Elementary magnets (Item No.: P1432400)

Curricular Relevance

Area of Expertise: Physics | **Education Level:** Age 14-16 | **Topic:** Electricity | **Subtopic:** Magnetism | **Experiment:** Elementary magnets

Difficulty

Intermediate

Preparation Time

10 Minutes

Execution Time

20 Minutes

Recommended Group Size

2 Students

Additional Requirements:

Experiment Variations:

Keywords:

Task and equipment

Introduction

This experiment will demonstrate that magnetization occurs as a result of the orderly arrangement of existing elementary magnets. The magnetized wire is divided – magnetic monopoles cannot be found. The magnetic order can be destroyed again in different ways.

Task

Equipment

Position No.	Material	Order No.	Quantity
1	Butane burner, Labogaz 206 type	32178-00	1
2	Iron wire, notched, d = 1,2 mm, 2 kg	06343-03	1
3	Bar magnet, l = 72mm	07823-00	2
4	Universal pliers	01620-00	1
5	Needle base	06316-00	1
6	Sprinkler w. iron powder, 20 ml	06305-10	1
7	Magnetic needle, l 40mm	06315-01	1
8	Butane cartridge C206, without valve	47535-01	1
9	Matches		

Set-up and procedure

Experiment 1

- Divide the notched iron wire in half using the universal pliers.
- Magnetize the wire piece: Stroke the wire piece ten times in an even and smooth motion over the entire length in one direction with one end of the bar magnet. During this process hold the magnet perpendicular to the wire and bring it back away from the wire (Fig. 1).

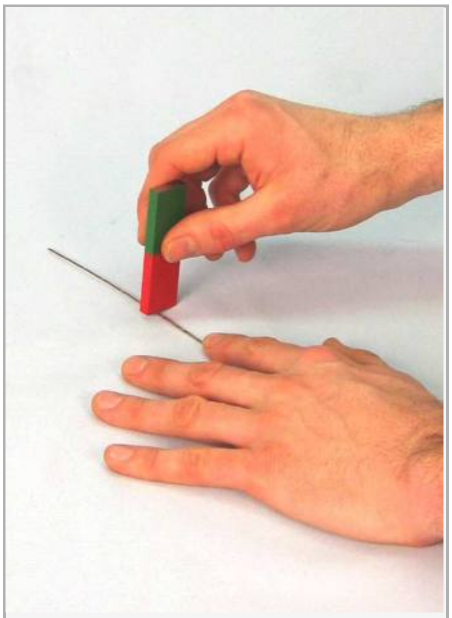

Fig.1

- Check the magnetization with the magnetic needle: at first approach one end of the wire piece and then the other (Fig. 2).

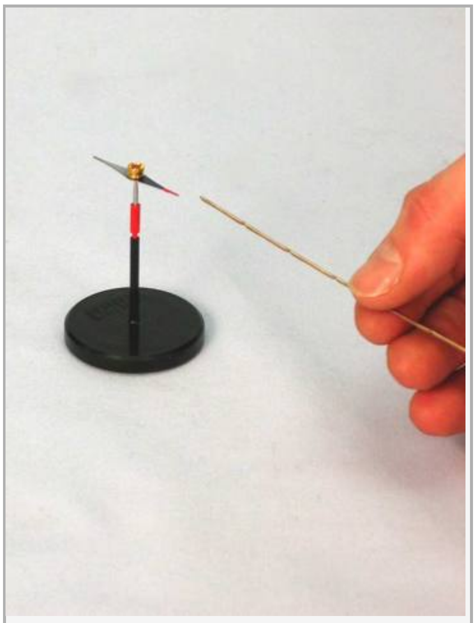

Fig.2

Experimental methods used to destroy the magnetization:

- Hit the wire piece flat on the table, at first one end and then the other end.
- Hold the wire piece with the pliers and heat up each spot over the burner until it begins to glow (Fig. 3).
- Cut the wire piece in half with the universal pliers

After each experiment check the magnetization with the magnetic needle and re-magnetize

Fig.3

Experiment 2

- Shake the sprinkler w. iron powder.
- Check up and down with the magnetic needle whether the powder is magnetized.
- Hold the magnet under the sprinkler, hold both upright, tap gently on the sprinkler and slowly remove the magnet in a downward movement.
- Check whether the iron powder is magnetic.
- Shake the sprinkler and check again.

Results and evaluation

Set-up

Experiment 1

The wire piece is magnetizable and can behave like a permanent magnet. It looses its magnetic properties if hit on a table or heated up until it glows. If the wire is divided, then a north pole and a south pole can be found on both wire pieces.

Experiment 2

After becoming magnetized the iron powder at the top in the glass attracts one end of the magnetic needle and below in the glass the other end of the magnetic needle. After shaking the magnetic effect can no longer be observed.

Procedure

The experiment results can be interpreted as follows: Magnetic materials contain small “elementary magnets”. These have the properties of permanent magnetization, which includes a magnetic field around the elementary magnets. During magnetization the elementary magnets are all turned in one direction so that their magnetic fields add up. If they are mixed up again, then their fields cancel each other. Heating up or hitting the notched wire is enough to destroy the alignment.
The elementary magnets of a magnetizable material are aligned to the field of a magnet. This then also becomes a magnet and is attracted by the other magnet. Most elementary magnets lose their orientation again if the magnet is removed. Whether a magnetizable material can become a permanent magnet depends on whether its elementary magnets are easily mixed up or even become unorganized again after they were once aligned. Non-magnetizable materials contain no such elementary magnets as contained in iron.

Remarks on the physical background:
Elementary magnets are also known as Weiss domains or magnetic domains. They each have a fixed magnetization direction. The domains are randomly dispersed in metal. On the whole the fields of the domains cancel each other out in the middle. During magnetization the domains grow in the field direction at the expense of others, which results in a total magnetization in the middle. Without a field the domain borders return to a random state for the most part. The remaining magnetization is called remanence.

Additional remarks:
A Weiss domain is an area of joint alignment of certain unpaired electrons in the individual atoms: The spins of these electrons couple to neighboring atoms over the exchange interaction of the conduction electrons and therefore form areas of the same alignment. Each of these spins has a magnetic moment. The aligned moments point together in the direction of a crystal axis. For each crystal axis there are two directions possible and with higher symmetry of the crystal several axes have the same value so that a number of orientations occur under the domains. Since metals are usually polycrystalline, there is a crystal axis in every direction.

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