Charging and Decharging of a condensator with Cobra SMARTsense

Physics > Electricity & Magnetism > Simple circuits, resistors & capacitors

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/5f4444a25eef7d00031fcaba

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Teacher information

Application

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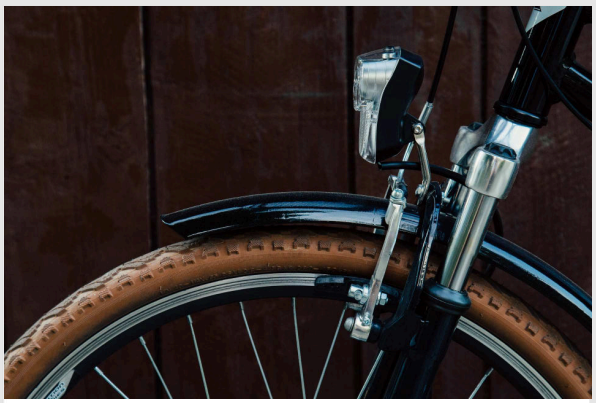

Bicycle lights with capacitors continue to light up even when you stop.

There are many applications for capacitors. A capacitor consists of two conductive surfaces separated by an insulating material. With its help, energy can be stored and then released again. For example in modern bicycle lamps. Here the capacitor is charged while riding and if you have to stop at a traffic light, it discharges again and the lamp can continue to shine.

How exactly a capacitor charges and discharges itself is investigated here in the experiment.

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Other teacher information (1/2)

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Prior knowledge

It is assumed that the students know that a capacitor can store charge. For the understanding of a RC-You should also know how to use the corresponding units Ohm and Farad.

Note

The test can also be extended to include devices with higher resistance and lower capacitance values. The noise and the limited resolution of the sensor will then become more noticeable.

Other teacher information (2/2)

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Learning objective

In this experiment, the charging and discharging process of a capacitor is to be reproduced.

Tasks

Examine the voltage and current characteristics of a capacitor during charging and discharging.

Investigate what the speed at which these processes occur depends on.

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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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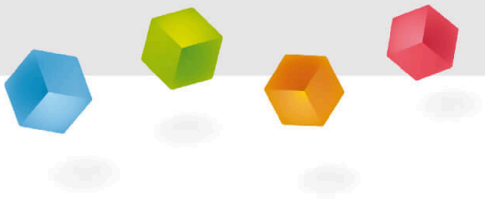

Student Information

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Motivation

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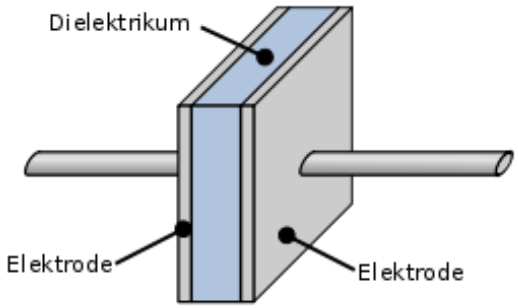

Capacitor design

Capacitors basically consist of two electrically conductive surfaces, the electrodes, which are separated by an insulating material, the dielectric. The size of the capacitance is determined by the area of the electrodes, the material of the dielectric and the distance between the electrodes. The electrodes and the dielectric can be rolled up or connected in parallel as a stack.

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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	Capacitor module 100 µF non-polar electrolytic, SB	05646-10	1
5	Capacitor module 470 µF non-polar electrolytic, SB	05646-47	1
6	Resistor module 50 Ohm, SB	05612-50	1
7	Resistor module 100 Ohm, SB	05613-10	1
8	Straight connector module, SB	05601-01	2
9	Angled connector module, SB	05601-02	1
10	Interrupted connector module with sockets, SB	05601-04	1
11	Junction module, SB	05601-10	1
12	Straight connector module with socket, SB	05601-11	1
13	Angled connector module with socket, SB	05601-12	2
14	Change-over switch module, SB	05602-02	1
15	Connecting cord, 32 A, 250 mm, red	07360-01	2
16	Connecting cord, 32 A, 250 mm, blue	07360-04	2
17	Connecting cord, 32 A, 500 mm, red	07361-01	1
18	Connecting cord, 32 A, 500 mm, blue	07361-04	1
19	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Set-up (1/3)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Set-up (2/3)

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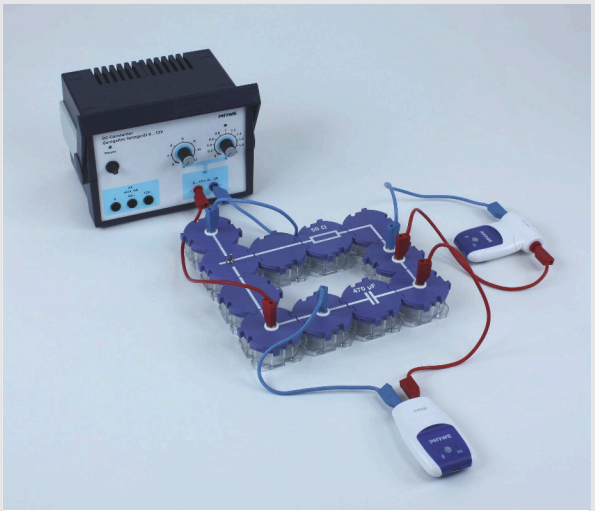

Experiment set-up

- Set up the experiment according to the overview photo and the circuit diagram.
- Set the changeover switch to position (1) at the beginning.
- Set the power supply unit to approx. 12 V, set the current limiter to the left stop, then switch on the power supply unit.

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Set-up (3/3)

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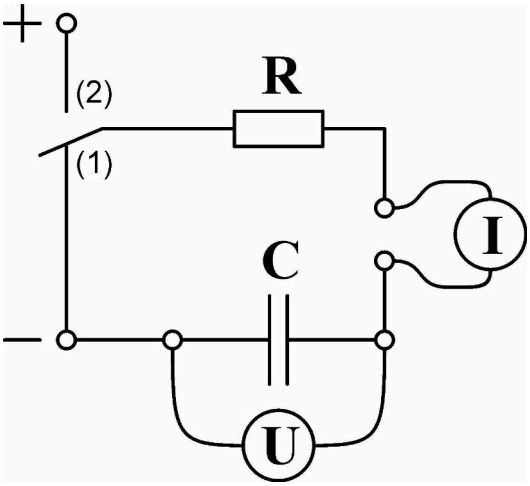

Circuit diagram

- Plus and minus are connected to the power supply unit.
- The changeover switch is initially set to (1) and is then switched back and forth between positions (1) and (2), whereby the capacitor C about the resistance R is alternately loaded and unloaded.
- For R the 50Ω or the 100Ω module, for C the 470- µF- or the 100-µF module.

Procedure (1/5)

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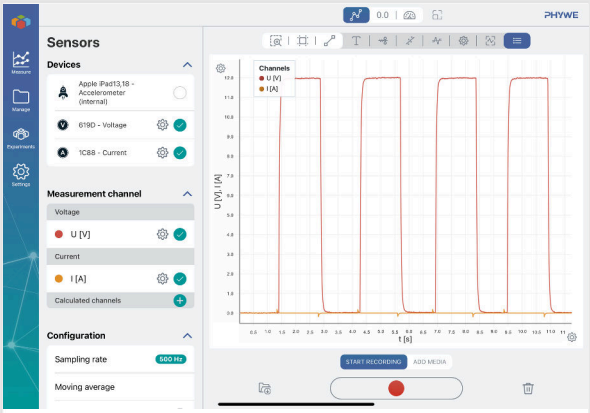

Measurement window

- Switch on both SMARTsense sensors and open the PHYWE measureAPP.
- Now connect the tablet to the sensors with Bluetooth turned on.
- Select the sensors "Current" and "Voltage" under "Measure" in the measureAPP
- Select the sampling rate of your choice. The higher the sampling rate the more accurate the measurement.
- Apply the voltage to the Y-axis U and the amperage I .
- Measured value recording in measureApp.

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Procedure (2/5)

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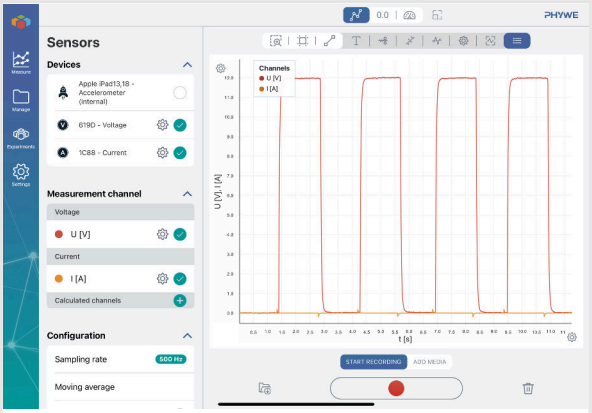

Measurement window

- Toggle the switch back and forth several times. The live data should then look like in the picture.
- End measurement and save measured values for further analysis and open them under "my measurements".
- In this way measurements for the four combinations of R and Cperform:
  - 470 µF and 50 Ω,
  - 470 µF and 100 Ω,
  - 100 µF and 50 Ω,
  - 100 µF and 100 Ω.

Procedure (3/5)

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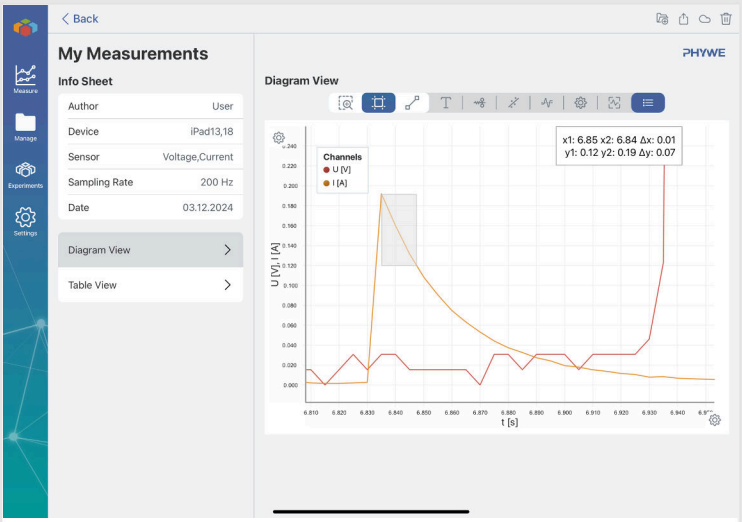

Measurement window

Recall in which parts of the trace the switch was in position (1) (capacitor discharge) or in position (2) (capacitor charge). Zoom in on the beginning of the section of a trace that belongs to a charging process using the "Zoom" function. Try to obtain an image as shown in the figure.

Use the "Measure" tool to evaluate the curves.

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Procedure (4/5)

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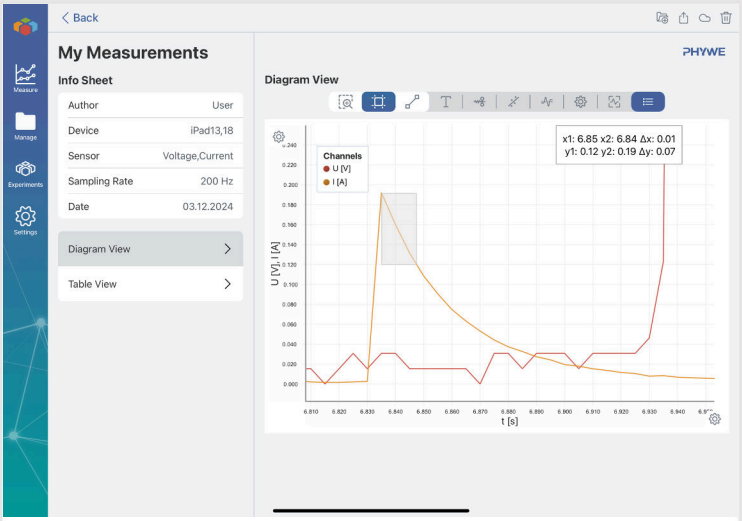

half-life of current

1. Determine the maximum current flowing and the maximum voltage across the capacitor and enter these values in the table of measured values: "Half-life" is usually understood to be the time that elapses until a physical quantity has dropped to half its initial value. Here we also mean the time after which the distance of a physical quantity from a final value has halved - here the voltage at the capacitor compared to its maximum value.

Procedure (5/5)

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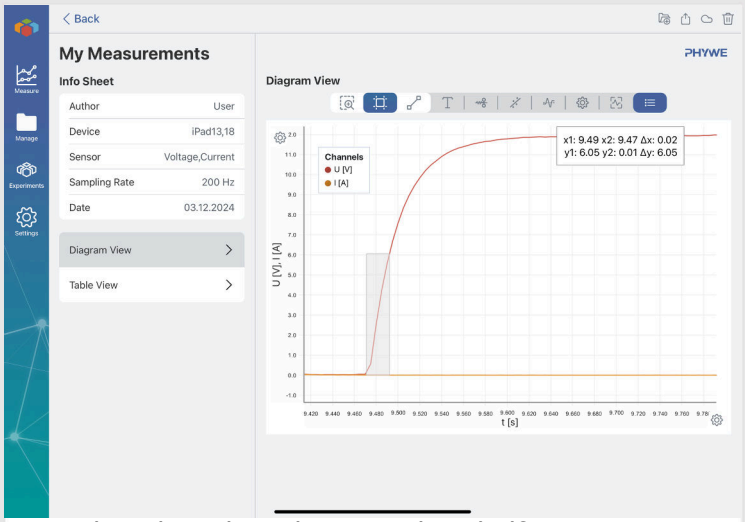

When does the voltage reach its half maximum?

1. After how long has the current dropped to half? After how long has the voltage on the capacitor increased to half the maximum voltage? Determine these half-lives and enter them in the table of measured values.

2. Investigate a discharge process in the same way and complete the table of measured values. Compare the half-lives.

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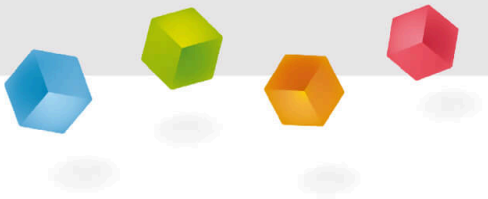

Report

Table 1

PHYWE

Component combination $C = 470\mu FC = 470\mu FC = 100\mu FC = 100\mu F$

$R = 50\Omega R = 100\Omega R = 50\Omega R = 100\Omega$

maximum current intensity				
\without switching on				
maximum current intensity				
\from switching off				
maximum stress				
am condenser				

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Table 2

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Component combination $C = 470\mu FC = 470\mu FC = 100\mu FC = 100\mu F$

$R = 50\Omega R = 100\Omega R = 50\Omega R = 100\Omega$

Half-life of the				
Voltage at switch-on				
Half-life of the				
Voltage At power off				
Product				
aus R and C				

Task 1

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Drag the right words into the gaps

When the switch is in position (2), the voltage U_N which the power supply unit supplies, to the _____ of capacitor and _____. Capacitors can store _____. When a capacitor is connected to a power source, a brief _____ occurs, which _____ the capacitor. When a charged capacitor is connected to an incandescent lamp or other resistor, it _____ and a brief current flows through the resistor. A capacitor can _____ the charge for a longer time if it is not connected to a resistor.

charges
electrical charge
discharges
resistor
series circuit
store
current surge

Check

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Task 2

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Complete:

The [ ] the resistance, the longer the charging time.

The [ ] the capacity, the longer the charging time.

The [ ] the resistance, the higher the maximum current.

Check

The tensions U_C and U_R

- are time-dependent
- are not time-dependent
- are location-dependent
- are unrelated

Slide	Score / Total
Slide 20: Capacitor	0/7
Slide 21: Multiple tasks	0/7

Total amount 0 / 14

Solutions Repeat Exporting text

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