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Magnetic Fields

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We live in a world of different electric appliances. Have you ever tried checking what electricity is made of? First of all, you have to understand the field that can produce an electrical one. There you go, magnetism.

We know that magnets attract paper clips, iron nails, and many other metal objects. But how do magnets affect each other? Suppose you had two magnets close to each other, what would you see? Look at Figure 1 and you can observe that there might be a simple situation of two interactions between magnetic forces: attraction or repulsion.

All magnets have two ends, or poles. The first one is called north (N), the other one is south (S). Figure 1 illustrates two important rules of magnets. Like poles repel. Opposite poles attract. A similar set of rules holds for charged objects.

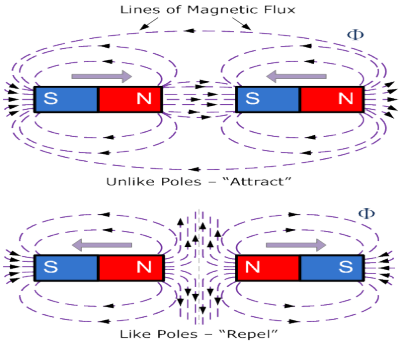
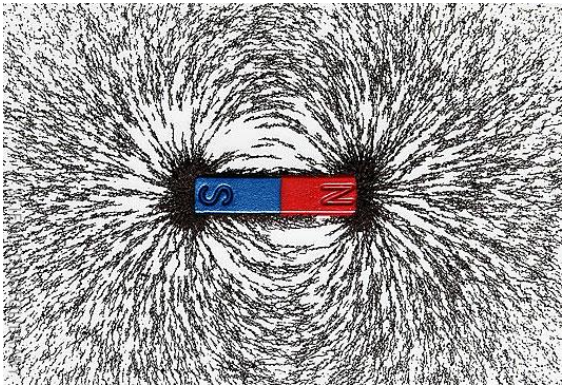


Figure 1: Interaction of Magnetic Force. Repulsion and Attraction

The closer you bring two magnets together, the stronger the force between them becomes. Move them apart and the force gets weaker. If you move them apart still farther, you will eventually feel no force. The force changes strength as you move within each magnet's magnetic field. The latter is the space around a magnet in which its force affects objects. A good picture of magnetic field can be made by sprinkling small iron filings around a magnet.



Attraction of Iron Filings

Notice that near a magnet's poles iron filings are crowded close together, as it could be at an enormous distance. Also pay attention to the pattern made of these filings in a form of curved lines that are called magnetic lines of force. They define the magnetic field [1].

There are some bigger things behind small magnets. The earth exerts magnetic forces on magnets and compasses. Our planet acts as if it has a giant magnet buried deep within it.

The earth's magnetic field exerts forces on charged particles from outer space called cosmic rays. When these particles reach the earth, they are trapped in zones called the van Allen belts.

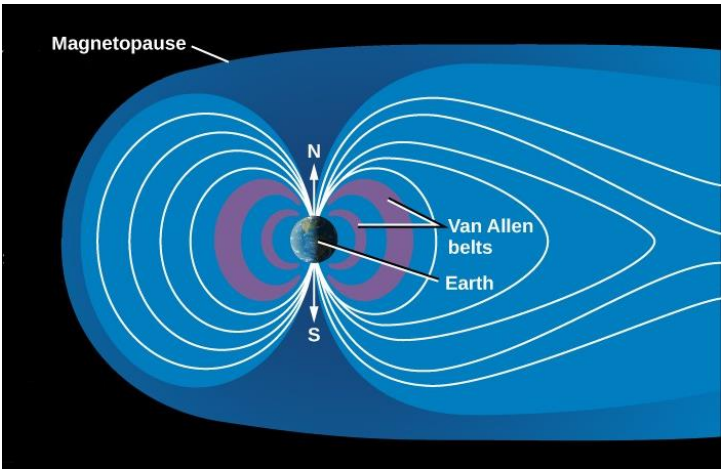


Figure 2: Model Earth's Magnetic Field

You thought magnets are made of special materials, didn't you? But that is not completely true. You can make a magnet out of iron, cobalt, nickel, and some other materials that are said to be magnetic.

Furthermore, what makes materials magnetic? Some scientists have proposed a model to explain magnetism [2]. According to their suggestion, magnetism is a property of electrons in motion. The most important motion is the spinning of the electrons. The spinning of an electron can set up a magnetic field around the electron. Most electrons spin in pairs in opposite directions; such spinning cancels out the field.

Atoms of magnetic iron, as any iron atoms, have four unpaired electrons. That's why it makes exerting forces on each other easier. Exerted forces set up small regions in a piece of iron called magnetic domains – a region where atomic magnetic fields line up in the same direction [3]. On Figure 3 you can see magnetic domains that are indicated by the arrows in the metal material.

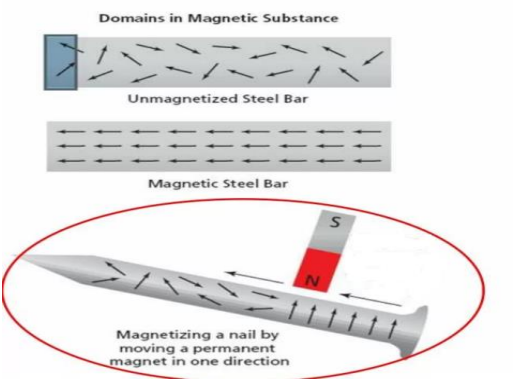


Figure 3: Magnetic Domains

If a strong magnet is near iron, poles of atomic magnets line up. So the piece of iron has become a magnet. These domains are normally invisible. However, scientists sprinkle a single crystal of iron with particles of iron oxide and it becomes lighter.

References:

1. National Geographic Electronic Database [Electronic resource]. – Mode of access: https://www.nationalgeographic.org. – Date of access: 13.03.2020.
2. Popular Mechanics: Scientific Popular Website. [Electronic resource]. – Mode of access: https://www.popularmechanics.com. – Date of access: 20.02.2020.
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