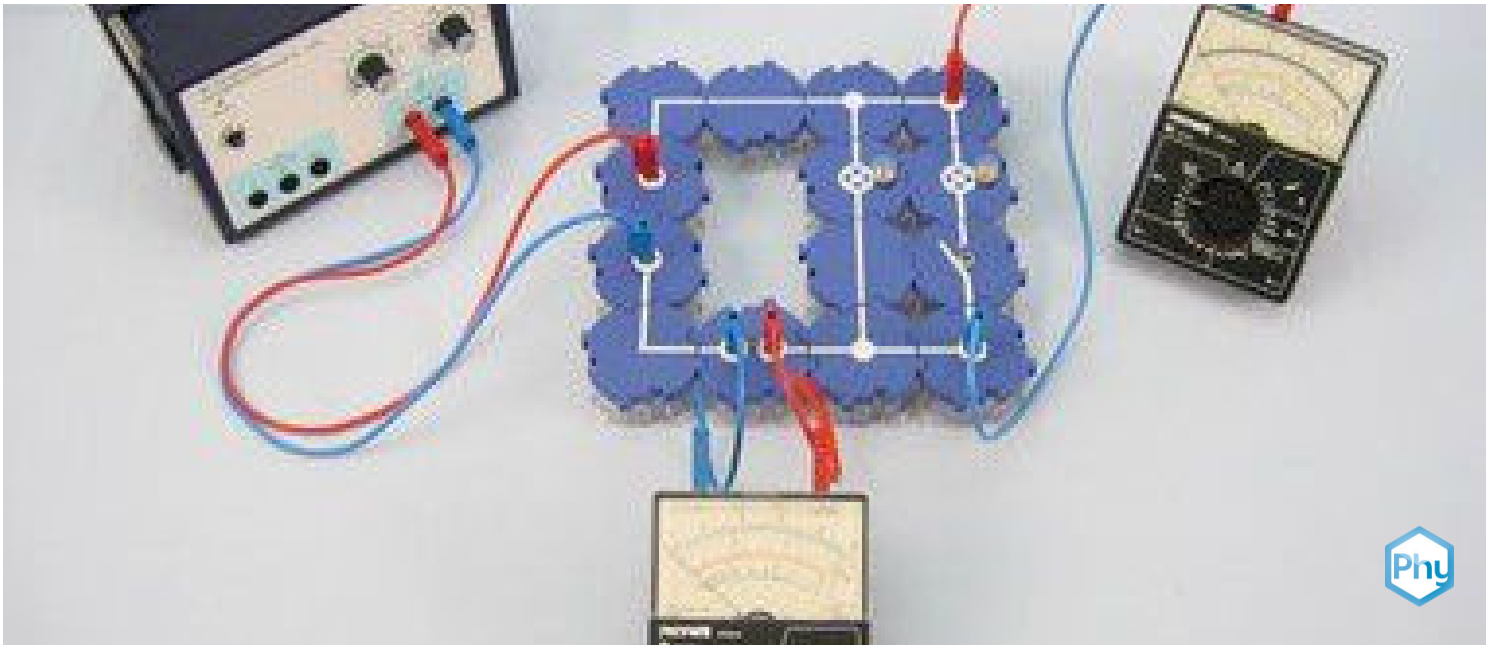
Electrical power and work



Physics | Energy | Energy forms, conversion & conservation

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4eb45738db8d0003265c5f

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Teacher information

Application

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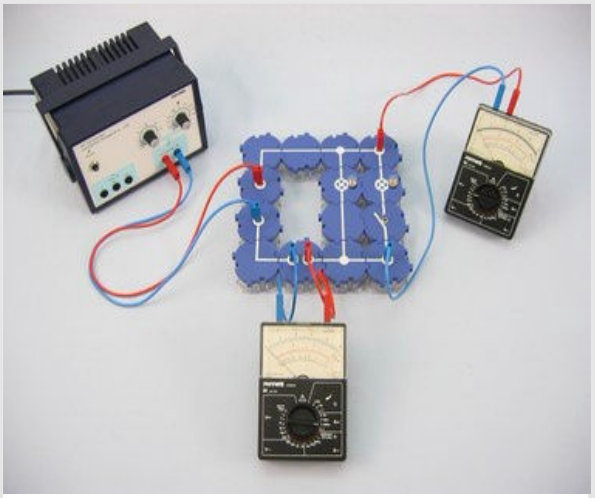

Experiment set-up

The performance P describes the energy turnover per time period. How great the power of an electrical device is, can be concluded qualitatively from how great its luminosity / brightness, heat emission, volume etc.

The SI unit of power is 1 Watt (W)

$$1\,W = 1\,VA$$

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Other teacher information (1/3)

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Prior knowledge

The students should be able to build a simple electric circuit. In addition, terms such as current, voltage and resistance or consumer should be known. Ideally, the energy term should be discussed beforehand.

Scientific principle

The electrical power is calculated as follows:

$P = U \cdot I$

Other teacher information (2/3)

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Learning objective

In this test, the brightness of incandescent lamps is used as a measure of electrical power. For example, the students easily realize that two identical lamps together have twice the power if they shine with the same brightness.

The students can use the book to understand the relationship between power and current and voltage.

$P \propto U$ for $I = konst.$ and $P \propto I$ for $U = konst.$

Tasks

Using the parallel and series connection of incandescent lamps, the students investigate the dependence of electrical power on current intensity and voltage.

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Other teacher information (3/3)

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As expected, the resistance values of incandescent lamps have a certain spread. It is therefore advisable that each experimental group receives two incandescent lamps that are as similar as possible (previously put together pairs that have the same current at 4.0 V.

Notes

The question of what the electrical power is dependent on is generally answered spontaneously by most students with amperage.

Recognising the dependence of power on voltage requires a higher didactic effort. It can be pointed out, for example, that a 6 V/ 0.5 A bulb and a 100 W bulb intended for mains voltage are passed through by currents of comparable intensity (0.5 A and 0.43 A respectively), but have very different (luminous) outputs.

Safety instructions

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

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Student Information

Motivation

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Charge your smartphone

Power generally describes how much energy is available per unit of time.

Newer smartphones can be recharged faster and faster. This means that they are able to absorb more energy in the same time. The power is therefore greater, although the same energy is stored at the end.

In this experiment you will learn on which variables the electrical power depends and how a changed power affects.

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Tasks

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On which variables are the electrical power and the electrical work dependent?

Investigate the dependence of electrical power on the current and voltage in an electric circuit by means of parallel and series connection of incandescent lamps.

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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module, SB	05601-01	2
2	Angled connector module, SB	05601-02	2
3	T-shaped connector module, SB	05601-03	2
4	Interrupted connector module with sockets, SB	05601-04	1
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	2
9	Connecting cord, 32 A, 250 mm, red	07360-01	2
10	Connecting cord, 32 A, 250 mm, blue	07360-04	2
11	Connecting cord, 32 A, 500 mm, red	07361-01	1
12	Connecting cord, 32 A, 500 mm, blue	07361-04	1
13	Filament lamps 4V/0.04A, E10, 10	06154-03	1
14	Analog multimeter, 600V AC/DC, 10A AC/DC, 2 MΩ, overload protection	07021-11	2
15	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

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Set-up

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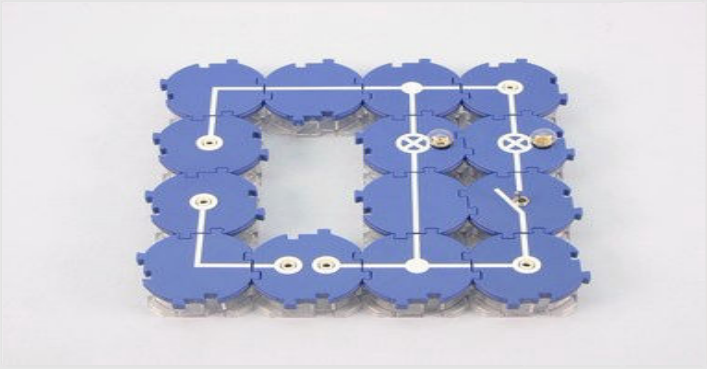
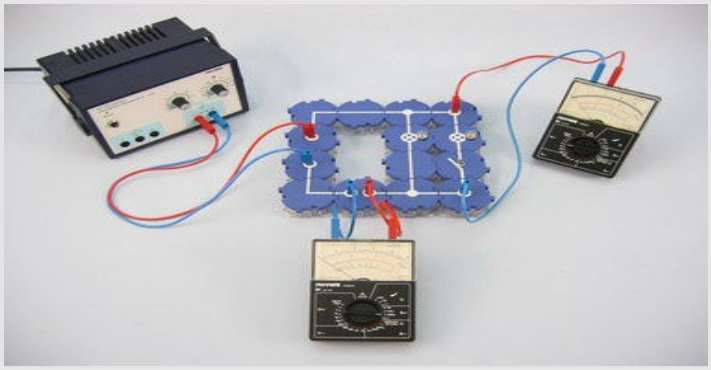
- Set up the circuit as shown in the figures. The switch is open first. Select the measuring range 10 V- for voltage measurement and the measuring range 300 mA- for current measurement. Insert the 4 V bulbs into the lamp sockets.





Procedure (1/2)

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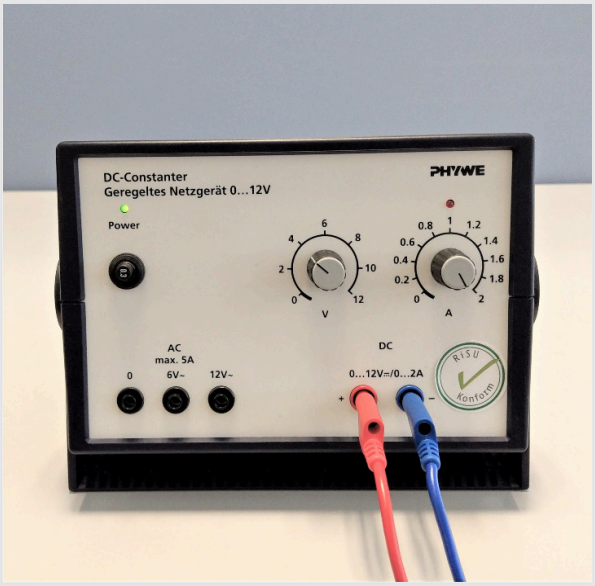

- Set the power supply unit to 0 V / 2 A and switch it on. Slowly increase the voltage at the power supply unit to approx. 4 V. Now carefully readjust the voltage until the voltage meter above the bulb L_1 shows exactly 4 V-. Measure the amperage I and write down your measured value.
- Close the switch and thus switch on the bulb L_2 parallel to the bulb L_1. Adjust the voltage to exactly 4 V- again, measure the current I again and note this value as well.
- Observe the brightness of the two bulbs when switching the second lamp on and off.
- Set the power supply unit to 0 V.

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Procedure (2/2)

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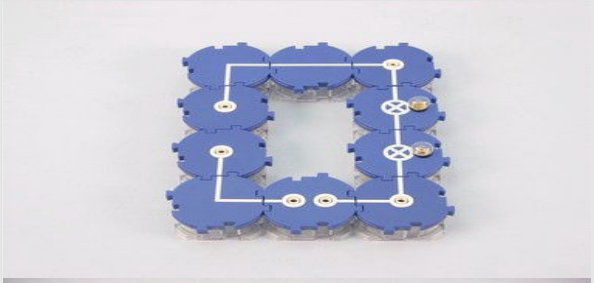

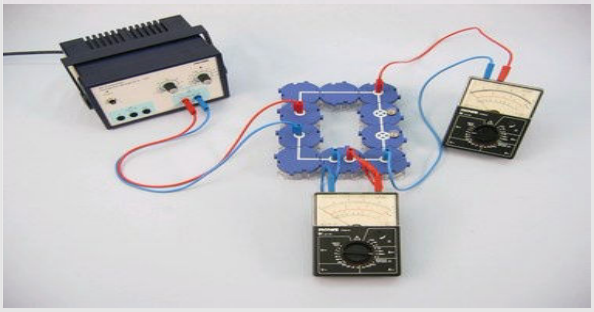

- Modify the test set-up as shown in the adjacent figures, thus connecting both bulbs in series.
- Connect the power supply unit and measuring instruments with the same measuring ranges.
- Increase the voltage at the power supply unit until the current is equal to that of your first measurement (one bulb) (about I = 0.04 A). Measure the necessary voltage U and note the two values in the protocol as well.
- Set the power supply unit to 0 V and switch it off.

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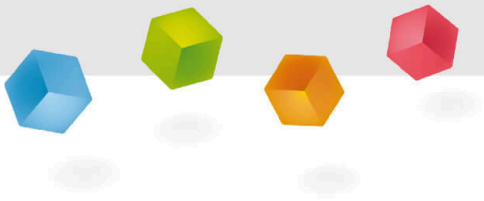

Report

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Table

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Note your measured values in the table. Calculate the electrical power $P = U \cdot I$.

Number of filament lamps	$U\,[V]$	$I\,[A]$	$P\,[VA]$
1			
2 (parallel)			
2 (in line)			

Task 1

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The two bulbs shine with the same brightness in parallel connection.

○ True ○ False

Check

The two bulbs shine with the same brightness in series connection.

○ True ○ False

Check

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Task 2

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What is the relationship between the performance P and the amperage I and the tension U?

- ☐ $P \propto I$
- ☐ $P = I$
- ☐ $P \propto U$
- ☐ $P = U$

Check

Task 3

PHYWE

Paste the words in the right places.

In the _____ of three or four incandescent lamps at the same _____, the measured _____ would be _____ or _____ that of an incandescent lamp.

Not used: _____

- parallel connection
- three times
- current
- four times
- voltage
- double

Check

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Task 4

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Paste the words in the right places.

In the _____ of three or four incandescent lamps at the same _____, the measured _____ would be _____ or _____ that of an incandescent lamp.

Not required: _____

- voltage
- series connection
- four times
- double
- current
- three times

Check

Task 5

PHYWE

These relationships can be summarised as follows: $P = U \cdot I$.

The unit for the electrical power is the so-called Watt: $1\,W = 1\,V \cdot 1\,A$.

If an incandescent lamp of the wattage P one day t long shines, then you get the electrical work by multiplying: $W_{el} = P \cdot t = U \cdot I \cdot t$. The electrical work based on the standard unit kWh is then paid to the electricity supplier according to the tariff.

Calculate the electrical work for the single bulb used in the experiment when it is lit for 5 minutes.

$W_{el}(5min) =$ _____ $Wmin =$ _____ Vh

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Slide	Score / Total
Slide 16: Multiple tasks	0/2
Slide 17: Relationship of P with U and I	0/2
Slide 18: three / four bulbs in parallel connection	0/6
Slide 19: three / four bulbs in series connection	0/6

Total amount 0 / 16

Solutions | Repeat | Exporting text

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