## Introduction

In this investigation I will attempt to find the relationship between voltage and resistance in a bulb using the equation: **Resistance= Voltage/Current.**

Resistance: Resistance is the force that acts against charged electrons as they attempt to make their way around a circuit. More resistance means that more energy is needed to push the same number of electrons around the circuit. Many factors determine the resistance of an object for from its length or its temperature. Resistance is measured in ohms (Ω). The formula for resistance is: **R=V/I**

Voltage is the driving force of electrons; to measure voltage is to measure the potential difference of energy between the positive and negative terminals. Voltage is a measure of the amount of energy that you are providing per coulomb of charge therefore 1vote = 1 joule per coulomb*. Voltage is measured in Volts (V) The formula for voltage is: **V= IR**

Current: The current of a circuit is the rate at which the electrons flow through it. Current is measured in amps. The formula for finding current is **I = Q/T** where 'Q' is the charge passing at a certain point in the circuit measured in coulombs. Current is measured in amperes (A).

## Plan

To do this I will carry out an experiment in which I will construct a bulb circuit with a voltmeter and an ammeter. Then, by passing a varying voltage across the bulb I will measure the current and, using Ohm's law: **R=V/I,** calculate the resistance.

In this circuit the bulb is the resistor. The filament of a bulb is made purposely thin to enable it to resist the flow of electrons and glow.

I hope to obtain approximately six 6 results in this experiment, to do this I intend to vary the voltage in 1volt steps up to 6 volts. I will increase the voltage using the voltmeter.

To ensure that the experiment is as accurate as feasibly possible, I will obtain at least 2 sets of results and then document them and construct graphs using the average.

In this experiment, voltage is the independent variable and current, the brightness of the bulb and resistance are dependant.

## Hypothesis

Ohm's Law states that: "the current through a metallic conductor (e.g. wire) at a constant temperature is proportional to the potential difference (voltage)". I believe that as the voltage increases the resistance will increase also, because: As a higher voltage is passed across the bulb the temperature of the filament will increase and subsequently the resistance.

*A coulomb a measurement of the charge of the electrons. One coulomb is equal to the combined charge of 6.25 x $10^{18}$ electrons.

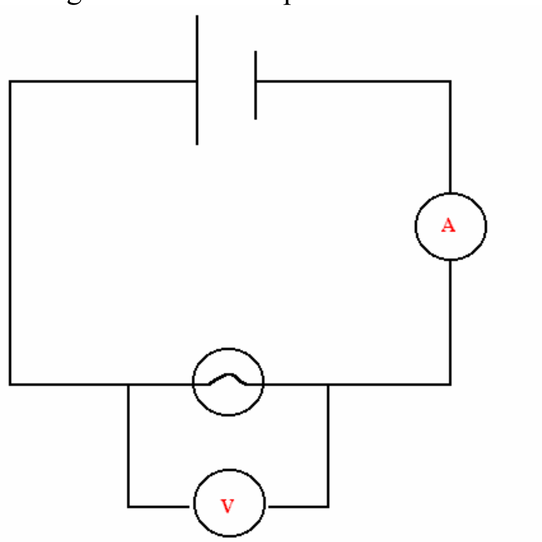
## Safety Notes

To ensure our safety the following measures where taken:

1) All school bags were packed away safely.
2) While setting up the circuit the power pack was set to ‘0’ volts and unplugged.
3) The circuit was not turned on until it was checked and approved by the teacher.
4) The maximum operational voltage for the bulb was 6 volts; this voltage was not exceeded for safety reasons.

**Apparatus:** Variable Voltage Power Pack, ammeter, voltmeter, bulb, connecting leads (wires)

**Method:** **(1)** The following circuit was set up:

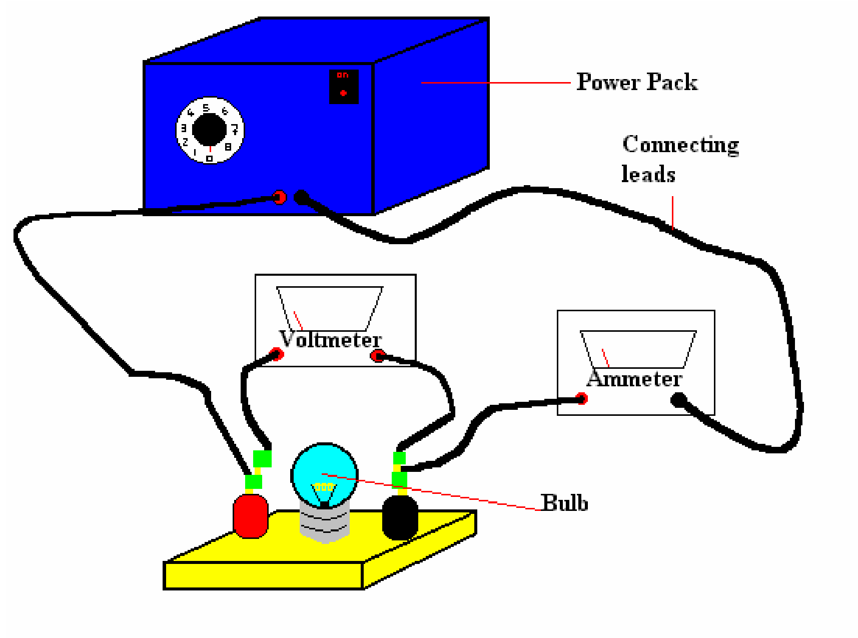



**(2)** Using the voltmeter to measure, the voltage was increased by adjusting the variable power pack from 0 to 1 volt.

**(3)** The reading on the ammeter changed, its new reading, at one volt was recorded

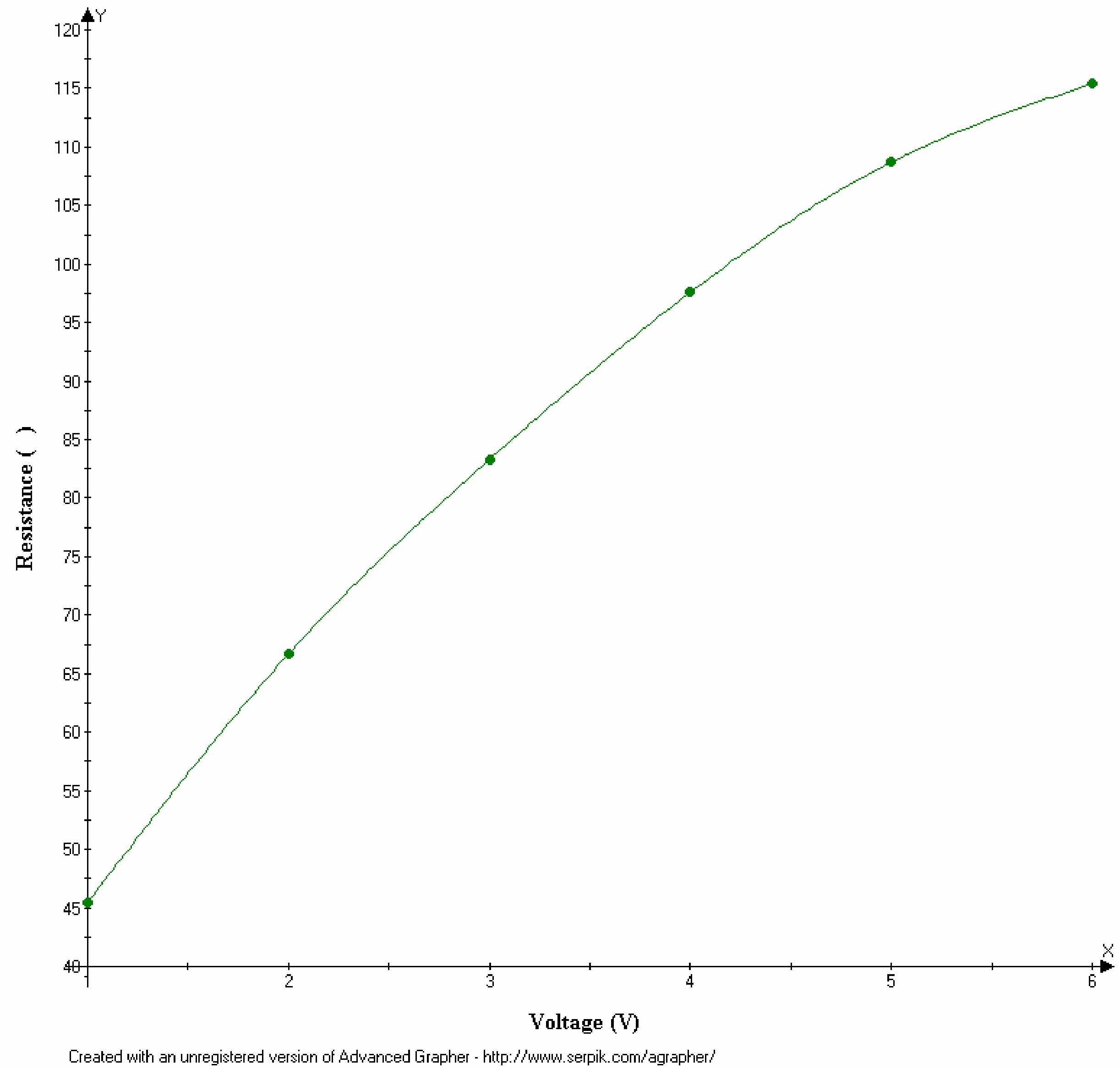
**(4)** Steps 2 to 3 were repeated 5 times, each time increasing the voltage by 1, up to 6 volts. Then the entire experiment was repeated twice so as to obtain 3 sets of results. Then the mean average was calculated then using the formula: Resistance= Voltage/current. The resistance in Ω (ohms) was calculated and recorded.

**Diagram**




## Graph

## Voltage vs. Resistance




## Interpretation

The voltage vs. Resistance decreasing curve graph shows a positive correlation between voltage and resistance, i.e.: as the voltage increases the resistance increases and vice versa.

## Conclusion

It is important to remember when using the Ohm's law only applies to resistors that do not increase in temperature: 'ohmic resistors.'

In this experiment however, the temperature of the resistor (the bulb) increases with the voltage. Therefore although the current still increases with the voltage, it does so at a decreasing rate: because of the increased resistance caused by the rising temperature. And therefore, because the bulb's temperature does not remain the same, it does not follow Ohm's law, and it can thus be described as a 'non-ohmic resistor.'

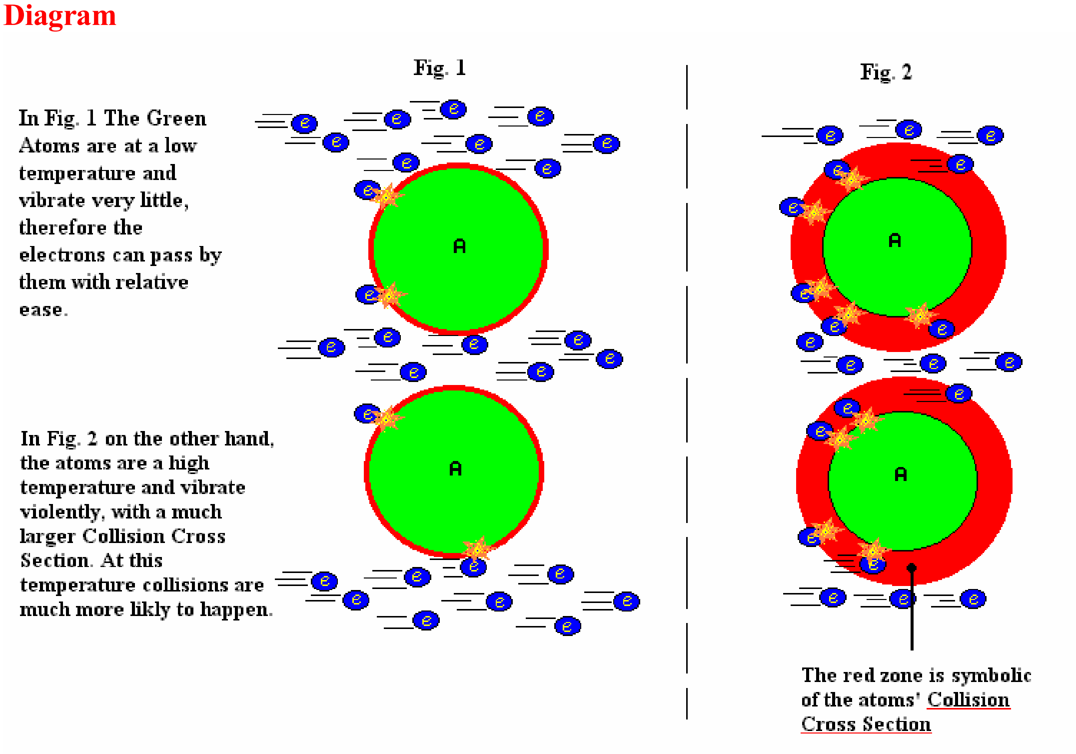
## The effect of temperature on resistance

From our study of kinetic theory we know that the temperature of matter is dependent on with how much energy its molecules vibrate. As I said before, the filament of a bulb is made thin because it needs to resist the flow of electrons in order to glow. When the voltage of electrons is increased, they are given more energy, and as they collide with the atoms in the filament of the bulb, some of their kinetic energy is lost to the filament as heat energy. As the temperature of the filament increases, its atoms vibrate faster and they become even more likely to collide with the electrons, we say therefore that the vibrated atoms have a larger **collision cross section**, i.e.: at higher temperature the atoms are more likely to collide.

This is how temperature affects resistance; the faster its molecules vibrate the larger their collision cross section, and the more difficult it is for the electrons to pass.

This is the reason why the voltage vs. resistance graph is a decreasing curve.

## Diagram




## Evaluation

Overall I think that the investigation has been successful, as I hypothesised there was a positive correlation between voltage and resistance. The results seem coherent and can be backed up with my scientific knowledge of kinetic theory and electricity.

I think that the investigation was executed with a fairly high level of accuracy; this can be seen in the tight grouping of the values measured for current. And because the voltage didn't exceed 6 volts I was enabled to choose a scale with 1 decimal place of accuracy. Likewise for the ammeter, due to the relatively low current in the circuit I was able to measure the current in milliamps (milliamp= thousandth of an amp). Although for the table and calculations this value was converted into amperes. For this type of investigation these levels of accuracy were acceptable.

The only downside with these results was that I could only reliably calculate the resistance to the same level of accuracy as my least accurate measurement, in this case voltage, which could only be measured to one decimal place.

Therefore if I were to do this investigation again, I would change certain aspects of the method and apparatus in order to increase the accuracy and reliability.

Firstly, the reading from the voltmeter could only be taken to one decimal place, limiting the accuracy at which I could reliably state this resistance. To solve this problem I would use a voltmeter whose scale was as accurate to that of the ammeter, 3 decimal places. Preferably I would use digital volt and amp meters that would rule out any human error that might occur when using the naked eye to determining a reading.

Secondly, to increase the accuracy I would obtain more sets of results, perhaps repeat the investigation twice and find an even more accurate average current.