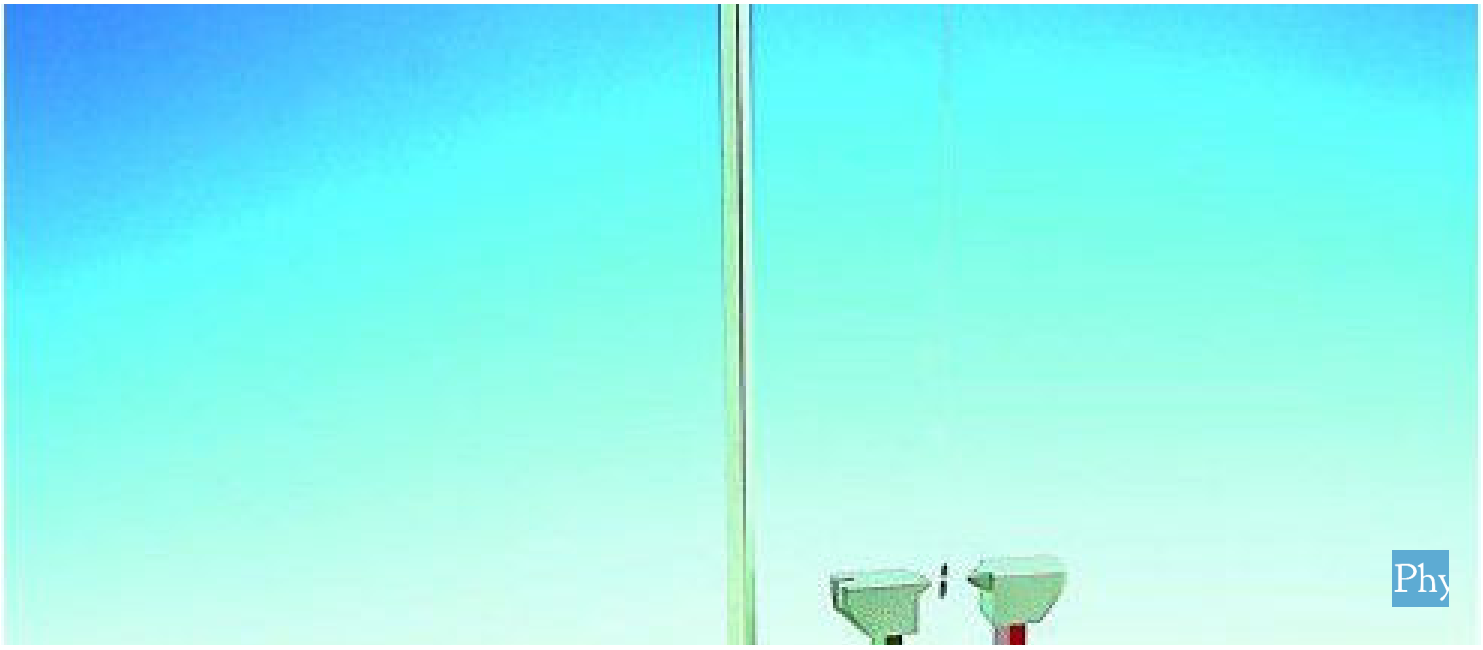
Ferromagnetism, paramagnetism and diamagnetism



The goal of this experiment is to investigate the different types of magnetism.

Physics > Electricity & Magnetism > Electromagnetic oscillations & waves

Difficulty level	Group size	Preparation time	Execution time
hard	2	45+ minutes	45+ minutes

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General information

Application

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Setup

Magnetism is a class of physical phenomena that are mediated by magnetic fields. Electric currents and the magnetic moments of elementary particles give rise to a magnetic field, which acts on other currents and magnetic moments. Magnetism is one aspect of the combined phenomenon of electromagnetism.

There are three different types of magnetism: Ferromagnetism, paramagnetism and diamagnetism.

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Other information (1/2)

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Prior knowledge

No prior knowledge required.

Scientific principle

The aim of this experiment is to study the behaviour of nickel, tungsten, and bismuth rods in a strong, inhomogeneous magnetic field. This field is formed, for example, between cone-shaped pole pieces that sit on a permanent magnet. The rods are suspended horizontally on a long and very thin silk thread so that they can move freely.

Other information (2/2)

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Learning objective

The goal of this experiment is to investigate the different types of magnetism.

Tasks

- Study the behaviour of nickel, tungsten, and bismuth rods in a strong, inhomogeneous magnetic field.

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Theory

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In a magnetic field, all of the materials are subject to more or less strong forces. Three types of materials can be distinguished.

Ferromagnetic materials: They are attracted by every magnet. Their permeability is very high, but not a constant. It depends on the external magnetic field intensity and the history of the material.

Paramagnetic materials: They are attracted into areas of high magnetic field intensity. Their relative permeability is slightly greater than one and it is independent of the field strength.

Diamagnetic materials: They are repelled from areas of high magnetic field intensity. Their relative permeability is slightly smaller than one and it is a material constant that is independent of the field strength.

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Equipment

Position	Material	Item No.	Quantity
1	Tripod base PHYWE	02002-55	1
2	Support rod, stainless steel, 750 mm	02033-00	1
3	Right angle clamp expert	02054-00	1
4	Rod with hook	02051-00	1
5	U-magnet, large, U-shaped, limb length 130 mm, colored poles	06320-00	1
6	Pole pieces for iron core, U-shaped	06493-00	1
7	Sample set Ferro-Para-Diamagnetism, Ni, W, Bi	06340-00	1
8	Silk thread, l = 200 m	02412-00	1

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Setup and Procedure

Setup

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Fig. 1: Experimental setup

- Fasten the support rod in the tripod base. Attach the rod with the hook to the upper end by way of the right-angle clamp.
- Attach the middle of the three rods to a silk thread of approximately 1 m so that they are suspended horizontally from the thread.
- Attach the pole pieces to the permanent magnet.

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Procedure

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- Fasten the thread with the nickel rod to the support system so that it is suspended above the space between the pole pieces.
- Observe its behaviour.
- Fasten the thread with the tungsten rod to the support system so that it is suspended between the pole pieces. Ensure that it can perform rotary oscillations.
- Observe the tungsten rod until it steadies.
- Use the bismuth rod in the same manner as the tungsten rod.

Evaluation

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Evaluation

The nickel rod is immediately attracted very strongly by the magnetic poles. It aligns itself in parallel with regard to the connecting line between the pole pieces.

In the end, the tungsten rod aligns itself in the direction of the connecting line between the pole pieces.

After it has stopped moving, the bismuth rod aligns itself perpendicularly with regard to the connecting line between the pole pieces.

Ferromagnetic and paramagnetic materials are attracted into the area of high magnetic field intensity, whereas diamagnetic materials are repelled.

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