Physics coursework

Visit summary report

For our physics coursework we had visited the Wembley arena on the 20th January, 2009 to watch a cultural event performed by a few Bollywood film stars. Wembley arena is a unique and special hall of London, where great numbers of events are hosted quite often.

On the day of our visit, once we settled in to watch the cultural show; I was amazed by the decorations and the thousands of dazzling lights of the arena. The show had the most impressive selections of music; its sounds were heard all the way through the show. As it was in my mind to look for some real applications of physics in our daily lives, I was observing how the beautiful lighting and sound were being controlled. From the knowledge I have so far gained suggests that these lighting and sound were being controlled by resistance in the electrical circuits involved.

Theory

What is resistance?

Electricity is conducted through a conductor, in this case wire, by means of free electrons. The number of free electrons depends on the material and more free electrons means a better conductor, i.e. it has less resistance. For example, gold has more free electrons than iron and, as a result, it is a better conductor. The free electrons are given energy and as a result move and collide with neighbouring free electrons. This happens across the length of the wire and thus electricity is conducted. Resistance is the result of energy loss as heat. It involves collisions between the free electrons and the fixed particles of the metal, other free electrons and impurities. These collisions convert some of the energy that the free electrons are carrying into heat. Resistance is usually given the symbol 'R'. The unit for electrical resistance is the ohm. Ohm's law is the voltage drop (V) across a resistor proportional to the current running through it.

The resistance of a given wire can be calculated using the following equation:

$R = \rho L / A$
Where:
L = Length (m)
A = cross-sectional area (m2)
ρ = resistivity of the metal
By rearranging the equation the resistivity of the metal can be calculated:
$\rho = R A / L$

The resistivity differs depending on the metal however it is constant at room temperature for each metal. This means that two pieces of wire made of the same metal and at room temperature should give the same result when calculating resistivity regardless of its length and cross-sectional area. The following equation can be used to calculate the resistance of a wire:

$R = V / I$ where: V = volts
I = amps
R = resistance

The factors affecting resistance

The resistance of a piece of wire is dependent on its temperature, length, cross-sectional area and the type of metal the wire is made of.

- Temperature of the wire: The higher the temperature of the wire, the higher the resistance. This is because the ions get more vibration energy and vibrate faster. The electrons are then repelled off course even more due to the ions interpreting their path.
- Length of wire: The length of the wire is directly proportional to resistance. Direct proportionality is a relationship in which one variable goes up if the other goes up, and down if the other goes down. The longer the wire, the more amounts of ions for the electrons to collide with. This means that it will take longer for the electricity to pass.
- Cross Sectional of the wire: A thick wire presents less resistance to the flow of electrons than a thin wire of the same material. The larger the cross-section, the lower the resistance. Resistance is inversely proportional to the cross section of the wire, (a relationship in which one variable goes up as the other goes down) therefore if the width is doubled, the resistance is also doubled.
- Material of the wire: Metals are the ideal conductors of electricity because they have free electrons that help the flow of current. The denser the material, the more atoms per unit of volume. So, the number of collisions increases. Insulators like Plastic or wood have such high resistance that they stop the current altogether.

Economical effects

Resistance occurs in using electricity; hence it is important to know the effects of consuming excessive electricity. One of the societal impacts is global warming. Global warming has been increasing in the past few years due to the increase in the production of carbon dioxide, among other gases, and fossil fuels. This can also result to pollution and acid rain, which damages our environment, destroys our ecosystems and our natural resources. Not only that, but our sea levels and rainfall can also be affected. Moreover, in terms of health, the products released from the combustion of fossil fuels are extremely dangerous, and could form respiratory and cardiac diseases, among other disabilities. When referring to our economy, we can see that people will start having money problems as not only will the prices for electricity increase but salaries have been lowered, due to the fact that our natural resources are running out because we are using them excessively.

Variable factors

The factors that I am going to vary are the length of the constantan wire and by adjusting the variable resistor to keep the voltage at a fixed value, I shall be measuring the corresponding current for different lengths such as 0cm,10cm, 20cm, 30cm, 40cm, 50cm, 60cm, 60cm, 70, 80cm and 90cm.. The factors that I am going to keep constant are: the thickness of the wire, the same wire, temperature and the set up of the circuit should be the same.

Apparatus:

- constantan wire
- power pack
- meter ruler
- crocodile clips
- sellotape
- connection leads
- ammeter
- voltmeter
- variable resister

Circuit diagram

Method

I started off with the experiment by setting up the circuit as shown above. I had to be careful in connecting the circuit, because the voltmeter had to be placed in parallel and the ammeter, which had to be placed in series. The constantan wire was cut to just over 100cm so the crocodile clips could attach onto the wire, making the results more accurate.

I stretched out the wire and sellotape it to the ruler. I did this so I do not need to cut the wire every time, all I have to do is just move one of the crocodile clips to another length. The power supply is then switched on. I will then record the reading of the ammeter and put the results in a table. After this I will adjust the variable resistor to 3 volts, which would show up on the voltmeter, I will record the reading of the ammeter. I will once again adjust the variable resistor to 3 volts this time and record the reading.

Safety

The safety precautions that I need to be taken into consideration are: Handle the power supply carefully. Be careful when touching the wire, it may be hot, it might even burn if the voltage exceeds. Do not carry out the experiment in wet areas, as waster is a very good conductor of electricity, which could be dangerous if it comes in contact with the current.

Fair testing

To ensure that I conduct a fair test I will ensure that the experiment is done at least twice to have more reliable and accurate results. Wire measurements are kept the same and the equipment is in a good working order. I will also ensure that the thickness of the wire stays constant for each length and current. I shall also ensure that the current passing through the wire will not change until all the lengths of wire have been tested and the voltages recorded, then I will increase/decrease the current to the desired voltage. After every time I experiment I will let the wire cool down before I start my other experiment. And to improve the accuracy I will ensure that the use of the ruler, wires, etc remains the same. I will also record the readings from the ammeter and voltmeter by 3 decimal places.

Observations

I will observe the resistance of the circuit and the current, the voltage and ohms. I will also observe the thickness has any effect on resistance and length. The will also observe the temperature to make sure the heating effect does not change any readings.