Electromagnets Coursework
By Samantha price

What is a electromagnet

Planning

An electromagnet consists of an iron core with a wire wrapped round it and current flowing through the wire

A conductor carrying a current (I) induces a magnetic field.

This due to the fact that moving charges induces magnetism and the current consists of moving (e)

What are they used for?

Electromagnets are widely used in technology and are the essential components of relays and circuit breakers. Electromagnets are also used in electromagnetic clutches and brakes. In some streetcars, electromagnetic brakes grip directly onto the rails. Very large electromagnets having cores several meters in diameter are used in cyclotrons, and high-power electromagnets are used to lift iron parts or scrap.

This was Found From Encarta

This has helped me so now I see a point in the experiment. Also people who use the high-powered electromagnet would need to know how to get it high powered. Keeping in mind current costs money so they may choose to use another way with a lower current.

About Electromagnets

(Core)

The iron core in an electromagnet is full of magnetic domains, which are randomly pointing anywhere therefore cancelling them out. When an electric current is passed through the coil; this induces a strong magnetic field. The iron core is then placed in this field; causing the domains to point in one direction (The direction of the field.) When the domains are pointing in one direction a magnet is made. The strength magnetic field produced by the solenoid is then increased greatly. The higher the current passing through the coil the stronger the magnetic field this is because there will be more electrons (e) moving there will be.

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Without being placed in magnetic field.

With being placed in a magnetic field.

(Solenoid coil)

If the double the amount of turns we will get double the amount of electrons moving in that location or area, increasing the magnetic field because of smaller individual magnetic field will merge making a tug of war effect. However increasing turns will not increase current.

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Experiment
I could either do about

1) How the amount of current passed through the coil affects the strength of magnetic field.
2) How the amount of turns affects the strength of magnetic field

I am going to do How the amount of current passed through the coil affects the strength of magnetic because I think the results will be more clearer as current is easier to determined than amounts of turns.

Aim

To investigate how the amount of current (I) affects the strength of an electromagnetic.

Prediction
I think the higher the current the stronger the Electromagnet because there will be more electrons moving in one location. I think if the current has doubled so will the amount o iron filings that are picked up. However when the magnetization of the core reaches its saturation level (When all the magnetic domains are turned in the direction of the magnetic field) the increase of current will have little effect on the current.

I will do a test to make sure of my prediction I will set-up equipment like in the method and I will see if 1 amp picks up more than 3

1A=0.13
3A=0.54

This show that it is almost doubled twice which shows my prediction is backed up.

Variables

Current (I)	
Length of core (mm)	95
Width of core (mm)	5
Number of turns in coil	15 with another 15 on top=30
The spaces between each turn in coil (mm)	as near as possible
The spaces at each end of core (mm)	15mm=right 50mm=left
The end of core used	right-15mm
Type of wire	Green 7stran

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How to keep variables the same

The only variable that can change is current

Measure the length and width of the iron core so that it stays the same.
Count the number of turns and keep the number the same.

Each turn should be as near as it can to the next without being on top of turn and make sure it is touching the iron core.

Measure the amount of room without the green wire turned on it at each end.

Use the same end of iron core each time.

Method

First I will do a test to see the intervals I should use in the experiment I will see if there is a big enough difference between 0.5 and 1 amps.
0.5=0.05
1=0.06
I think that the difference between these (0.01) is insignificant and therefore I should do my experiment with 1amp intervals
Gather equipment; green wire, iron core, power pack, circuit ammeter, iron fillings weights that measure to every hundredth of a gram
Turn the green wire around the iron core 15 times then another 15 above. Leaving 15mm on the right and 50mm on the left end of iron core.
Arrange circuit including electromagnet and ammeter.
When all is set-up without turning the power on see if the electromagnet picks up any iron filings if it does weigh the amount. If it does this will be because some of the domains are lined up because of another experiment.
Then put the power up until the ammeter reads 1 amp then place electromagnet in iron filing and measure the mass.
Repeat this going up an amp each time until 6 amps is reached because any higher is dangerous.
Repeat experiment 3 times using same variables.

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Results

Amount of amps	Mass of Iron filings picked up, on first go (grams).	Mass of Iron filings picked up, On second go (grams)	Mass of Iron filings picked up, On third go (grams)
1	**0.10**	**0.07**	**0.11**
2	**0.26**	**0.29**	**0.28**
3	**0.59**	**0.52**	**0.52**
4	**1.23**	**0.92**	**1.43**
5	**1.86**	**1.77**	**2.22**
6	**2.34**	**2.45**	**2.59**

Averages

Current (Amps)	Average of results
1	**0.09**
2	**0.28**
3	**0.54**
4	**1.19**
5	**1.95**
6	**2.46**

Analysing

From my graph I can see that as the current increases the strength of the magnet does.

Does the strength of the electromagnet double as the current does at any point using my graph.
1A=0.17

2A=0.34

3A=0.60

4A=1

My best fit line shows that from 1 to 2 the mass of iron filings has doubled as well as the current (0.17*2=0.34) However from 2 to 3 it is almost double (0.34*2=0.68) and 3 to 4 there is a lot in the difference. It can be seen clearly that at first the line looks linear until it reaches 3 amps and then it starts to curve gently. This means the electromagnet has become more efficient. My findings are backed up by Kim's results she found before 3A her results were doubling then after 3A the best fit line became steeper.

The reasons for the curve could be that the electromagnet becomes more efficient. This diagram show that at a low current the magnet may not be relying on the domains turning around but instead how many electrons are moving in one location.

However this diagrams when there is more current the electromagnet not only relies on the amount of electrons moving in one location but the amount of domains lined up in the core. Therefore the second one is more efficient than the first.

My graph cannot be interpolated because I stated at zero, which is the lowest amount of current.

However I can extrapolate my graph cause there can be more than 6amps Although I wouldn't be able to use the same wire because it would be dangerous as it would melt. I could use another wire that has a higher resistance to heat.

If I had enough room to extrapolate my graph I would remember my prediction that "at a point all domains would have turned round therefore the magnetism will only be relying on amount of electrons moving in one location so it will be more like the start of the graph where it is linear. However the domains will be jiggling causing them not to line up so the best-fit line will flatten out. Another reason that backs up this theory is on my graph my best fit line looks vertical if I extrapolate following this line then I will end up with an infinitely strong magnet which is impossible which shows something else must happen.

Evaluation

I am confident about my best-fit line, as there is a low degree of scatter in my points. There are no anomaly as all fit in to the to the pattern. Although there is a small amount of error as not all points lie on the best-fit line. There could be numerous reasons why the errors were made,

1) Residual magnetism
   As my friend and me were sharing a circuit this may have caused residual magnetism as the poles may have changed which would have affected my results.
2) Dropping some iron filings
   Where the points are lower than the best-fit line (1-3+6amps) this could be the reason as the mass would be lower.
3) Iron filings sticking to crocodile clip
   Where the points are higher than the best-fit line (4+5amps) this could be an explanation. This would make the mass of the iron filings mass higher because it would be an unfair test as the surface area would be bigger.

Some of my prediction has been backed up, “the higher the current the stronger the Electromagnet because there will be more electrons moving in one location.”

Although most of it hasn’t been backed up, “if the current has doubled so will the amount of iron filings that are picked up.” This is due to the fact the electromagnet became more efficient.

Also this part of my prediction wasn’t backed up, “when the magnetization of the core reaches its saturation level (When all the magnetic domains are turned in the direction of the magnetic field) the increase of current will have little effect on the current.” Even though my results were unable to back this up I still think this will happen if the current was high enough.

Another reason why I would like to increase the current is to be surer about my best-fit line. As the last 2 results could be anomalies and the best fit line linear.

I think the experiment went well however if I did it again I would:

1) Make sure residual magnetism wasn’t an issue
2) Be more firm with variables (for example no iron filings on crocodile clips and no dropping iron filings)
3) The current was increased so I have a good chance to back up my prediction.

From this experiment I know how companies that use high-powered electromagnet do to make them high powered however I think this is an expensive way so another way may be more appropriate for example amount of turns and surface area of core.