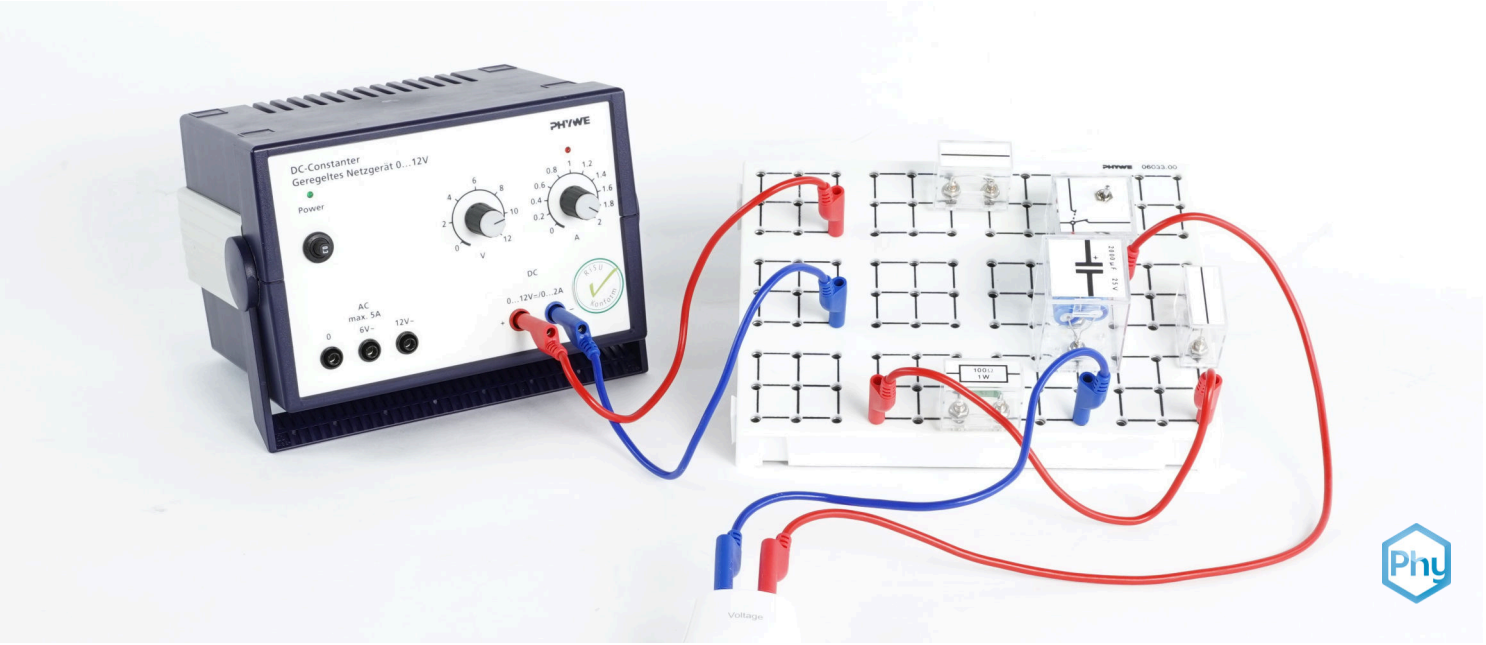
Charging and discharging process of an electrolytic capacitor with Cobra SMARTsense



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

Difficulty level	Group size	Preparation time	Execution time
easy	-	10 minutes	20 minutes

This content can also be found online at:

https://www.curriculab.de/c/67ac810e08e5d600020a91ef

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Teacher information

Application

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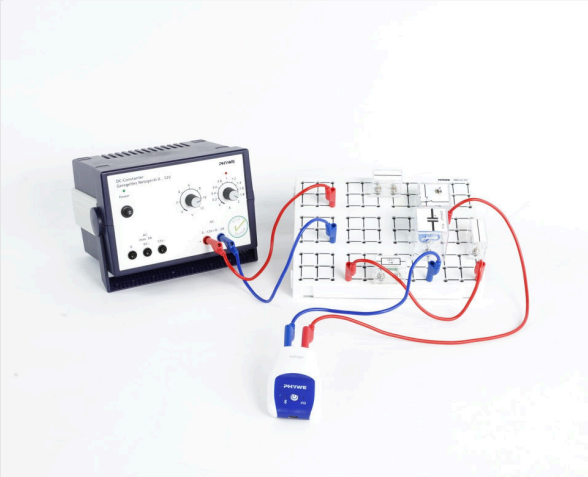

Experimental setup

There are many applications for capacitors. A capacitor consists of two conductive surfaces that are separated by an insulating material. It can be used to store and release energy. This is the case, for example, with modern bicycle lights. Here, the capacitor is charged while riding and when you have to stop at traffic lights, it discharges again and the lamp can continue to light up.

How exactly a capacitor, or more specifically an electrolytic capacitor, charges and discharges is investigated here in this experiment.

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Other teacher information (1/2)

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Prior knowledge

It is assumed that the students are aware that a capacitor can store charge. For the understanding of a RC-circuit, the units Ohm and Farad should be known.

Principle

The charging and discharging process of an electrolytic capacitor can be analysed over time by measuring the voltage across the capacitor with a sensor. A changeover switch is used to switch the electrolytic capacitor and a resistor back and forth between a circuit with a power supply unit (charging process) and without a power supply unit (discharging process).

Other teacher information (2/2)

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Learning objective

In this experiment, the charging and discharging process of an electrolytic capacitor is to be observed. The aim is to analyse the voltage curve of the electrolytic capacitor over time.

Tasks

1. Construction of a circuit in which a capacitor is either charged or discharged by actuating a switch.
2. Investigation of the time course of the voltage on the electrolytic capacitor during these processes.

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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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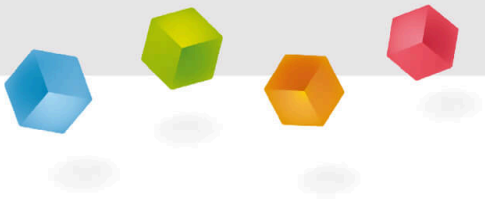

Student information

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Motivation

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Camera flash triggered by electrolytic capacitor

What do camera flashes, loudspeakers and electric cars have in common?

They all use electrolytic capacitors to store and release energy at lightning speed. These small components are crucial for many modern technologies - from fast light pulses in flash units to the stabilisation of circuits in powerful motors.

But how exactly does it work? In this experiment you will learn how an electrolytic capacitor charges and discharges and why this is indispensable for so many technical applications!

Tasks

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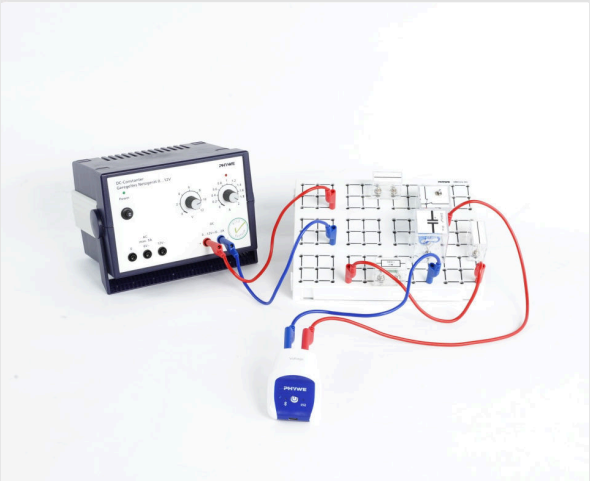

Experimental setup

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Material

Position	Material	Item No.	Quantity
1	Plug-in board, for 4 mm plugs	06033-00	1
2	PHYWE Power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
3	Connecting cord,19 A,25cm, blue	07313-04	2
4	Connecting cord,19 A,25cm, red	07313-01	3
5	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage ± 30 V (Bluetooth + USB)	12901-01	1
6	Wire building block, housing G1	39120-00	2
7	Resistor 100 Ohm, 1W, G1	39104-63	1
8	Electrolyte capacitor 2000 µF/35V, G2	39113-08	1
9	Change over switch, G3	39169-00	1
10	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Setup (1/2)

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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 launching the app, ensure that **Bluetooth is enabled** on your device (smartphone, tablet, or desktop PC).

iOS

Android

Windows

Setup (2/2)

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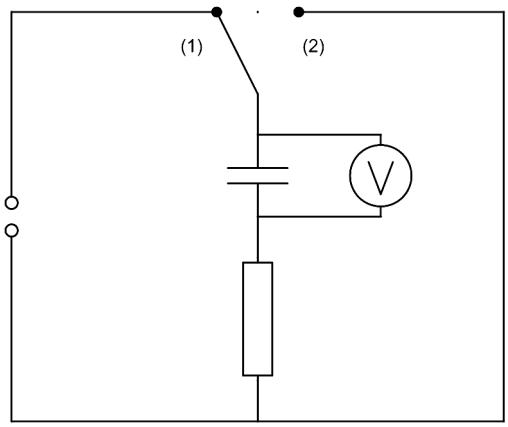

Circuit diagram

- Set up the experiment according to the circuit diagram.
- Use components with the following specifications:
  - $R = 100\Omega$
  - $C = 2000\mu F$
    - **Pay attention to the polarity of the electrolytic capacitor!**
- Initially set the changeover switch to position (2).
- Set the power supply unit to approx. 10 V and the current limit to the left stop. Switch on the power supply unit.

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Procedure (1/4)

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Cobra SMARTsense Voltage

- Switch on your Cobra SMARTsense Voltage by pressing and holding the button on the sensor for 3 seconds.
- Open measureAPP on your tablet or smartphone and make sure that the end device can connect to Bluetooth devices.
- Select the sensor "Voltage".
- Under Configuration, set the sampling frequency to 500 Hz.

Procedure (2/4)

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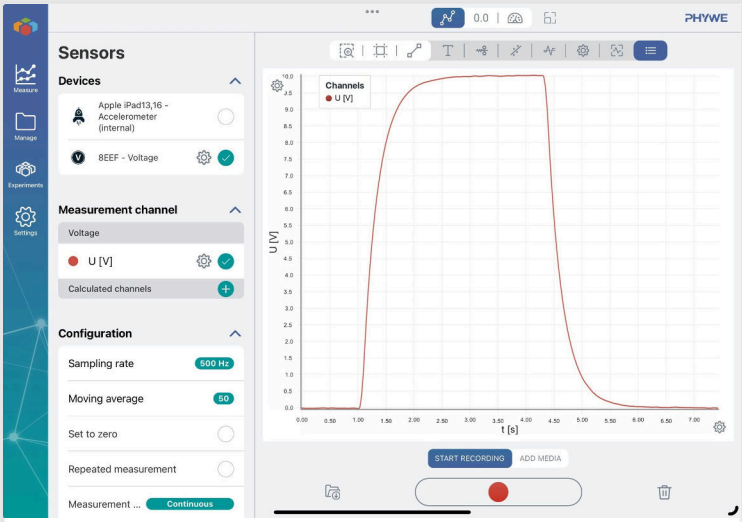

Example measurement

- Start a measurement.
- Switch the switch back and forth several times and observe the live voltage data in the measureAPP.
- End the measurement and save the measurement for further analysis. You can now find the measurement data under "my measurements".

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Procedure (3/4)

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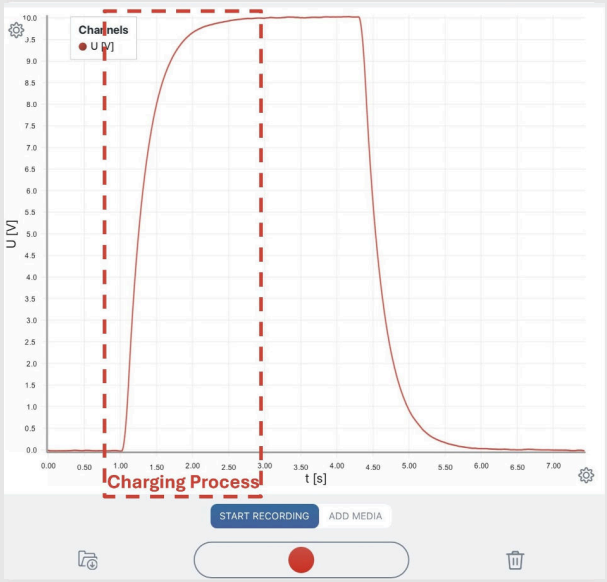

- Use the zoom function and increase the voltage curve during the charging process.
- Determine the maximum voltage at the capacitor and enter the value in the table, which you can find in the report section.
- Determine the half-life. After what time has the voltage risen to half the maximum voltage? Enter the value in the table.

Procedure (4/4)

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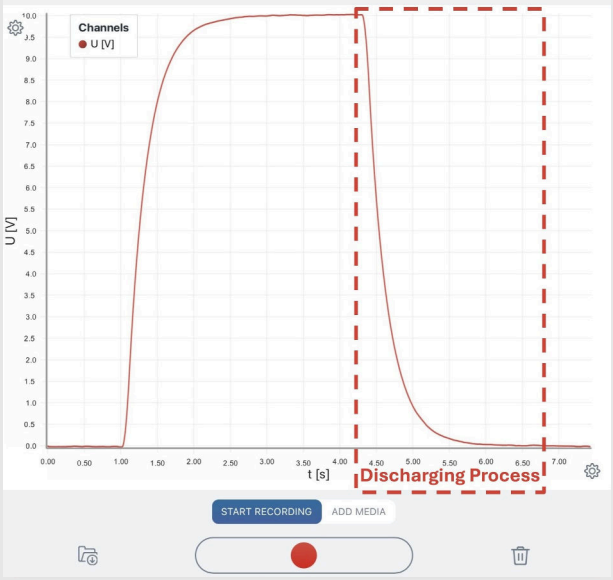

- Now examine the discharging process in the same way.
- Determine the half-life and enter it in the table.

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Report

Measured values

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Maximum voltage V on the capacitor	
Half-life $t_{1/2}$ Charging process	
Half-life $t_{1/2}$ Discharging process	
Time constant τ $\tau = R \cdot C$	

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Task 1

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Fill in the missing words.

When the switch is in position (1), the power supply unit is connected to the circuit with the capacitor and [ ], providing a voltage of U_N. The capacitor is [ ]. When the switch is pressed again, the [ ] is disconnected from the closed circuit and the capacitor [ ]. Both the charging and discharging processes exhibit a voltage behavior that can be described by an [ ] function. The half-life of both processes are [ ].

Check

Task 2

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The voltage on the electrolytic capacitor increases linearly during charging.

- True
- False

Check

Without an resistor, the electrolytic capacitor cannot be charged.

- True
- False

Check

The half-life depends on the capacitance of the capacitor.

- True
- False

Check

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Task 3

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What factors influence the speed of the charging process in an RC circuit?

- [ ] The capacitance of the capacitor.
- [ ] The value of the resistor.
- [ ] The size of the switch.
- [ ] The sampling frequency of the voltage sensor

Check

Slide	Score / Total
Slide 18: Charging and discharging process	0/6
Slide 19: Multiple tasks	0/3
Slide 20: The charging process	0/2

Total amount 0 / 11

Solutions Repeat Export text

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