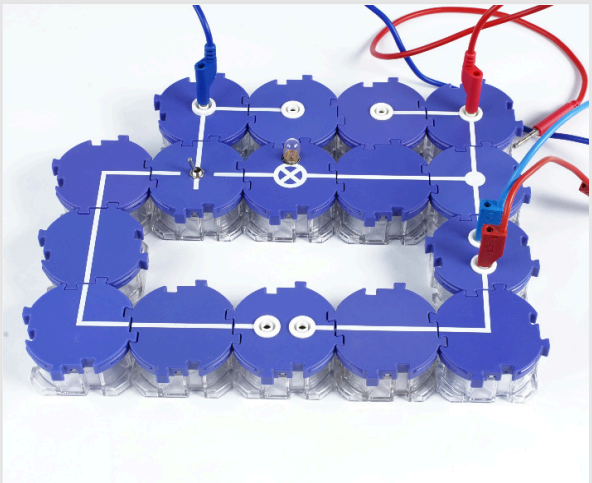

Fig. 1

- Fill the grooved trough with diluted sulphuric acid (approx. 5 %) and put the lead electrodes, cleaned with emery paper, into the trough.
- Set up the experiment as shown in Fig. 1, Fig. 2 and Fig. 3, which are shown on the next pages. The change-over switch is set to 1 (charging).
- Set the power supply unit to 0 V and switch it on.
- Adjust the voltage at the power supply so that the ammeter reads about 200 mA.

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Set-up and Procedure (1/3)

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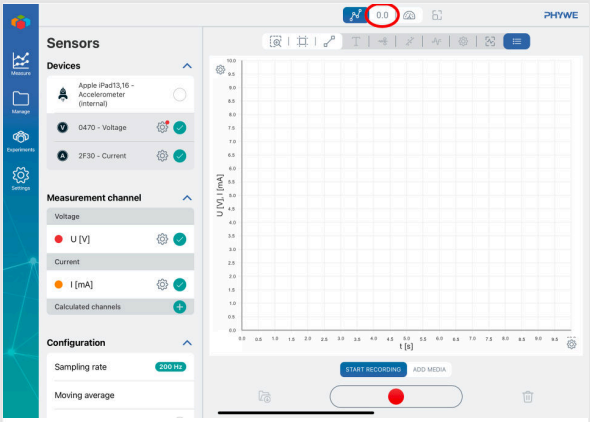

Fig. 2

- Turn on both SMARTsense sensors and make sure the tablet can connect to Bluetooth devices. To turn them on, press and hold the power button for three seconds.
- Open the PHYWE measure app and select the sensors "Current" and "Voltage."
- Choose a sampling rate within the range of 200 Hz.
- Display the measurement results as numbers by switching to the red-marked section (see the figure on the left).

Set-up and Procedure (2/3)

PHYWE

- Adjust the voltage at the power supply so that the ammeter reads about 200 mA.
- Observe the voltmeter and the light bulb for a few minutes and record your observations in the report under "Result - Observations 1".
- Select the measuring range 10 V again and set the changeover switch to 1. Set the (charging) current to approx. 200 mA.
- After about half a minute, set the switch to position 2 (discharge). Observe the bulb and measure the voltage.

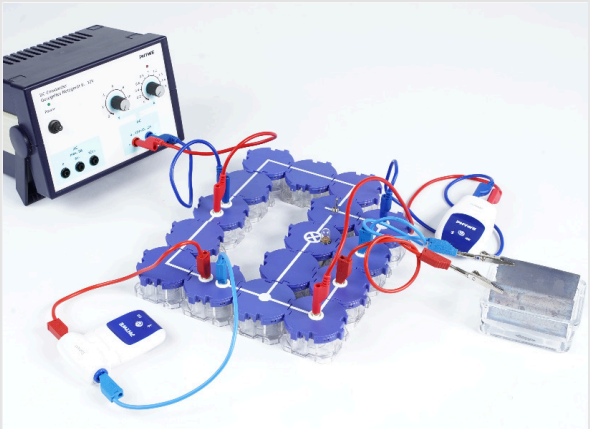

Fig. 2

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Set-up and Procedure (3/3)

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- Compare your readings with those recorded in the previous part of the experiment and record your observations in the report under "Result - Observations 2".
- Set the power supply unit to 0 V and switch it off.
- Take the electrodes out of the solution, rinse them with water and look at them carefully. Note any changes in the report.
- Dispose of the aqueous solution properly, clean the grooved trough and wash your hands with soap!

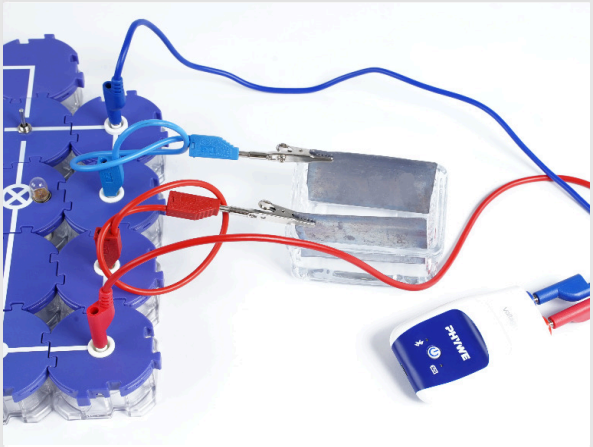

Fig. 3

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Report

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Observation (1/3)

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Write down your observations and measurements for the first part of the experiment. What is the voltage between the electrodes?

Observation (2/3)

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

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Observation (3/3)

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Write down your observations about the electrodes.

Task (1/2)

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Describe the construction and mode of operation of a lead-acid battery cell, taking into account the facts noted under "Result - Observations 1".

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Task (2/2)

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Drag the words into the correct boxes!

In general, the removable capacity of a battery decreases with increasing _____. One of the reasons for this is the increasing _____ at the internal resistance of the battery with increasing current, which causes the output voltage to drop accordingly, so that the final discharge voltage is reached earlier. In addition to the _____, the limited _____ of the electrochemical processes and charge transport processes in the battery is also responsible for its decreasing capacity with increased discharge current.

- discharge current
- internal resistance
- speed
- voltage drop

Check

Slide	Score / Total
Slide 19: Capacity	0/4

Total score 0 / 4

Show solutions | Repeat | Export text

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