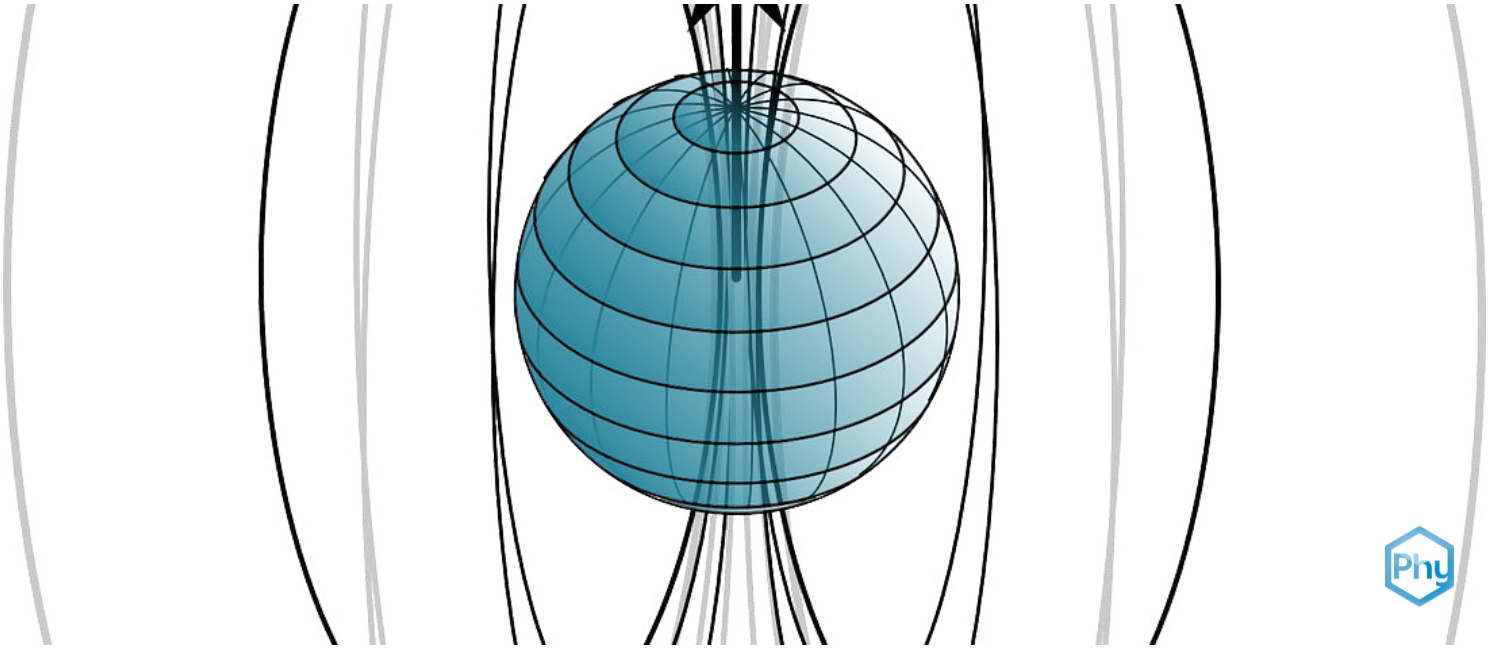
Earth's magnetic field strength and direction with Cobra SMARTsense



Physics > Electricity & Magnetism > Electromagnetism & Induction

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4b2840c3481500038cb3f9

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Teacher information

Application

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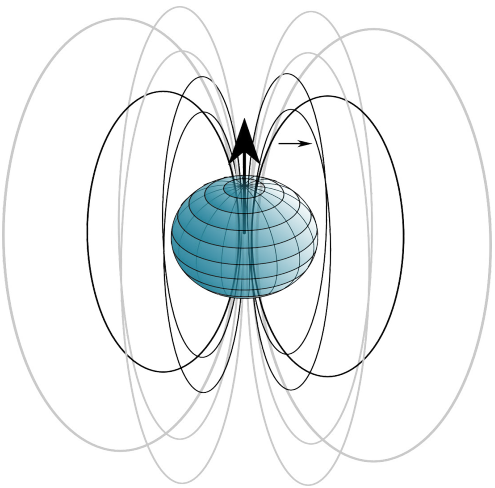

Magnetic field lines of the

Magnetic fields are always directed: There is a north and south pole. The field from north to south pole is defined as positive and from south to north pole as negative.

Probably the most important magnetic field for us humans is the earth's magnetic field. On the one hand it offers us protection and on the other hand it has been used for centuries for navigation with the help of a compass. However, the magnetic north pole is not the same as the geographic north pole of the earth. The magnetic poles of the earth move and are not completely static. Furthermore, the direction of the magnetic field lines is different at every point on the earth's surface.

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Other teacher information (1/2)

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Prior knowledge

The students should be familiar with the basics of magnetic flux density and it should be known that there is a geomagnetic field.

Scientific principle

The magnetic field is defined positively from the north pole to the south pole and negatively from the south pole to the north pole. The direction of magnetic fields can be determined with a compass. Hall probes are generally used for the quantitative determination of magnetic flux densities.

Other teacher information (2/2)

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Learning objective

In this experiment the magnetic field direction and the magnetic field strength of the earth shall be investigated. It should be understood by which means these two quantities can be quantitatively determined.

Tasks

The students measure the magnetic field of the earth. In order to determine the magnetic field strength quantitatively, first the direction of the magnetic field is determined. This is particularly useful for vector calculus in three-dimensional space.

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Safety instructions

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

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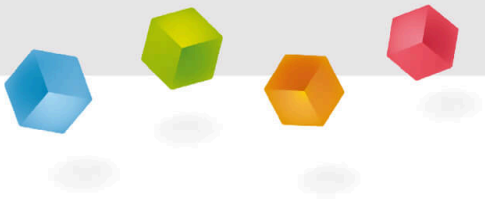

Student Information

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Motivation

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Compass for navigation

As you know, a compass always shows the north-south direction, which is why you can orientate yourself with its help. But in fact, the direction does not completely coincide with the geographical north-south direction.

All magnetic fields always have a north and a south pole. This applies to permanent magnets as well as to the earth's magnetic field. By definition, the magnetic field from north to south pole is positive. The strength of a magnetic field is position-dependent and results from the so-called magnetic flux density at the respective location.

In this experiment you learn to determine the direction and strength of the earth's magnetic field.

Tasks

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Determine the direction and strength of the earth's magnetic field. Measure the magnetic flux density in two different planes.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - 3-Axis Magnetic field	12947-00	1
2	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Additional equipment

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Position	Equipment	Quantity
1	Paper	DIN A4
1	Adhesive tape	

Set-up (1/2)

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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

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Set-up (2/2)

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Sheet fixed on the table with adhesive tape

Stick a sheet of paper onto the table with the adhesive tape.

Start measureAPP on the tablet and switch on the Cobra SMARTsense magnetic field sensor (hold down the I/O button for about 3 seconds).

Select the sensor in measureAPP and connect it to the App. The following settings must be made:

- Fine measuring range (- 5 mT ... + 5 mT)
- 1 measuring channel: X direction
- Measuring frequency: 200 Hz

Procedure (1/3)

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stroke on the paper

- Start a measurement and rotate the sensor in the horizontal plane in a circle (one complete rotation).
- Draw an arrow on your sheet of paper for the direction where the magnetic field is strongest.

Now calibrate the magnetic field sensor. For this purpose, the magnetic field sensor must be set to zero in the field-free state (average value when rotating around an axis in the earth's magnetic field).

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Procedure (2/3)

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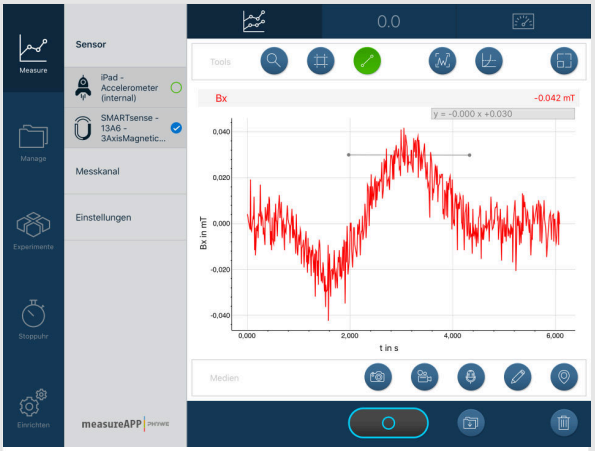

Measurement of the earth magnet in the horizontal plane

- Start a new measurement, rotate the sensor in the horizontal plane again and note the values for the maximum and minimum in the protocol.
- To do this, draw a horizontal line through the maximum/minimum in the measured data.

Procedure (3/3)

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- Place the magnetic field sensor crosswise to the arrow:
  - Now rotate the magnetic field sensor in the vertical plane.
- Place the magnetic field sensor parallel to the arrow:
  - Rotate the magnetic field sensor in the vertical plane again.
- Note the maximum and minimum values for both measurements in the protocol.

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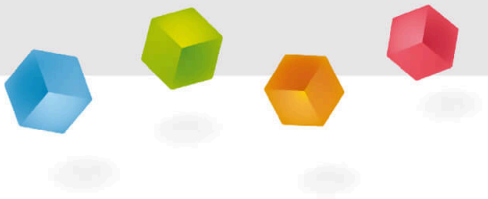

Report

Task 1

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1. measurement (horizontal)	$B\,[mT]$
Minimum	
Maximum	
ΔB	

Enter your measured values for the minimum and the maximum from the horizontal plane.

Calculate the amount from both values $\Delta B = B_{max} - B_{min}$.

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Task 2

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2. measurement (vertical-transverse)	$B\,[mT]$
Minimum	
Maximum	
ΔB	

3. measurement (vertical-parallel)	$B\,[mT]$
Minimum	
Maximum	
ΔB	

Enter your measured values for the minima and maxima from the vertical plane.

Calculate the amount from both values $\Delta B = B_{max} - B_{min}$.

Task 3

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Drag the words to the correct places.

The magnetic field is _____. There is a north and south pole. The field is defined as _____ from north to south and _____ from south to north.

directed

negative

positive

Check

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Task 4

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With which formula can the maximum of the third measurement be calculated therotically from the previous measurements?

- $B = \sqrt{\Delta B_h + \Delta B_v}$
- $B = \sqrt{(\Delta B_h)^2 + (\Delta B_v)^2}$
- $B = (\Delta B_h + \Delta B_v)^2$
- $B = \Delta B_h + \Delta B_v$

Check

Task 5

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Which unit is used to describe the magnetic flux density?

- $Newton\ [N]$
- $Tesla\ [T]$
- $Volt\ [V]$
- $Joule\ [J]$
- $Amper\ [A]$

Check

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Slide	Score / Total
Slide 19: Direction of the magnetic field	0/3
Slide 20: Vector addition	0/1
Slide 21: Unit of magnetic flux density	0/1

Total amount 0 / 5

Solutions | Repeat | Exporting text

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