

Magnetic Fields: How they are affected by types of magnetic materials

M7-2 physical science

Testable Question

& Purpose

Question: How do different types of magnetic materials (diamagnetic, paramagnetic, and ferromagnetic) affect an iron magnet's magnetic field?

Purpose: To inform others about the science behind magnets and to figure out why a system with magnets may not be working.

Abstract

In my experiment, I tested how different types of magnetic materials (diamagnetic, paramagnetic, and ferromagnetic) affect an iron magnet's magnetic field. The purpose of this experiment was to inform individuals on the science behind magnets, and to help one figure out why a system with magnets may not be working. My hypothesis is that the ferromagnetic material would have the most influence on the magnet's field, followed by the paramagnetic and diamagnetic material, respectively. I tested this by sprinkling iron filings onto a plate, and under that plate, would be the materials that I am testing. The filings represent the magnetic field that exists. I took a picture of each test, and using these pictures, I wrote the dimensions of the magnetic field that was represented by the filings. The average area of the control (the iron magnet) was 45.4 cm², the average area of the diamagnetic material was 38.75 cm², the average area of the paramagnetic material was 43.85 cm², and the average area of the ferromagnetic material was 44.15 cm². I found out that my hypothesis was not supported, and that none of the materials affected the iron magnet's magnetic field. This is because there was not a significant enough change in the field represented by the iron filings.

Hypothesis

If I test the effects of different magnetic materials on an iron magnet's magnetic field, then the ferromagnetic material being tested would affect the magnet's region of influence the most. This would be followed by the paramagnetic material, and diamagnetic material, respectively. I believe this because ferromagnetic materials are stronger than those that are paramagnetic, and diamagnetic. Also, paramagnetic, and diamagnetic materials are both weak, however, diamagnetic materials are even weaker.

Materials

The materials for this project include:

- 12-ounce (21262.1 grams) Jar Iron Filings from <https://www.amazon.com/>
- A (1) diamagnetic material- a bronze screw
- A (1) paramagnetic material- an aluminum bar
- Four (4) ferromagnetic material- One rectangular prism shaped magnet (iron) and three cylindrical magnet (neodymium). When you test the neodymium magnets, you will connect all three together.
- Two (2) paper plates
- A device that can take pictures
- A computer

Procedures

1. On one plate, make two perpendicular lines, and make marks on these lines that represent one (1) cm intervals. Use the other plate to hold the iron filings that you have already used.
2. Situate the rectangular prism shaped magnet under the marked plate. Sprinkle iron filings onto the plate, around the magnet. Make sure not to sprinkle the filings directly above the magnet. Continue to sprinkle these filings until they start to pile up or until the field doesn't seem to be affecting the new filings. Also, make sure to orient the magnet so that it is at its least possible height. It is recommended that you do not put the magnet directly over the lines you created, so that you can take your measurements easier. Take a picture of each test. After each test, dump the iron filings into the second plate.
3. Repeat this 19 additional times. These tests represent the control.
4. Repeat steps 2 and 3 for the other ferromagnetic material, the paramagnetic material, and the diamagnetic material. Note that you will test these materials with the original magnet that was tested above. You may need to move the original magnet up higher. You can do this by using coins. Also, note that after you have used all the filings in the jar, you should use a funnel (whether an actual funnel or a piece of paper put into the form of a funnel) to put them back into this jar. Another thing to note is that when you are testing these materials, make sure that you sprinkle the iron filings around both materials. Also, make sure that the materials are about 2 cm away from each other. If you are testing the ferromagnetic material and you cannot position the materials 2 cm away from each other, then put them as close as possible to each other, without letting them attract, and come together.
5. Look at all the pictures you have taken. Analyze the size of the original magnet's magnetic field by measuring the length and width of the field (the portion displayed by the iron filings), based off the centimeter intervals you had previously made on the plate. Make sure to only measure the areas with large amounts of filings (not the areas with only thin strands of filings). Put this information into an excel spread sheet (or another similar program), and format it so that one column includes the dimensions of the longer side, one of the shorter side, and one of their product (the area of the field). Include the average for each set of tests (for each type of material) in another column.
6. Put this information into a bar graph, with each set of tests represented by one bar on the graph. This bar should represent the average of the 20 tests. Create four more graphs that represent every individual test. Each set of tests is represented by one of these four graphs.

Variables

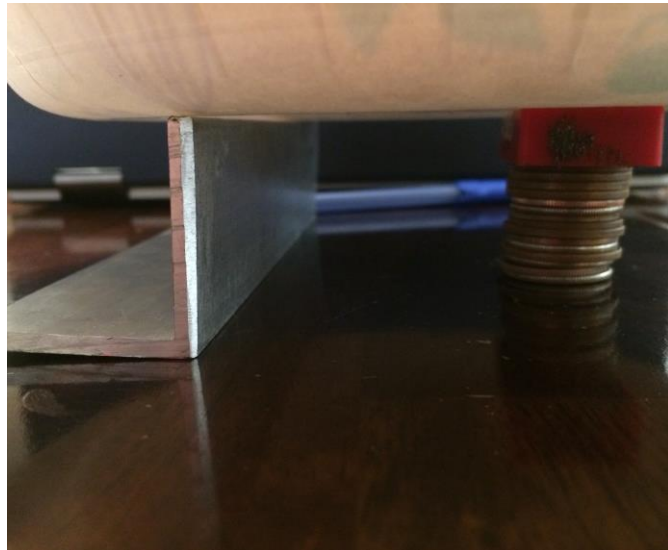
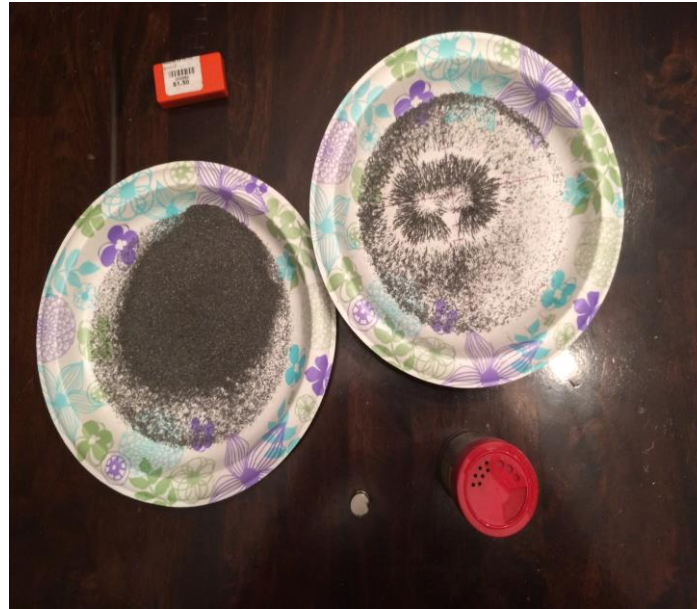
Independent Variable: The magnet affecting another's field.

Dependent Variable: How iron filings reacts to the changed magnetic field.

Constant Variables:

- The iron filings (I will use the same jar of iron filings)
- The distance between materials

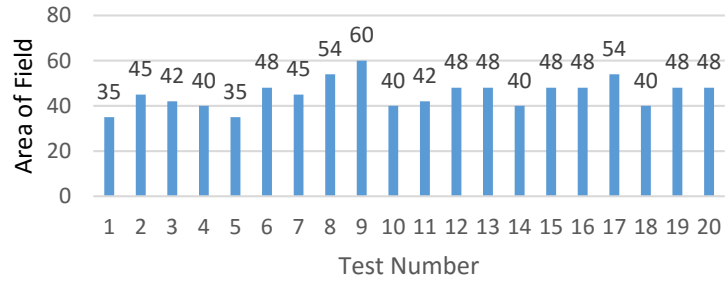
Pictures



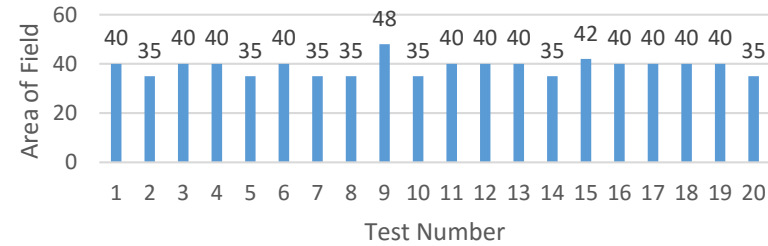
Results (Graph)

All measurements are in centimeters.

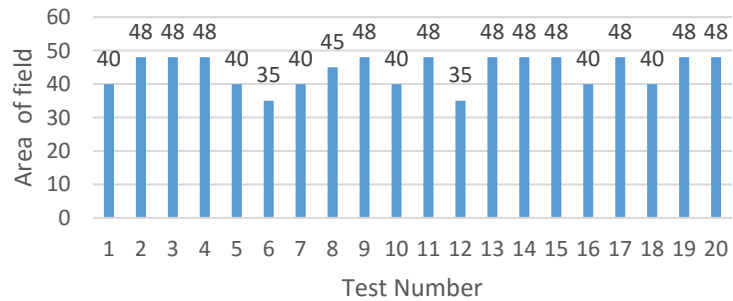
Control Tests 1-20



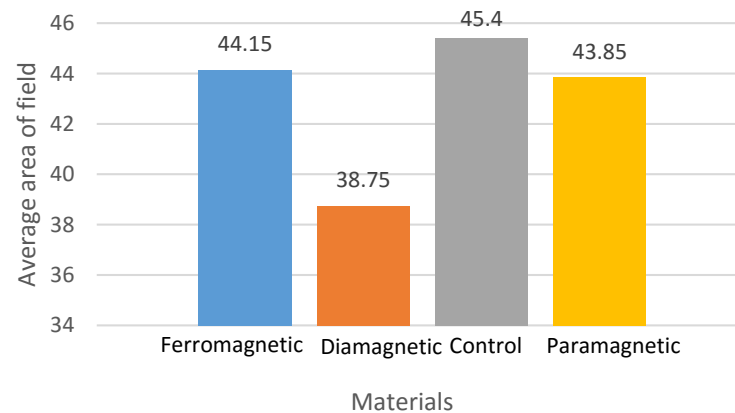
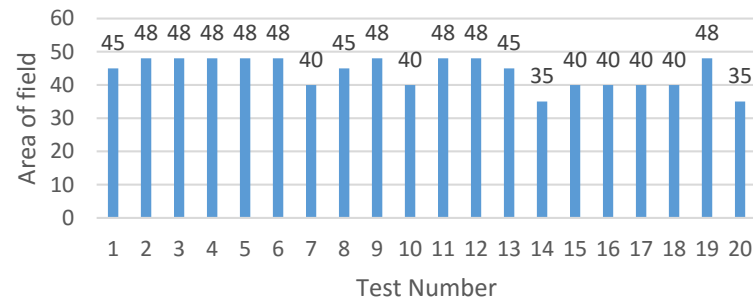
Diamagnetic Tests 1-20



Ferromagnetic Tests 1-20



Paramagnetic Tests 1-20



Results

The average of each set of tests are:

- Control: 45.4 cm²
- Diamagnetic: 38.75 cm²
- Paramagnetic: 43.85 cm²
- Ferromagnetic: 45.4 cm²

Conclusion

Based off my results, I can conclude that my hypothesis was not supported. I originally stated that the ferromagnetic material would have the greatest impact, followed by the paramagnetic and diamagnetic materials, respectively. However, it seemed that these materials had no impact on the field of the iron magnet. While the size of the field demonstrated by the iron filings changed, this change was too insignificant to say that the field changed. Also, while I was conducting my experiment, I was not able to notice any difference between the size of the fields. The variation displayed in my data is simply due to the way I designed my experiment. In addition, it seemed that when I tested the ferromagnetic material, the ferromagnetic material and the original magnet seemed to co-exist, since there were no differences in the iron filing's placement from the control tests.

Sources Used

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