

## Physics coursework

### Aim

*The aim of this investigation to see the strength of an electromagnetic by varying many variable, and seeing how this affects the performance of the electromagnet.*

### Variables

*there are many variables which can increase or decrease the magnetism of the electromagnet. these are the following variables:-*

*Number of coils:- the more the number of coils the more the electromagnetism because, each coil creates a magnetic field. So the more coils the more magnetic fields thus the magnetism increases.*

*Current:- this will increase the number of electrons going around the electromagnet therefore increasing the amount of magnetism.*

*Distance:- the distance the electromagnetic is away from the target object will also decrease the magnetism.*

*Type of iron core:- the material of the iron core could dramatically change the amount of magnetism.*

*Length of nail:- The length of the nail will be a controlling factor, because the longer the nail is the more coils can be fitted around the nail, thus making more magnetic fields, and increasing magnetism.*

*Length of wire:- The longer the wire is, the more opportunity for making more coils and increasing magnetism. Also the longer the wire is, and the number of coils increase, also there will be more electrons available to travel around the iron nail, therefore increasing magnetism.*

*Thickness of wire:- The thicker the wire is, the more electrons can travel through the wire simultaneously, and this will create more magnetic fields, therefore increasing magnetism.*

*Voltage:- As potential difference increases in the formula  $V=I \times R$ , this means as voltage increases so will current and resistance, if current is increased this will allow more electrons to flow, causing the magnetism to increase.*

*Resistance:- If the resistance of the variable resistor is increased, the voltage and current will drop as a result, therefore decreasing the amount of electrons passing through the wire, and also decreasing the magnetism.*

### Theory

*When insulated wire is wrapped round an iron nail and the ends of the wire are connected to a battery the nail becomes capable of picking up iron filings and paper clips. This is called an electromagnet. The nail is magnetised by the current in the wire. If the battery is disconnected then the iron clips will fall off. This is because most of the magnetism has been lost.*

*The passage of an electric current along a wire creates a magnetic field around the wire. The fields are in the shape of a series of concentric rings. The more coils used in the electromagnet, the stronger the magnet is. If there is one coil, and another is added, then the two coils have twice the strength of one. This is because the current going through the wire makes the soft-iron core is the factor that induces electromagnetism, as so when there is more current, there will be more wire or or a more magnetised core. Magnets were formed when certain molten metals, (iron, nickel and cobalt,) cool . Normally when the atoms in a non magnetic crystallise, the atoms point in random directions. But because of the properties of the metals mentioned, these atoms line up into parts of the magnetic with similar directions called domains. This is because the earth has a magnetic field, and the atoms in the metal all follow the these magnetic lines and form these domains. This is similar to what happens when an electromagnet is formed.*

*Magnetic fields are historically described in terms of their effect on electric charges. A moving electric charge, such as an electron, will accelerate in the presence of a magnetic field, causing it to change velocity and its direction of travel.*

*In unmagnified iron, the domains are all facing in different directions, so end up cancelling each other out.*

*If they all end up facing in the same direction they become magnetised.*

*The magnetic effect of current is very interesting; a wire carrying electrons has a magnetic field around it.*

*Method*

*To investigate how the strength of an electromagnet increases by changing various variables. The variable I will be using is increasing the number of coils. As the number*

*of coils increase so should the magnetism in direct proportion. For example as the number of coils doubles so should the magnetism double. To test this I will wrap a wire around a iron nail for the right amount of coils, and touch the hook of the Newton meter and see how much it can pull the Newton meter down, and record that reading. The circuit was set out like as shown in the diagram below:-*

*As you can see in the diagram the variable resistor is set in series, and the voltmeter in parallel and ammeter in series. The ammeter is used to check the current is kept consistent. The apparatus we used are listed below:-*

- 1.variable resistor*
- 2.ammeter*
- 3.voltmeter*
- 4.wire*
- 5.iron nail*
- 6.newton meter*
- 7.power pack*

*To start of with I connected everything up using crocodile clips, and also did the experiment standing up for safety reasons. Then i put the power pack up to 4v, so that it would work efficiently and things wouldn't get too hot to handle.*

*Safety*

*For safety i will ensure im always standing up, to avoid any awkward situations which could arise. Standing up is much more easier to get out of the way of certain hazards. Secondly i will conduct the experiment on a wooden surface, to ensure if any electrical problems happen it will no be conducted. Thirdly, i will not conduct the experiment anywhere near any wet surfaces, or taps etc, this is mainly because water is very conductive of electricity, and could cause electrical shocks. Also i will not be conducting the experiment direct from the mains, because the voltage is too large, and could be very dangerous, instead i will be using a power pack, which is much more safer then the mains.*

### *Fair test*

*I am testing the effect of increasing the number of coils around a 9 inch nail, and the effects of doing so. To ensure there is a fair test, all over varying factors will have to be kept constant. This includes, keeping the length of wire the same length and thickness. Also keeping the current the same so that the flow of electrons will be similar. Voltage will be determined by the power pack, and the switch will always be on 4v. The variable resistor will be used to ensure the correct amount of current is travelling through the wire. Also i will be using the same nail, so there is no chance of different length of nails, or different cores etc. The newton meter that i will be using, will be the same one for all experiments, so that the results become more accurate. Also i will ensure that it will only be a touch on the newton meter by the electromagnet, and no bias is being used.*

### *Prediction*

*I predict that as the number of coils increase so will the amount of magnetism, because of the increase in magnetic fields. This will increase the reading on the newton meter. Also as the number of coils double so will the amount of magnetism double, increasing the amount of newtons being pulled will double.*

*This graph shows what i will expect from my results, it is basically a line which is  $y=x$ . Also Y is directly proportional to x.*

*Which can be seen in the following graph:-*

### Preliminary Experiment

*I will be doing a preliminary experiment to find out what values to use in the experiment and to see which ones are most appropriate and sensible and will be good enough to ensure a good conclusion.*

*Firstly i tested what voltage i should be using:-*

*This graph below shows the results plotted on a graph:-*

*This table clearly shows that 4v is definitely the best value, because it is towards the middle in terms of Newton's pulled. Also it is far from being too hot to work with, and also it will be still a low voltage so not dangerous.*

*Secondly i will test the right current to use whilst conducting the experiment at 4v.*

*The graph below shows the values on a graph:-*

*These results suggest that 2A is the best current to use, because its results are quite large in size, so any anonymous results will be easy to tell, and also, the current is yet quite low, so it is not dangerous.*

### *Final Experiment*

*These are the values i will be using for the final experiment:-*

- 1. Power pack set to 4v*
- 2. Resistance on variable resistor changed so that ammeter reads 2A*
- 3. Increasing number of coils from 10 coils- 100coils, these values were obtained from the preliminary experiment.*

*Every coil will be tested 3 times, and the mean result will be taken, so that the average value is taken into account making all the results interlocking. This will also making anonymous results more visible. This will make the results much more accurate and reliable.*

*Between every different number of coils testing I will turn of the power pack, mainly for two reasons firstly so that the nail become demagnetized and secondly so that there is no safety hazard.*

*The Newton meter I will be using will be a very scientific one and is very accurate, and this will make my results more accurate, and will provide a better foundation to make a firm conclusion.*

*Results recorded straight after each testing, and were all written up in a table so that results wouldn't get mixed up, and I had the exact figures needed, to manipulate. I have chosen a large range, because if there was a small range, I would only know about the interpolated results, and wouldn't know what happened when the results extrapolated.*



*These are the results that i have obtained, they are pretty close together, and there has been no anonymous results, so these results are pretty good enough to make a firm conclusion. Also you can see that the as the number of coils increases so does the magnetism because the newtons the electromagnetic is able to pull is increasing. I will now plot the points on a graph, and draw a tredline to see if there are any visible outliers, and how the correlation has been. I will plot the average results only.*

*From this graph you can see that there is very strong correlation, and all the points are pretty close to the line of best fit. Also the results have all been increasing at a steady pace as the number of coils has, and they are all in proportion.*

*If you look at 50 coils and look at 100 coils the results are and respectively, and this basically is twice as much, and so is the number of coils. This is because as the number of coils are doubled, the number of electrons have doubled, creating twice as many magnetic fields, and therefore doubling the amount of magnetism.*

*Figuring out the gradient of the line of best fit, will be able to show how the number of coils is proportional to newtons the electromagnet was able to pull.*

*(50,1.25) and (100,2.5)*

*Lie exactly on the line of best fit, so these values can be used to figure out the gradient.*

*This is the equation used to figure out the gradient:-*

*So the gradient of the line is:-*

$$\frac{2.5-1.25}{100-50} = \frac{1.25}{50} = 0.025$$

*The relationship between the electromagnet in terms of coils is, number of coils multiplied by 0.025 and this should give the amount of newtons that it pulled.*

*These results do agree with my prediction, in my prediction i predicted that the double number of the coil, would make twice as many electrons passing through, and consequently double the amount of magnetic fields, thus doubling the amount of*

*magnetism. Also almost every value is in a proportion of 0.025 of the magnetism it was able to pull.*

### *Evaluation*

*Everything went superbly, there was no outliers, because the degree of accuracy involved in the experiment. Also all the results went up in proportion, and i also found a formula which connects number of coils, to the number of newtons it was able to pull. Also all the results on a graph were in a very strong positive correlation. There was no outliers visible on the graph either. Also, the experiment was repeated 3 times, and a great degree of accuracy was involved to make sure there was no biases or unfair testing. Everytime we tested the same value, the results were very similar or even the same, showing that there was no chance of anonymous results. This shows the experiment was very reliable, and that it should be good enough to make a firm conclusion, that as the number of coils increases, so does the magnetism in direct proportion.*

### *Conclusion*

*I would like to do this experiment again, and have a much larger range, to see what happens when u extrapolate outside the points which i have tested, and wanting to know if the same formulas and proportions, and correlations apply. Also i would like to repeat the testing of each value up to 5 times so the accuracy is increased even more, and instead of analysing the mean, i would like to analyse the modal values. Also i would like to see how the other factors which affect the performance of the electromagnet, actually change the magnetism, and would like to test these, also to see if there is any further, interlocking formulas etc.*