GCSE PHYSICS COURSEWORK:
MODULE 5 ENERGY & ELECTRICITY

Investigate the effect of changing the length of a wire on the current flowing through it.

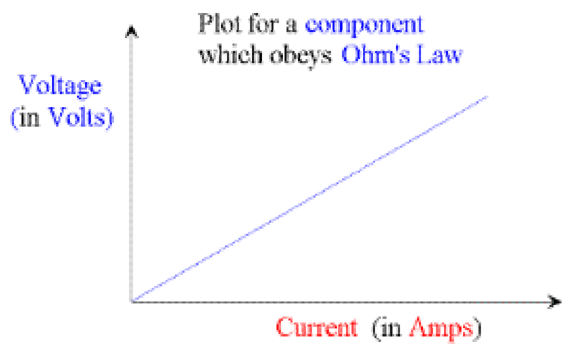
Skill Area P: Planning

This coursework assignment deals with the relationship between the length of a wire and the current flowing through it. I will refer to other factors that determine current so that I can *use scientific knowledge and understanding to turn ideas into an appropriate strategy*. It is important to understand what current is to progress with the investigation.

- Electricity is a **flow** of **charged particles**, which may be electrons or ions
- **Current** is the measure of the rate of flow of electrical charge. Electric current is measured in **amperes,** A. The ampere is defined in terms of the magnetic effect of an electric current.
- Electric **charge** is measured in **coulombs,** C. One coulomb is defined as the amount of charge passing a point in a circuit each second when the current is one ampere.
- Current will only flow through a component if there is a **voltage** across that component.
- The equation for current is defined as: **I = V / R** where I = current, V = voltage or potential difference or p.d., R = resistance.
- **Voltage** is the "push" or energy given to the charges (usually electrons).
- **Ohm's Law** states that the current through a metallic conductor at constant temperature is proportional to the voltage.
- **Resistance** is measured in **Ohms** (symbol Ω). It is a measure of how much the current is slowed down. The bigger the resistance, the smaller the current.

There is of course a balance between voltage and resistance. The aim of voltage is to push the current around the circuit, and the resistance i s opposing it – the relative sizes of the voltage and resistance decide how big the current will be:
INCREASE in **VOLTAGE** → **INCREASE** in **CURRENT**
INCREASE in **RESISTANCE** → **DECREASE** in **CURRENT**

If the resistance of a component is constant (stays the same) for di fferent values of V and I, then a plot (graph) of V against I will be a straight line. The gradient (slope) of the line shows how big the resistance is.



In reality, an increase in current through a component will change its temperature (the temperature usually goes up), and so Ohm's Law is only a generalisation but it works quite well for many components.

There are also other factors that affect current:

- Material
- Temperature
- Thickness

Material – Certain types of materials have a greater resistance than others.
Temperature – an increase in temperature results from an increase in voltage, and essentially an increase in current. From this we can deduce that at high temperatures the resistance is lower.
Thickness – A wire with a greater thickness has a larger diameter for the electrons to flow through. This means there is more space for them to flow freely. The result → Resistance decreases.

In general:

Increase in voltage → increase in push on electrons → electrons flow faster → charge flows faster → Current increases/Resistance decreases
My hypothesis states that: *"If I increase the length of a wire the effect on the current flowing through it will be that it decreases. If I decrease the length of the wire the current should increase".*

The effect of length on current is the key factor that I intent to investigate.

My statement can be backed up by the theory which states that: -

1. Electrons flowing through a material of a greater length have to travel a longer distance and so there is a greater chance for resistance to occur. Since there is more resistance, the current decreases.
2. Electrons flowing through a material with a small length have less distance to travel, there is less chance for resistance to occur and so the current increases. This can be reinforced by the fact that a shorter wire gets hot when electrons flow through it and this increase in temperature is a result of an increase in current as the electrons have more energy.

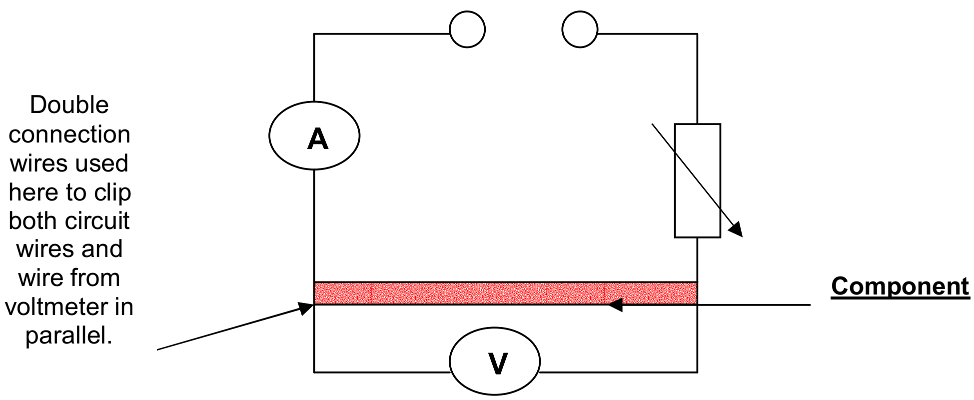
In order to carry out this investigation the following apparatus will be used: -

- Power pack
- Voltmeter
- Ammeter
- Variable Resistor (to maintain the voltage)
- Wire attached to a ruler of approx. 1m length (chosen type)

- Standard wiring for circuit
- Crocodile clips (to be clipped to chosen wire; the length of the wire will be altered depending on the position of the crocodile clips)

The power pack will provide the source of power for the investigation. Both a voltmeter and an ammeter will be used. The desired voltage will be set on the power pack, although we know that the voltage in the wire can change according to it's length. The variable resistor will be used to maintain the voltage as this is one of the factors that needs to be the same.

Basic setup:



The voltmeter must be placed in **parallel** around the **component** (in this case the wire attached to the ruler). The component, ammeter and the variable resistor are all in **series** and can be placed anywhere in the circuit.

This is a good way of carrying out the task. The circuit is simple and it's structure enables us to take results effectively. The component coloured in red indicates that the length can be changed by moving the position of the crocodile c lips on either end.

The procedure for taking results is as follows: -

1. Set the power pack to the desired voltage, for arguments sake say 1V.
2. Check that the Voltmeter reading shows 1V, by using the variable resistor.
3. Now observe the reading on the Ammeter. The reading will probably change slightly continously but take a reading that is the most stable.
4. Record this reading on your table. The table should have a space for Length and Current.
5. Now shorten the length of the wire slightly by changing the positio n of the crocodile clips, maintain the voltage using the variable resistor, and jot down your reading from the ammeter.

This procedure should be repeated until you reach the **minimum length**. (The minimum length will be discussed in the preliminary section later on).

To ensure that obtain a good quality of results this experiment needs to be fair. Since it is the length of the wire that we are essentially investigating, this is the only factor that should be changed during the investigation. All other vari ables shouldn't change.

If possible all the results should be taken in one lesson as you can guarantee that the same equipment will be used. The component **must** remain the same throughout the investigation as should all the other equipment.

An important factor that needs to be controlled is the **temperature.** As we know a higher temperature means a greater current. Continuous variations in temperature will have the consequence of inaccurate results and in the long run may not be sufficient enough to suppo rt my prediction. The aim is to obtain reliable evidence that supports my prediction and enables me to draw a conclusion from. A way of managing the temperature is outlined in the preliminary section.
To ensure greater accuracy it will be necessary to repe at the experiment. That is, I will take two sets of readings. To ensure consistency and accuracy across the whole investigation I need to decide on the range of values to take. The maximum length of wire to use is **1 metre.** I decided that readings of **10** different lengths should be sufficient enough to produce a pattern and also a curve for graphs in the Analysing and considering evidence (A) section of the coursework.

I have done some earlier work in order to help this planning. This is called the **preliminary** or **initial** work. The aim of doing preliminary testing is to: *find out the most suitable conditions that can be used to do this investigation.* Preliminary testing is particularly effective as it provides you with more information about the investigation you are going to carry out. I selected some values to test (at the upper and lower extremities of the proposed range), in order to find out if the values proposed will in fact give reasonable data.

The aim of the preliminary testing was to find:

- ✓ The material of the wire combined with the voltage that provided us with the greatest **range** of values for minimum and maximum lengths and currents.

The maximum length of the wire is typically 1 metre since the wire was fasted to a metre stick. The minimum leng th is the smallest length where the current could be read before the wire started to heat up. As stated earlier, and increase in temperature means a decrease in resistance and the quality of the results will begin to fluctuate. This is an essential aspect of fair testing.

A greater range of lengths and currents enables us to make the investigation more accurate as we are able to obtain a greater number of results that are of a good quality. I will collect a total of **20** results after repeats.

Skill Area P: Planning

Preliminary Testing

1) Constantan 0.45mm

Voltage	Min L	Current	Max L	Current	Range L	Range I
1V	30cm	1.01	90cm	0.53	60cm	0.68
2V	57cm	1.07	90cm	0.70	33cm	0.37
3V	74cm	1.25	90cm	1.04	16cm	0.19

2) Constantan 0.31mm

Voltage	Min L	Current	Max L	Current	Range L	Range I
1V	16cm	0.84	90cm	0.16	74	0.68
2V	32cm	0.98	90cm	0.32	58	0.66
3V	58cm	0.92	90cm	0.49	40	0.43

3) Nichrome 0.31mm

Voltage	Min L	Current	Max L	Current	Range L	Range I
1V	15cm	0.45	90cm	0.07	75	0.38
2V	30cm	0.47	90cm	0.15	60	0.32
3V	40cm	0.49	90cm	0.23	50	0.26

The row highlighted in yellow provides us with the best conditions as it had the greatest overall range. We can deduce that **Constantan 0.31mm** was the best suite dmaterial for this investigation. The greatest range occurred when the investigation took place at 1 volt. The chosen maximum length was **90cm** since there was tape stuck at the end of the stick. The minimum length before the wire was hot was 16cm but this can obviously vary. I decided to take readings for 10 values and to count down in intervals of 7cm from 90cm. This made the minimum value **29cm.** In my opinion it is sufficient enough to take 10 readings as these can be **analysed** to observe a pattern or trend and to complete a smooth curve on a graph to demonstrate this.

Safety

Safety is of course important to take into consideration during all practical work in the laboratory. Overall the experiment is quite safe as I am not de aling with dangerous chemicals or radioactive substances. However, electricity is being used and it is important that care is taken at all times to avoid potential scenarios that may lead to electrical shock. This can be managed by:

- Ensuring there is no wa ter near the work area.
- Being aware of the potential dangers of electricity.
- Managing the working environment to ensure the safety of myself and others.