The electromagnet with SMARTsense (Item No.: P1086869)

Curricular Relevance

Area of Expertise: Natural Sciences

Education Level: Age 11-14

Topic: Nature and technology

Subtopic: Electrical and magnetic devices in daily use

Experiment: The Electromagnet with SMARTsense

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:

- paper clip
- key
- tablet PC with measureAPP

Experiment Variations:

Keywords:

electromagnet, coil, iron core, Ampère's law, current, magnetic field, magnetism, attractivity

Information for teachers

Educational objective and competences

The students will examine the working principle of an electromagnet by measuring the magnetic field and observing the attractivity of ferrous objects. Furthermore, they will find that this effect only occurs by combing a coil with a iron core as both parts separately only show low till no magnetic properties. Additionally, the students have the option to compare their observations with the magnetic field of a permanent magnet.

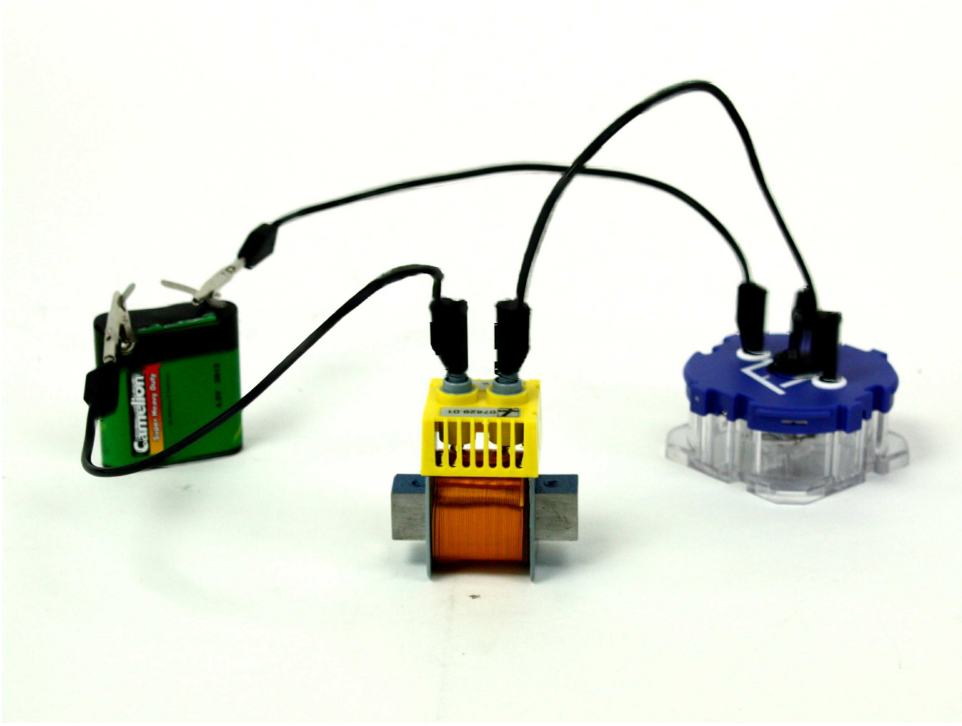

Fig. 1: Setup

Safety information

For this experiment, the general notes and instructions concerning safe experimentation in science classes apply.

Didactic notes

Procedure

- If the experiment is too time consuming, parts of the experiment can easily be skipped, for example the experiment works fine without the comparison with the permanent magnet.
- Since a battery is used for the experiment, the set-up does not present any electrical hazards. However, we still recommend using the ON/OFF switch, since the students may not be able to determine when electricity is dangerous. Make sure that the students always interrupt the electric circuit when they change the set-up of the experiment.
- The coil is set for a permanent current of 1 A. Make sure, that the electric circuits are not closed to long and are opened after the measurement.

Robert-Bosch-Breite 10
D - 37079 Göttingen
Tel: +49 551 604 - 0
Fax: +49 551 604 - 107
info@phywe.de
www.phywe.com

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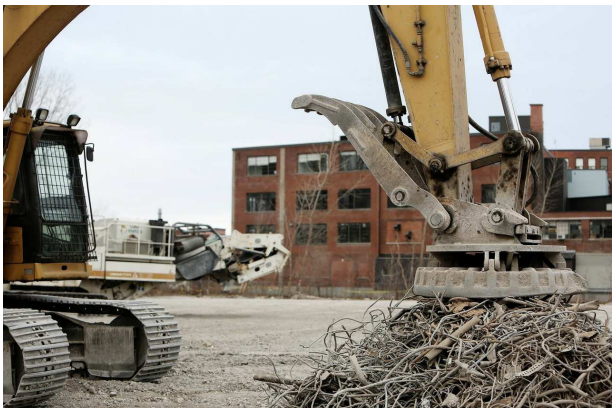
Experiment (with Tablet PC)

Introduction

In other experiments you already observed that magnets attract ferrous objects which then stick to the magnet. If you want to separate a nail from a magnet you have to pull them away from each other.

Electromagnets can be turned “off”. Afterwards the ferrous objects simply fall from the magnet. Maybe you already know electromagnets from a junk yard.



Electromagnet on junk yard.

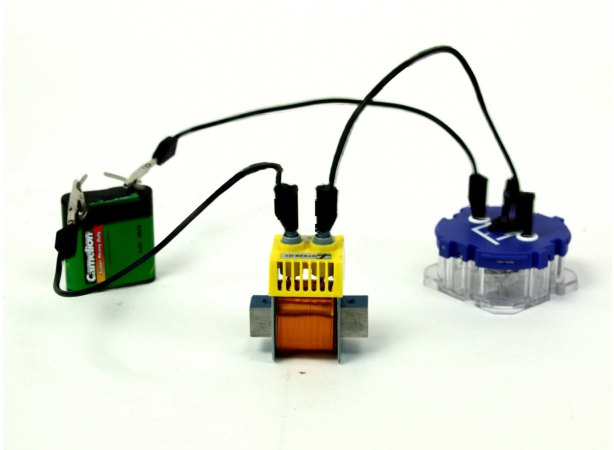
Application

Electromagnets are often used in every day life. Mostly when you want to attract an object magnetically for a short period of time.

- The lifting magnet: Most junk yards have one to lift up ferrous parts and set them off at a different location.
- Fire doors: These doors are kept open by a magnet. If some sets off the fire alarm, the magnet turns off and the door closes automatically.
- For garbage seperation: Objects made of iron are separated with a magnet from the rest of the garbage.
- In a hospital: Many machines for examinations use powerful electromagnets.

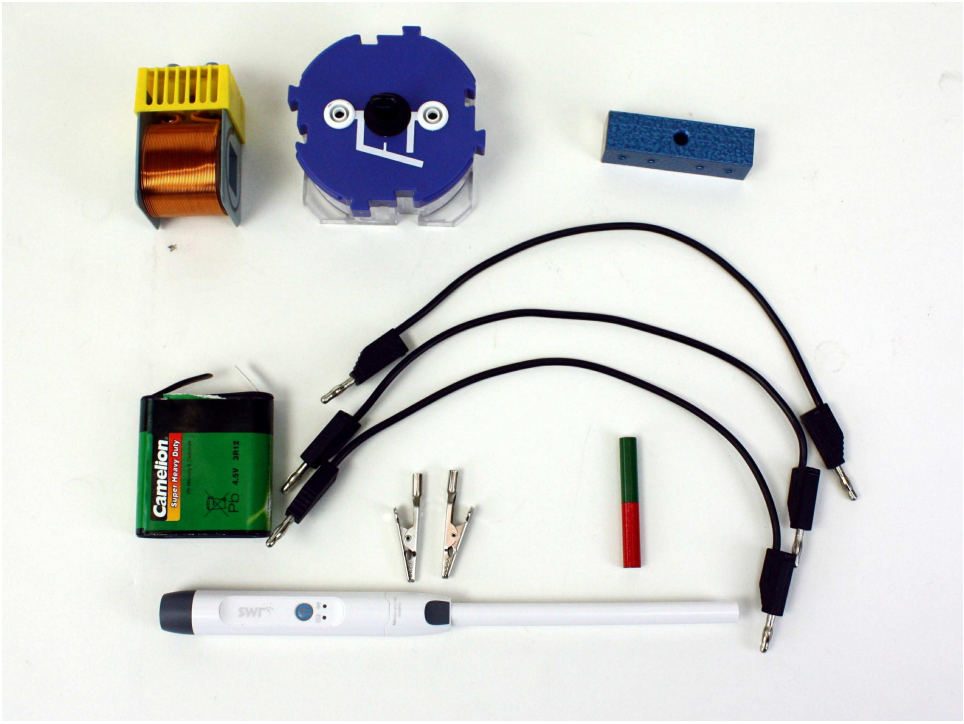
Task

1. Build an electromagnet.
2. Examine its effects on other objects and the magnetic field while turning it on and off.
3. Compare the magnetic field of an electromagnet to the one of a permanent magnet.



Setup

Equipment and procedure



Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - Magnetic field, ± 64 mT	12911-00	
2	Flat battery 4.5 V	07496-01	1
3	On-/Off-switch	09390-07	1
4	Coil, 400 turns	07829-01	1
5	Yoke	07833-00	1
6	Alligator clips, blank, 10pc	07274-03	(2)
7	Connecting cord, 32 A, 250 mm, black	07360-05	3
8	Magnet, d=8 mm, l = 60 mm	06317-00	
Additionally			
9	Tablet PC		
10	PHYWE measureAPP		
11	Paper clips, key, ect.		

Setup

Set up the experiment as shown in fig. 1.

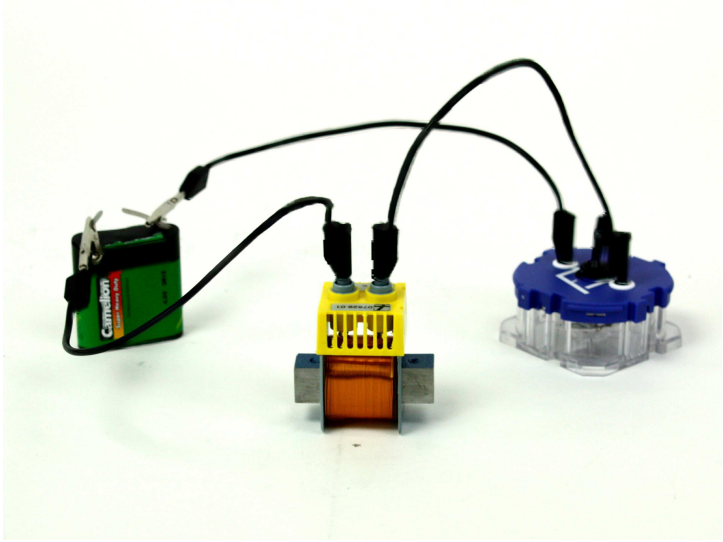


Fig. 1: Setup

Before you connect the battery, ensure that the ON/OFF switch is set to off. To do so, set the lever to the OFF position as shown in Fig. 2

This is to ensure that current will not flow through the electric circuit. Turn the switch on only for the measurement and switch if off again immediately afterwards.

Do not change the set-up of the experiment unless the ON/OFF switch is set to off!

Fig. 2: Switch in the OFF position

Insert the yoke into the coil.

Set the electric circuit up in the following order:

Battery – On-/Off-switch – Coil with yoke – Battery

Use cables to connect the components.

- You can connect the cables directly to the blue component and the coil.
- Connect a crocodile clip to each of the battery terminals. You can then connect the cables to the clips.

Procedure

1. Hold paper clips, key etc near the yoke in the coil. Observe what happens.

   Turn the ON/OFF switch on. The electric circuit is now closed.

   Now hold the objects near the coil again and observe what happens.

   Turn the ON/OFF switch off again.

   What happens when you turn the switch off? Write down your observations into the report.

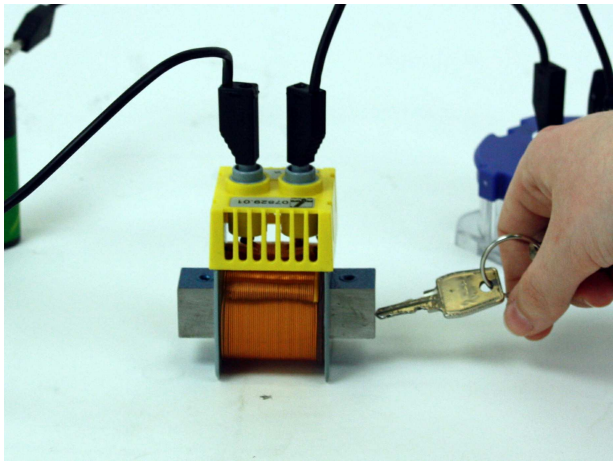


Fig. 3

2. Turn on your Cobra SMARTsense-Magnetic field. Open the measureAPP and select the magnetic field sensor.

   Set the sampling rate as high as possible. Start the measurement.

   Turn the ON/OFF switch on. The electric circuit is now closed.

   Move the sensor towards the yoke.

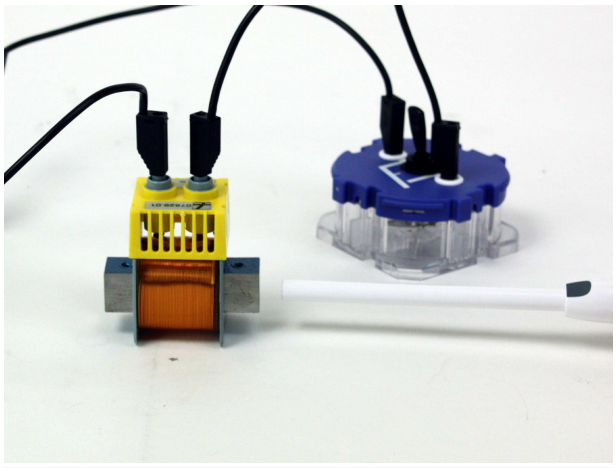


Fig. 4

   Turn the ON/OFF switch off again.

   What do you observe? End the measurement and save it. Write down your observations in the report.

3. Turn the ON/OFF switch on. The electric circuit is now closed.

   Start the measurement.
   Move the sensor around the coil. Change the orientation of the sensor as shown in fig. 5 and 6. Is there a difference? End the measurement and save it.

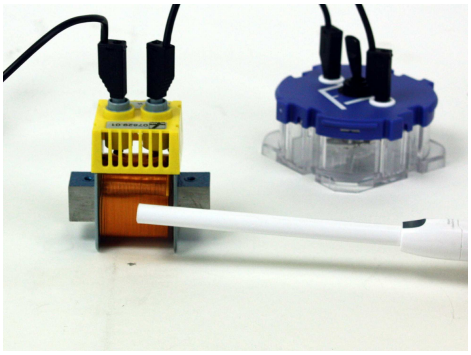


Fig. 5

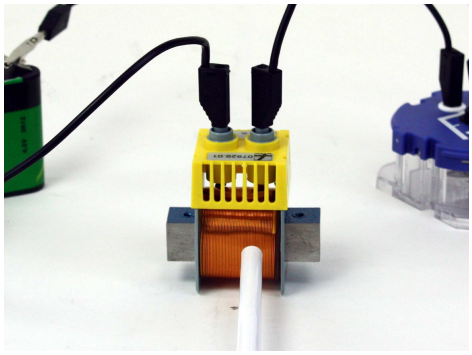


Fig. 6

   Turn the ON/OFF switch off again.

4. Repeat the measurement with the permanent magnet.

5. Take the yoke from the coil. Measure the magnetic field intensity of the live coil and the yoke separately. Did something change? Write down your observations in the report. Turn the On/Off-switch off after you are done.

Evaluation

Within this experiment you examined the properties of a live coil with an iron core.

Open the report and answer the questions.