# Self-induction when switching off a circuit (Item No.: P1377100)

## Curricular Relevance

**Area of Expertise:** Physik
**Education Level:** Klasse 10-13
**Topic:** Elektrizitätslehre
**Subtopic:** Elektromagnetische Induktion
**Experiment:** Die Selbstinduktion beim Ausschaltvorgang

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

**Additional Requirements:**

**Experiment Variations:**

**Keywords:**

## Task and equipment

## Information for teachers

## Additional information

In the last experiment, the students learned that self-induced voltage is formed in a coil when a direct current circuit is closed, and that this self-induced voltage counteracts the connected voltage. Now, they should learn that self-induced voltage formed when a circuit is opened has the same direction as the original (i.e. connected) voltage.
If the students can already predict the results of the first experiment based on their knowledge of the laws of induction and Lenz's Law, then they should carry out the experiment to confirm their prediction nevertheless. Furthermore, the second experiment should demonstrate that self-induced voltage can attain values that greatly exceed the original voltage.

## Notes on setup and procedure

In the first experiment, the teacher may need to advise the students not to wait too long to flip the switch to position 2. Taking too long to switch over may cause the magnetic field to collapse due to the spark at breaking before the self-induced current can flow through the ammeter.
To save time, it is recommended that the pointers on the ammeter are shifted before starting the first experiment and then set back to zero. A student can take care of this before class.

## Remarks

Before starting the second experiment, the teacher should go into the trigger and operating voltages of the neon lamp used in the experiment and, if necessary, demonstrate the trigger voltage in a preliminary experiment. To do this, connect the neon lamp in series with a 100 kΩ resistor and then connect a direct voltage source. Starting at 0 V, slowly increase the voltage until the neon lamp lights up. For power supply, you can use the power supply unit 0...600 V (order no. 13672-93).
High self-induced voltages when opening circuits can damage technical combination circuits and electronic components. Make sure that the necessary measures are taken to prevent this from happening, e.g. that the capacitors are connected in parallel.


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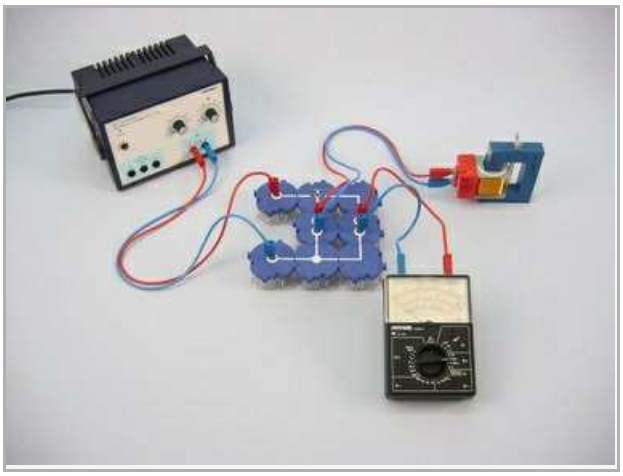
## Task and equipment

### Task

### What effect does a coil have when the circuit is opened?

Investigate the direction of the self-induced voltage produced when a direct current circuit is opened.



## Equipment


| Position No. | Material | Order No. | Quantity |
|---|---|---|---|
| 1 | Straight connector module, SB | 05601-01 | 1 |
| 2 | Angled connector module, SB | 05601-02 | 4 |
| 3 | T-shaped connector module, SB | 05601-03 | 2 |
| 4 | Interrupted connector module, SB | 05601-04 | 2 |
| 5 | Junction module, SB | 05601-10 | 2 |
| 6 | On-off switch module, SB | 05602-01 | 1 |
| 7 | Change-over switch module, SB | 05602-02 | 1 |
| 8 | Socket module for incandescent lamp E10, SB | 05604-00 | 1 |
| 9 | Coil, 1600 turns | 07830-01 | 1 |
| 10 | U-core | 07832-00 | 1 |
| 11 | Yoke | 07833-00 | 1 |
| 12 | Tightening screw | 07834-00 | 1 |
| 13 | Neon lamp 110 V AC, E10 | 07506-90 | 1 |
| 14 | Connecting cord, 32 A, 250 mm, red | 07360-01 | 1 |
| 15 | Connecting cord, 32 A, 250 mm, blue | 07360-04 | 1 |
| 16 | Connecting cord, 32 A, 500 mm, red | 07361-01 | 2 |
| 17 | Connecting cord, 32 A, 500 mm, blue | 07361-04 | 2 |
| 18 | PHYWE power supply DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A | 13506-93 | 1 |
| 19 | Multi-range meter, analogue | 07028-01 | 1 |

# Set-up and procedure

## Set-up

## First experiment

- Place the coil on the U-core.
- Use the tightening screw to press the U-core and the yoke together firmly.
- Set up the experiment as shown in Fig. 1 and Fig. 2. The changeover switch should be set to position 1 initially.
- Select measurement range of 30 mA- and shift the pointer on the ammeter out of the zero position to the right by turning the adjusting screw on the back panel.

**Important!** Since you do not know which direction the self-induced current is going to flow before the experiment, you must enable the pointer to deflect to the left without damaging the meter!

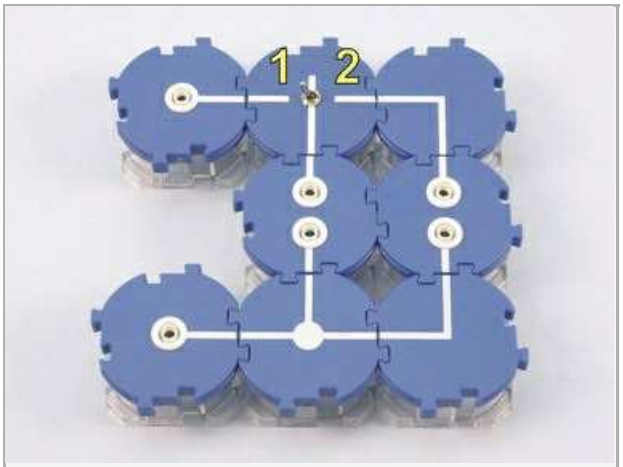


Fig. 1

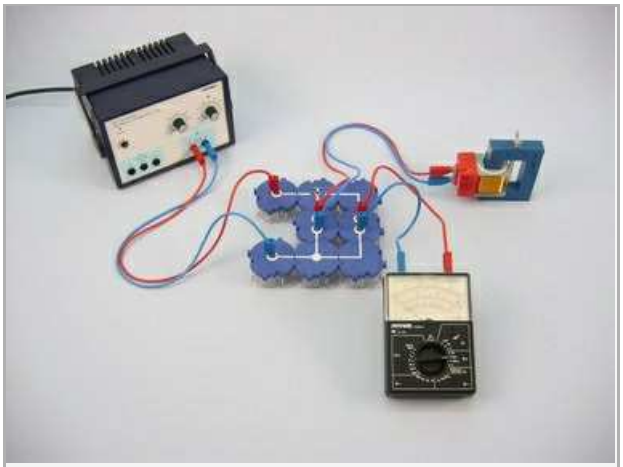


Fig. 2

## Second experiment

Set up the experiment as shown in Fig. 3 and Fig. 4.

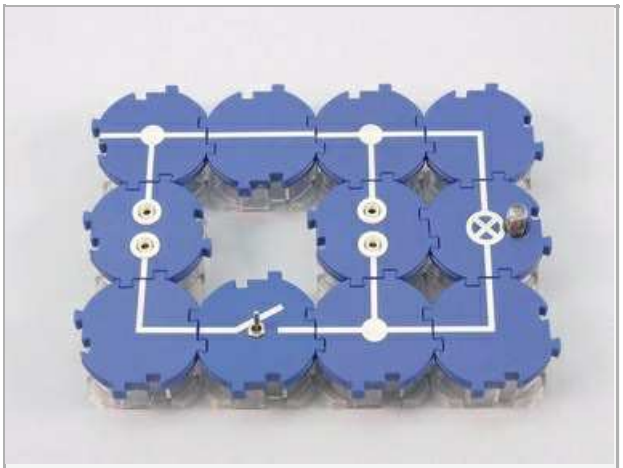


Fig. 3

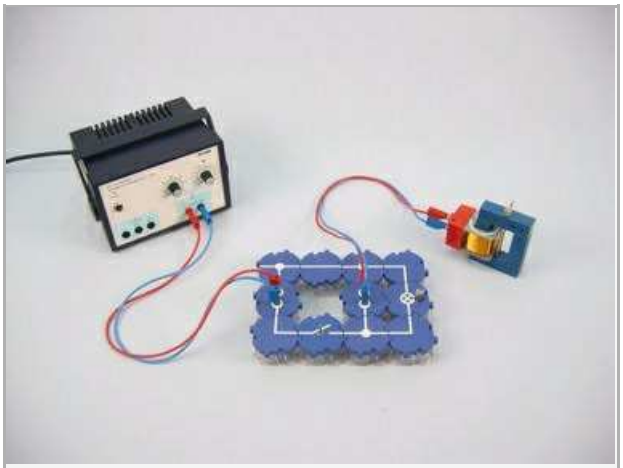


Fig. 4

# Procedure

## First experiment

- Switch on the power supply unit and set the direct voltage to 10 V.
- Switch the changeover switch to position 2, thereby closing the left circuit and opening the right circuit. Observe the deflection of the pointer on the ammeter.
- Switching from position 1 to position 2 should be done as quickly as possible.
- Switch the changeover switch back again and note the reaction of the ammeter under Result - Observations 1.
- Switch off the power supply unit.

## Second experiment

- Switch on the power supply unit and set the direct voltage to 10 V again.
- Turn the switch on.
- Turn the switch off and observe the neon lamp.
- Toggle the switch back and forth repeatedly, observe the neon lamp, and note your observation under Result - Observations 2.
- Switch off the power supply unit.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# Report: Self-induction when switching off a circuit

## Result - Observations 1

Note your observations.

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## Result - Observations 2

Note your observations.

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## Evaluation - Question 1

The observations you made in the first experiment should indicate to you the direction of the self-induced current and, consequently, that of the self-induced voltage when the circuit is opened. Refer to your observations and explain.

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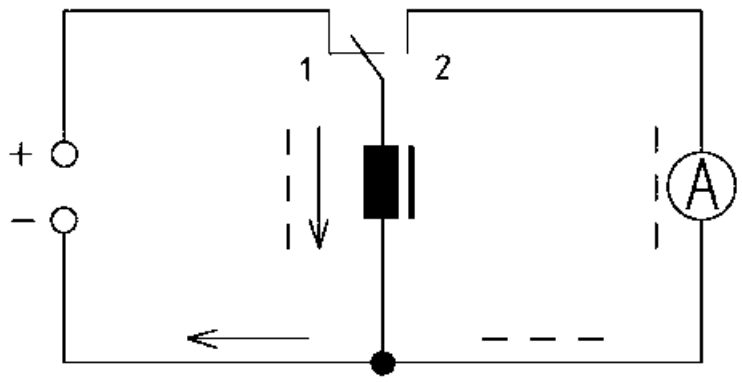
## Evaluation - Question 2

Draw in the direction of the self-induced current when the circuit is opened (use the dotted lines).

Where:

represents the direction of the original coil current.

represents the direction of the self-induced current.



## Evaluation - Question 3

What conclusion can you draw about the level of the self-induced voltage based on your observation in the second experiment?
*Note*: Compare the connected voltage with the trigger voltage of the neon lamp.

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