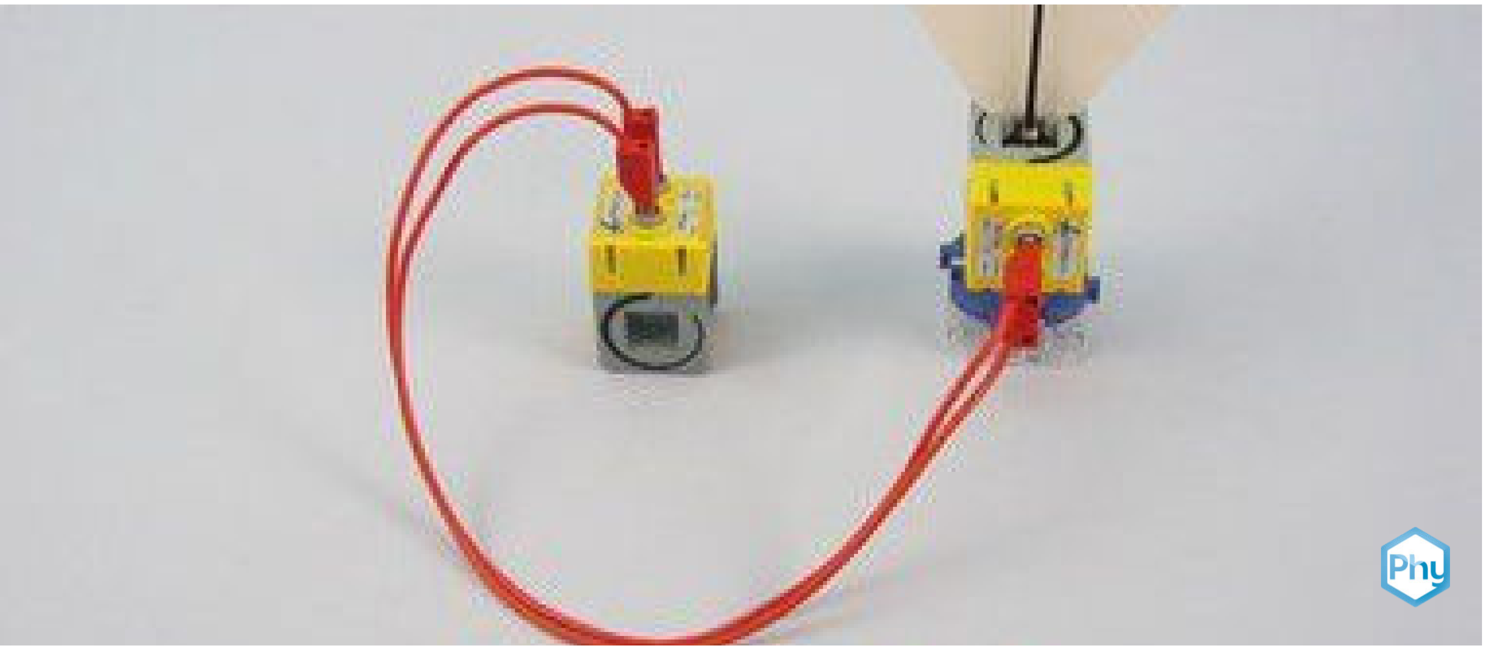
Generation of an induced voltage with permanent magnets



Physics	Electricity & Magnetism	Electromagnetism & Induction
Physics	Electricity & Magnetism	Electric generator, motor, transformer

Difficulty level	Group size	Preparation time	Execution time
easy	1	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4fde2137ffe20003f0fe6b

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Teacher information

Application

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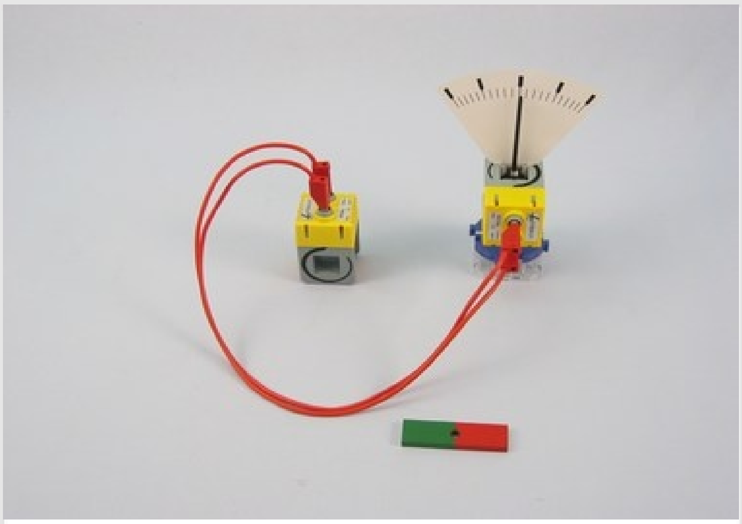

Experiment set-up

Electromagnetic induction, or Faraday induction, has many possible applications and it is impossible to imagine our everyday life without it.

For example, microphones and loudspeakers convert acoustic signals into electrical signals and vice versa.

Generators such as the bicycle dynamo, water turbines on dams or wind turbines also use the principle of induction to produce electricity.

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Other teacher information (1/3)

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Prior knowledge

Students should know that a conductor carrying current is surrounded by a magnetic field. They should also know that this magnetic field can cause mechanical movement in interaction with another magnetic field. Here they should demonstrate the reversal of this phenomenon.

Scientific principle

The change of the magnetic field on a conductor (here: a coil) causes an electric field. The law of induction states

$$rot\vec{E} = \vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

Other teacher information (2/3)

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Learning objective

The students should learn that electrical energy can be generated by menchanical movement. They should recognize that a voltage is only induced when the magnetic field within a coil (or conductor loop) changes.

Tasks

The students are to set up a galvanometer to measure induced voltages and generate an induction voltage by the interaction of a permanent magnet with a coil.

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Other teacher information (3/3)

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Notes

The galvanometer has the advantage over the multiple measuring instrument that it can deflect to both sides and therefore allows the indirect observation of currents of different directions.

Quantitative statements on the induction voltage are not aimed at with this experiment.

As the measuring mechanism of the galvanometer also has a permanent magnet, care should be taken that the bar magnet to be experimented with is not moved in the immediate vicinity of the galvanometer. Otherwise the sensitive measuring mechanism will react to the magnet and falsify the measured values to be expected by induction.

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

Motivation

Wind farm with wind turbines

If one wants to convert mechanical energy into electrical energy, this is done primarily through electromagnetic induction.

You probably know this principle from applications such as the bicycle dynamo for the Farad lamps or from wind turbines in wind parks or water turbines in dams. In all these applications, magnets are usually moved relative to conductor loops, which induces an electrical voltage.

In this experiment you will investigate how an electric voltage can be induced with the help of a permanent magnet.

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Tasks

- Set up a galvanometer for qualitative voltage measurement.
- Move a permanent magnet in various ways relative to a coil connected to the galvanometer.

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Equipment

Position	Material	Item No.	Quantity
1	Straight connector module with socket, SB	05601-11	1
2	Coil, 400 turns	07829-01	2
3	Iron core, I-shaped, laminated	07833-00	1
4	magnet, l = 72mm, rodshaped, colored poles	07823-00	1
5	Galvanometer movement	07875-00	1
6	Galvanometer scale	07876-00	1
7	Notch bearing with plug	07877-00	1
8	Connecting cord, 32 A, 500 mm, red	07361-01	2

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Set-up (1/2)

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Set up the galvanometer according to the illustrations. Assemble the coil with 400 turns, the chine bearing, the galvanometer scale and finally the galvanometer movement.

Plug the finished galvanometer into a cable module with socket.

Set-up (2/2)

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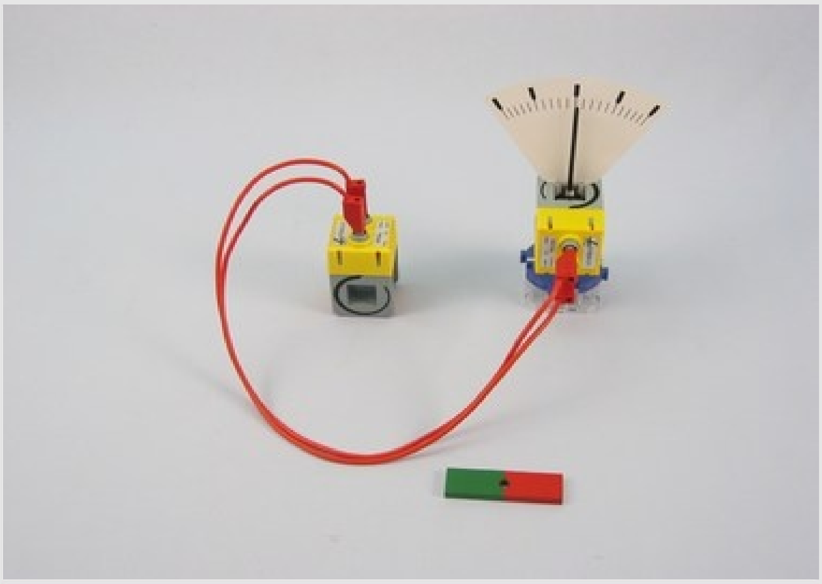

Complete the test setup as shown in the adjacent figure. Connect the second coil with the two connecting leads to the coil of the galvanometer.

Position the second coil as far away as possible from the galvanometer so that only the induced voltage affects the galvanometer and not the magnetic interaction of the permanent magnet with the galvanometer movement.

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Procedure

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Carry out the following test steps one after the other. Observe the deflection of the galvanometer pointer and write down your observations.

1. Move the magnet with the **North Pole** into the coil and out again after a short pause.
2. Move the magnet with the **South Pole** into the coil and out again after a short pause.
3. Move the magnet in and out of the coil faster.
4. Move the coil towards the magnet and after a short pause move it away from the magnet again.
5. Let the magnet rest in the coil.
6. Rotate the magnet by tilting it slightly around its longitudinal axis without moving it.

*Note*The movements in steps 1, 2 and 4 should be as fast as possible.

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Report

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Table 1

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Enter your observations for the pointer deflections (to the left/right or smaller/bigger) in the table.

Movement	1a. North Pole into Coil	1b. North Pole out of Coil	2a. South pole into coil	2b. South pole out of coil	3. faster movement of the magnet
deflection of the pointer					

Movement	4a. Coil towards the	4b. Coil away from magnet	5. magnet rests in the coil	6. rotation of the magnet around the longitudinal axis
deflection of the pointer				

Task 1

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The voltage that the galvanometer indicated during the test is called induction voltage. The process by which it is generated is called electromagnetic induction.

What is the direction of the induction voltage dependent on (compare the results of steps 1. and 2.)?

- [ ] The direction depends on which pole of the magnet faces the coil.
- [ ] The direction depends on whether the movement of the magnet is into or out of the coil.
- [ ] The direction depends on how fast the magnet is moved.

Check

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Task 2

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What does the strength of the induction voltage depend on (compare the result of step 3. with the previous ones)?

- ○ The strength of the induction voltage depends on the speed of the movement.
- ○ The strength of the induction voltage depends on the pole of the magnet.
- ○ The strength of the induction voltage depends on the direction of movement of the magnet.

Check

Task 3

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Complete the following text. Drag the words to the appropriate places.

For the generation of the ______ it ______ whether the ______ moves e.g. towards the coil or the ______ towards the magnet.

Not required: ______

- coil
- doesn't matter
- important
- induction voltage
- magnet

Check

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Task 4

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Complete the following definition for induction voltages. Drag the words to the appropriate places.

A ________ is ________ when the ________ enclosed by the ________ changes.

- magnetic field
- voltage
- induced
- induction coil

Check

Slide	Score / Total
Slide 16: Comparison of the measurements - direction of the induced...	0/2
Slide 17: Comparison of the measurements - strength of the inductio...	0/1
Slide 18: Result of the relative movement	0/5
Slide 19: Definition of induction	0/4

Total amount 0/12

Solutions Repeat Exporting text

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