Series and parallel connection of voltage sources

(Item No.: P1372100)

Curricular Relevance

Area of Expertise: Physik

Education Level: Klasse 7-10

Topic: Elektrizitätslehre

Subtopic: Der einfache elektrische Stromkreis

Experiment: Reihen- und Parallelschaltung von Spannungsquellen

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Information for teachers

Additional information

It frequently occurs in practice that single-cell batteries must be connected together to act as the power supply for portable or mobile electrical and electronic devices (drills, flashlights, radios etc.).
The students should discover which objectives one can fulfill with a series or parallel connection of single-cell batteries.

Notes on setup and procedure

The 6 V / 0.5 A lamp is recommended, because it has a relatively low resistance, so that measurable voltage drops are to be expected under load.

Remarks

The explanation why the operating voltage (voltage under given load) is smaller than the no-load voltage cannot be given until the influence of the internal resistance of a voltage source and its load-carrying ability has been worked on.
The measured values which the students obtain can differ relatively greatly from each other and from the values given in the sample answers, as they are dependent on the condition of the single-cell batteries. The fresher (less used) the batteries are, the less effect the load has on the voltage.
According to make, the single-cell batteries can have a voltage which is above 1.5 V. In this case, a higher measurement range must be considered.

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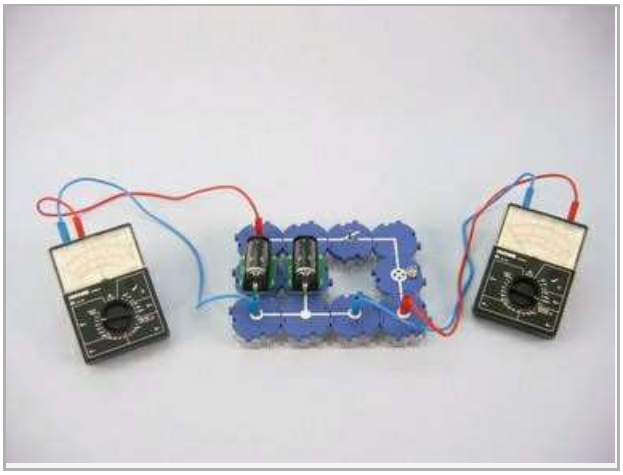
Task and equipment

Task

What can be achieved by connecting voltage sources in series and in parallel?

Connect two batteries, first in series and then in parallel, and determine the effect on the voltage and the current.



Equipment

Position No.	Material	Order No.	Quantity
1	Straight connector module, SB	05601-01	4
2	Angled connector module, SB	05601-02	1
3	T-shaped connector module, SB	05601-03	2
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	On-off switch module, SB	05602-01	1
8	Socket module for incandescent lamp E10, SB	05604-00	1
9	Battery holder module (C type), SB	05605-00	2
10	Connecting cord, 32 A, 500 mm, red	07361-01	2
11	Connecting cord, 32 A, 500 mm, blue	07361-04	2
12	Battery cell, 1.5 V, baby size, type C	07922-01	2
13	Filament lamps 3.5V/0.2A,E10, 10	06152-03	(1)
14	Multi-range meter, analogue	07028-01	2

Set-up and procedure

Set-up

First experiment

Set up the circuit as shown in Fig. 1 and Fig. 2. Add the battery and connect a voltmeter (left) and an amperemeter (bottom right) to your circuit (Fig. 2). Select the 3 V− and 300 mA− measurement ranges.

Note: The "1" indicates the position where you will later add a second battery socket.

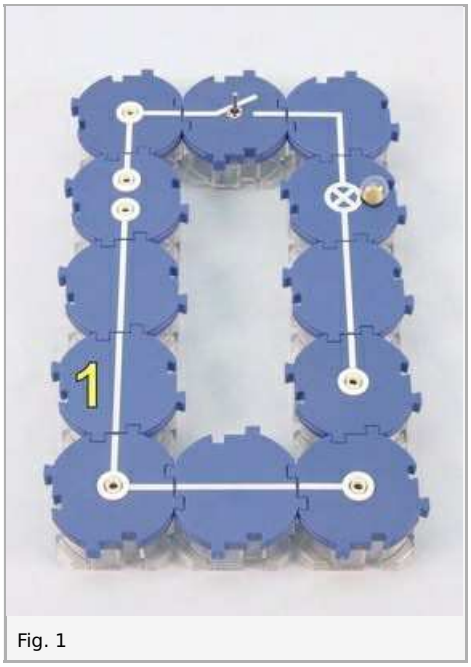


Fig. 1

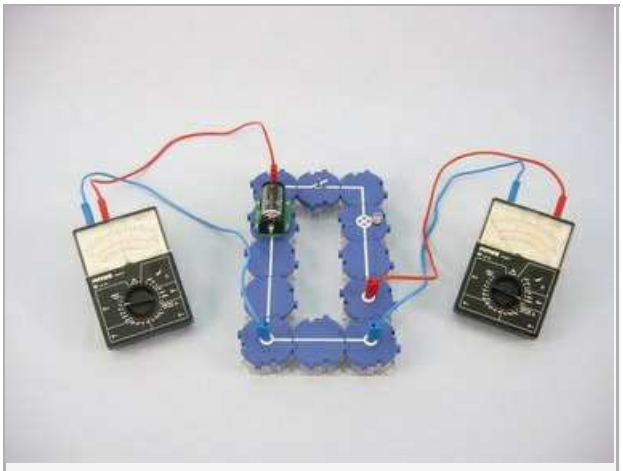


Fig. 2

Second experiment

Set up the circuit as seen in Fig. 3. Add a voltmeter (left), an amperemeter (right) and two batteries (Fig. 4). Be careful that the battery terminals of the same name (sign) are connected to each other.

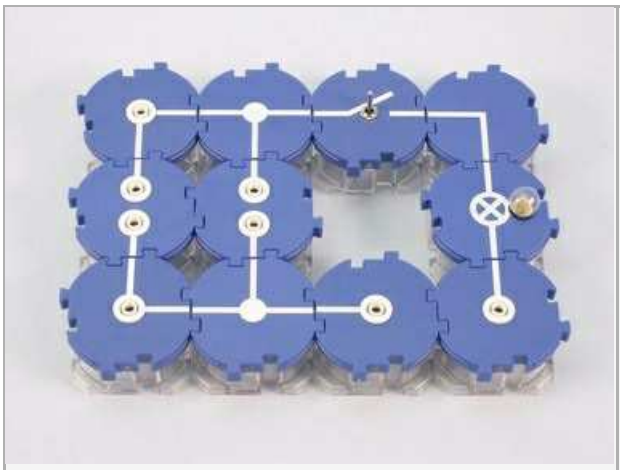


Fig. 3

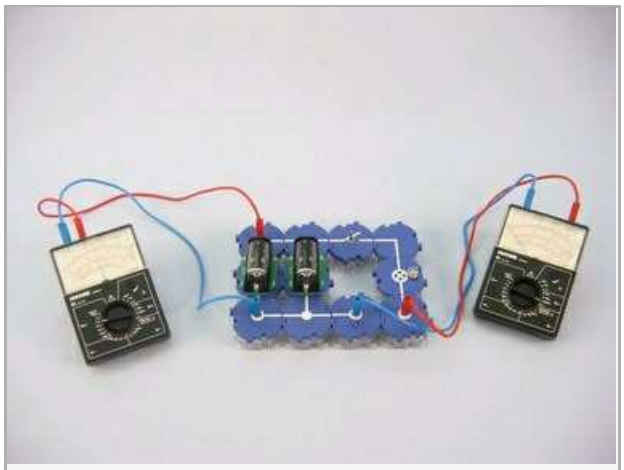


Fig. 4

Procedure

First experiment

- With the switch open, measure the voltage at rest U_L (no load) and enter the measured value in Table 1, line 1 (report).
- Close the switch, measure the current I and voltage U_B (under load) and observe the brightness of the lamp. Enter your observation and measured values in line 1 of Table 1 in the report.
- Open the switch.
- Remove connector module 1 and replace it with the second battery so that this is connected in series with the one already positioned in the circuit (connect the positive terminal of the first one to the negative terminal of the second one).
- Again measure the voltage at rest U_L and enter the measured value in line 2 of Table 1.
- Close the switch, measure U_B and I , and observe the brightness of the lamp.
- Enter the measured values and your observation in line 2 of Table 1.
- Turn one of the batteries round by 180 degrees so that the two positive terminals (or negative terminals) are connected to each other.
- As previously, first measure the voltage at rest U_L and then U_B and I under load and observe the lamp. Note the results in line 3 of Table 1.
- Open the switch.

Second experiment

- Change the experiment as shown on the Setup page.
- With the switch open, measure the voltage at rest U_L and enter the measured value in Table 2 in the report.
- Close the switch. Measure the voltage U_B and the current I under load and observe the lamp. Enter the measured values and observation in Table 2.
- Open the switch.

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Report: Series and parallel connection of voltage sources

Results – Table 1

Enter the measurement results of first experiment in the table 1:

	No load	Under load		
	U_L in V	U_B in V	I in mA	Lamp brightness
1 Battery	1	1	1	1
2 Batteries(+ to −)	1	1	1	1
2 Batteries(+ to +)	1	1	1	1

Results – Table 2

Enter the measurement results of second experiment in the table 2:

	No load	Under load		
	U_L in V	U_B in V	I in mA	Lamp brightness
2 Batteries	1	1	1	1

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Evaluation – Question 1

What is achieved with a series connection of batteries (and in general of voltage sources)?

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Evaluation – Question 2

Which relationship is given in a series connection between the total voltage U_t and the voltages U_1 and U_2 of the individual batteries?

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Evaluation – Question 3

Attempt to formulate an explanation why no voltage is present with the other (wrong) connection of the terminals (refer to line 3, Table 1).

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Evaluation – Question 4

Compare the voltage at rest to that under load.

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Evaluation – Question 5

What is achieved by the parallel connection of the voltage sources?

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