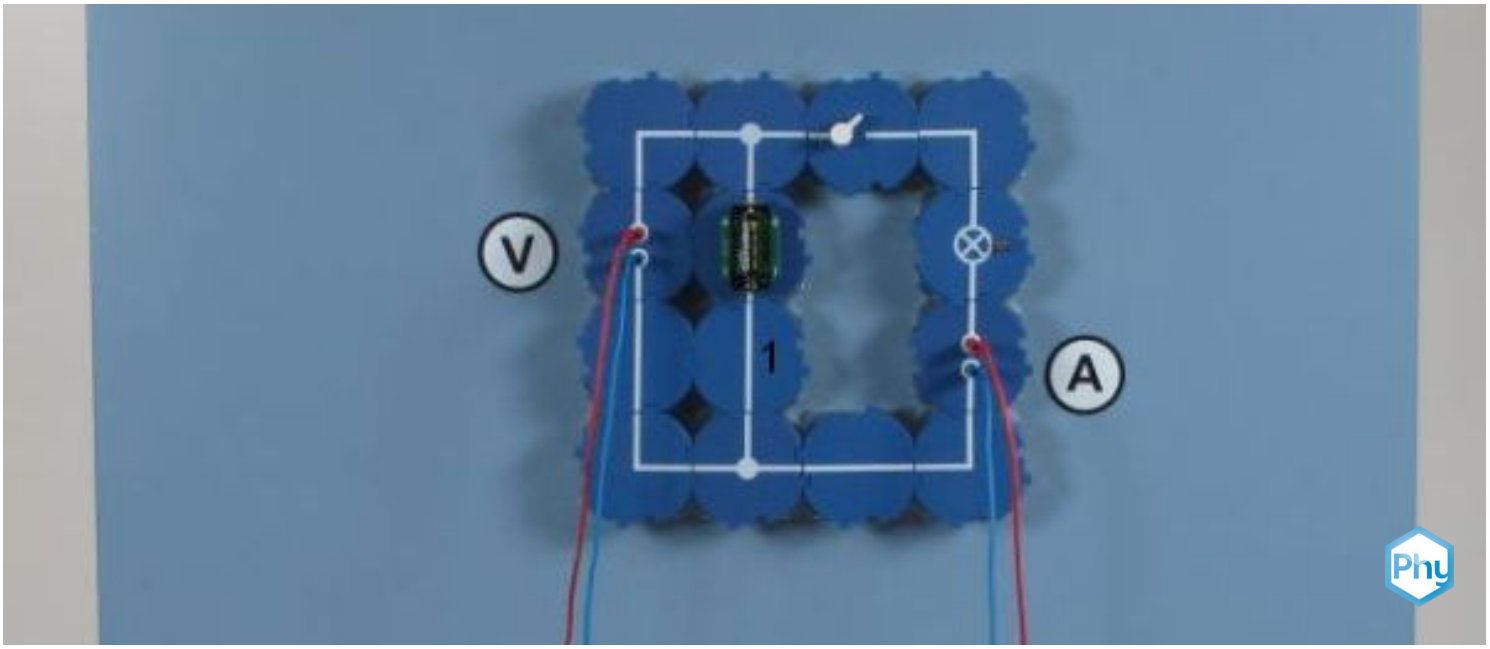
Series and parallel connection of sources of voltage



What can be achieved by connecting voltage sources in series and parallel will be demonstarted.

Physics > Electricity & Magnetism > Simple circuits, resistors & capacitors

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

This content can also be found online at:

http://localhost:1337/c/6474ba5321530f000293d7fc

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General information

Application

Series or parallel connection?

In everyday life, it is often the case that several monocells have to be connected together to form batteries for the power supply of mobile electrical devices. There are many examples of applications: drills, torches, radios, children's toys and many more.

Remark: Originally, the term 'battery' only referred to the interconnection of several monocells. Colloquially, however, individual monocells are often referred to as 'batteries'.

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Other information (1/2)

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Prior knowledge

Students should be familiar with the breakdown of a simple circuit and know the terms amperage and voltage.

Principle

By connecting voltage sources in series, an increase in the available voltage is achieved.

Other information (2/2)

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Learning objective

Students should recognise the difference between batteries connected in series and in parallel.

Tasks

First, two batteries are connected in series and then in parallel and it is investigated how this affects the voltage and current to be measured in the circuit.

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Safety instructions

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The general instructions for safe experimentation in science lessons apply to this experiment.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Demo Physics board with stand	02150-00	1
2	Connector, straight, module DB	09401-01	2
3	Connector, angled, module DB	09401-02	4
4	Connector, T-shaped, module DB	09401-03	4
5	Connector interrupted, module DB	09401-04	4
6	Switch on/off, module DB	09402-01	1
7	Socket for incandescent lamp E10 ,module DB	09404-00	1
8	Battery holder module (C type), SB	05605-00	2
9	Connecting cord, 32 A, 1000 mm, red	07363-01	2
10	Connecting cord, 32 A, 1000 mm, blue	07363-04	2
11	PHYWE Demo Multimeter ADM 3: current, voltage, resistance, temperature	13840-00	2
12	Battery Type C 1.5 V - Pack of 2 pieces	07400-00	2
13	Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
14	Electr.symbols f.demo-board,12pcs	02154-03	1
15	G-clamp	02014-01	2

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Setup and procedure

Set-up (1/2)

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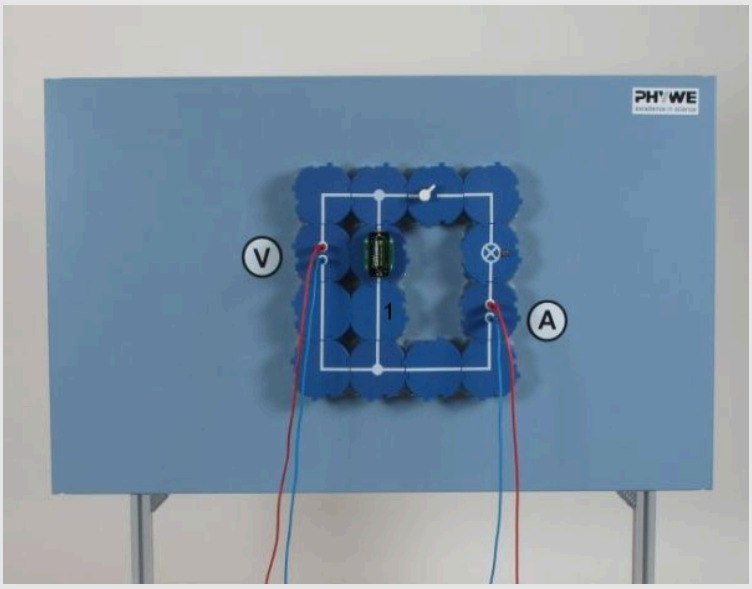

- Build the series circuit according to the illustration on the left.
- Set the following measuring ranges: 3 V- and 300 mA-.

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Set-up (2/2)

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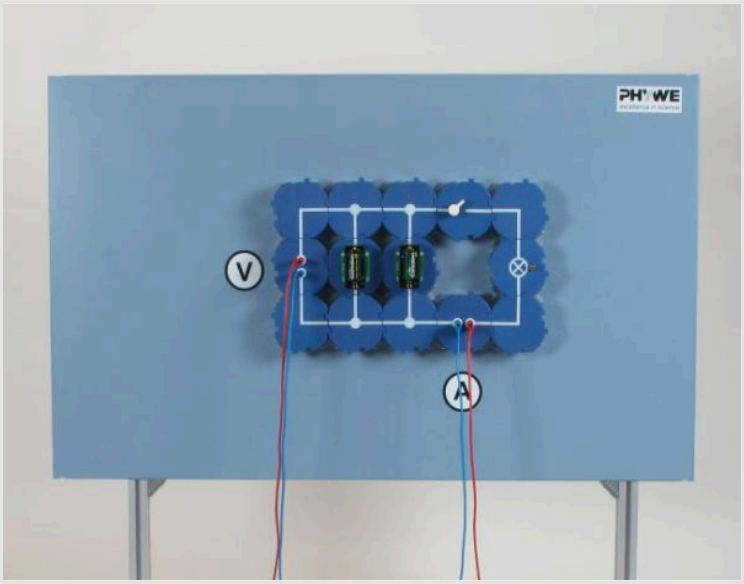

- In the second part of the experiment, build a parallel circuit according to the illustration on the left.
- Poles with the same name should be connected to each other.

Procedure (1/3)

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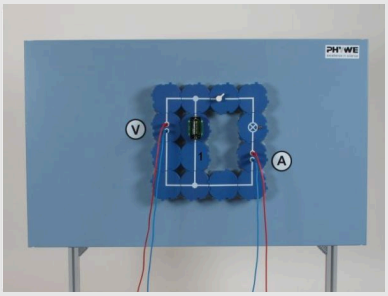

Series connection:

- Measure the open-circuit voltage with the switch open U_L and note the measurement results.
- Close the switch and measure the amperage I and tension U_B (under load).
- Observe the light bulb and note down the measurements and observations.
- With the switch open, remove line module 1 and connect the second battery in series with the first.
- Measure the open circuit voltage again U_L and note the measurement results.

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Procedure (2/3)

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- Close the switch and measure U_B and I.
- Observe the brightness of the light bulb and note down the measurements and observations.
- Now open the switch and turn one of the two batteries (with the battery holder) 180°.
- Fair as before first U_L, afterwards U_B and I and watch the light bulb.
- Note down the measurement results and observations.

Procedure (3/3)

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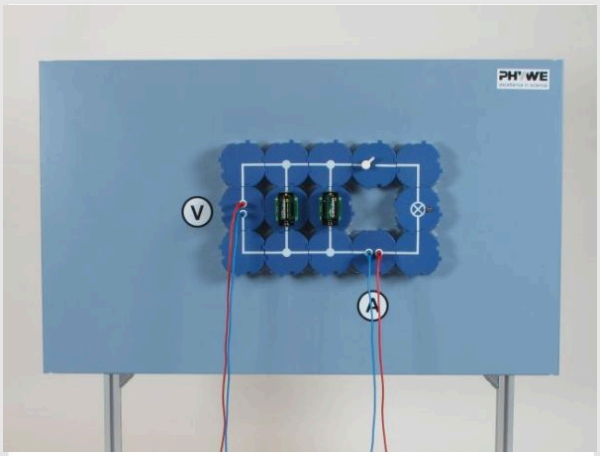
Parallel connection:

- Measure the open-circuit voltage with the switch open U_L and note the measurement results.
- Close the switch and measure the amperage I and tension U_B (under load).
- Observe the light bulb and note down the measurement results and observations.



Parallel connection

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Evaluation

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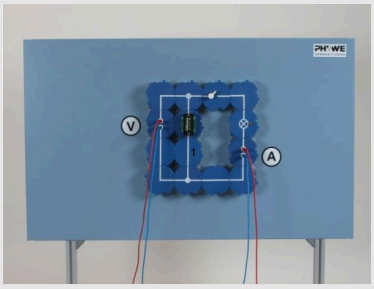

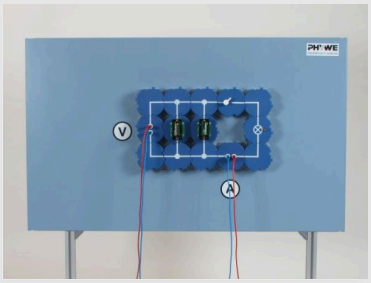

- By connecting voltage sources in series, an increase in the available voltage is achieved.
- The following equation applies for the series connection of two voltage sources $U_G = U_1 + U_2$.
- Care must be taken to connect the positive pole of one voltage source to the negative pole of the next.
- The voltage under load, the operating voltage, is lower than the open-circuit voltage.
- By connecting (similar) voltage sources in parallel, the open-circuit voltage cannot be increased, but the difference between the open-circuit and operating voltage is reduced as a result, i.e. the load can be increased without the operating voltage dropping more.

Note

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- The explanation for the fact that the operating voltage (voltage under load) is smaller than the open-circuit voltage can only be given once the influence of the internal resistance of a voltage source on its load capacity has been worked out.
- The fresher ("unused") the batteries are, the lower the load on the voltage. The incandescent lamp recommended for use has a resistance of about 12 Ω. If a significantly higher voltage drop is to be demonstrated, the 1 Ω /2 W resistor can be used instead of the incandescent lamp.
- For many students, the series connection of single cells is not new. They know it from the operation of portable or mobile electrical and electronic devices (torch, radio, etc.).

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