Capacitors in direct current circuits (Item No.: P1382000)

Curricular Relevance

Area of Expertise: Physics
Education Level: Age 14-16
Topic: Electricity
Subtopic: Properties of electrical components
Experiment: Capacitors in direct current circuits

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	10 Minutes	2 Students

Additional Requirements:

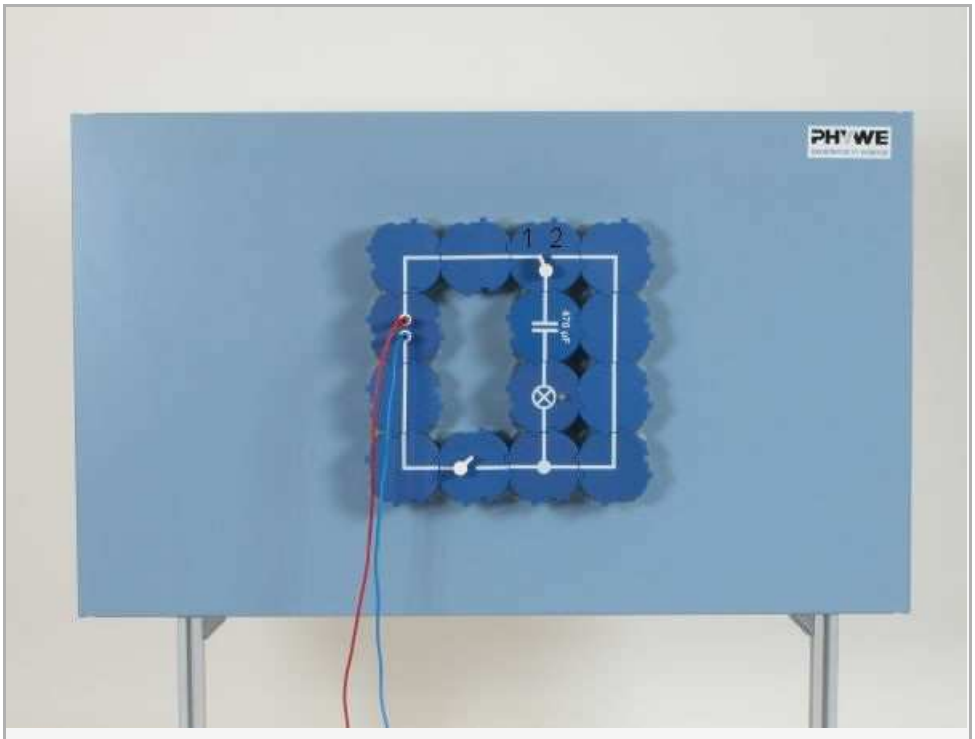
Experiment Variations:

Keywords:

Principle and equipment

Principle

An investigation is to be made into how a capacitor behaves when a direct current circuit is opened and closed.



Experimental set-up

Equipment

Position No.	Material	Order No.	Quantity
1	Multimeter ADM2, demo., analogue	13820-01	1
2	PHYWE power supply, universal DC: 0...18 V, 0...5 A / AC: 2/4/6/8/10/12/15 V, 5 A	13500-93	1
3	Demo Physics board with stand	02150-00	1
4	Switch on/off, module DB	09402-01	1
5	Socket for incandescent lamp E10 ,module DB	09404-00	1
6	Connector interrupted, module DB	09401-04	2
7	Capacitor(ELKO)0.047 mF,module DB	09445-47	1
8	Capacitor(ELKO),0.47 mF,module DB	09446-47	1
9	Electr.symbols f.demo-board,12pcs	02154-03	1
10	Connector, straight, module DB	09401-01	4
11	Connector, angled, module DB	09401-02	4
12	Connector, T-shaped, module DB	09401-03	1
13	Filament lamps 4V/0.04A, E10, 10	06154-03	1
14	Connecting cord, 32 A, 1000 mm, red	07363-01	2
15	Connecting cord, 32 A, 1000 mm, blue	07363-04	2

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Set-up and procedure

- Connect up the circuit as shown in Fig. 1 with the 470 µF capacitor installed and the on/off switch first open.
- Apply 12 V direct voltage, bring the changeover switch to position 1 (charge) and operate the on/off switch several times, observing the lamp while doing so (1).
- Close the circuit with the on/off switch and repeatedly operate the changeover switch, observing the lamp while doing so (2).
- Bring the changeover switch to position 1, then break the circuit with the on/off switch; after 1 or 2 seconds, turn the changeover switch to position 2 and observe the lamp, repeat this procedure several times (3).
- Replace the 470 µF capacitor by the 47 µF capacitor, repeat the experimental steps above (4).
- Replace the lamp by the measuring instrument; set the 10 mA- measurement range; carry out the experiment first with the 470 µF capacitor, then with the 47 µF capacitor, observe the deflections of the measuring instrument and note the measured values (5).

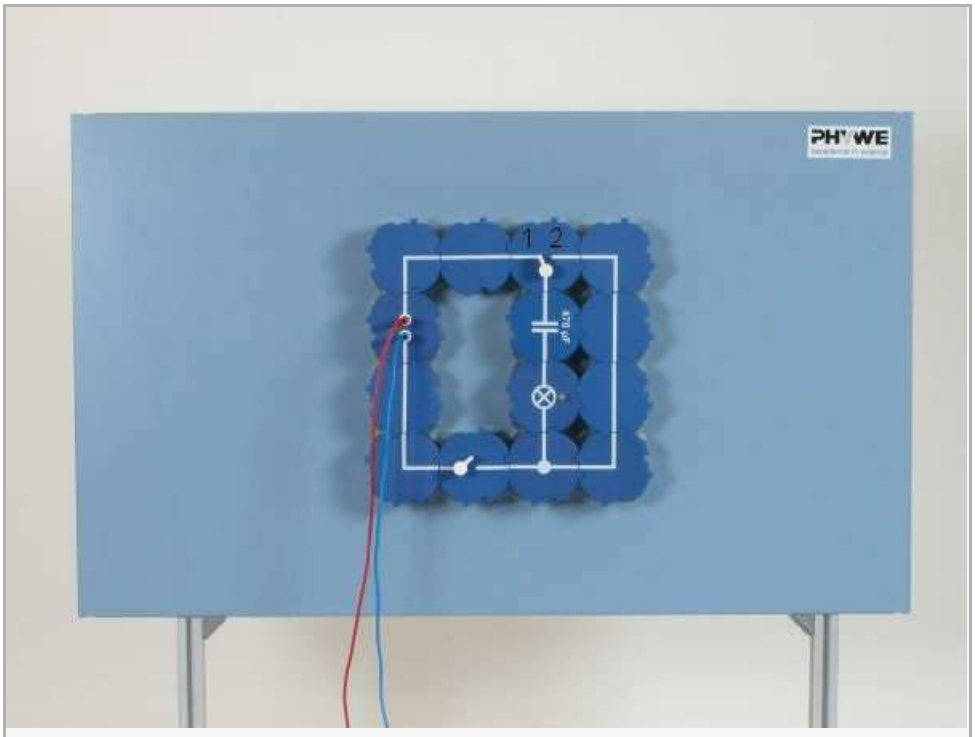


Fig. 1

Observation and evaluation

Observation

1. The lamp lights up briefly when the changeover switch is brought to position 1 (charge) and the on/off switch is closed; it does not light up again when the on/off switch is subsequently operated several times.
2. The lamp lights up briefly with each switching of the changeover switch, as soon as the on/off switch is closed.
3. The lamp also lights up when the capacitor is separated from the current source by the on/off switch after the charging process and the changeover switch is first brought to position 2 (discharge) after some seconds.
4. The lamp does not light up, neither during charging nor discharging, when a capacitors with only a small capacity is used.
5. When the lamp is replaced by a measuring instrument, this shows a brief deflection in each case, i.e. on charging and discharging; the deflection when charging is in the opposite direction to that when discharging, however. The deflections are smaller with a capacitor of small capacity.

Evaluation

Capacitors can store charges of electricity. When a capacitor is connected to a current source, there is a brief current impulse which charges the capacitor. When a charged capacitor is connected to the current source from which it was charged, it cannot accept any further charge; there is therefore no flow of current.

When a charged capacitor is connected to a lamp or other resistance, it discharges and a current flows briefly through the resistance. A capacitor can store its charge for a long time when it is not connected to a resistance.

Remarks

The size of the charge that a capacitor stores at a certain voltage depends upon the capacity of the capacitor. This is expressed in farads.

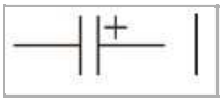
From the relationship $C = Q/U$ it follows that a capacitor of 1 farad capacity can store a charge of 1 As, when it is charged by a voltage of 1 V.

Smaller units are the microfarad (µF), the nanofarad (nF) and the picofarad (pF).

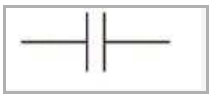
The value of the capacity is generally marked on the capacitor. The larger the capacity of the capacitor, the larger the amount of charge that can be stored at the same voltage.

Charging and discharging currents flow in opposite directions.

Since the recommended capacitors are unpoled, or bipolar (both terms are commonly used), it is not necessary to pay attention to the polarity. The graphical symbols used in wiring diagrams enable the type of capacitor to be recognized:



Electrolytic capacitor, poled, or



Electrolytic capacitor, unpoled (bipolar)