ELECTROMAGNETS

PLANNING

SCIENTFIC THEORY:

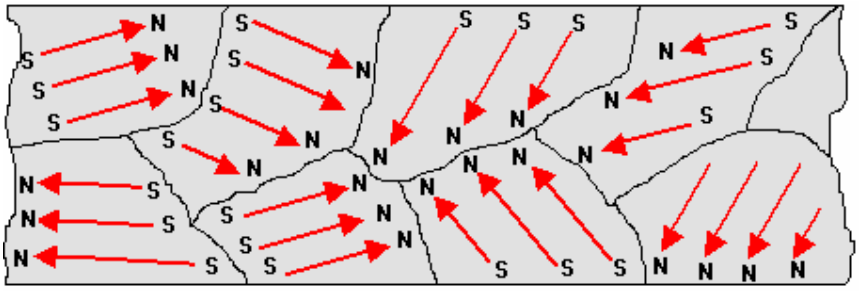
Electromagnets

An electromagnet is a device consisting of a solenoid usually a cylindrical coil of insulated wire in which an iron core is placed. An electric current passed through the coil induces a strong magnetic field along the axis of the helix. When the iron core is placed in this field, microscopic domains that can be considered small permanent magnets in the iron align themselves in the direction of the field, thus increasing greatly the strength of the magnetic field produced by the solenoid. The magnetization of the core reaches saturation once all the domains are completely aligned, and an increase of the current in the solenoid has little further effect. When the current is switched off, the core retains only a weak residual magnetism.

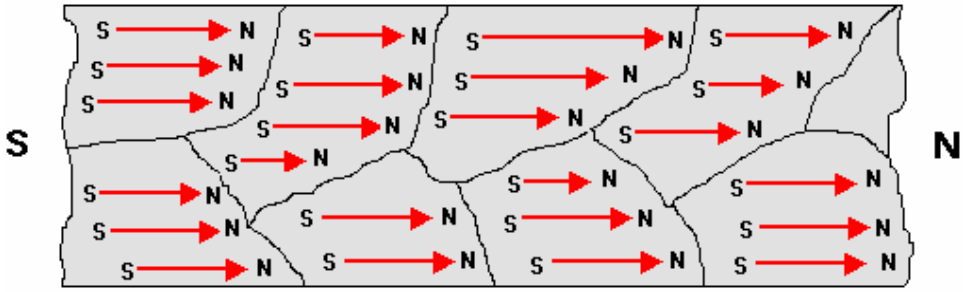
The Domain Theory

The domain theory of magnetism suggests that a magnetic material such as iron contains within its structure tiny cells called domains and that mini molecular magnet exist inside theses domains.

In an unmagnetised piece of iron all the mini magnets within a particular domain point in the same direction but in each neighbouring domain they point in different directions. The result of this is that the magnetised effect of the domains cancel each other out.



In an unmagnetised piece of iron all the domains are lined up so that their magnetic effect reinforce each other.



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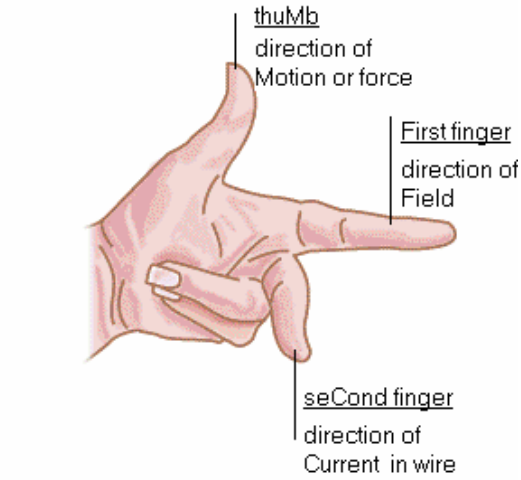
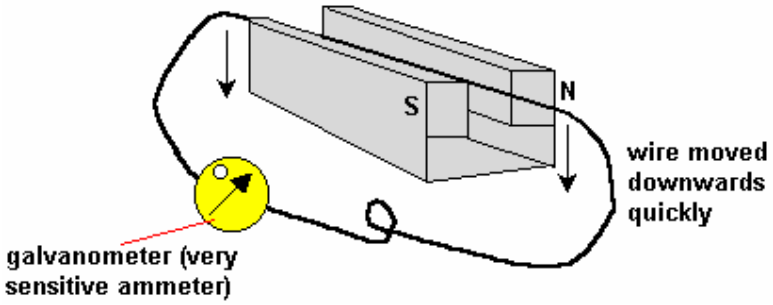
Flemming's left hand rule

Using Flemming's left hand rule the direction of the force/motion can be predicted



Electromagnet induction

If a conductor such as a piece of wire is moved through a magnetic field cutting magnetic lines of force a voltage or emf will be induced across its ends. The process which produces the emf is called electromagnetic induction. If the wire is part of a complete circuit the induced emf will cause a current to flow.

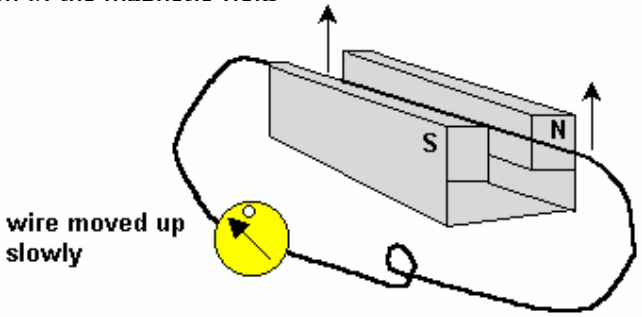


The size and direction of the induced emf depends upon:

- The speed at which the magnetic lines of force are cut
- The number of coils cutting the magnetic lines of force
- The strength of the magnetic field

The direction of the induced emf depends upon:

- The direction of the motion
- The direction of the magnetic field



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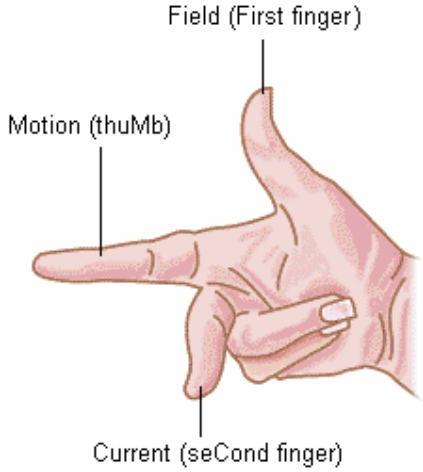
You can predict the direction of the induced emf using Fleming's right hand rule.



REFERNECES:

To help me with my scientific theory, I used:

- Physics through diagrams- Brian Arnold
- 1999 Encyclopaedia

AIM:

My aim for this experiment is to find out what kind of effect the strength of an electromagnet has if the number of turns on the coil and the current going through the coil are increased.

KEY FACTORS:

The main factors which determine the strength of the magnetic field are:

1. The size of the current flowing through the coil. This is one of the key factors I will be focusing on.

2. The number of turns on the coil. This is another key factor I will be focusing on.

3. The cross-sectional area of the coil

4. What the coil is wrapped around. (Wrapping it around a magnetisable material such as soft iron creates a stronger magnetic field)

PREDICTION:

I predict that if you increase the current flowing through the coil, the stronger the electromagnet will be. I also predict that if you increase the number of turns on the coil the electromagnet will be stronger.

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HYPOTHESIS:

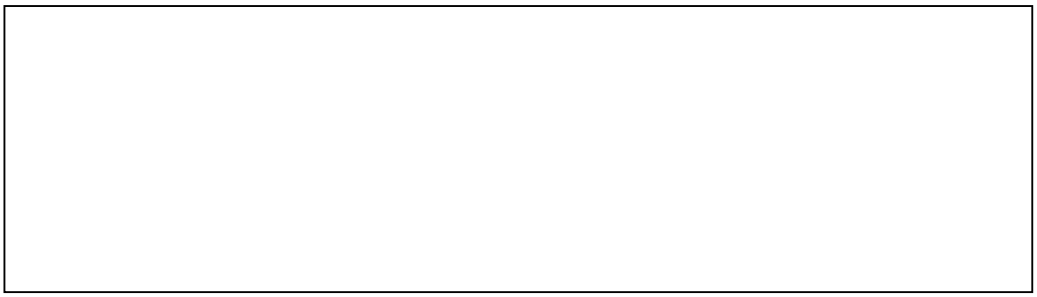
The electromagnet will be stronger if the number of turns on the coil is increased because there will be electrons travelling through the coil which will produce a magnetic field. If you increase the number of coils, you create a stronger magnetic field, which means a stronger magnet.

The electromagnet will be stronger if the current flowing through the coil is increased because there will be more electrons travelling through the coil which means a stronger magnetic field, hence a stronger magnet.

APPARATUS:

Equipment's that I'm going to use for this experiment are: power pack, crocodile clips, nail, coil of wire, paper clips, and ammeter.

DIAGRAM:



METHOD:

Below is the method for the first key factor; number of coils:

1. Set up the experiment as shown on the diagram
2. Get the nail and put 5 coils around it.
3. Switch the power pack on and take the nail to the paper clips.
4. The nail should attract the paper clips toward it.
5. Switch the power pack off and count the number of paper clips caught.
6. Do the same for 10, 15, 20, and 25 coils.
7. Repeat the whole experiment another two times to make the result accurate by making an average.

Below is the method for the first key factor; current:

1. Set up the experiment as shown on the diagram
2. Get the nail and put 5 coils around it.
3. Switch the power pack on and put it on 2 amps.
4. Take the nail and put it near the paper clips.
5. The nail should attract the paper clips towards it.
6. Switch the power pack off and count the number of paper clips caught.
7. Record the result and do the same for 4, 6, 8, 10, and 12 amps.

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8. Repeat the whole experiment another two times to make the results accurate by making an average..

FAIR TEST:

For this experiment to be fair, I need to consider a few things:

- Keep the number of turns the same when I am doing the experiment for the current.
- Keep the current the same when doing the experiment for the number of turns.

SAFETY:

Safety is a major aspect to any experiment:

MEASURMENTS:

I will use two different tables for the two variables; number of coils and the current.

		Number of Paper Clips Caught			
		1st results	2nd results	3rd results	Average*
Number of Coils	5 coils				
	10 coils				
	15 coils				
	20 coils				
	25 coils				

		Number of Paper Clips Caught			
		1st results	2nd results	3rd results	Average*
Current (Amps)	2				
	4				
	6				
	8				
	10				

* Answer rounded off to whole number

	12				

RELIABILITY:

I am going to repeat the experiment at three times. This is so it will enable me to make an average time. To make an average, I have to add the three result of the same variable, and then divide the answer by three. By making an average, my results would be more accurate.

OBSERVATION

RESULTS TABLE:

		Number of Paper Clips Caught			
		1st results	2nd results	3rd results	Average*
Number of Coils	5 coils	6	8	7	7
	10 coils	15	14	18	16
	15 coils	38	34	29	34
	20 coils	44	51	38	44
	25 coils	71	45	75	64

		Number of Paper Clips Caught			
		1st results	2nd results	3rd results	Average*
Current (Amps)	2	4	2	4	3
	4	8	9	6	8
	6	10	15	16	14
	8	21	24	18	21
	10	26	25	26	26
	12	28	30	31	30

* Answer rounded off to whole number

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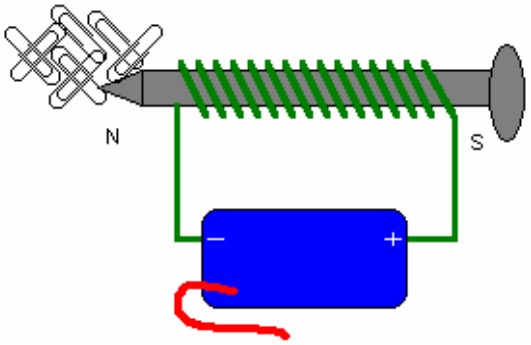
ANALYSIS

EVALUATION

I think I the way I carried out the experiment was suitable. I made a plan showing what to do which was very important. From my results table and graph, I did notice an anomalous result. This was the part when the number of coils was the key factor, and I had to put 25 coils on the core. It was an anomalous result because the other two result of the same number of coil was around the region of 70, but this result was in the region of 45 (the results for 20 coils were in the region of 45). This could be an anomalous result for four reasons. The first could be that I might have miscounted the paperclips. The next could be that I put less than 25 coils on the nail or I used the 20-coiled nail of the previous experiment by mistake. Another reason could be that instead of the current staying at 5 amps, it might have been reduced accidentally. The final reason could be that there was too much time given for the electromagnet to pick up the paperclips. So, if I had the opportunity to do the experiment again, I will be extra careful when counting the clips, check the current and coil is correct all the time, and give the same time to give the electromagnet to pick up the paperclips.

The way I did the experiment was that I put turns of coils on the iron nail and connect the wires to a power pack. I then took the nail near to some paper clips which attracted to the nail:



Using paperclips is not a good way of doing this kind of experiment because it takes time to count them, and you may miscount. So, if I had the opportunity to do the experiment again I will use iron fillings instead of paperclips. This method will not only be quick but also accurate because when you take the electromagnet near the iron fillings, it will attract them and you only have to weigh them, instead of counting.

To improve the experiment even more I could use a soft steel core instead of an iron core. This will improve the experiment because it will make sure that the core isn't remained magnetically charged from the previous experiment, and so doesn't produce any anomalous results.

I could also extend the experiment and see if the cross-sectional area of the coil effect the electromagnet. This could be done by……
I also could also repeat the experiment four times instead of three, which will make the results eve more accurate, when making the average, which can be done by adding the four results and dividing the answer by four.

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