Magnetic flux density of a thick coil (Item No.: P6300369)

Curricular Relevance

Area of Expertise: Physics

Education Level: Age 10-13

Topic: Electricty

Subtopic: Electromagnetic induktion

Experiment: Magnetic flux density of a thick coil

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	30 Minutes	2 Students

Additional Requirements:

- PHYWE Netzgerät, RiSU-2016-konform

Experiment Variations:

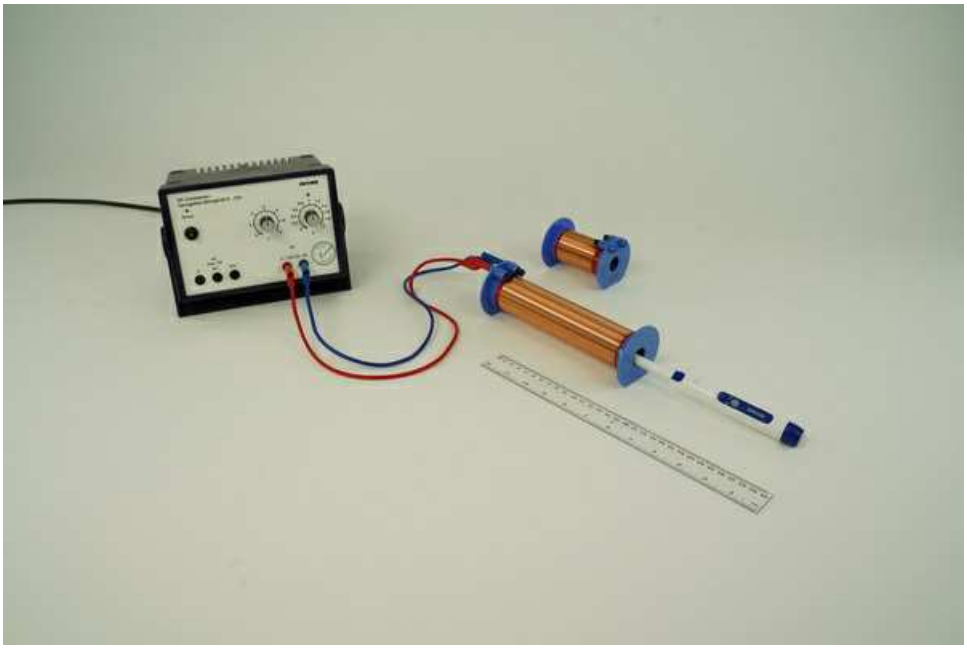
- Tablet with measure App

Keywords:

magnetic field of a coil, magnetic field inside of a coil, magnetic fiel outside of a coil, current carrying coil, magnetic flux density of a coil

Information for teachers

Introduction

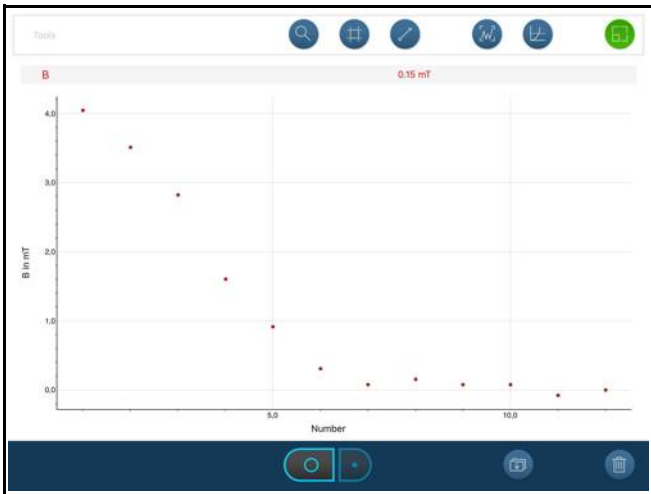


Application
The strength of the magnetic field of a coil depends on the distance of the coil. Expensive clothes or other goods are often electronically secured. These are unlocked at the cash register with a magnet. There is always a place where the EC card may not be stored, otherwise the magnetic strip of the EC card may be damaged. Further away, however, it is not a problem to lay down the card. The magnetic field weakens at greater distance.

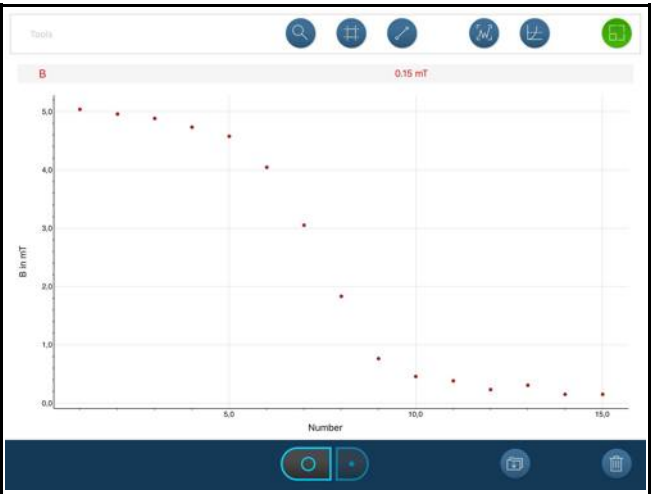
Educational objective
In this experiment, is to be investigated the Depending of the magnetic flux density on the distance to the current-carrying coil and the winding number. The winding density is the same for the coils used.

Task
1. Measure the magnetic flux density of the 41mm Ø coil with a windingnumber of 100 along the longitudinal axis of the coil (z-

axis).
2. Measure the magnetic flux density of the 41mm Ø coil with a windingnumber of 300 along the longitudinal axis of the coil (z-axis).



Magnetic field of the coil with 100 turns.



Magnetic field of the coil with 300 turns

Prior knowledge
The students should have already gained experience concerning the basics of direct and alternating current as well as the principle of magnetic induction.

Principle
The current carrying coil generates a magnetic field. The magnetic flux density is alomost constant inside of a long thin coil. Outside of the coil, the magnetic flux density falls off quickly. The magnetic flux density inside of a long coil is:

$$B = \mu \frac{NI}{l}$$

B is the magnetich flux density, μ is the magnetic permeablity, N is the winding number, I is the amperage and l is the lenght of the coil.

Notes concerning the set-up and execution of the experiment
When measuring the magnetic field of the coil, make sure that the magnetic sensor indicates the magnetic flux density at the tip of the magnetic sensor. Look exactly where the turns of the coil stop.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic field	12947-00	1
2	Induction coil, 300 turns, d = 40 mm	11007-01	1
3	Induction coil, 100 turns, d = 40 mm	11007-05	1
4	Ruler, l = 30 cm	09851-40	1
5	Connecting cord, 32 A, 750 mm, red	07362-01	1
6	Connecting cord, 32 A, 750 mm, blue	07362-04	1
7	PHYWE power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1

Safety information

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

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Introduction

Application and Task

Application
Your mobile phone or your EC-card shoudn't be close to a magnet, otherwise it's can be damaged. A current-carrying coil also generates a magnetic field. At what distance is the magnetic field dangerous for your EC-card? How is the magnetic field with growing distance?

Aufgabe
1. Measure the magnetic flux density of the 41mm Ø coil with a windingnumber of 100 along the longitudinal axis of the coil (z-axis).
2. Measure the magnetic flux density of the 41mm Ø coil with a windingnumber of 300 along the longitudinal axis of the coil (z-axis).

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic field	12947-00	1
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Setup and Procedure

Setup

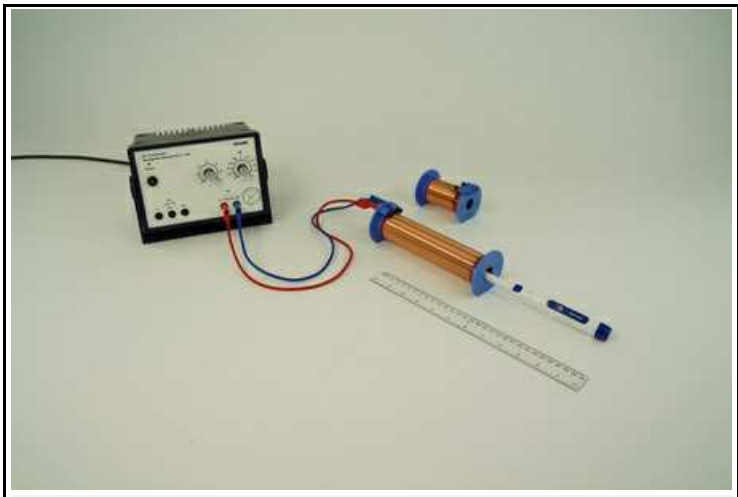

fig. 1

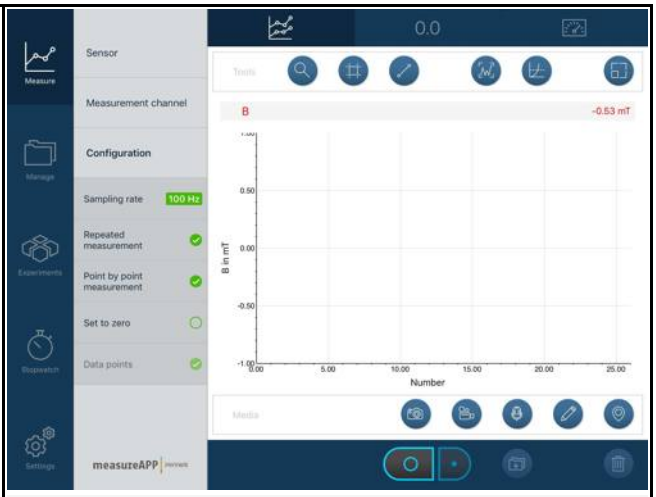

fig. 2

Build the experiment as shown in fig. 1. Connect the short coil with a diameter of 41mm and 300 turns to the power supply (amperage=1,2 A). Connect your tablet to the Cobra SMARTsense magnetic field sensor. Select point by point measerement [Configuration-> Point by point measerment (fig. 2)].

Procedure

1. Insert the magnetic field sensor in the middle of the coil and measure the magnetic flux density.
2. Go in 1cm steps with the magnetic field sensor from the coil and take each time a measuring point by pressing a button until you are with the tip of the magnetic field sensor 5cm outside the coil.
3. Repeat step 2 and step 3 for the long coil with a diameter of 41mm and 300 turns.

Report: Magnetic flux density of a thick coil

Evaluation - Question 1 (2 points)

What is the magnetic flux density in the middle of the coil with 100 turns? Enter the absolute value. The unit is mT. 3.5 - 5

Evaluation - Question 2 (2 points)

What is the magnetic flux density in the middle of the coil with 300 turns? Enter the absolute value. The unit is mT. 4.5 - 5.5

Evaluation - Question 3 (8 points)

Describe the course of the magnetic flux density, especially at the end of the winding of the coil.

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Evaluation - Question 4 (5 points)

Provide hypotheses why there is a lower magnetic flux density in the middle of the 100-turn coil than in the 300-turn coil, although the winding density (turns per length) is the same.

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Evaluation - Question 5 (5 points)

You have applied the magnetic flux density from the center to one end of the coil with the measureApp. What do you think would the course look like if you had measured the whole longitudinal axis?

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