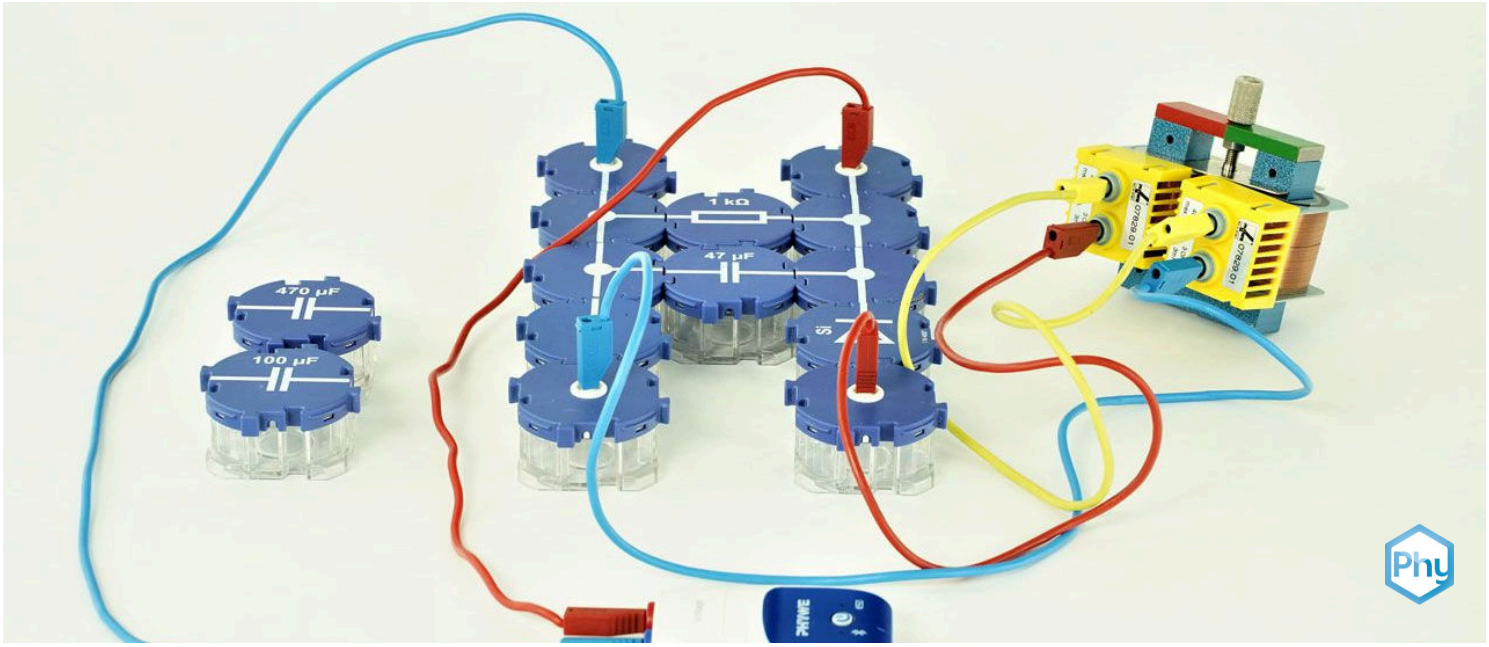
Generation of an AC voltage, rectification and smoothing with Cobra SMARTsense



Physics | Electricity & Magnetism | Electromagnetism & Induction

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

This content can also be found online at:

http://localhost:1337/c/5f059e71b1669c0003e543c5

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Teacher information

Application

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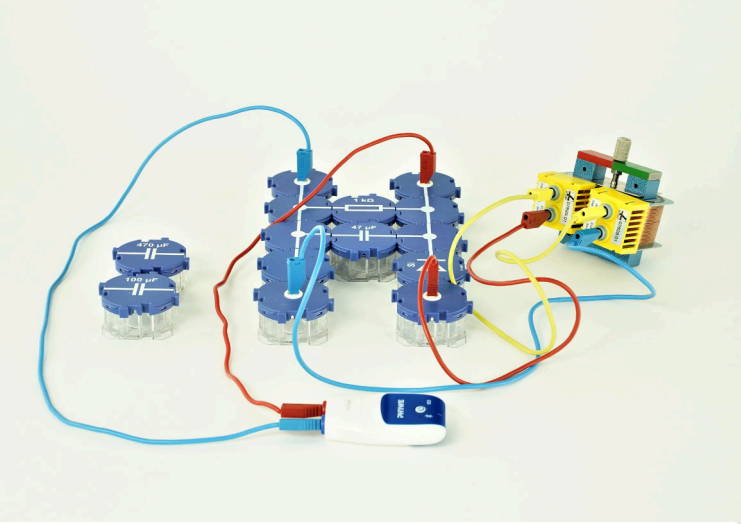

Test setup

An AC voltage as an input signal can be modulated by a rectifier and any voltage fluctuations that occur can be smoothed out so that a constant DC voltage is obtained.

As an example of use, the function of a power supply unit for charging the battery can be explained here, depending on the smartphone or tablet used.

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Other information (1/2)

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Prior knowledge

Students should be familiar with the basics of DC and AC voltage and the principle of magnetic induction.

Principle

In the (alternating) field of a periodically moving magnet, an alternating voltage is induced in a coil. The property of a diode to allow electric current to pass in one direction only is used to rectify the induced alternating voltage. A capacitor connected in parallel to the load (resistor) smoothes the rectified AC voltage.

Other information (2/2)

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Learning objective

Understand the principle of converting kinetic energy into electrical energy using an AC voltage generator and the function of a diode as a rectifier and a capacitor for smoothing the signal.

Tasks

1. Generation of an alternating voltage with the generator.
2. Observation of the signal change during rectification and smoothing by various electrical components.

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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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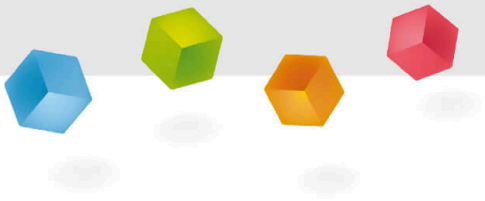

Student Information

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Motivation

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Loading Smartphone

How does a charger for a smartphone or tablet work?

If you want to charge the battery of your smartphone or tablet, you can't connect your mobile device directly to the power outlet with a cable. You need a charger with a relatively large plug head.

In this experiment you learn what happens in a charger.

To understand this, you will learn how an alternating voltage can be generated and how it can be influenced by various electrical components.

Tasks

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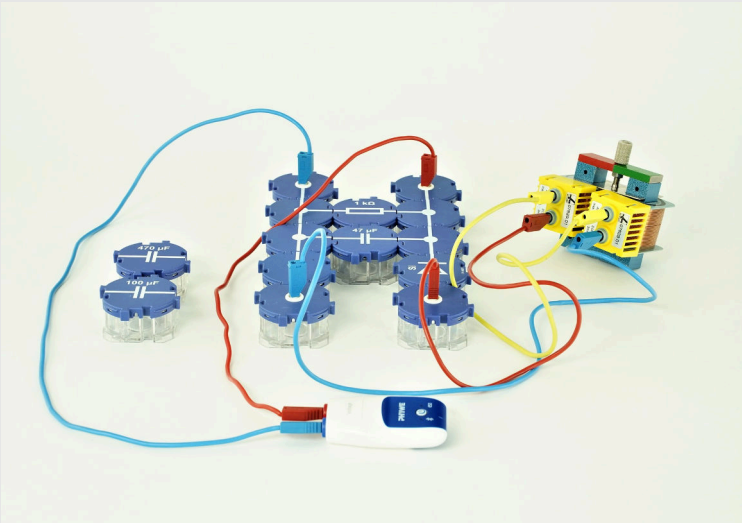

Test setup

1. First measure the voltage at the load resistor, which is generated when the magnet rotates over the coils without using other components.
2. Measure the voltage when using diode and load resistor.
3. Measure the voltage with additional use of the different capacitors in parallel to the load resistor.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - Voltage, ± 30 V (Bluetooth + USB)	12901-01	1
2	Coil, 400 turns	07829-01	2
3	Iron core, U-shaped, laminated	07832-00	1
4	Rotating stem	07836-00	1
5	Bearing plate	07837-00	1
6	magnet, l = 72mm, rodshaped, colored poles	07823-00	1
7	T-shaped connector module, SB	05601-03	4
8	Straight connector module, SB	05601-01	1
9	Junction module, SB	05601-10	4
10	Resistor module 1 kOhm, SB	05614-10	1
11	Silicon-diode module 1N4007, SB	05651-00	1
12	Capacitor module 47 µF non-polar electrolytic, SB	05645-47	1
13	Capacitor module 100 µF non-polar electrolytic, SB	05646-10	1
14	Capacitor module 470 µF non-polar electrolytic, SB	05646-47	1
15	Connecting cord, 32 A, 500 mm, red	07361-01	1
16	Connecting cord, 32 A, 500 mm, blue	07361-04	1
17	Connecting cord, 32 A, 250 mm, red	07360-01	1
18	Connecting cord, 32 A, 250 mm, blue	07360-04	1
19	Connecting cord, 100 mm, yellow	07359-02	1

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Set-up (1/3)

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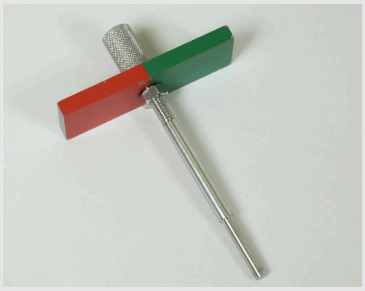

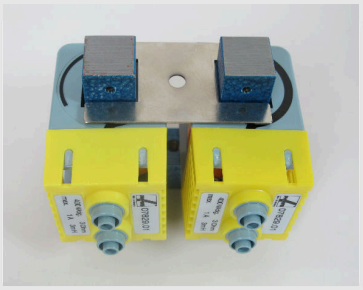

First, fix the bar magnet between knurled nut and nut on the rotating handle.

Then slide the two coils onto the U-iron core and fit the bearing plate.

Set-up (2/3)

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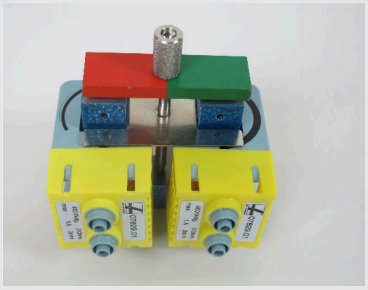

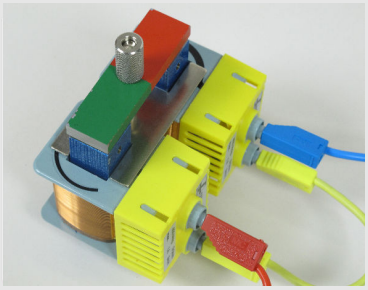

Push the rotating handle with magnet between the two coils through the holding plate. Adjust the height of the magnet so that it can rotate about 1 cm above the ends of the U-core.

Connect the lower sockets of both coils with the yellow cable.

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Set-up (3/3)

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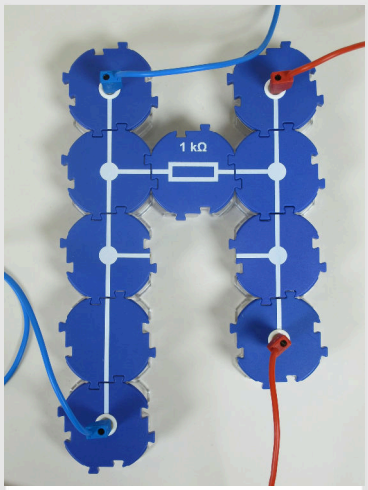

Set up

Now plug the blocks together according to the illustration on the left.

Connect the upper socket of the first coil to the connector block at the bottom right using the red cable and the upper socket of the second coil to the connector block at the bottom left using the blue cable.

Connect the connection module on the top left with the blue cable to the blue socket "voltage -" and the connection module on the top right with the red cable to the red socket "voltage +" of the sensor unit Electricity.

Procedure (1/4)

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1. Turn on your Cobra SMARTsense power by pressing and holding the button on the sensor for 3 seconds.
2. Open the measure app on your tablet or smartphone.
3. Select the sensor "Cobra SMARTsense Voltage" and set "Repeat Measurement".
4. After starting the measurement, the measured voltage is plotted against the time axis until you press Stop.

Voltage sensor

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Procedure (2/4)

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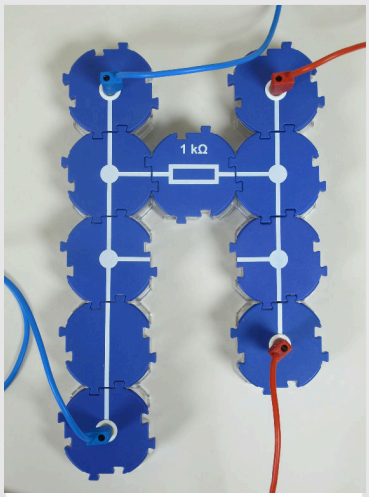

Set up

First measure the voltage at the resistor, which is generated by the rotation of the magnet over the coils (figure left).

Start the measurement recording in measureAPP and set the magnet in rotation with your fingers.

Terminate the measurement after the magnet has stopped and save it.

Procedure (3/4)

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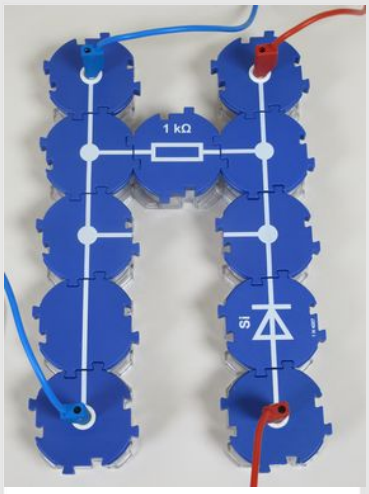

Set up

Now install the diode according to the illustration. Repeat the measurement.

It should always be saved after the measurement is finished.

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Procedure (4/4)

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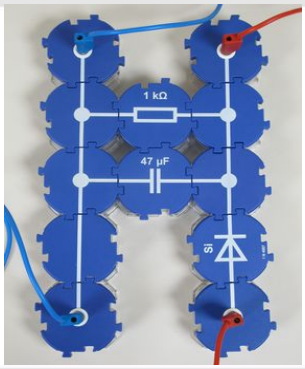
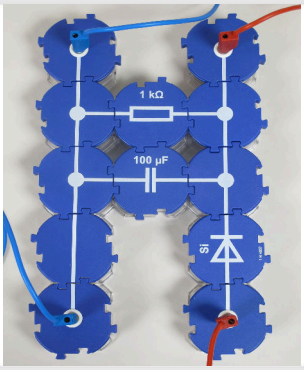
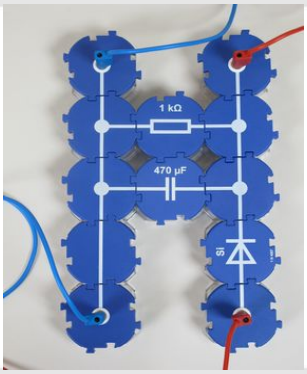
Connect one capacitor each (47µF, 100µF, 470µF) in parallel to the resistor and repeat the measurement.







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Report

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Task 1

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How does the voltage signal change when you install the diode and capacitors?

Without diode and without capacitor a voltage signal can be measured, which changes its sign depending on _____. If the speed of rotation decreases, the measured voltage also decreases. If the diode is inserted, only _____ of the original signal is passed. There is no change in the sign of the voltage, so the current only flows _____ (this is why it is called rectification). By inserting a capacitor into the circuit, the signal is _____.

smoothed | in one direction | half | the speed of rotation of the magnet

Check

Task 2

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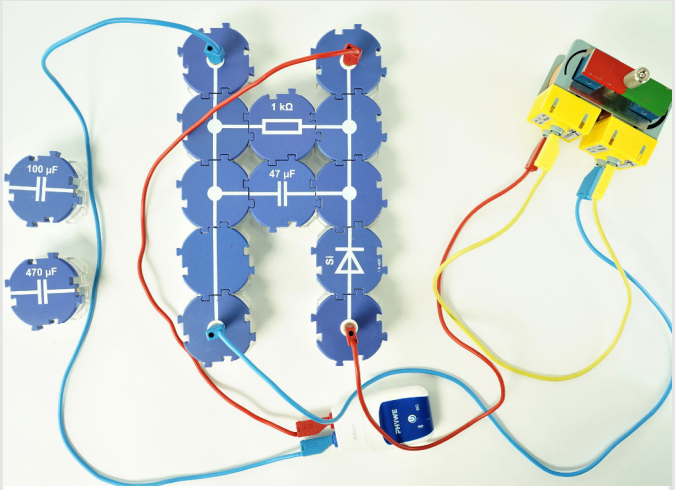
How is the alternating voltage generated in this experiment?

- [ ] by converting kinetic energy into electrical energy
- [ ] with a generator
- [ ] by magnetic induction

Check



Set up

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Task 3

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Fill in the missing words

The capacitor and the resistor must be connected [ ].

If the capacitor is exchanged for a capacitor with a higher capacitance, the signal is smoothed [ ].

Check

Slide	Score / Total
Slide 18: Components	0/4
Slide 19: AC voltage	0/3
Slide 20: Capacitor	0/2

Total amount 0 / 9

Solutions Repeat

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