FORCE LAB DUE TO A PERMANENT MAGNET

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OBJECTIVE: To Create an experiment to determine the magnetic force between multiple magnets.

MATERIALS: three Donut-shaped magnets. A Diamagnetic Bar to hold the three magnets in place. A table clamp and stand to hold the experiment, and a length of string, a set of masses: 10 g, 20 g, 30 g, 40g.

PROCEDURE:The length of thread was tied to two sides of one of the magnets and made long enough to dangle beneath the suspended magnets. In the first part of the experiment, only two of the magnets were used. In the second and third parts of the experiment all three magnets were suspended on the bar. (Magnet 1 is on the bottom, Magnet two is in the middle, and Magnet 3 is on top.)

**Two Magnets**

1. Set two donut-shaped magnets in such repulsive orientation, and through its hole in the bar.
2. Measure the distance between 1st and 2nd magnets.
3. Add ***10g*** weight to the **second** magnet and measure the distance between 1st and 2nd magnets.
4. Repeat step 3 for the different weight ***20g***, ***30 g*** and ***40g***.

**Three Magnets**

1. Add 3rd magnet in such repulsive orientation and measure the distance between 1st and 2nd, and 2nd and 3rd.
2. Add ***10g*** weight to the **second** magnet and measure the distance between 1st and 2nd magnets.
3. Repeat step 6 for the different weight ***20g***, ***30 g*** and ***40g***.
4. Add ***10g*** weight to the **third** magnet and measure the distance between 1st and 2nd, 1st and 3rd, and 2nd and 3rd magnets.
5. Repeat step 8 for the different weight ***20g***, ***30 g*** and ***40g***.

The Data gathered was graphed (Force vs Change in length) using Microsoft Excel and a trend line was created and the equation for the line was observed.

DATA: Two Magnets: Magnet 2 has variable hanging mass, magnet 1 is on the bottom.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass | | length Right | | length Left | | Average | *Length change* | Force |
| grams | kg | cm | meters | cm | meters | meters | meters | N |
| 0 | 0 | 1.5 | 0.015 | 1.3 | 0.013 | 0.014 | 0 | 0 |
| 10 | 0.01 | 1.3 | 0.013 | 1.1 | 0.011 | 0.012 | 0.002 | 0.098 |
| 20 | 0.02 | 1.1 | 0.011 | 0.8 | 0.008 | 0.0095 | 0.0045 | 0.196 |
| 30 | 0.03 | 0.8 | 0.008 | 0.7 | 0.007 | 0.0075 | 0.0065 | 0.294 |
| 40 | 0.04 | 0.7 | 0.007 | 0.5 | 0.005 | 0.006 | 0.008 | 0.392 |

Part 2: 3 magnets, mass attached to magnet 2 length measured between 1 and 2

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass | | length Right | | length Left | | Average | *Length change* | Force |
| grams | kg | cm | meters | cm | meters | meters | meters | N |
| 0 | 0 | 0.9 | 0.009 | 0.8 | 0.008 | 0.0085 | 0 | 0 |
| 10 | 0.01 | 0.7 | 0.007 | 0.7 | 0.007 | 0.007 | 0.0015 | 0.098 |
| 20 | 0.02 | 0.5 | 0.005 | 0.5 | 0.005 | 0.005 | 0.0035 | 0.196 |
| 30 | 0.03 | 0.5 | 0.005 | 0.4 | 0.004 | 0.0045 | 0.004 | 0.294 |
| 40 | 0.04 | 0.5 | 0.005 | 0.3 | 0.003 | 0.004 | 0.0045 | 0.392 |

Part 3: Three magnets with the string tied to Magnet 3 and so when mass was added measurements were made between Magnets 1 and 2, 3 and 2 and 1 and 3.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Magnet 1 - Magnet 2 | | | | Magnet 2 - Magnet 3 | | | | Magnet 1 - Magnet 3 | | | |
| Mass | | length Right | | length Left | | length Right | | length Left | | length Right | | length Left | |
| grams | kg | cm | meters | cm | meters | cm | meters | cm | meters | cm | meters | cm | meters |
| 0 | 0 | 1.1 | 0.011 | 0.7 | 0.007 | 1.3 | 0.013 | 1.2 | 0.012 | 2.9 | 0.029 | 2.5 | 0.025 |
| 10 | 0.01 | 0.9 | 0.009 | 0.6 | 0.006 | 1 | 0.01 | 0.8 | 0.008 | 2.5 | 0.025 | 2 | 0.02 |
| 20 | 0.02 | 0.7 | 0.007 | 0.4 | 0.004 | 0.8 | 0.008 | 0.7 | 0.007 | 2.1 | 0.021 | 1.6 | 0.016 |
| 30 | 0.03 | 0.6 | 0.006 | 0.3 | 0.003 | 0.6 | 0.006 | 0.5 | 0.005 | 1.8 | 0.018 | 1.4 | 0.014 |
| 40 | 0.04 | 0.4 | 0.004 | 0.4 | 0.004 | 0.4 | 0.004 | 0.4 | 0.004 | 1.5 | 0.015 | 1.4 | 0.014 |

Averages and Calculated change in length due to each mass hung on the string.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (1-2) | (2-3) | (1-3) | (1-2) | | (2-3) | | (1-3) | |
| **Average** | **Average** | **Average** | *Length change* | Force | *Length change* | Force | *Length change* | Force |
| meters | meters | meters | meters | N | meters | N | meters | N |
| 0.009 | 0.0125 | 0.027 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0075 | 0.009 | 0.0225 | 0.0015 | 0.098 | 0.0035 | 0.098 | 0.0045 | 0.098 |
| 0.0055 | 0.0075 | 0.0185 | 0.0035 | 0.196 | 0.005 | 0.196 | 0.0085 | 0.196 |
| 0.0045 | 0.0055 | 0.016 | 0.0045 | 0.294 | 0.007 | 0.294 | 0.011 | 0.294 |
| 0.004 | 0.004 | 0.0145 | 0.005 | 0.392 | 0.0085 | 0.392 | 0.0125 | 0.392 |

OBSERVATIONS: As more magnets were added the distance between magnet 1 and 2 seemed to half. The amount of external force experienced by the magnetic system was constant throughout each step of the experiment because the same hanging masses were used.

RESULTS:

Part 1 Slope equation: y = 47.494x - 0.0035

Part 2 Slope equation: y = 78.811x - 0.0168

Part 3 Slope equations:

1-2: y = 71.977x - 0.0127

2-3: y = 46.397x - 0.0267

3-1: y = 29.884x - 0.0222

CONCLUSION: In the Experiment it would be possible to determine the magnitude of the net magnetic force by calculating the total force in the experiment and subtracting the force due to the variable hanging mass.