Electromagnetic induction with Cobra SMARTsense

Physics > Electricity & Magnetism > Electromagnetism & Induction

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

This content can also be found online at:

http://localhost:1337/c/639e69bd04df6e0003e1127f

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

PHYWE

Teacher information

Application

PHYWE

Traffic lights controlled with the help of induction

Electromagnetic induction is a phenomenon that was discovered and described by the English experimental physicist Michael Faraday in the 19th century. The law of induction states that an electric field is created as soon as a magnetic flux changes. This electric field can then often be detected by measuring the electric voltage. Today, this so-called induction effect is mainly used in electrical machines such as electric motors, generators and transformers, but it is also used in everyday areas. For example, for the switching of traffic light systems. Here, induction loops are installed in the road, which register as soon as a vehicle stands on them.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Other teacher information (1/2)

PHYWE

Prior knowledge

The students should already have worked on and understood basic experiments on the electric motor (for example, DC motor and synchronous motor) in order to have a feeling for the magnetic fields generated by energised coils.

Principle

Electromagnetic induction, also called Faraday induction, occurs, for example, when a permanent magnet is moved through the windings of a coil. The relative movement causes a change in the magnetic flux around the windings of the coil and thus the generation of an electric current.

Other teacher information (2/2)

PHYWE

Learning objective

In this experiment, the process of electromagnetic induction and its benefits are to be worked out and understood.

Tasks

The students are to drive a permanent magnet mounted transversely to the axis of rotation with the help of a crank and a belt and thus set it in rotation. Then they are to bring a coil with an iron core close to the rotating permanent magnet and measure the voltage or current generated by it.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Safety instructions

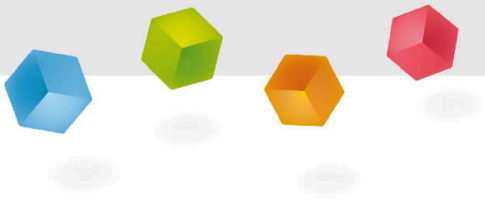
PHYWE

The general instructions for safe experimentation in science lessons apply to this experiment.

Notes on implementation:

- For this experiment, it is a good idea for the students to work in pairs. One person operates the crank and another holds the coil.
- The measuring instrument used should be designed to measure either AC voltages in the millivolt range or AC currents in the milliampere range.

PHYWE



Student information

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Motivation

PHYWE

Traffic lights controlled with the help of induction

Electromagnetic induction means that an electric field is generated in a conductor (and thus an electric current) by a change in magnetic flux density. The changes in the magnetic flux density can be caused, for example, by an alternating magnetic field of a coil or by the movement of a permanent magnet. For example, traffic lights in road traffic can be switched automatically. Induction loops in the road register a change in the magnetic field caused by a car standing on it and the traffic lights are switched to green.

Tasks

PHYWE

You know that you can generate movement from electricity, for example in an electric motor. In this experiment, you have to find out whether this process also works in reverse, i.e. whether you can generate electricity from movement.

For this purpose you will proceed as follows:

1. Set up the experiment and connect the coil to a multimeter.
2. Set the permanent magnet in rotation and observe the multimeter.

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Equipment

Position	Material	Item No.	Quantity
1	Student set Electric motor / Generator, TESS advanced Physics	15221-88	1
2	Cobra SMARTsense Current - Sensor for measuring electrical current ± 1 A (Bluetooth + USB)	12902-01	1
3	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage ± 30 V (Bluetooth + USB)	12901-01	1
4	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Set-up (1/3)

PHYWE

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 starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

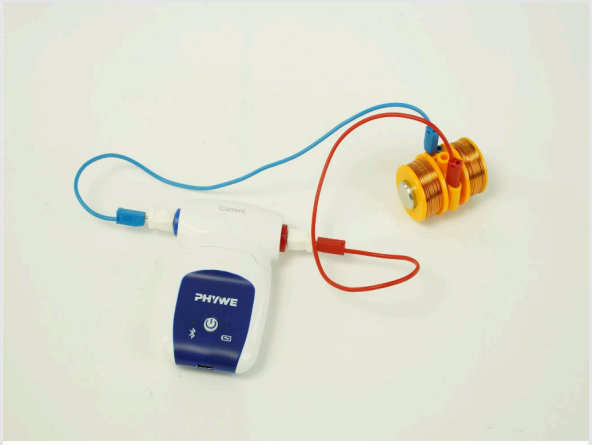
iOS

Android

Windows

Set-up (2/3)

PHYWE



Connect coil and SMARTsense (Current)

Connect the coil and the Cobra SMARTsense using the connecting leads and reducer plugs.

Use the Cobra SMARTsense Current to measure electrical currents.

Put the iron core into the coil.

Then set up the generator by mounting the permanent magnet on the commutator and coupling the crank to the commutator with the help of the belt. In this experiment, the power reverser is only used as a rotary axis.

PHYWE

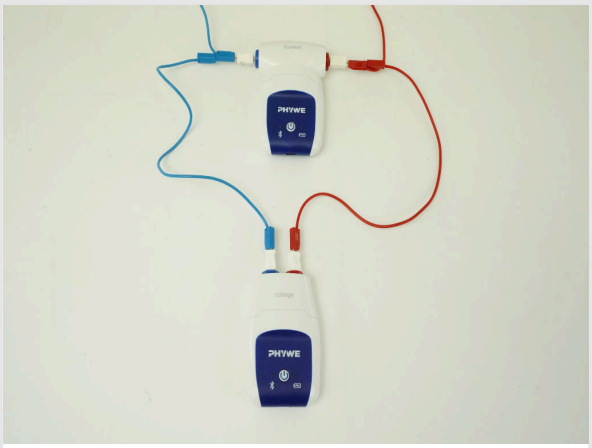
Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Set-up (3/3)

PHYWE



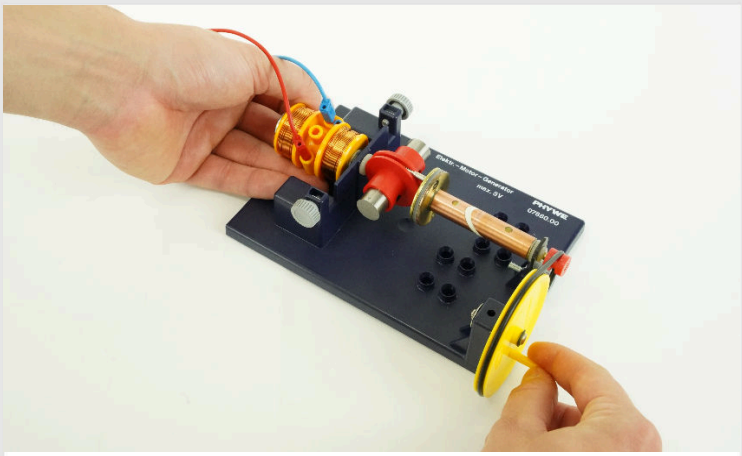
SMARTsense Current & SMARTsense Voltage connected in parallel

Note: You can also connect the SMARTsense Voltage in parallel to the SMARTsense Current in order to measure both the current and the voltage simultaneously during the experiment.

Turn on the SMARTsense(s) by pressing and holding the I/O button for about three seconds. Start the measureAPP and select the sensor(s) to connect.

Procedure (1/2)

PHYWE



Experiment set-up 1 - Coil with iron core

Experiment: Part 1

- Position the coil with iron core and connected SMARTsense near the permanent magnet as shown in the illustration.
- Start a measurement and make the permanent magnet rotate rapidly using the pulley with crank and drive belt.
- What are you observing? Save your measurement if necessary.

PHYWE

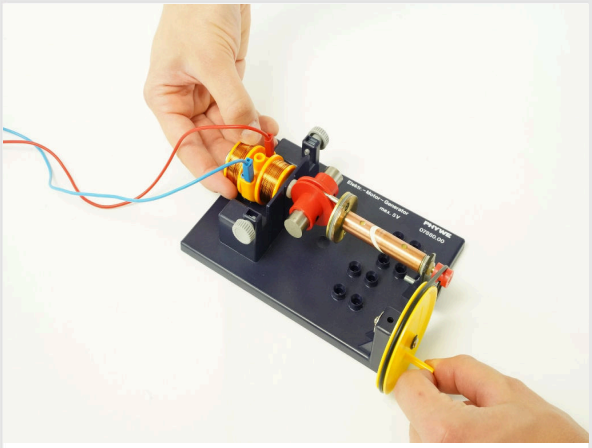
Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Procedure (2/2)

PHYWE



Experiment set-up 2 - Coil without iron core

Experiment: Part 2

- Repeat experiment 1, but this time without the iron core in the coil.
- Approach the coil to the permanent magnet and start a new measurement.
- Set the permanent magnet to rotate at the same speed as in the first part of the experiment and observe the resulting curve.
- Finish the measurement and save your measurement if necessary.

PHYWE

Report

PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

Task 1

PHYWE

Which of the following statements agree with your observations?

- [ ] In the 2nd part of the experiment, the maximum measured values were comparatively large.
- [ ] In the 1st part of the experiment, the maximum measured values were comparatively small.
- [ ] In the 1st part of the experiment, the maximum measured values were comparatively large.
- [ ] In the 2nd part of the experiment, the maximum measured values were comparatively small.

Check

Task 2

PHYWE

The process observed in the experiment is called "electromagnetic induction". Describe the principle of electromagnetic induction.

Electromagnetic induction occurs, for example, when you move a _____ quickly past a _____. This movement creates an _____ field in the conductor and thus a _____ which can be measured. This works as long as the magnet is _____, _____ no voltage is induced. In this way, for example, a _____ can be used to generate electricity.

dynamo/generator
permanent magnet
electric
at rest
current
conductor loop
moving

Check

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

Task 3

PHYWE

Think about which of the following applications you could use this principle for.

- [ ] To boil water using an induction cooker.
- [ ] To create a so-called eddy current brake with the help of induction, which can be used to brake trains.
- [ ] For the generation of electricity. For example, turbine-driven generators in hydroelectric power plants.

Check

Slide	Score / Total
Slide 16: Observations	0/2
Slide 17: Conclusion	0/7
Slide 18: Application examples	0/3
Total	**0 / 12**

Solutions Repeat

PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de