GCSE Science coursework (practical experiment)
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Electromagnetism through a coil

Electromagnetism

Electromagnetic Theory

In the late 18th and early 19th centuries, the theories of electricity and magnetism were investigated simultaneously. In 1819 an important discovery was made by the Danish physicist Hans Christian Oersted, who found that a magnetic needle could be deflected by an electric current flowing through a wire. This discovery, which showed a connection between electricity and magnetism, was followed up by the French scientist André Marie Ampère, who studied the forces between wires carrying electric currents, and by the French physicist Dominique François Jean Arago, who magnetized a piece of iron by placing it near a current-carrying wire. In 1831 the English scientist Michael Faraday discovered that moving a magnet near a wire induces an electric current in that wire, the inverse effect to that found by Oersted: Oersted showed that an electric current creates a magnetic field, while Faraday showed that a magnetic field can be used to create an electric current. The full unification of the theories of electricity and magnetism was achieved by the English physicist James Clerk Maxwell, who predicted the existence of electromagnetic waves and identified light as an electromagnetic phenomenon.

Magnetic induction

Magnetic induction is the production of magnetic properties in unmagnetized iron or other ferromagnetic material when it is brought close to a magnet. The material is influenced by the magnet's magnetic field and the two are attracted. The induced magnetism may be temporary, disappearing as soon as the magnet is removed, or permanent depending on the nature of the iron and the strength of the magnet. Electromagnets make use of temporary induced magnetism to lift sheets of steel: the magnetism induced in the steel by the approach of the electromagnet enables it to be picked up and transported. To release the sheet, the current supplying the electromagnet is temporarily switched off and the induced magnetism disappears.

Magnetic saturation

Magnetic saturation is magnetisation to the point beyond which a further increase in the intensity of the magnetising force, will produce no magnetism. Basically, over magnetising.

Magnetic domains

Small area in a magnetic material that behaves like a tiny magnet. The magnetism of the material is due to the movement of electrons in the atoms of the domain. In an

Unmagnetized sample of material, the domains point in random directions, or form closed loops, so that there is no overall magnetisation of the sample. In a magnetised sample, the domains are aligned so that their magnetic effects combine to produce a strong overall magnetism.

Experiment

What I will be trying to find out

I will be trying to find out how alternating the current (amperes), passed into a coil, would affect the strength of a coil magnet. We will measures the current by using an ammeter. To measure the strength of the magnet, we will be seeing how many paperclips can be hung from the electromagnet.

Prediction

I think that, the more current that is passed through the coil, the stronger the magnetic field will be. I think this because, the more current passed through the coil of wire (i.e. electrons), the more magnetism will be induced into the 'horseshoe shaped' piece of unmagnetized iron. The more magnetism induced into the iron, the more paperclips it will hold, unless the iron becomes 'saturated'. This is when too much magnetism is induced into the iron so that it becomes 'de-magnetised'.

Experiment planning

What I will vary

For this experiment, I will be varying the amount of current passed through the wire coil, measured in amperes. To measure the current, we will use an ammeter, and to vary the current, alternate on the power pack.

What I will not change to make a fair test

To ensure that the experiment is a fair test, and so that I obtain accurate results, I will not change either the coil around the iron yoke or the type of wire that I will be using. Making sure that the results and outcome are accurate and more importantly, correct in significance to theories, wholly depends upon making the test as fair as possible.

What I will be measuring

The variable in this experiment will be the alternating current (amperes), this is the part that we will vary to obtain to differing results. The results that will be measuring, are how many paperclips can be hung from the magnetised yoke by A.C (alternating current).

Health and safety

As this experiment involves main electricity, there are a few precautions, which have to be taken into consideration. The first and most important precaution with any experiment involving electricity of any kind is to be away from any liquids. With this specific experiment, one important precaution is to not turn the voltage too high. Before the experiment, we did some preliminary testing to see how high we could take the voltage up to. Our results showed that the maximum voltage we could go to was 8 volts. Anything above that make the wires too hot, which could either melt the wire or de-magnetise the iron yoke.

Apparatus

- *Power pack*
- *Ammeter*
- *Iron yoke (horseshoe shaped)*
- *Regular coil wire*
- *Clamp and stand*
- *Paperclips*
- *Mains socket.*

Method

1. *Make a coil of wire around an un-magnetised iron yoke.*
2. *Attach the coil to a clamp and stand.*
3. *Connect the wires from the coil, to the ammeter and the power pack.*
4. *Plug in the power and switch on at the first current reading (1-ampere).*
5. *Count the amount of linked paperclips that stick to the magnetised yoke and record for each different current.*

Diagram

Results table

Amperes	*EXPT 1*	*EXPT 2*	*EXPT 3*	*AVERAGE*	*EXPT 4*	*EXPT 5*	*EXPT 6*	*AVERAGE*
1	1	2	1	1.333	3	2	2	2.333
2	4	5	5	4.333	5	3	6	4.666
3	7	9	8	8	8	8	7	7.666
4	13	13	12	12.66	12	11	12	11.66
5	18	19	21	19.33	17	19	20	18.66
6	21	20	23	21.33	20	20	22	20.66
7	26	24	27	25.66	25	27	27	26.33
8	30	33	32	31.66	31	33	31	31.66
9	34	35	33	34	35	35	33	34.33
10	41	41	40	40.66	40	39	42	40.33

Conclusion

What I found out

I found out that, when the current increases, so does the power of the magnetism. This enabled more paperclips to be hung from the iron yoke. As the current increased, we were able to add more and more clips to the chain without them falling off. This does work in conjunction to the theory, that the more electrons flow into a coil, the stronger the magnetic field becomes.

The reason that this happens is because, when the magnetic field around the coil becomes stronger, more magnetism can be induced from the coil into the iron yoke to magnetise it. The constant flow of electrons means that the yoke can take the weight of the paperclips currently attached plus allowing more to be added to the chain, each time the current is changed.

Do my results match my predictions?

I predicted that, the more current that is passed through the wire coil, the more paperclips can be hung from the iron yoke, and that also, the magnetic field will be stronger around the wire coil.

I found out that, the more the current was increased, the more paperclips could be hung from the yoke. This meant that, the magnetism around the coil did increase as the current increased.

Yes my results did match my prediction correctly. I predicted the same final outcome of the experiment.

Evaluation

Were the results accurate?

The results were fairly accurate, but we have no accurate theory to predict the best possible results, so we do not know if they are correct or not. To get the best results we could, we repeated the experiment to see how good the second set of results would be.

Do the results fit a pattern?

The results fitted a very vague pattern, for every ampere the current goes up, the average of three results goes up approximately 4 paperclips each time.

How could I improve the method used?

The method used is a fairly accurate way but there is one thing, which you cannot guarantee, whether there is any magnetism in the atmosphere, which could interfere with the experiment. Other small problems with the experiment, which cannot be altered like accurate ammeter readings, can also change the final outcome of the experiment.