Electrical Properties of a Filament Lamp – Does a Filament Lamp Obey Ohm's Law?

Prediction

I predict that the filament lamp will not obey Ohm's law, as the temperature cannot be kept constant through a bulb. The brighter the bulb is the more heat will be released. Ohm's law only applies when the temperature is constant. I expect the amps to increase as the voltage does as well as the resistance, so I expect the graph to have a positive gradient. The graph will have voltage (V) plotted on the x-axis and the current (I) will be plotted on the y-axis. After the bulb has been lit there will be a steep gradient on the graph, but after a while the gradient will become less steep and slowly the graph will start to become more cureved, as the resistance will not be increasing at a constant rate.

Scientific Explanation

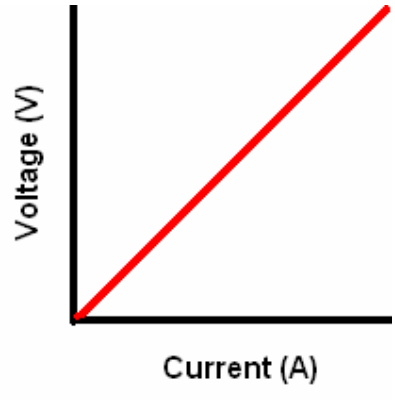
I came to my prediction after considering Ohm's Law. Ohm's Law is named after the scientist that discovered it and expresses the relationship between voltage, resistance and current. It stated that voltage (V), current (I) and resistance (R) are directly proportional.

Ohm's Law most simply translates to the equation, V = IR, or:

Voltage = Current × Resistance

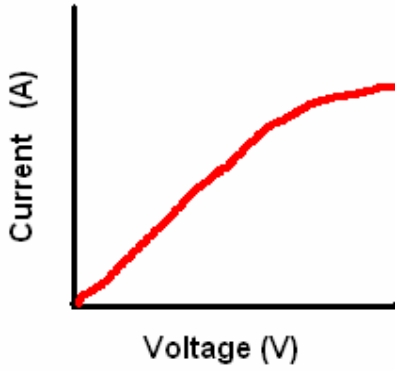
However, this law only applies when there is a constant temperature. A filament light bulb produces heat that cannot be kept constant. As the lamp gets brighter it will produce more heat.

If the voltage and current are directly proportional for a metal conductor at a constant temperature we can expect a graph of results to look like this:



The current and voltage would rise proportionally resulting in a straight line. If you double the voltage, the current will also double.

Because the lamp does not have a constant temperature, the graph will result in a curve and therefore will not obey ohm's law. The graph will look more like this:



The reason that Ohm's law has to have constant temperatrure is because the electricity flows through the filament in the light bulb. It is hard for the electrons to move through the filament. As the electrons move they bump into the filament's atoms and give up part of their energy. This loss of energy knocks the voltage and current out of proportion. As the lamp gets hotter, its atoms vibrate more rapidly which bump the electrons more vigorously and cause the loss of the electron's energy to happen faster. This explanation shows how I came to the prediction that the filament light bulb will not obey Ohm's law.

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Variables

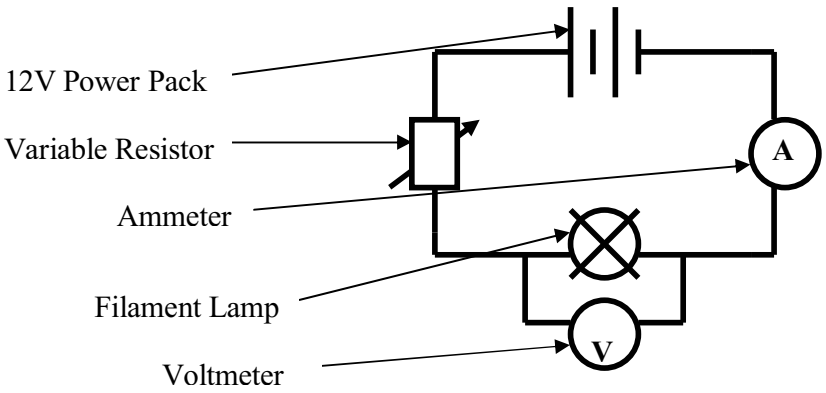
I am going to change the resistance and monitor the voltage and current. I am going to use the voltage as a basis for the experiment and for every 1volt increase I will record the current reading. The voltage will be controlled by a variable resistor.

I am going to use the same equiptment througout the experiment because different bulbs may have filaments with different resistors. I am going to wait for the bulb to cool down to it's original temperature after every attempt so the temperature of the filament lamp is the same for every attempt.

Preliminary Work

I set up the equiptment for the experiment that I am going to do. I used the variable resistor to find the minimum and maximum voltage that I could record. The maximum voltage was 10.8V and the minimum was 1.8V. This information is important because it means I can draw up the basis for my table of results. I have decided to take ten values, one record every 1 volt. I feel that this number of results will enable me to draw an accurate conclusion.

Method



- I will connect up the ammeter, the variable resistor, the filament lamp and the voltmeter with wires. Then I will attatch the power pack and plug it into the mains supply.

- I will set the variable resistor to the point that 1.8V shows up on the voltmeter. I will then take the ammeter reading and record it in a table.

- I will alter the variable resistor until the voltmeter shows an increase of one volt and take the ammeter rading. I will reapeat this until I have all ten records and the voltmeter reads 10.8V.

- I will repeat the experiment three times to get a more accurate result. After each experiment I will allow the lamp to cool down for 15 minutes so the heat produced from the last attempt doesn't affect the next attempt.

- I will measure the current in amps.

- I will take the average from all three attempts to get accurate results and plot a line of best fit to eliminate anomalies.

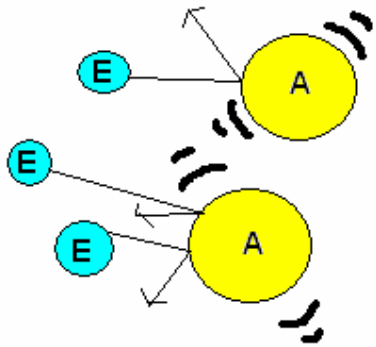
Safety

Whenever using mains electricity in experiments you must be careful to avoid electric shocks. Make sure that when the experiment is finished tthat you turn off all electricity. Do not let wires connected to electricity make contact with your skin. The filament lamp can become very hot so make sure that you do not burn yourself on it. Make sure none of the equiptment is faulty.

Conclusion

In conclusion the results graph proves that a filament bulb does not obey Ohm's law as the gradient changes in steepness and curves horizontally. This proves that the increase in resistance was not constant; otherwise the line would have been straight.

I believe that filament lamps aren't ohmic resistors because of the heat generated by the bulb. I think this because if the bulb is generating heat, then the heat cannot be kept constant throughout the experiment. And as Ohm's law says, 'this is only true when the temperature is kept constant'. The scientific reason that heat affects the resistance is in the electons. The lamp's atoms vibrate violently when heated. The electrons meet the atoms, they hit them and lose some of their energy because the atoms knock them with a lot of force.



If the lamp obeyed ohm's law, the resistance would be the same. My results fully agree with my prediction. I knew that Ohm's law only applied when there is a constant temperature and I knew that a filament lamp does not provide these conditions.

Evaluation

My results were of good quality and have produced a good conclusion. The graph showed no anomalies and produced a smooth curve. I did the experiment three times so I could find the average result. This reduces the risk of any slight anomalies really affecting the final results.

To refine my method I could have let the lamp cool down for a longer period of time to ensure each experiment was the same. I could have done more experiments to get a more accurate average. I could refine my results by taking more readings of the voltage and current. I could have measured the results in Millie-amps to get an accurate result.

I think my results are sufficiently accurate because I have similar results with other members of my class. I did repeat the experiment three times to make sure it was accurate. My research agreed with my findings. I also have enough results to draw an accurate conclusion.

"There are conductors in which the current that flows is not proportional to the applied voltage. These do not follow this law and are called nonohmic conductors." Columbia Encyclopaedia, Sixth Edition. This quote says that the filament lamp is a nonohmic conductor because it does not follow Ohm's law.