The power and work of an electric current (Item No.: P1381900)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Electricity
Subtopic: Electrical energy, power and work
Experiment: The power and work of an electric current

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

Additional Requirements:

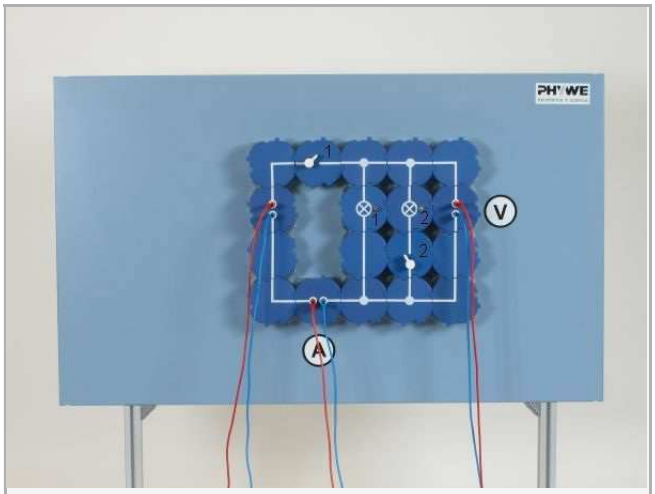
Experiment Variations:

Keywords:

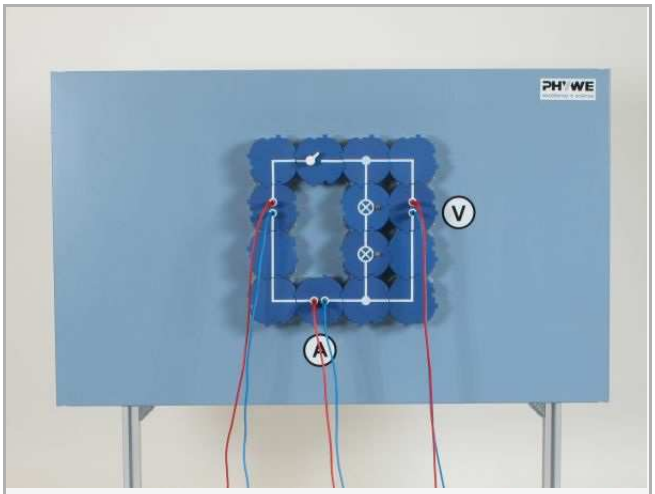
Principle and equipment

Principle

The dependence of electric power and work on the current and the voltage is to be investigated using a series and a parallel connection of filament lamps.



Experimental set-up Part 1



Experimental set-up Part 2

Equipment

Position No.	Material	Order No.	Quantity
1	Multimeter ADM2, demo., analogue	13820-01	2
2	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13500-93	1
3	Demo Physics board with stand	02150-00	1
4	Switch on/off, module DB	09402-01	2
5	Socket for incandescent lamp E10 ,module DB	09404-00	2
6	Connector interrupted, module DB	09401-04	3
7	Electr.symbols f.demo-board,12pcs	02154-03	1
8	Connector, straight, module DB	09401-01	3
9	Connector, angled, module DB	09401-02	4
10	Connector, T-shaped, module DB	09401-03	4
11	Filament lamps 4V/0.04A, E10, 10	06154-03	1
12	Connecting cord, 32 A, 1000 mm, red	07363-01	3
13	Connecting cord, 32 A, 1000 mm, blue	07363-04	3

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Set-up and procedure

- Connect up the circuit as shown in Fig. 1, with switches S_1 and S_2 open; select the 10 V- and 100 mA- measurement ranges.
- Switch on the power supply and set it to 0 V; close switch S_1.

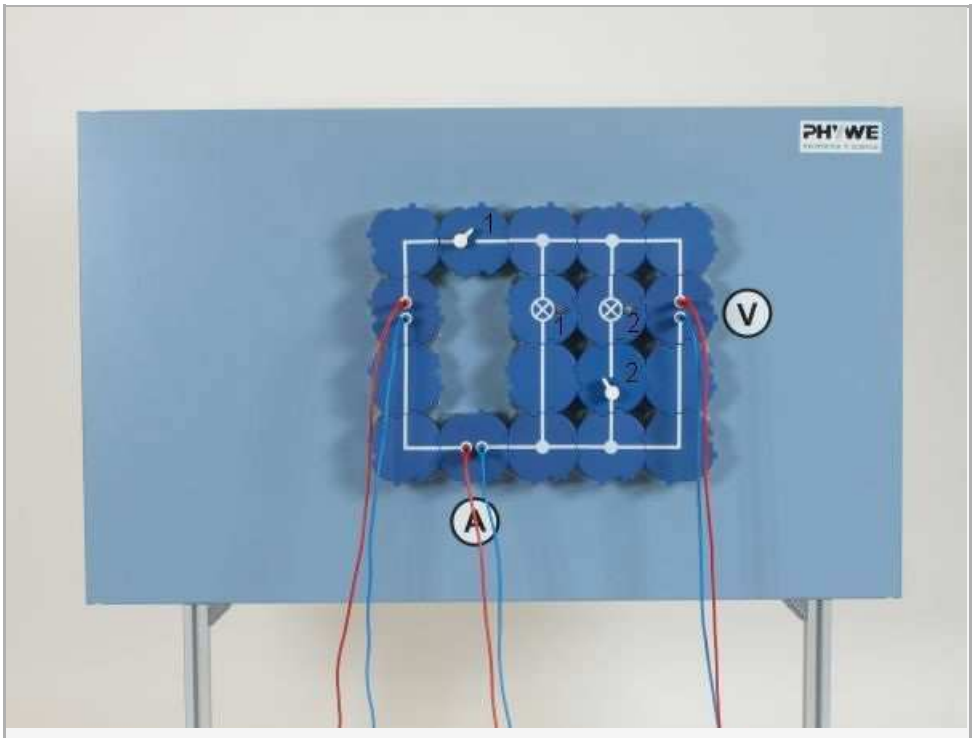

Fig. 1

- Increase the power supply voltage until the voltmeter shows 4 V; measure the current I and enter this measured value in Table 1.
- Close switch S_2 and so switch filament lamp L_2 parallel to L_1; readjust the voltage to 4 V if necessary; observe the brightness of each of the lamps (1), measure and note the current.
- Open switch S_1 and change the circuit as in Fig. 2, so that the two lamps are connected in series.

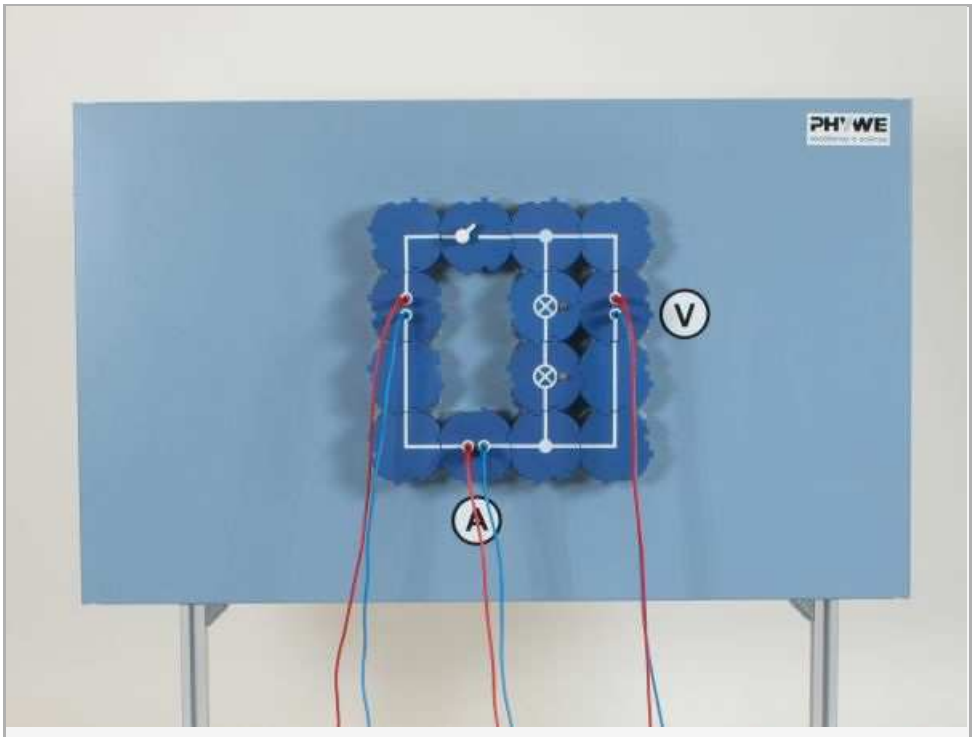

Fig. 2

- Close the switch and observe the brightness of the lamps (2).
- Increase the power supply voltage until the current has reached 0.04 A; measure the voltage required for this and note it in line 3 of Table 1; observe the brightness of the lamps.

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Observation and evaluation

Observation

1. The two lamps light up equally brightly, and so have the same lighting power.
2. The two lamps light up equally brightly, but only weakly.
3. The two lamps light up with full brighness and the same lighting power as observed in (1).

Tabelle 1

Number of lamps	$\frac{U}{V}$	$\frac{I}{A}$	Lamp performance
1	4	0.04	normal
2 (in parallel)	4	0.08	double
2 (in series)	8	0.04	double

Evaluation

You can estimate the power of an electrical device by its lighting power (brightness), hotness, loudness etc.. In this experiment, the lighting power of a lamp is used as a measure of the electrical power $P\mathrm{el}$. From lines 1 and 2 of Table 1 we find that:

$P_{el} \sim I \, for \, U = constant$;

from lines 1 and 3 of Table 1, it follows that;

$P_{el} \sim U \, for \, I = constant$.

On combining these proportionalities, we obtain: $P_{el} \sim U * I$.

On selecting the watt as unit for electrical power, and laying down that 1 W = 1 V · 1 A, we obtain the equation:

$P_{el} = U * I$

for electrical power.

When an electrical device of power $P_{el} = U * I$ is switched on for a period of t, then it follows analogously from the equation which defines physical work, $W = P * t$, that

$W_{el} = U * I * t$

is the equation for electrical work.

Remarks

In this experiment, it has been assumed that the lighting and heating effects of the two lamps are approximately equal, and so also the electrical power required for their operation.
The resistance values of filament lamps are, however, subject to a wide variation.We therefore recommend that several lamps be tested prior to starting the experiment, to pair up two lamps which have an as equal as possible current at U = 4 V. The set of magnetically adhering electrical symbols for the demonstration board enables circuits to be demonstratively labelled.
The set consists of V and A indicators as well as blanks on which whatever is appropriate can be written, e.g. the connections for current and voltage measurements. The blanks can also be used to label the applied voltage or to describe resistances, positions, switch settings etc..

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