Chapter Two: Electricity

Static Electricity

-**Static electricity is when an electrical charge is held by an insulator or an insulated conductor**

-Rubbing a polythene rod with a dry cloth means that the electrons are transferred to the rod, the rod is negatively charged and the cloth is positively charged

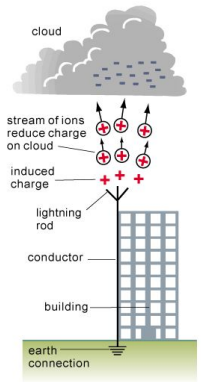
-Rubbing a Perspex rod with a dry cloth transfers the electrons to the cloth, the cloth is negatively charged, the rod is positively charged.

Electric Fields

-**An electric field is a region where a force acts on a charged particle at a distance**

-An electric field will be strongest nearest the charged particle, where the field lines are the closest together, these arrows travel from positive to negative

-Lightning is caused when a negatively charged cloud passes over an area, a positive charge is induced (the negative charge in the cloud repels the electrons on the object, and the positive ions are attracted), when the difference in charges are strong enough to ionise the air, lightning sparks



Current

-**Current is the flow of charge in a circuit, a flow of electrons**

-The size of an electric current is the rate of the flow of electrical charge (electrons)

-This moves from negative to positive through the circuit

- Measured with ammeters which goes in series in the circuit

$$I = Q / t$$

Current = Charge / time

Potential Difference

-**A measure of the work done or energy transferred to a component by each coulomb of charge that passes through it**

-Measured with a voltmeter which goes in parallel in the circuit

$$V = I \times R$$

Potential Difference = current x resistance

Resistance

-**Is a measure of how hard or easy it is for charge to flow through a circuit**

-In general, the hotter a material is, the more that its particles will be vibrating, meaning there is more resistance as it is harder for the charge to flow

-Ohm's law states that **'the current through a resistor at a constant temperature is directly proportional to the potential difference across the resistor'**

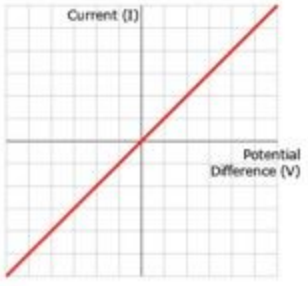
Series and Parallel Circuits

	Series	Parallel
Current	Is the same everywhere in the circuit	Is shared between the components
Voltage	Is shared between the components	Is the same across each component
Resistance	For the whole circuit the total resistance is the sum of all of the individual resistors $R_{total}=R_1+R_2+R_3$	

I-V Graphs

-Plot the potential difference on the X axis and the current on the Y axis

-The steeper the line, the less resistance there is (resistance = 1 / gradient)



The graph shows the resistor is obeying Ohm's Law. The straight line tells us the current is proportional to the potential difference across the resistor.

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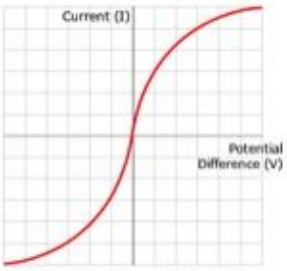
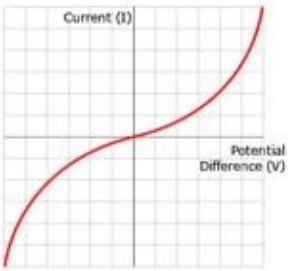
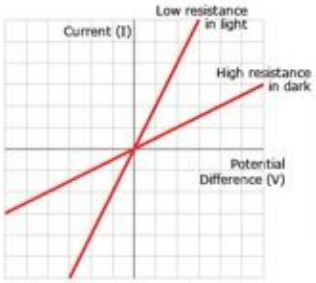


The graph for a filament lamp is not a straight line and therefore does not obey Ohm's Law. As more current flows in a lamp the metal filament gets hotter. The metal atoms in the filament vibrate faster and further from their positions. This results in an increase in collision with the travelling electrons hindering their flow and causing more resistance. This is shown by the flattening out of the graph as the current increases indicating that the resistance is increasing.



The graph for a thermistor is not a straight line and therefore does not obey Ohm's Law. The plot is actually the reverse of that of the lamp. As more current flows the graph gets steeper. The thermistor is a semiconductor and conducts more electricity when heated. This is because as the temperature increases the thermistor makes available more free electrons to carry the current. Therefore as the current increases the thermistor get hotter releasing more electrons resulting in a reduction in resistance.



An LDR is a semi-conductor. When light shines on it releases electrons which increases the number of electrons to carry the current. Thus, as the light increases the current increases resulting in a reduction in resistance. In the dark however no extra electrons are available so the current experiences a greater resistance.

Control Circuits

-Thermistors decrease the resistance with an increasing temperature, it is a form of semiconductor, meaning it conducts more easily when heated

-Thermistors can be used for:

- *to turn on a greenhouse heater when it gets cold*
- *to act as a fire alarm*
- *keep a fish tank from getting too cold*

-Light dependent resistors (LDRs) become less resistant when the amount of light increases within them

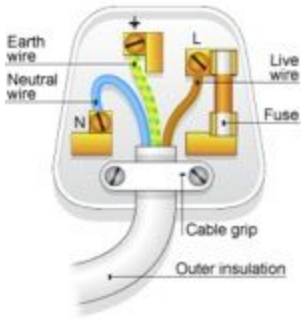
-LDRs connected in the right way can be used as light meters to:

- *tell a cricket umpire when it is too dark*
- *to turn on streetlights when it gets dark*

-Diodes only let electricity flow across them in one direction, they need about 0.6V to start conducting

Electricity in the home

-**Mains electricity has an alternating current (50Hz) and is at 230V**



-The live wire carries a high PD into and around a house, the fuse is always connected to the live wire

-The neutral wire provides a return path to the local substation, the neutral wire is earthed, there is no current in the neutral wire until the appliance is connected

-The earth wire is connected to the metal case of an appliance, providing a path to the ground to prevent the case from becoming charged

Transmitting electricity

-**The national grid is a collection of power cables and transformers that connect power stations to factories and houses**

-The pd of the electricity passing through the wires is 40,000V, this means that there is less resistance, making the process more efficient

-Transformers are responsible for either increasing or decreasing the potential difference of the electricity (230V in houses, 40,000V in the national grid)

-Step up transformers increase the pd, whereas step down transformers decrease the pd

Energy Transfers

-Energy needs to be transformed from either mains electricity or batteries in order to be useful

-When charge flows in a circuit, electrical work is done (energy is transferred)

$$E = Q \times V$$

Energy transferred = charge x potential difference

Power

-**Power is the amount of energy transferred per second**

-A more powerful appliance can transfer energy more quickly

$$P = V \times I$$

Power - potential difference x current

$$P = I^2 \times R$$

Power = current^2 x resistance