Magnetic field of a coil and amperage (Item No.: P6300469)

Curricular Relevance

Area of Expertise:	Education Level:	Topic:	Subtopic:	Experiment:
Physics	Age 16-19	Electricty	Electric generator, motor, transformer	magnetic field of a coil and amperage

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

Additional Requirements:

- Power Supply
- Tablet mit measure App
- Digital multimeter

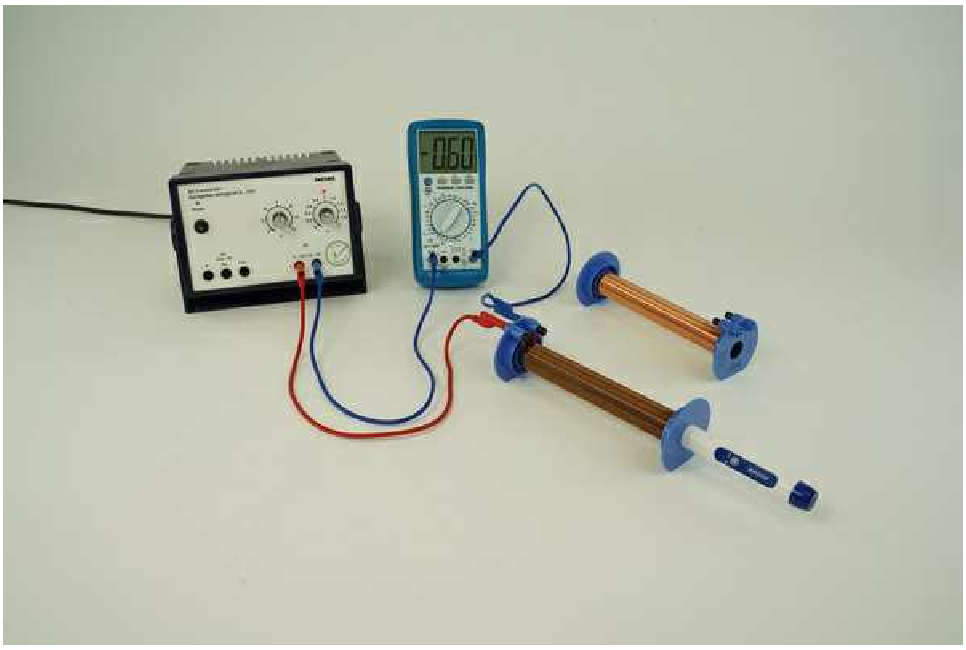
Experiment Variations:

Keywords:

magnetic field of a coil, magnetic flux density of a coil, current carrying coil

Information for teachers

Introduction



Application
Coils are installed in many electronic objects. For example, the are instelled in a transformer, an electric motor or loudspeakers. Coils generate only a magnetic field when the Coil is connected to a power source.

Educational objective
In this experiment, you will investigate the magnetic flux density with two coils with different winding density while you increasing the current intensity.

Task
1. Measure the magnetic flux density inside of the 26mm Ø Coil with windingnumber of 75 while you inceasing the current.
2. Measure the magnetic flux density inside of the 26mm Ø Coil with windingnumber of 300 while you inceasing the current.

Prior knowledge
The students should have already gained experience concerning the basics of the principle of magnetic flux density.

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.
The magnetic flux density B is proportional to the current I and the winding number N.

Notes concerning the set-up and execution of the experiment
The maximum current of 1.2A should not be exceeded, otherwise the coils may overheat.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic Field	12947-00	1
2	Induction coil, 300 turns, d = 25 mm	11007-03	1
3	Induction coil, 75 turns, d = 25 mm	11007-07	1
4	Connection cord, 32 A, 500 mm, red	07361-01	1
5	Connection cord, 32 A, 500 mm, blue	07361-04	2
6	PHYWE power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
7	Digital Multimeter, 2.000 Counts, 600V AC/DC, 10A AC/DC	07129-00	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
Coils are installed in electric motors, tranformers or in loadspeakers. A coil generates a magnetic field when connected to the power supply. What happens when the current is increased? Is the winding density of a coil important?

Aufgabe
1. Measure the magnetic flux density inside the 26mm Ø coil with a windingnumber of 75, while increasing the current in 0,1A steps. Finish the measurement at a amperage of $I = 1{,}2A$.
2. Reapeat the process wih a 26mm Ø coil with a windingnumber of 300.

Equipment

Position No.	Material	Order No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic Field	12947-00	1
2	Induction coil, 300 turns, d = 25 mm	11007-03	1
3	Induction coil, 75 turns, d = 25 mm	11007-07	1
4	Connection cord, 32 A, 500 mm, red	07361-01	1
5	Connection cord, 32 A, 500 mm, blue	07361-04	2
6	PHYWE power supply, 230 V, DC: 0...12 V, 2 A / AC: 6 V, 12 V, 5 A	13506-93	1
7	Digital Multimeter, 2.000 Counts, 600V AC/DC, 10A AC/DC	07129-00	1

Setup and Procedure

Setup

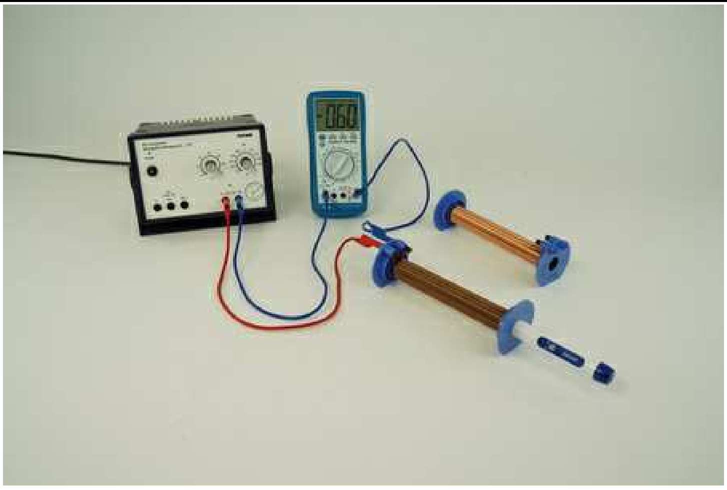

fig. 1

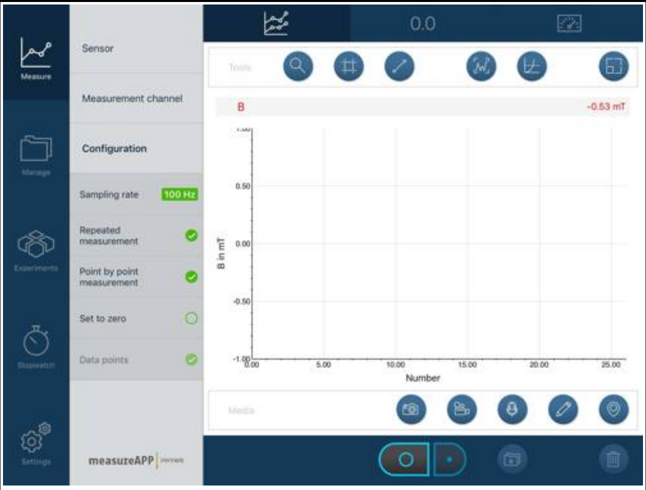

fig. 2

Build the experiment as shown in fig. 1. Connect the Power supply, an ampere meter and the coil (26mm Ø, N=75) in series.Connect your tablet to the Cobra SMARTsense magnetic field sensor. Select point by point measerement [Configuration-> Point by point measerment (fig. 2)].

Procedure

1. Turn on the power supply and increase the current to $I = 0,1A$.
2. Insert the magnetic field sensor in the center of the coil and record a measuring point by pressing the button.
3. Increase the current in $0.1A$ steps until you are at a current of $I = 1.2A$.Pick always up one measurement point.
4. Change the coil and install the coil with $N = 300$ turns.
5. Repeat steps 1-3.

Report: Magnetic field of a coil and amperage

Evaluation - Question 1 (7 points)

Compare your measurements. Which of the following statements are correct?

- [x] The higher the current, the higher the magnetic flux density
- [ ] The higher the current, the smaller the magnetic flux density
- [x] The slope of the measured values is linear
- [ ] The slope of the measured values is exponential
- [ ] The slope of the measured values is square
- [x] The slope of the measured values of the 75-turn coil is smaller than that of the 300-turn coil
- [ ] The slope of the measured values of the 75-turn coil is larger than that of the 300-turn coil

Evaluation - Question 2 (5 points)

The coils have the same length but different numbers of turns. Why is the magnetic flux density at the same current in the coil with 300 turns larger? Which of the statements is correct.

- [ ] One coil has more turns. The winding density does not matter.
- [x] The winding density is crucial.
- [ ] The wire thickness is crucial.
- [ ] The magnetic flux density is the same for both coils.