<u>Investigation of magnetic fields in wires</u>

<u>Variables</u>

Independent variable – Current/Amperes

Dependent variable – Mass(force exerted by wire)/kg

Control variables – Length of wire passing through the magnetic field

- Magnetic flux density of the magnetic field (use the same magnets)
- Potential difference in the power supply (use the same battery/maintain the same voltage)
- Use the same set of scales (make sure to zero before use)
- Thickness of the copper wire (thickness of the wire can affect the current passing through it)

<u>Equipment</u>

Electronic weighing scales – Used to measure the mass/force exerted on top of it/0.01g

Thick copper wire – The thick copper wire will have the current flowing through it and experience the force

Variable resistor – Used to vary the current throughout the wire (required as our independent variable is the current)/0.01 Ω

DC Power supply – Provides the potential difference across the wire (the electromotive force)

Ammeter – Measures the current in the wire which can be recorded/set to a specific value/0.01A

2 Magnets with opposite poles within a metal cradle – The 2 magnets will be used to create the magnetic field; a cradle is used to create a stand for the 2 magnets and becomes the point of contact on the scales

Clamp/retort stand – Holds and maintains the wire in the magnetic field

30cm-1m ruler – Used to measure the length of the magnets (the length of wire which is under influence of the magnetic field)/1mm

Crocodile clips – Holds the ends of the wire in place to the clamp stand

<u>Risk assessment</u>

Electrical equipment – Water should be kept away from the electrical equipment, in particular the copper wire which is passing through the magnetic field. All liquids should be kept far away in order to reduce the risk of electrocution. Furthermore, the current shouldn't be allowed to go too high through the copper wire as it will increase resistance and the temperature of the wire. Therefore, the wire can begin to melt and become red hot, increasing the risk of a fire or burns. The wire should be checked over a few times to see if there are any breaks. A break in the wire could form an arch across it and spark, also increasing the risk of burns or fire.

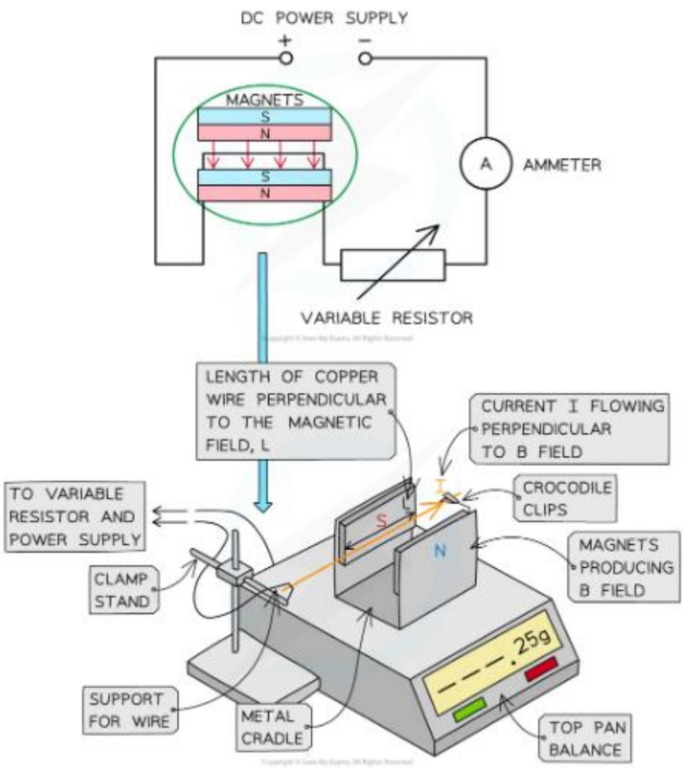
When touching the wire, make sure to use the back of your hand as an electric shock will cause the muscles to contract. If the student grabs the wire with the front of their hand, their muscles will contract forcing them to grab hold of the wire, inducing more electric shocks. By touching the wire with the back of your hand, you are much more likely to flinch away.

Magnets – If a student has an artificial organ, they should be made aware of the use of magnets as in some cases, they can interfere with the machinery and malfunction. This could be deadly to the student, so it is important that they are made aware of the use of magnets. However, it is likely that the magnets being used in the practical are too weak to have a significant effect on the student's artificial organs.

Clamp stand/heavy weights – The student should be careful when working with the clamp stand as it is rather heavy and could be dangerous if it falls on the student. The clamp stand should be kept in the middle of the table so that in the event of it toppling over, it doesn't fall on the student's foot.

Method

1. Firstly, the apparatus should be set up so that the wire is completely perpendicular between the two magnets. This can be done using a set square.
2. Measure the length of one of the magnets using the 30cm rule, noting it down as L, the length of wire in the magnetic field.
3. Once the magnet has been placed on the weighing scales, the balance should be reset to 0 to negate the mass of the magnets, only measuring the force applied by the wire.
4. Change the resistance in the variable resistor so that a current of 0.5A flows through the wire. This can be checked through the ammeter which should display a value of 0.5A.
5. As a current flows through the wire, it will experience a force upwards which can be observed in the wire and on the balance. The value of the force pushing downwards can be measured on the balance; this may be small, in which event, increasing the ammeter should result in a greater force (F=BIL).
6. The mass recorded on the balance should be noted down in a table.
7. Repeat the procedure, increasing the current in intervals of 0.5A between 8-10 readings
8. Repeat the experiment 3 times to calculate a mean of the mass readings, reducing uncertainty.



Errors

Systematic errors – Make sure to zero the balance in order to avoid a zero error

Random errors – Make sure that there are no high currents passing through the copper wire as an increased current will increase the wire's resistance.

- Repeat the experiment by turning the magnet in the metal cradle and wire by 90º

Analysing results

Analysing the Results

- The magnetic force on the wire is:

$$F = BIL$$

- Where:
  - F = magnetic force (N)
  - B = magnetic flux density (T)
  - I = current (A)
  - L = length of the wire (m)

- Since $F = mg$ where m is the mass in kilograms, equating these gives:

$$mg = BIL$$

- Rearranging for m:

$$m = \frac{BIL}{g}$$