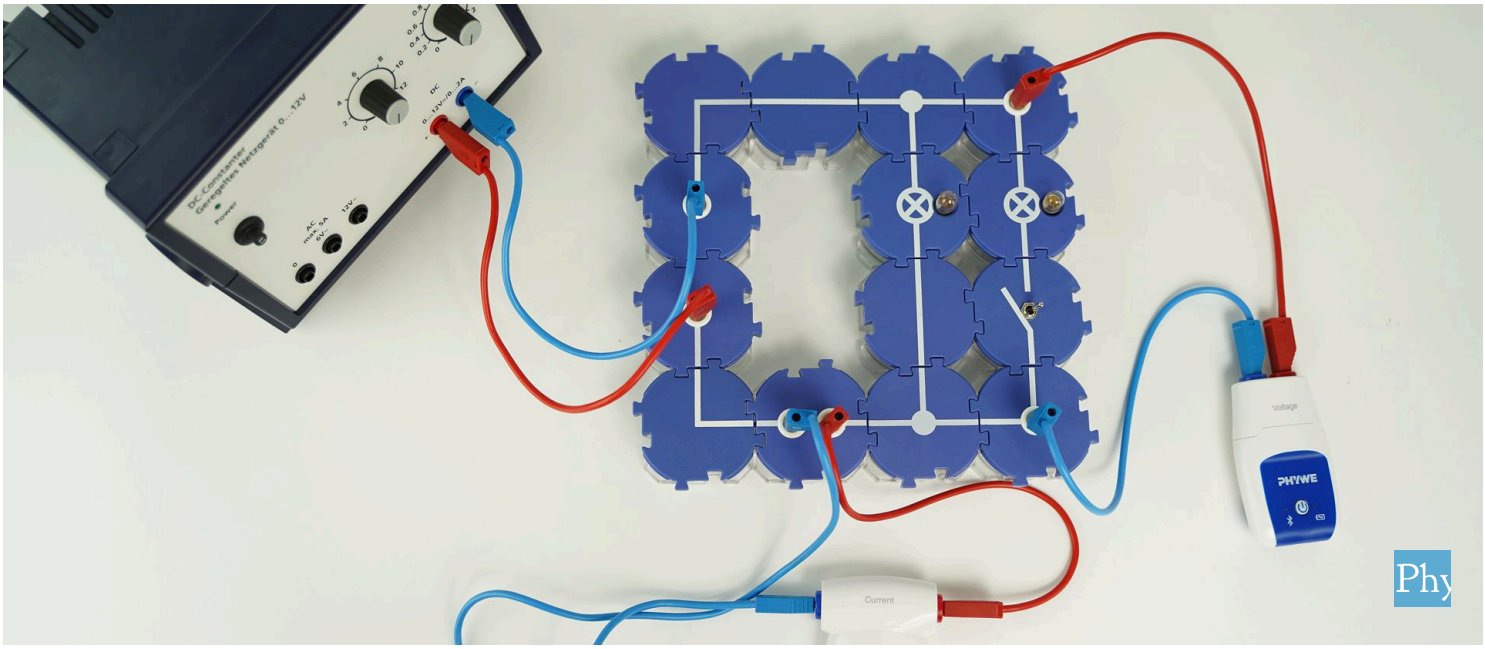
The electrical power and work with Cobra SMARTsense



Physics	Energy	Energy forms, conversion & conservation
Physics	Electricity & Magnetism	Use of electrical energy, energy supply

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	20 minutes

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Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
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Teacher information

Application

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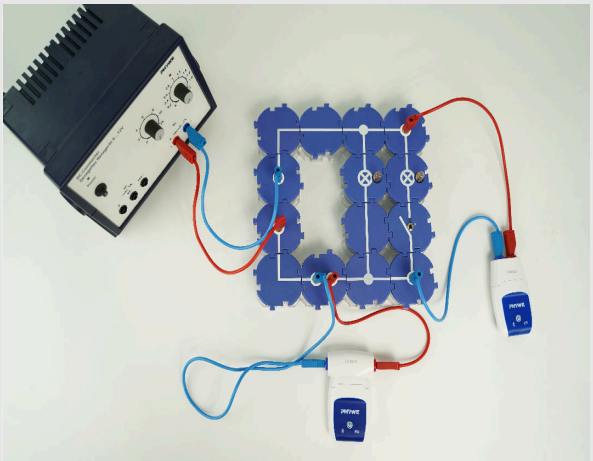

Experiment setup

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

The SI unit of power is 1 Watt (W)

$ 1 \, W = 1 \, V A $

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Other teacher information (1/3)

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Previous knowledge

The students should be able to construct a simple electric circuit. They should also be familiar with terms such as current, voltage and resistance or load. The concept of energy should ideally 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 experiment, the brightness of light bulbs is used as a measure of electrical power. The students can easily see, for example, that two identical lamps together have twice the power if they shine with the same brightness.

The students can deduce the relationship between power and current as well as voltage from the experiment.

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

Tasks

Students investigate the dependence of electrical power on current and voltage using the parallel and series connection of light bulbs.

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Other teacher information (3/3)

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As expected, the resistance values of the incandescent lamps have a certain scattering range. It is therefore advisable for each experimental group to receive two incandescent lamps that are as similar as possible (beforehand, put together pairs that have the same amperage at 4.0 V).

Notes

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

To recognize the dependence of power on voltage requires more didactic effort. For example, one can point out that a 6 V/ 0.5 A incandescent lamp and a 100 W incandescent lamp intended for mains voltage have currents of comparable strength flowing through them (0.5 A and 0.43 A respectively), but have very different (luminous) powers.

Safety instructions

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

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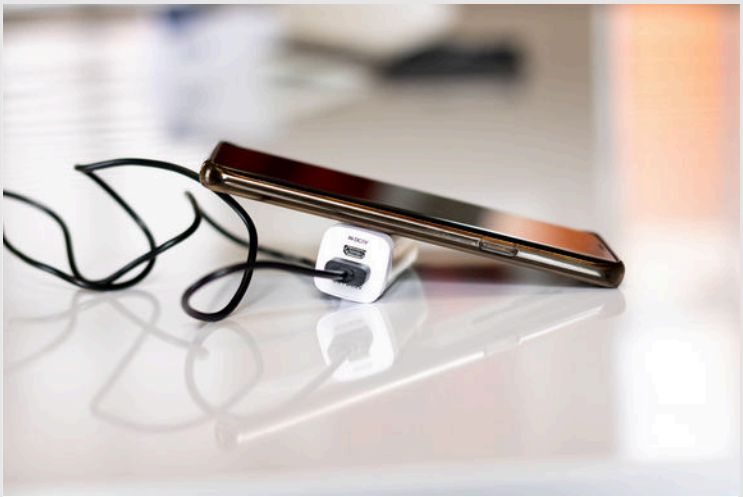
Student Information

Motivation



Charging your smartphone

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

Newer smartphones can be charged 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 about the variables on which electrical power depends and what the effects of a change in power are.

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Tasks

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On which quantities do the electrical power and the electrical work depend?

Using the parallel and series connection of light bulbs, investigate the dependence of the electrical power on the amperage and voltage in an electric circuit.

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Equipment

Position	Material	Item No.	Quantity
1	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
2	Cobra SMARTsense - Voltage, ± 30 V (Bluetooth)	12901-00	1
3	Cobra SMARTsense - Current, ± 1 A (Bluetooth)	12902-00	1
4	Straight connector module, SB	05601-01	2
5	Angled connector module, SB	05601-02	2
6	T-shaped connector module, SB	05601-03	2
7	Interrupted connector module with sockets, SB	05601-04	1
8	Junction module, SB	05601-10	2
9	Angled connector module with socket, SB	05601-12	2
10	On-off switch module, SB	05602-01	1
11	Socket module for incandescent lamp E10, SB	05604-00	2
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	1
15	Connecting cord, 32 A, 500 mm, blue	07361-04	1
16	Filament lamp 6 V/3 W, E10, 10 pcs.	35673-03	1
17	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Structure (1/2)

The Cobra SMARTsense and measureAPP are required to measure current and voltage. The app can be downloaded free of charge from the App Store - see below for QR codes. Check whether Bluetooth is activated on your device (tablet, smartphone).

measureAPP for Android operating systems

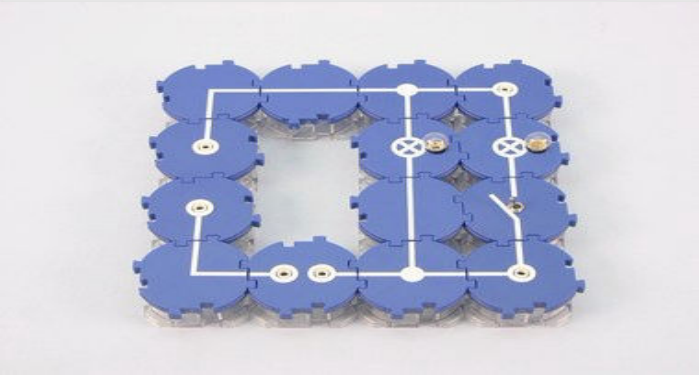
measureAPP for iOS operating systems

measureAPP for Tablets / PCs with Windows 10

Structure (2/2)

Set up the circuit as shown in the illustrations. The switch is open at first.

Insert the 4 V bulbs into the lamp sockets.



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Procedure (1/3)

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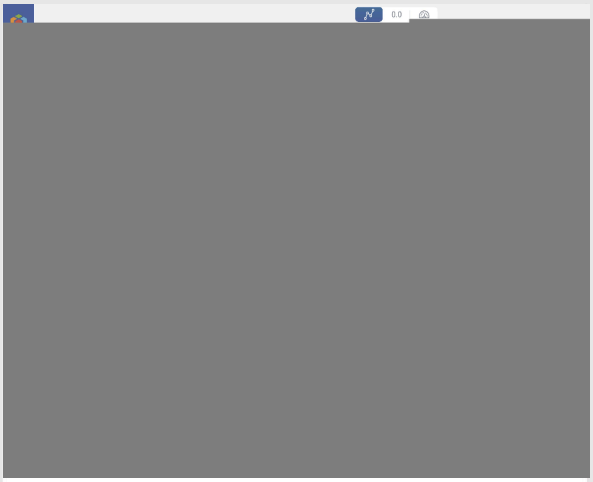

Measuring window

- Turn on both SMARTsense sensors by pressing and holding the power button and make sure the tablet can connect to Bluetooth devices.
- Open the PHYWE measureAPP and select the sensors "Current" and "Voltage" as shown in the figure.
- Select the sampling rate of your choice. The higher it is, the more accurate the measurement will be.
- Prove the y-axis with the voltage U and the current I.

Procedure (2/3)

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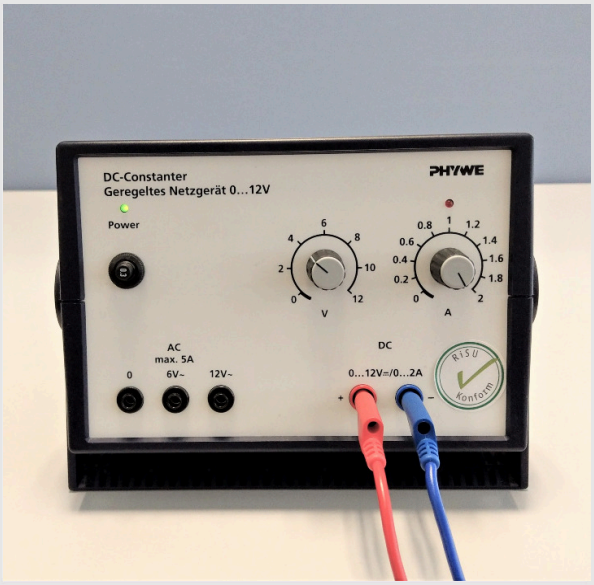

- Set the power supply unit to 0 V / 2 A and switch it on. Slowly increase the voltage at the power supply unit to approx. 4 V. Now carefully adjust the voltage until the voltmeter is above the bulb. L_1 reads exactly 4 V-. Measure the current I and note your reading.
- Close the switch and thus turn on the bulb L_2 parallel to the bulb L_1. Adjust the voltage again to exactly 4 V-, measure the current I again and note this value as well.
- Observe the brightness of the two bulbs when the second bulb is switched on and off.
- Set the power supply to 0 V.

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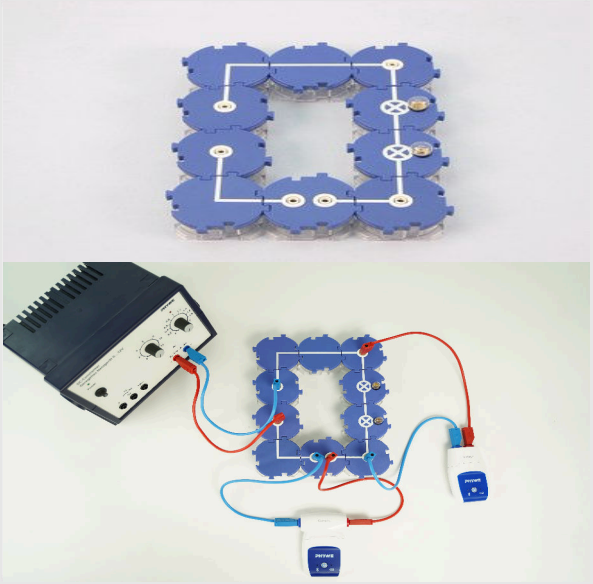
Implementation (3/3)



- Change the experimental set-up according to the adjacent illustrations and thus connect both bulbs in series.
- Connect the power supply and the measuring instruments.
- Increase the voltage at the power supply until the current corresponds to that of your first measurement (a light bulb) (about I = 0.04 A). Measure the necessary voltage U and note the two values in the log as well.
- Set the power supply to 0 V and switch it off.

Report

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Table 1

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

Number of bulbs	$U\,[V]$	$I\,[A]$	$P\,[VA]$
1			
2 (parallel)			
2 (in series)			

Task 1

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The two bulbs shine equally brightly in the parallel circuit.

○ True ○ False

Check

The two incandescent lamps shine equally brightly in the 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 current I and the voltage U?

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

Check

Task 3

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Insert the words in the right places.

In the _____ connection of three or four incandescent lamps at the same _____, the measured _____ would be _____ or _____ as large as compared to one incandescent lamp.

Not needed: _____

current
double
voltage
parallel
three times
four times

Check

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Task 4

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Insert the words in the right places.

In the _____ connection of three or four incandescent lamps at the same _____, the measured _____ would be _____ or _____ as great as compared to one incandescent lamp.

Not needed: _____

voltage
three times
double
series
current
four times

Check

Task 5

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

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

When an incandescent lamp of wattage P a period t is illuminated for a long time, then the electrical work is obtained by multiplication: $W_{el} = P \cdot t = U \cdot I \cdot t$. 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 light bulb used in the experiment when it is lit for 5 min.

$W_{el}(5min) = Wm$ [ ] [ ]

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Slide	Score/Total
Slide 18: Multiple tasks	0/2
Slide 19: Relationship of P with U and I	0/2
Slide 20: three/four incandescent lamps in parallel connection	0/6
Slide 21: three/four incandescent lamps in series connection	0/6

Total 0/16

Solutions Repeat Export text

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