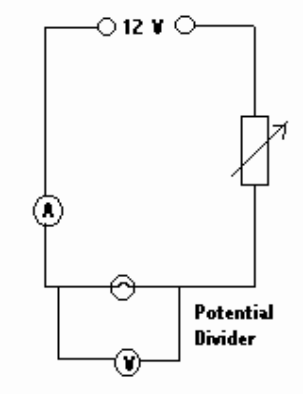
Is a filament lamp an ohmic resistor?

During this coursework I am investigating to find out whether a filament lamp is an ohmic resistor, an ohmic resistor is a resistor that follows ohm's law.



(Left) is the circuit we will be using, in the circuit there is a 12volt battery an ammeter a bulb a voltmeter and a variable resistor.

12 v = 12 volt battery
(A) = Ammeter (V) = voltmeter

= Battery ▭ = variable resistor

I want to get the results as accurate as possible so I shall us a digital ammeter and voltmeter and record my results to 2 decimal places.

Before I started the investigation I had to find some research. I researched 3 books to find out mainly about resistance, ohm's law and ohmic resistors.

The first book was: -
Extension Physics by Brian Milner

"To make a bulb light up, you must out a potential difference (voltage) across it. A current can then flow through the filament of the bulb. The filament resists a current flowing though it, so we say it has a resistance".

"We measure resistance in units called ohms. To measure a resistance you nee to know how big a current flows through it when you put a particular potential difference (P.D) across it. Then you can work out the resistance like this:

$$\text{Resistance (ohms,)} = \frac{\text{Potential difference (volt, V)}}{\text{Current (amperes, A)}}$$

The filament of a bulb becomes hot because it resists the current flowing through it."

Physics for today and tomorrow, 2nd edition: tom Duncan.

Ohm's law:

"When the same p.d. is applied across different conductors different current flow depending on how easily electrons can more in them. The opposition of a conductor's to current flow is called its resistance. A long thin wire has more resistance than a short thick one of the same material because a given p.d. causes a smaller current in it."

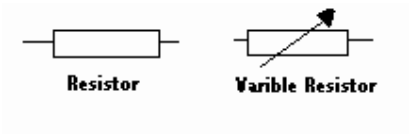
“A good conductor has a low resistance and a poor conductor as a high resistance. Silver is the best conducting material. But copper, the next beat is much cheaper and is used for connecting wire and cables in electric and cables in electric circuits. Good insulators for static electricity are also good for current electricity.
Finally in the last book I got this information, which I think is a lot simple
Heinemann coordinated science: foundation physics: David Song.

Resistance-how difficult it is for electric current to flow through something.

Resistor – An accompaniment in a circuit, which makes it difficult for electric current to flow

You can calculate the resistance with this equation:

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} \quad \text{or} \quad R = \frac{V}{I}$$



You can use resistors to change the current in a circuit. A big Resistance will let a small current flow a variable Resistance

Allow you to vary the current. The theatre technician slides the variable qwert to make the lights brighter and dimmer. It is harder for current has to flow the one end, then the next, the total resistance is equal to the sum of the resistances. It is easier for the current to flow through qwert s connected in parallel. Some current can flow through one qwert, and some through the other. The smaller resistor gets bigger share of the current.

Physics for today & tomorrow

The current through a metallic conductor is directly proportional to the P.D. across its ends if the temperature and other physical conditions are consistent.

After I looked up the information in those book I decided to further my research by looking up ohms law on a website Called http://ohmslaw.com/ohmslaw

Ohms law

Ohms Law is a mathematical equation that shows the relationship between Voltage, Current and Resistance in an electrical circuit. It is stated as:

- V = I x R
- R = V / I
- I = V / R

Where

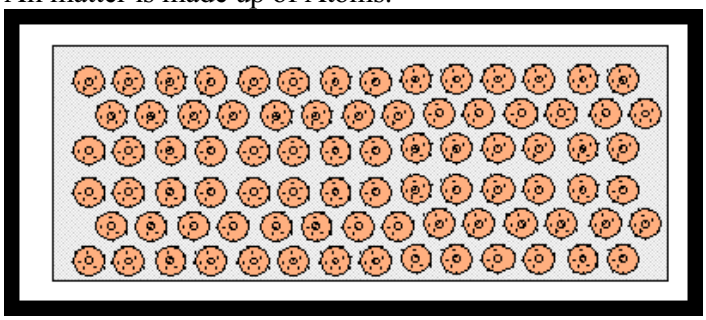
- **V** = **V**oltage
- **I** = **C**urrent (**I** stands for **I**NTENSITY)
- **R** = **R**esistance

In order to understand what Ohms Law is all about you need to understand electricity and what makes Voltage, Current and Resistance in a circuit.

What is Current?

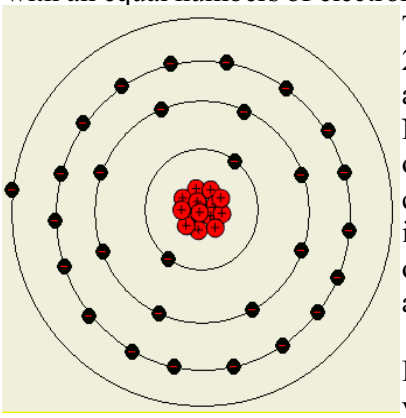
Current is the movement of electrons in a circuit but "What are electrons and what makes them move"

All matter is made up of Atoms.



Piece of metal made up of Atoms

Each atom is made up of a nucleus that has a certain number of protons and neutrons with an equal numbers of electrons in orbit.



The copper atom has 29 protons in its nucleus with 29 electrons orbiting the nucleus. The electrons are arranged in orbits called shells.

Notice that in the copper atom, the outside shell has only one electron. The outer shell of any atom is called the **valence shell.** When the **valence electron** in any atom gains sufficient energy from some outside force, it can break away from the parent atom and become what is called a **free electron**.

It is very easy to provide enough energy to cause the valence electron to become free. Some sources of energy are heat, light, magnetic fields and a voltage source. When the valence electron becomes free it leaves behind an atom that has a positive charge. Remember that the copper atom has 29 + protons and 29 electrons so if one electron leaves orbit we are left with +29 protons and 28 electrons. That means the atom has a more positive charge because of the one less electron. This is an unbalanced atom and is not natural. The atom will always try to get an electron back into the valence orbit to become normal or balanced again.

This is the one fact that you should remember and try to visualize when working with electrical circuits.

Electric current is the movement of electrons from one atom to another in a conductor.

If you can visualize a piece of copper wire with billions of atoms and each one of them losing an electron and all the electrons jumping to other atoms, you will begin to see what current is.

Current is the movement of electrons in a conductor.

The more electrons that move in a conductor the more current you have in the circuit. The name we give to current so we can talk about it is AMPERE and the symbol is I.

Resistance

Resistance is the opposition of electron flow in a circuit and is based on the physical size of the conductors. Since current is the movement of free electrons in a circuit then the number of atoms in a wire make a big difference as to how many electrons can flow at any given time. The bigger the diameter a wire is, the more atoms there are in the wire, so the more free electrons. The smaller the diameter of wire the fewer the number of atoms so the fewer the number of free electrons.

In other words, large size wires will have more atoms therefore more current and small size wires will have fewer atoms and therefore less current.

If we want to control the amount of current flowing in a circuit we can use smaller wire to allow less current and larger wire to allow more current. The name we give to this opposition is called RESISTANCE and the symbol is R. The amount of resistance is called OHMS.

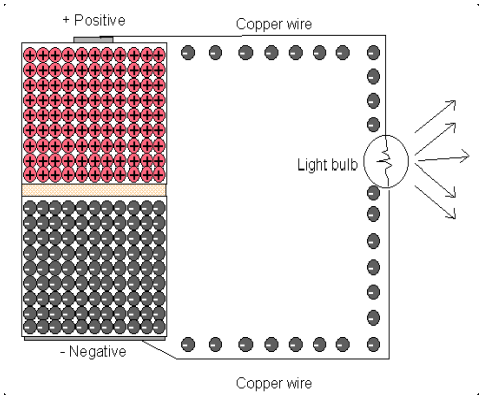
Resistors are components that are manufactured to have a specific amount of resistance and are marked with various values of OHMS. The markings are in the form of coloured bands around the resistor body. To read the value of a resistor you must know the colour code used for the number system.

Voltage

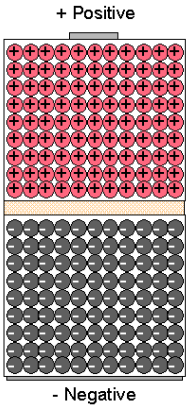
Voltage is the potential difference in a circuit and it is caused by the unbalanced state of atoms. If you recall, when an electron leaves the orbit of an atom it leaves a hole or a positive charge. This hole or positive charge will attract any electron that comes close to it so that it can go back to a normal state. In order to have current flow you must have a source of atoms with missing electrons and you must have a source of negative electrons. If these sources of charges have a current path to flow through then the electrons will be attracted to the positive atoms to fill the holes. You need a complete circuit made of conductive material in order to have current flow and the current will flow from the negative source to the positive source.

Here is picture of how you can think of a voltage source like a battery. Notice that the top half of the battery has all positive charges and the bottom half has negative charges.

The following picture shows a complete circuit that the electrons can follow to produce current.



Ohms law states that if you have **one volt** applied to a **one ohm** resistance the current will be **one amp**.



Knowing that, it is possible to calculate the voltage, resistance and current in a circuit if you know 2 of the values using the equations V=IxR, R=V/I and I=V/R

Method

1 The first crocodile clip is clipped to the wire at the 0cm position on the metre rule.
2.The second crocodile clip is clipped to the required position depending on the required length of wire.
3.The power supply is turned on. The voltage and current are then read off the ammeter and voltmeter, and recorded.
4.The power supply is then turned off and the second crocodile clip is moved to the next position.

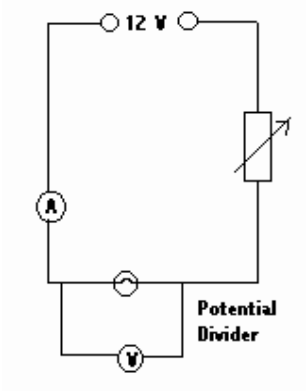
The above steps are completed for each length and then the entire investigation is repeated for accuracy. I will also use digital ammeters and voltmeters for accuracy.

OBSERVATION

With reading my research I have came to a prediction that The longer the wire, the higher the resistance this is because the longer the wire, the more times the free electrons will collide with other free electrons This is because, the particles making up the metal, and any impurities in the metal. So, more energy is going to be lost in these collisions as heat.

I set out my apparatus as shown;

Using this I decided to record results I decided to simultaneously record the volts and amps to work out the resistance.



Length	Amps	Volts	Resistance( )
15cm	3.78	0.85	0.22
30cm	2.75	1.28	0.47
45cm	2.33	1.47	0.63
60cm	2.01	1.61	0.80
75cm	1.77	1.74	0.98
90cm	1.53	1.91	1.25
100cm	1.31	1.94	1.48

But we did not include the variable resistor at first. We placed a thin copper wire along a metre stick and took reading of how many amps, there was and the potential difference and increase the length of the wire by 15cm until we got to 100cm. Then we divided the amps by the potential difference to work out the resistance to see if it was an ohmic resistor.

I did the following calculations

- V = I x R I = Current (I stands for INTENSITY) (Amps)
- R = V / I R = Resistance
- I = V / R **V = V**oltage (potential difference)

R = V / R
0.22 = 3.78 / .85

To make sure the results were accurate I first attached the conductor at 15 cm then raised it to 30cm, then to 45,60,75,90,100 cm.

By the chart I noticed that has I increased with the length, and also the lower the amps the higher the volts

Safety

In order to perform a safe experiment, a low voltage of 3V was chosen so that overheating was minimilised. Furthermore, lengths lower than 15cm were not tried, which also helped to avoid overheating.

Now I added a variable resistor to my circuit. The job of this is to vary the amount Amps going round the circuit.

With Variable resistor

Length	Amps	Volts	Resistance( )
1. 15cm	0.10	0.02	0.20
2.	0.12	0.02	0.17
3.	0.14	0.03	0.21
4.	0.21	0.04	0.19
5.	0.28	0.06	0.21
6.	1.94	0.41	0.21

Length	Amps	Volts	Resistance( )
1. 30cm	0.09	0.04	0.44
2.	0.11	0.05	0.45
3.	0.14	0.06	0.43
4.	0.20	0.09	0.45
5.	0.29	0.13	0.45
6.	1.69	0.74	0.44

Length	Amps	Volts	Resistance( )
1. 45cm	0.09	0.05	0.50
2.	0.10	0.06	0.80
3.	0.15	0.09	0.60
4.	0.21	0.13	0.62
5.	0.33	0.20	0.63
6.	0.67	0.41	0.61

Length	Amps	Volts	Resistance( )
1. 60cm	0.08	0.06	0.75
2.	0.10	0.08	0.80
3.	0.14	0.11	0.79
4.	0.22	0.18	0.82
5.	0.38	0.30	0.79
6.	0.62	0.44	0.79

Length	Amps	Volts	Resistance( )
1. 75cm	0.08	0.09	1.13
2.	0.11	0.11	1.00
3.	0.14	0.15	1.07
4.	0.21	0.21	1.00
5.	0.31	0.31	1.00
6.	0.50	0.50	1.00

Length	Amps	Volts	Resistance( )
1. 90cm	0.08	0.17	2.13
2.	0.10	0.20	2.00
3.	0.15	0.30	2.00
4.	0.25	0.46	1.84
5.	0.40	0.57	1.43
6.	0.86	1.27	1.48

Length	Amps	Volts	Resistance( )
1. 100cm	0.09	0.12	1.30
2.	0.12	0.16	1.30
3.	0.16	0.22	1.38
4.	0.25	0.34	1.36
5.	0.48	0.64	1.30
6.	0.95	1.29	1.36

Conclusions

Having performed the investigation, the following conclusion were drawn:

As predicted, an increase in length resulted in an increased resistance

Evaluation

Looking at the graph i can see that ohms law does happen with the variable resistor

If thought that Ohm's Law applies, and then another possible explanation could be that at some points properly in the lower lengths, the wire was not allowed to cool completely so that the temperature was higher for that measurement. Whilst unlikely this would cause a higher resistance as explained previously. However, it is now known, after researching the metal alloy "constantan," that the resistivity which is the electrical resistance of a conductor of particular area and length of this alloy is *not* affected by temperature. So, in these experiments Ohm's Law does not apply.