Problem

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

Equipment

Plug-in board	06033.00	1
On/off switch	39139.00	1
Changeover switch	39169.00	1
Lamp holder E10	17049.00	1
Neon lamp, 110 V, E10	07506.90	1
Coil, 1600 turns	07830.01	1
U-core	07832.00	1
Yoke	07833.00	1
Tightening screw	07834.00	1
Wire building block	39120.00	3
Connecting cables, 25 cm, red	07360.01	1
Connecting cables, 25 cm, blue	07360.04	1
Connecting cables, 50 cm, red	07361.01	2
Connecting cables, 50 cm, blue	07361.04	2
Multi-range meter	07028.01	1
Power supply, 0...12 V-, 6 V~, 12 V~	13505.93	1

Set-Up and Procedure

First Experiment

— Place coil on U-core.
— Use the tightening screw to press U-core and yoke together firmly.
— Set up experiment as shown in Fig. 1. Changeover switch should be set to position 1 initially.
— Select measurement range of 30 mA- and shift the pointer on the current meter 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 allow for the pointer to deflect to the left without damaging the meter!
— Switch on the power supply unit and set direct voltage to 10 V.
— Put switch changeover switch to position 2, thereby turning the left circuit on and the right circuit off. Observe deflection of pointer on current meter.
— Switch changeover switch back again and note reaction of current meter under (1).
— Switch power supply unit off.

Second Experiment

— Set up experiment as shown in Fig. 2.
— Switch on power supply unit and set direct voltage to 10 V again.
— Turn switch on.
— Turn switch off and observe the neon lamp.
— Toggle switch back and forth repeatedly, observe neon lamp, and note observation under (2).
— Switch power supply unit off.

Fig. 1

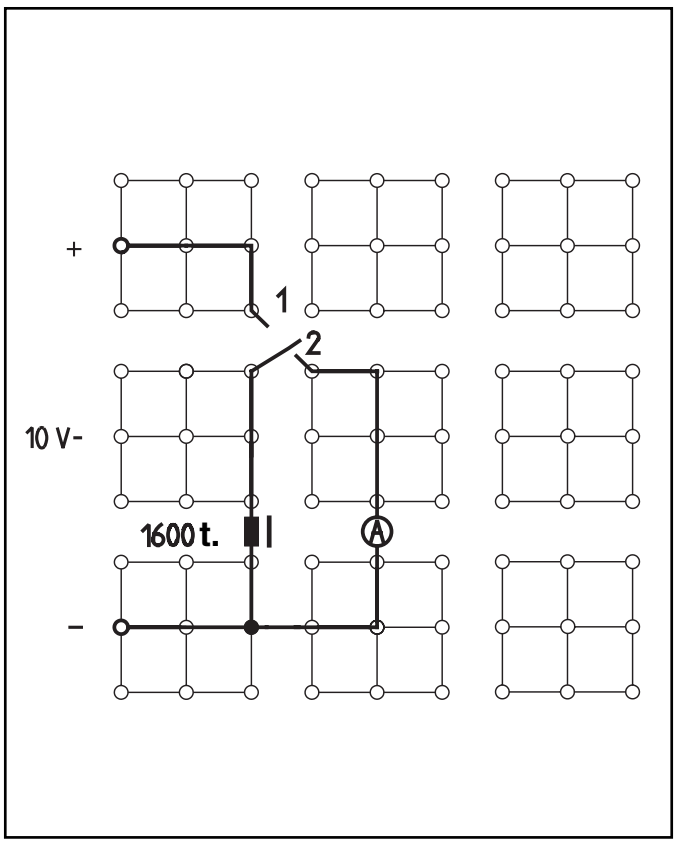
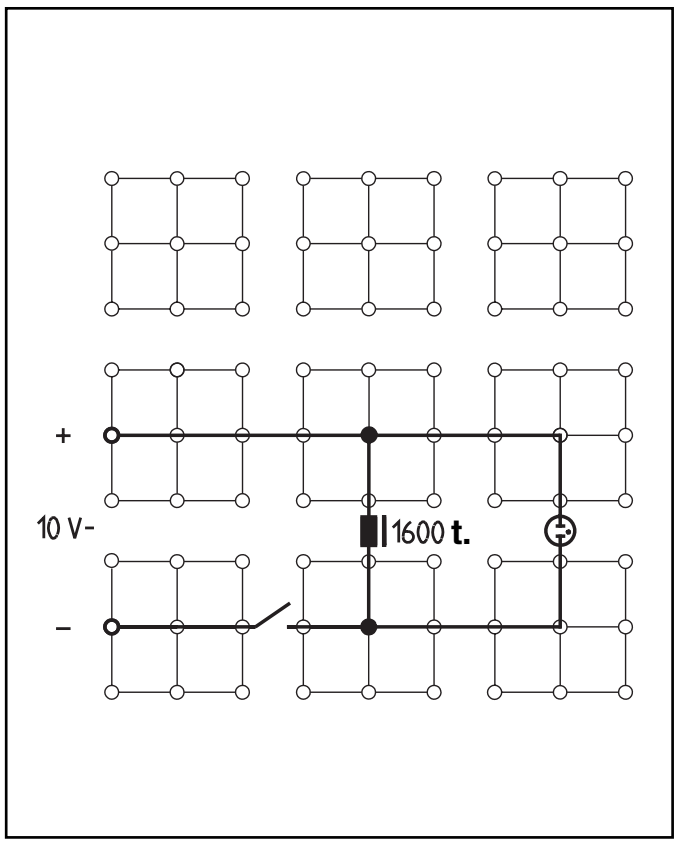


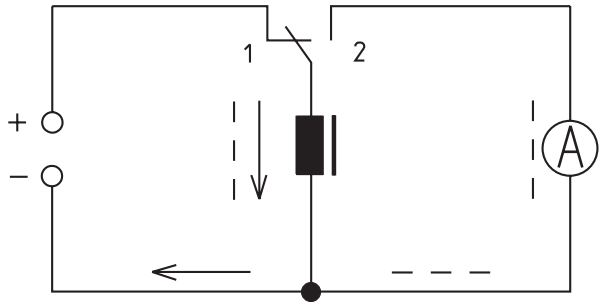
Fig. 2



Observations

(1)

(2)



⟶ Direction of the original coil current

– – ⩾ Direction of the self-induced current

Fig. 3

Evaluation

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 switched off. Expound upon your observations and explain.

2. Draw in the direction of the self-induced current when the circuit is switched off in Fig. 3 (use the dotted lines).

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.)

(What effect does a coil have when the circuit is switched off?)

In the last experiment, the students learned that self-induced voltage is formed in a coil when a direct current circuit is switched on, and that this self-induced voltage counteracts the connected voltage. Now, they should learn that self-induced voltage formed when a circuit is switched off has the same direction as the original (i.e.ÿconnected) 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.

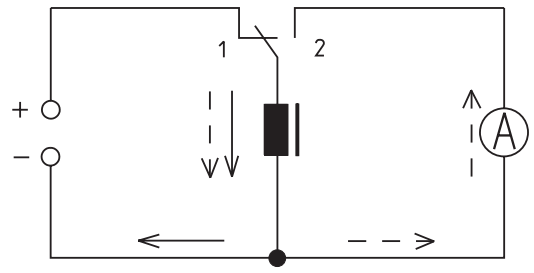
Notes on Set-Up and Procedure
In the first experiment, the instructor may need to advise the students not to wait too long to flip the switch to position 2. Taking too long to switch over may cause the magnetic field to collapse due to the spark at breaking before the self-induced current can flow through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

Observations
(1) The pointer on the current meter deflects to the left when the original circuit is interrupted.
(2) The neon lamp shines briefly each time the circuit is interrupted.

Evaluation
1. A self-induced current is formed when the circuit is switched off. It flows in the same direction as the original current. Therefore, the self-induced voltage also has the same direction as the original voltage.
2. See Fig. 3.
3. Self-induced voltage is many times greater than the connected voltage of 10 V since the trigger voltage of the neon lamp is about 70 V (operating voltage = 110 V).

Notes
Before starting the second experiment, the instructor should expound upon 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 0600 (order no. 13672.93).
High self-induced voltages when switching off a 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.

Fig. 3



⟶ Direction of the original coil current
– – > Direction of the self-induced current

(What effect does a coil have when the circuit is switched off?)

Room of notes