

Gauging the Gauss Gun

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Acknowledgments

My Father: for helping me acquire materials, build the project and measure trajectory distances.

My Mother: For Encouraging me and helping with the readings.

Feild, Quellen “Gauss Rifle: A magnetic linear accelerator” <http://www.scitoys.com/>:

Doug Miller <http://www.deosil.com/doug/gauss>

Coil Gun <http://www.wikipedia.com/coilgun>

Abstract

For my 2006 Science Fair project I decided to build and test a Gauss rifle. I wanted to do this project because I was interested in weapons involving magnets. I had read about rail guns and wanted to build something similar to one.

The purpose of this project was to test the effect of adding magnets to my gauss rifle. My hypothesis was that each time I added a magnet I would observe the same increase in distance. If my hypothesis was correct, I could predict how many magnets I would need to achieve a set distance.

To build my rifle, I used six magnets and a several steel balls. The magnets were taped at a set distance apart on two rulers. The steel balls were arranged with two after each magnet and one left over to start the reaction. The leftover steel ball was released into the first magnet which started a chain reaction between the magnets and the balls. The result was similar to pool balls colliding on a pool table. I ran five trials for each magnet, and I had six magnets. I made a chart to record my results. Chalk marked the point at which the ball made contact. I used a tape measure to determine distance. After each round was done, I circled the marks for the balls.

I put my results in Excel and turned them into a graph. The results did not support my hypothesis. In fact, they showed a steady incremental decrease in the amount added for each magnet. I theorized that there were factors in the experiment, unaccounted for, that effected to the results. I formed two new hypotheses: 1) That the magnets were of different strength resulting in different increases in distance 2) That the distance the steel ball traveled along the ruler impacted the results (because of a flaw in my original experiment design when more magnets were added, the distance the steel ball traveled down the ruler was reduced).

To test the first new hypothesis, I repeated the same experiment three times using different magnets. The results for all three were similar so the difference in magnets did not explain my original results. To test the second hypothesis, I changed the way the magnets were added to the ruler which eliminated the difference in the launch point on the ruler. But the incremental decrease in distances still existed. By disproving my new hypotheses, I concluded that there was a decrease in the effectiveness of additional magnets. The reason for the decrease is unknown, but its existence has been proven. This means I can not easily predict the length the steel ball will travel depending on the number of magnets. It also shows that at some point I will not benefit from adding additional magnets.

Experiment

Problem: Each Time I add a magnet, will the ball travel the same incremental distance farther?

Materials/Equipment: Thirteen steel balls, six iron neodymium magnets, two vices, one cutting board, two rulers, one wooden board, chalk, and tape measurer

Procedure: Glue two rulers onto a long wood rod and glue and tape until dry. When dry, tape six Iron Neodymium magnets to two rulers with the magnets three inches apart. Then place two balls in front of each magnet. Finally, I attach the contraption to a saw horse and drop an extra ball one inch behind the first magnet. The gauss rifle should fire with a one ball on each side of each magnet. Carefully roll each ball to the nearest corner before removing to prevent the tape from tearing. Mark the landing location of the ball and mark with chalk then use measuring tape to record the distance. Then remove one magnet from the equation and fire another five times. Repeat until done with all magnets.

The other experiment testing the strength of individual magnets is conducted as follows. Same set up as before. Two magnets are lined up on the rulers. Add a third magnet. Record results, Switch out magnets, then repeat until all results recorded. Look for significant differences in the distances achieved by different magnets.

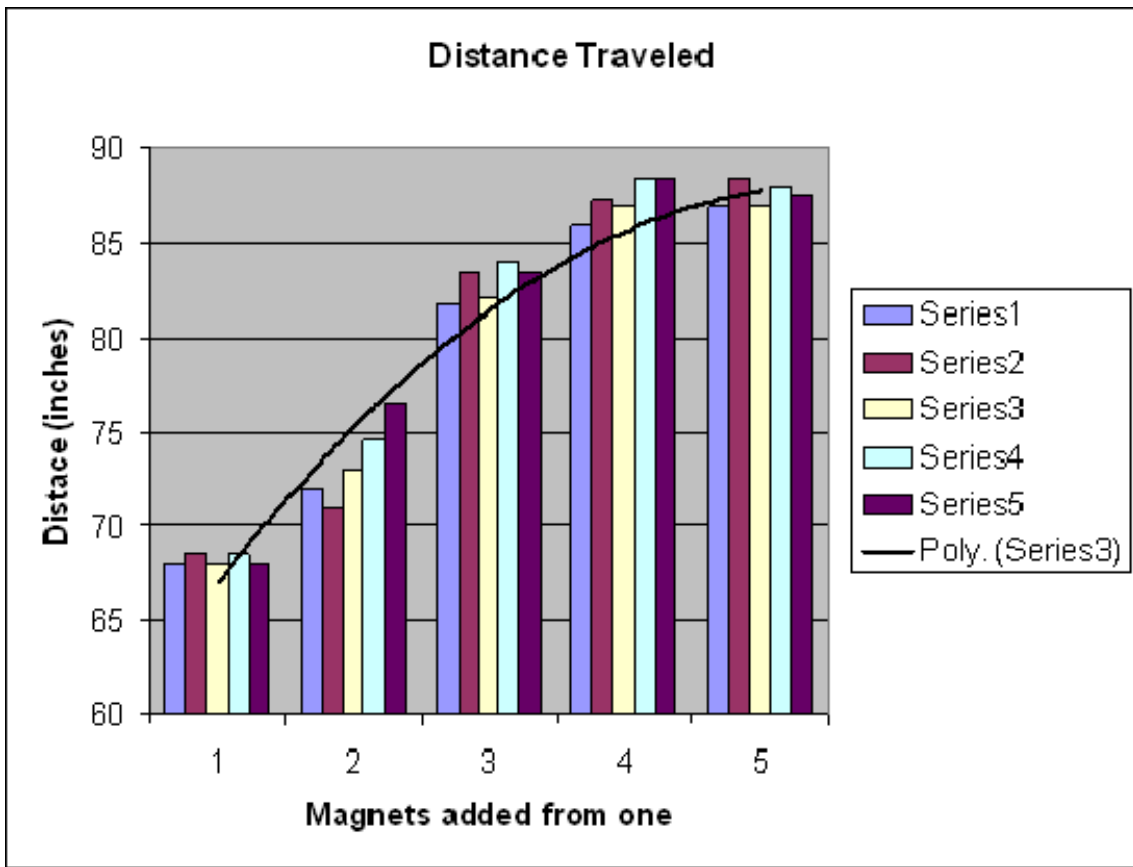
The two most significant variables in my experiment were: (1) the independent variable of the number of magnets and (2) the dependant variable of the distance traveled by the steel ball. Also, other variables include: the distance the first ball travels when it is let go of, the speed of which it is let go of (yes, it is important). These variables were all independent, affecting the speed at which the steel ball traveled. Also, the magnets had to be taped down correctly and they had do be constantly straight. The independent variables were controlled and their influence eliminated to the point where they had no effect. Also, the experiments conducted after the original were done to make sure three unaccounted for variables had no effect on the experiment.

Data

I recorded the information by marking the area the ball landed in with chalk and used a tape measurer to measure the distance. As I explained before, there is a decrease in the distance added after each new magnet.

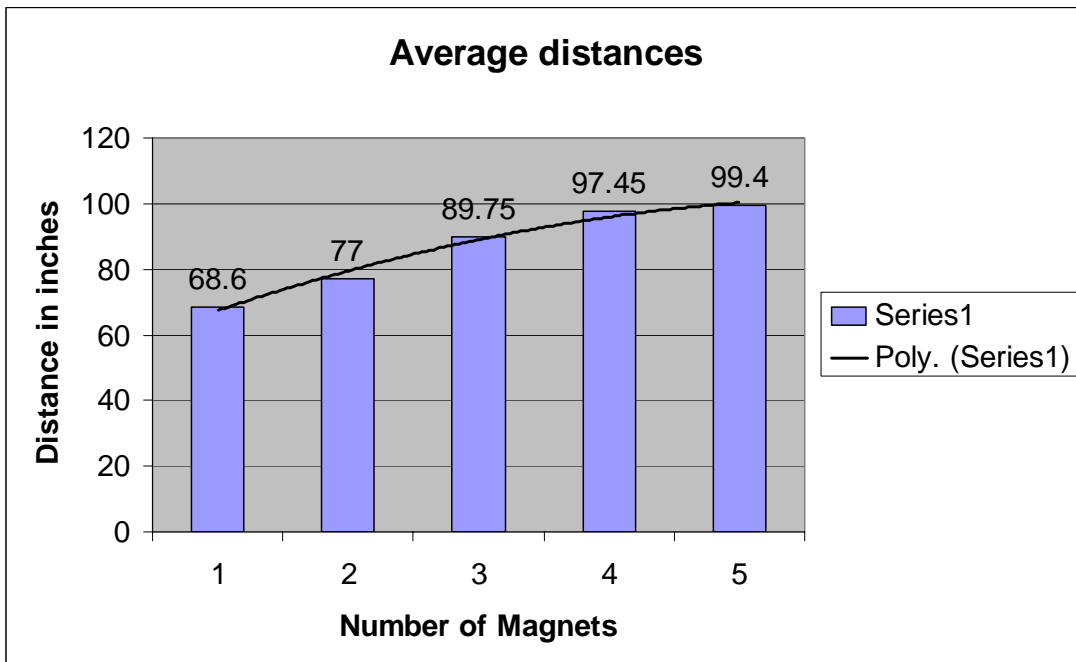
These are the graphs for Experiment 1.

# of magnets	2	3	4	5	6
Trial 1	68	75	87.75	95	99
Trial 2	68.5	74	89.5	96.25	93.5
Trial 3	68	76	88	96	99
Trial 4	68.5	77.5	90	97.5	100
Trial 5	68	79.5	89.5	97.5	99.5

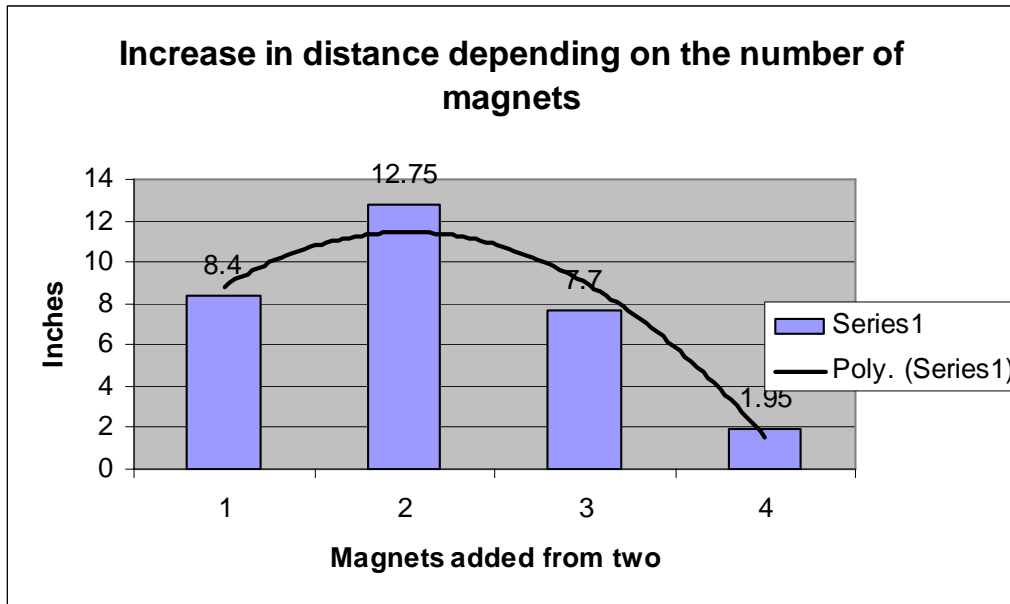


This graph is a chart of all of the trials from the first experiment.

	4				
	2	3	4	5	6
	68.6	77	89.75	97.45	99.4



These are my averages from my first experiment.

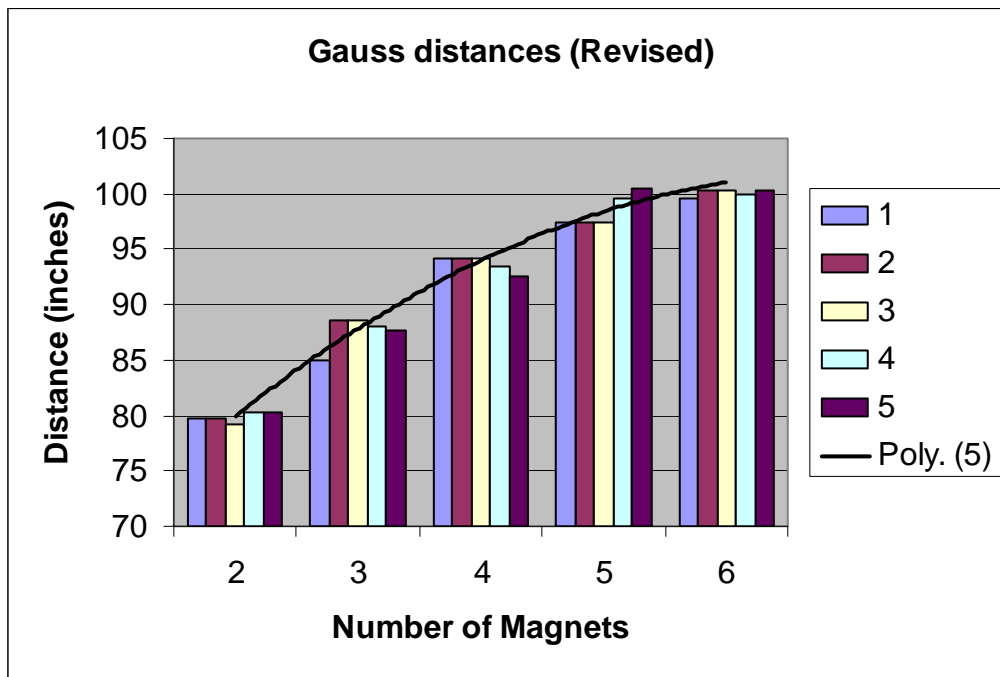


This is the Increase in distance depending on the number of magnets.

5

These are the results from my second experiment.

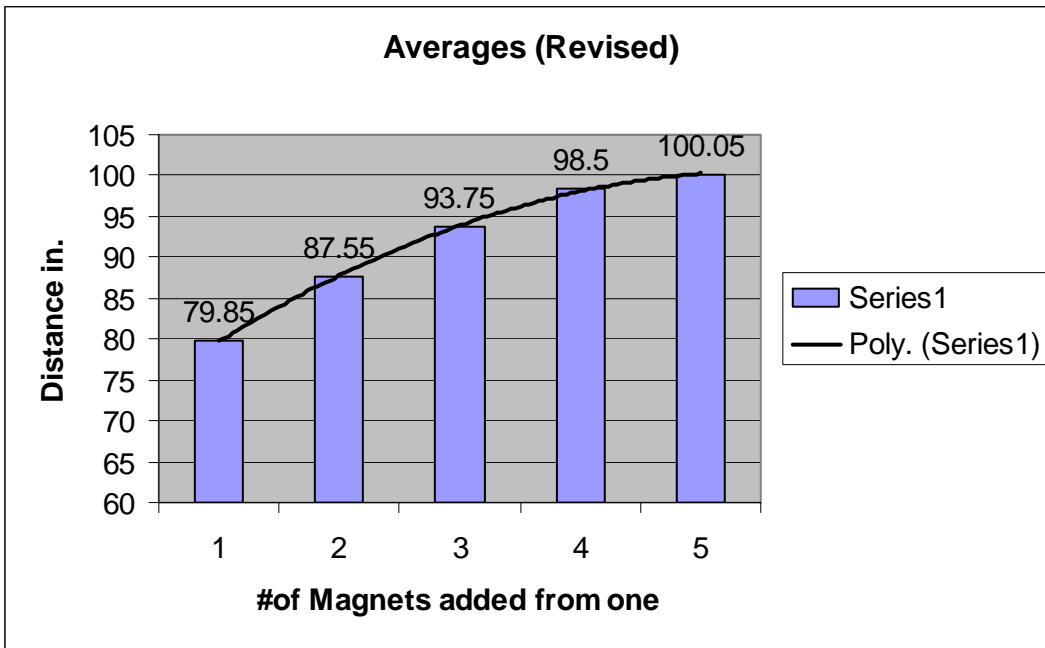
All Trails					
	2	3	4	5	6
1	79.75	85	94.25	97.5	99.5
2	79.75	88.5	94.25	97.5	100.25
3	79.25	88.5	94.25	97.5	100.25
4	80.25	88	93.5	99.5	100
5	80.25	87.75	92.5	100.5	100.25



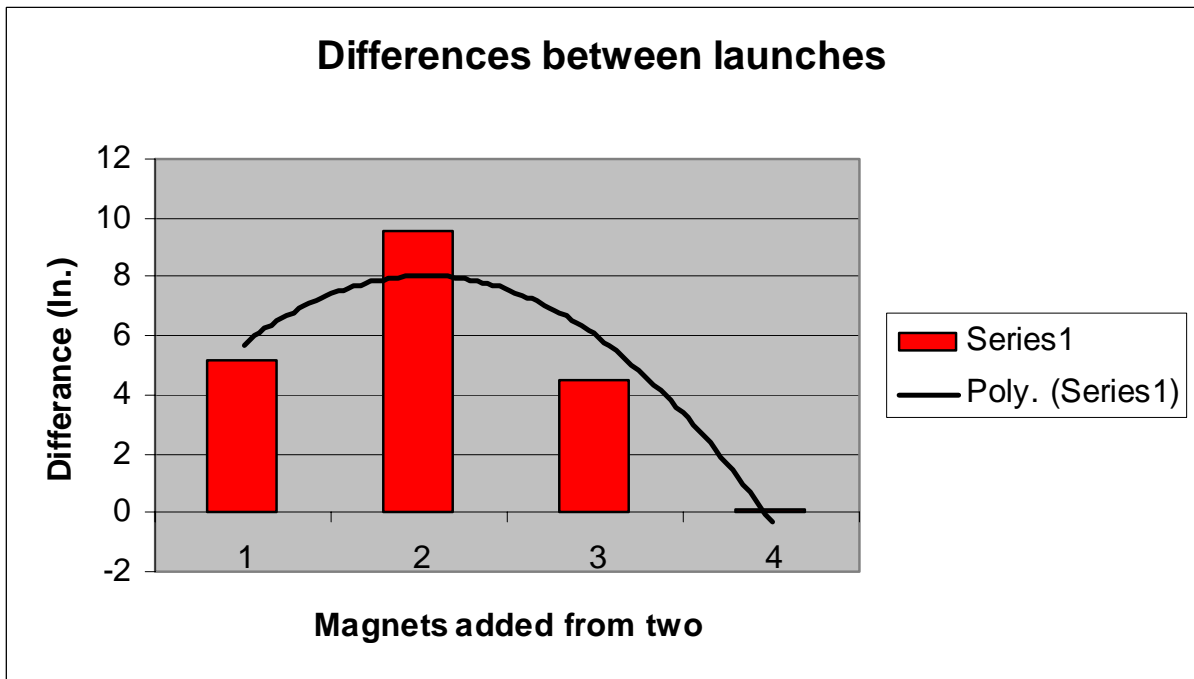
These are the averages for Experiment 2.

Magnets

2	3	4	5	6
80	88	94	99	100

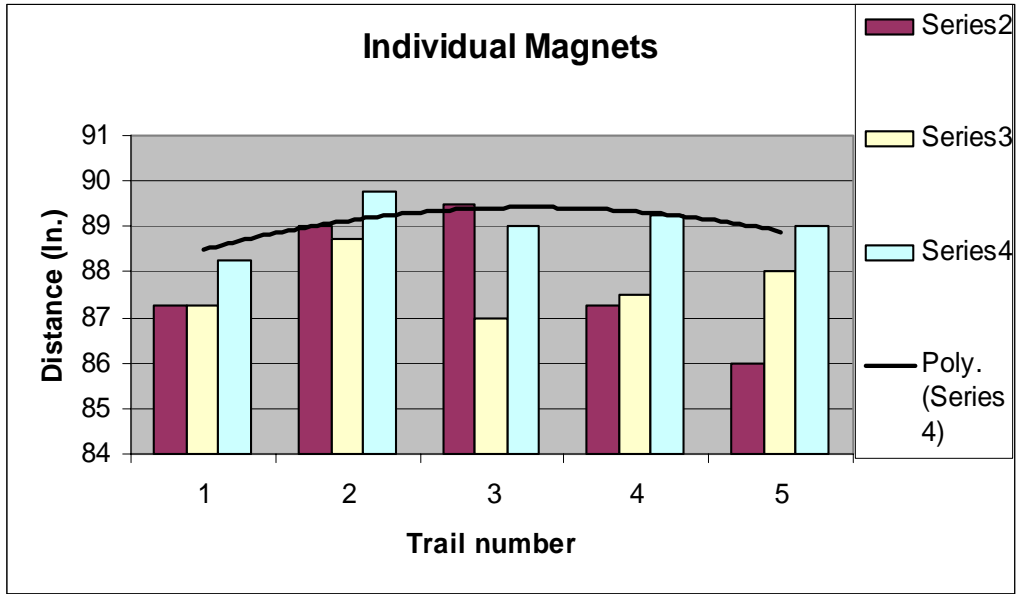


These are the differences for experiment 2.

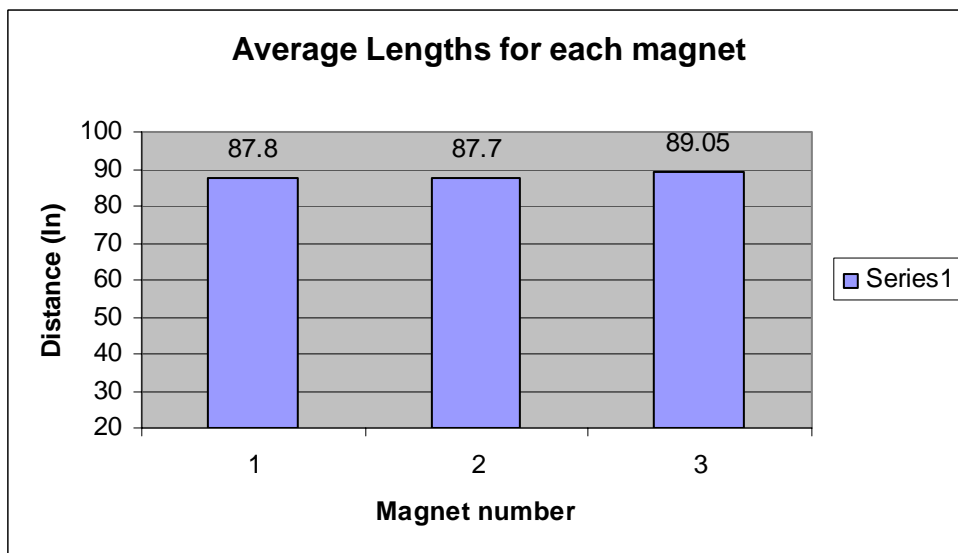


This is the information from Experiment 3.

Magnet#				
Trai	3	4	5	
1	87	87	88	
2	89	89	90	
3	90	87	89	
4	87	88	89	
5	86	88	89	



These are the average differences between magnets.



Conclusion

From the results of my experiment I conclude that my original hypothesis was incorrect, and that the distance the gauss device fires does not increase in the same increment each time a magnet is added. Even after a second round of experiments I also discovered that the Gauss device loses incremental distance after each magnet is added. My second hypothesis, that the way magnets were added affected the experiment, improved the experiment design and there was a slight difference in the results, but it still did not support my original hypothesis. My hypothesis regarding magnet to magnet variation also showed some differences between magnet strength, but again not enough to support my original hypothesis. Eventually, the benefit of adding magnets to the “Magnetic Linear Accelerator” will decrease until there is little to no effect on the distance the steel ball travels.

