Current in series circuits:

Current flows from positive to negative. (conventional current)

Electron flows from negative to positive

Current is the flow of charge around the circuit.

Current in a series circuit is the same all the way round wherever you measure.

Current in parallel circuits:

The current in parallel circuits splits to the different branches (shared).

Potential difference in series circuits:

Potential difference is the amount of energy transferred.

Potential difference is shared in series circuits between the components.

Potential difference in parallel circuits:

Potential difference in parallel circuits is the same for all the components.

Branches with more than one component share the potential difference but both of those sum up to equal the potential difference of the other components.

Potential difference from batteries:

A battery contains two or more cells.

Potential difference of the cell adds up to equal the potential difference of the battery.

Charge in circuits:

Charge is measured in coulombs (C)

Charge = Current x Time

$Q = I \times t$

Calculate energy transferred by components:

Energy = Charge x Potential difference

$E = Q \times V$

$Q = E/V$ - (easier to remember)

Resistance:

Current is the flow of electrons in a circuit.

As electrons move through a component such as a wire, the electrons collide with atoms in the wire. This causes the transfer of electrical energy into thermal energy.

The resistance tells us the potential difference required to drive a current through a component.

The higher the potential difference = The higher the resistance

Resistance is measured in Ohms.

$R = V/I$

Resistance = Potential difference/Current

$V = I \times R$

<u>Resistors in circuits:</u>

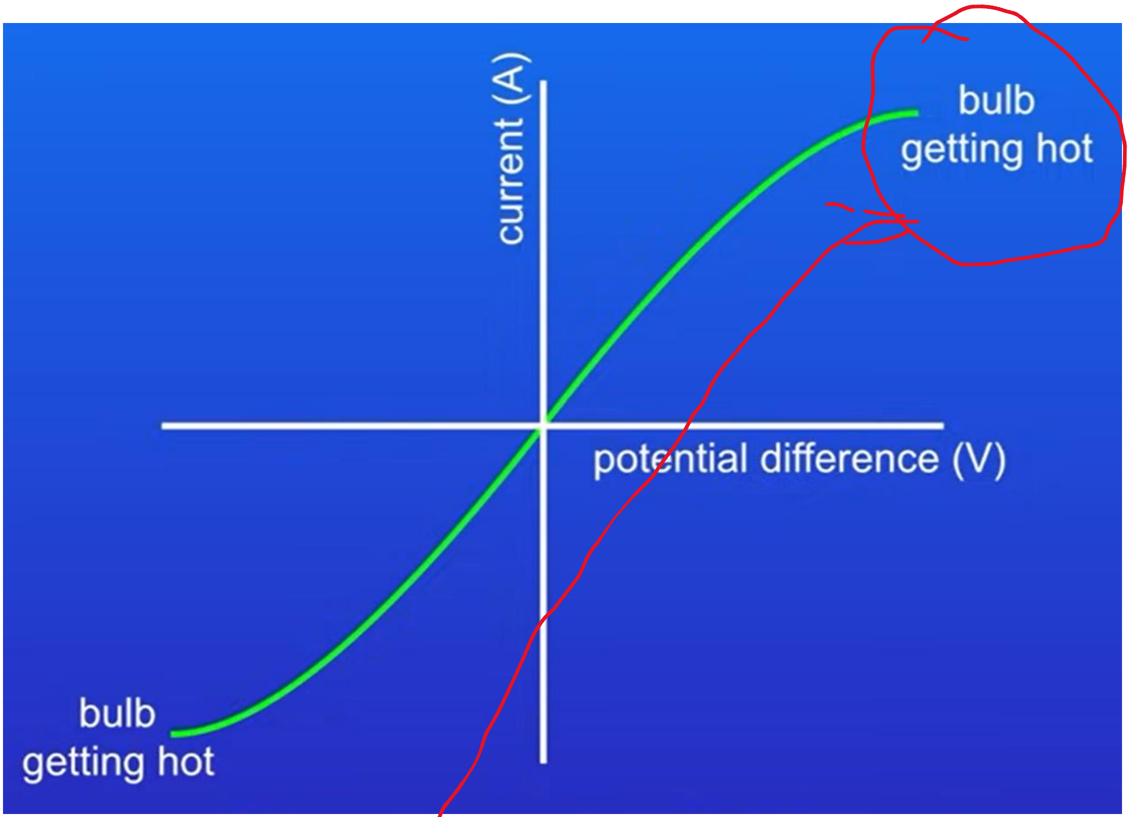
Definition of an Ohmic conductor:

The current is directly proportional to the potential difference when the temperature is constant.

Resistance of a filament lamp:

The current through a filament lamp is not directly proportional to the potential difference because the temperature is not constant. This causes the atoms to vibrate more causing more collisions between the electrons and the atoms increasing the resistance.

This graph shows the relationship of the current and the potential difference between the filament lamp:



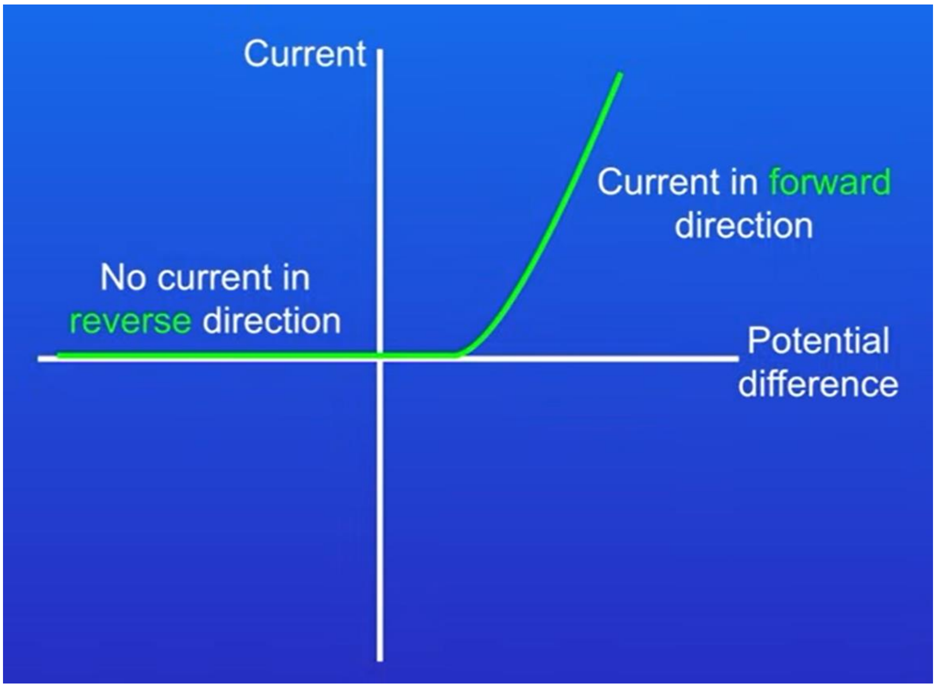
The resistance is increasing so the current is no longer increasing

Diode and LEDs:

The current through a diode only flows in one direction because the diode has a very high resistance in the opposite direction.

Diodes are useful for controlling the flow of the current in the circuit.

This graph shows the relationship between the current and the potential difference:



An LED is also a diode.

An LED emits light when the current flows through it

LEDs are a very energy efficient source of light

Resistors in series and parallel circuits:

V= I x R

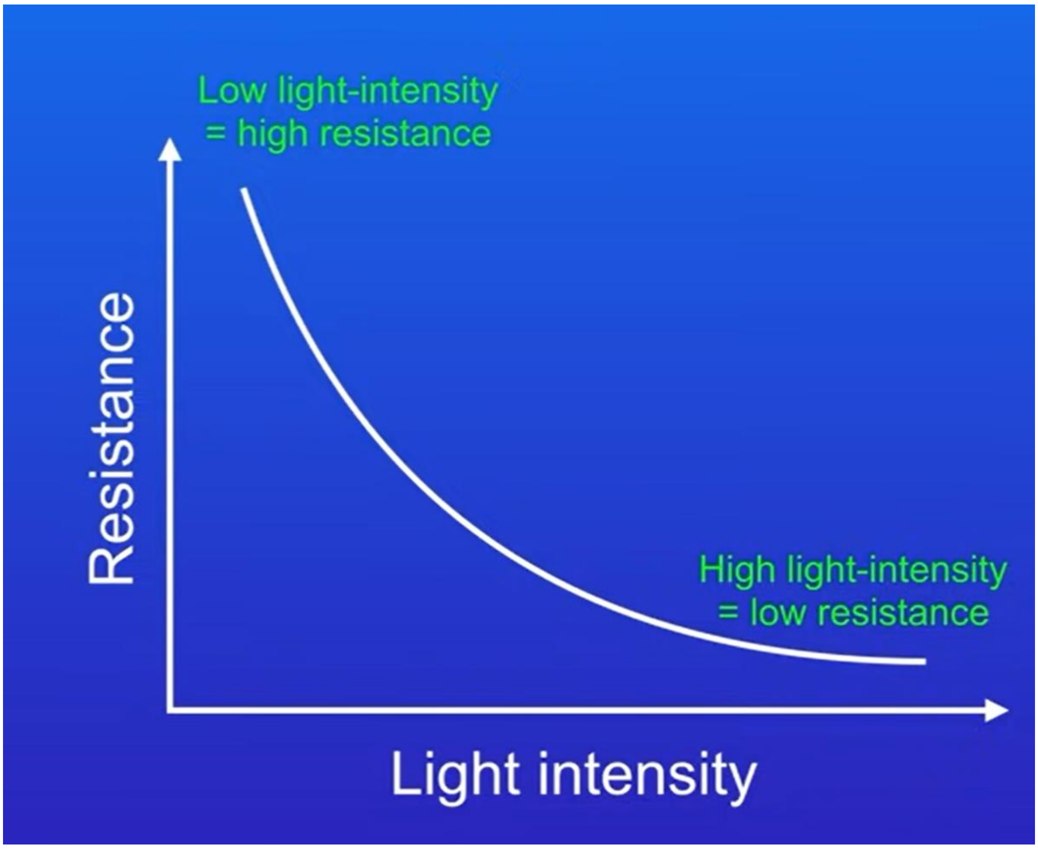
In series circuits, the resistors in series add together. This is because the current has to go through each resistor in series.

In parallel circuits, the resistance of resistors is less than the resistance of the smallest resistor. This is because there are more pathways for the total current to flow so more total current will flow and the resistance will decrease.

If the current has increased but the potential difference has not changed then the total resistance will decrease

Light dependent resistors:

In dark conditions the LDR has high resistance:

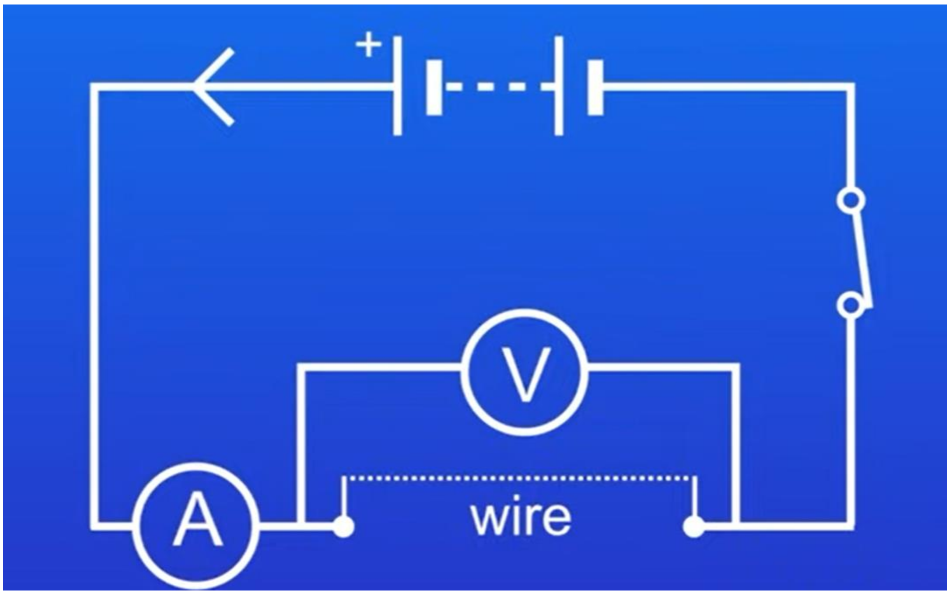


It takes very little energy for the current to pass through the LDR because it has low resistance. This makes the potential difference low.

Thermistors:

When the temperature increases, the thermistor resistance decreases

Required practical - resistance:

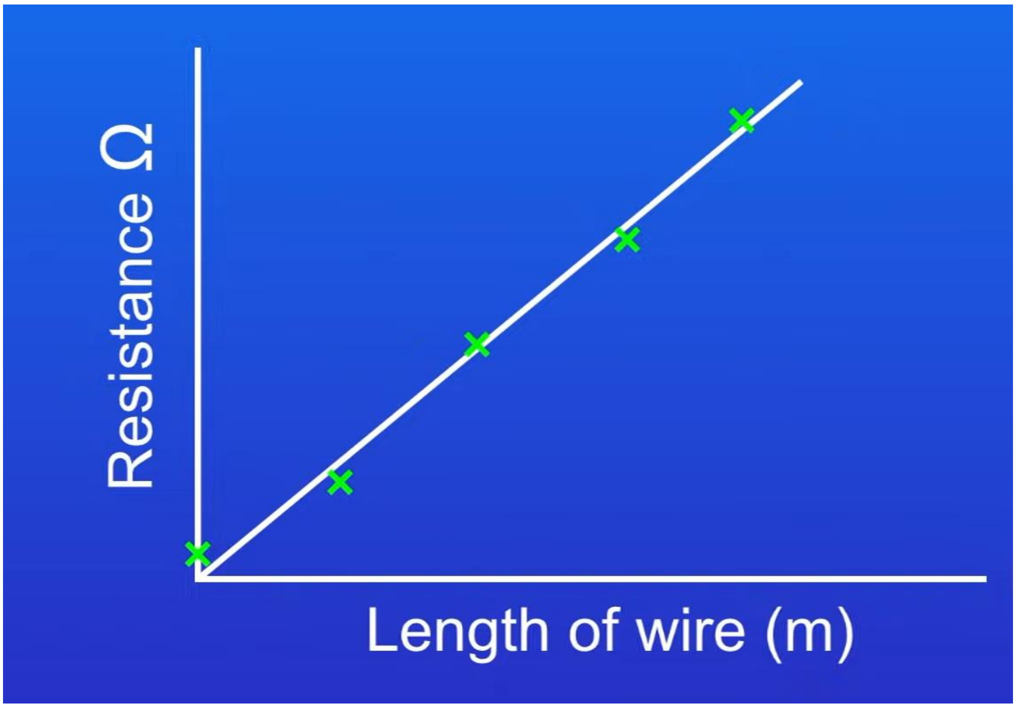


Steps:

1. Connect a battery pack to the circuit.
2. Connect an ammeter to measure the current.
3. Connect the voltmeter to measure the potential difference.
4. Attach a wire to a meter ruler using tape
5. Connect the wire to the circuit using two crocodile clips.
6. Turn off the circuit in between readings to stop the wire from overheating.
7. Move the crocodile clips further apart to increase the length of the wire.

8. Record the readings for each of the different lengths and write these results into a table.
9. Calculate the resistance using the equation – $R = V/I$
10. Plot a graph to show the relationship between the resistance and the length of the wire

This is what the graph should look like:

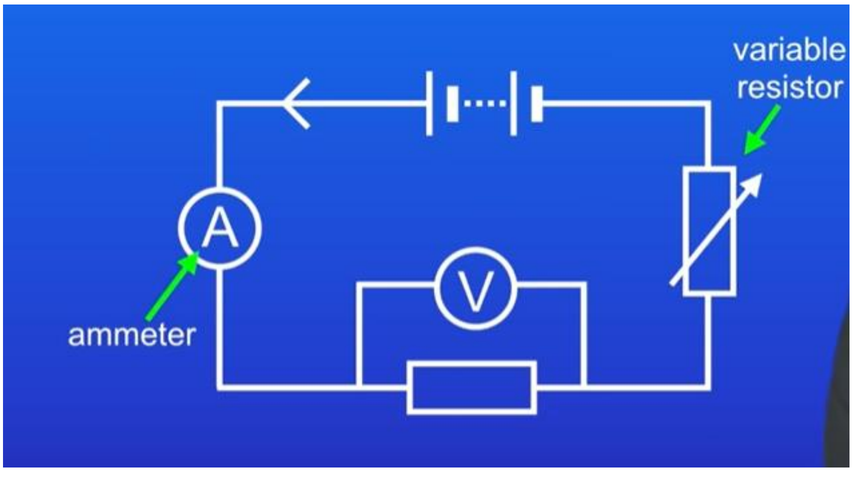


The resistance of the wire is directly proportional to the length of the wire

Problems with this practical:

- There is a small resistance when the length of the wire is 0m (zero error – A value on the instruments that should be zero but isn't)
    Solution – Subtract amount from result
- The crocodile clip is not at zero on the meter ruler
- There is also resistance caused by the contact between the crocodile clip and the wire
- If the temperature of the wire increases, the resistance will also increase.
    Solution – Use a low potential difference which will help keep the current low and stop it from overheating
    Solution – Turn off the circuit between readings.

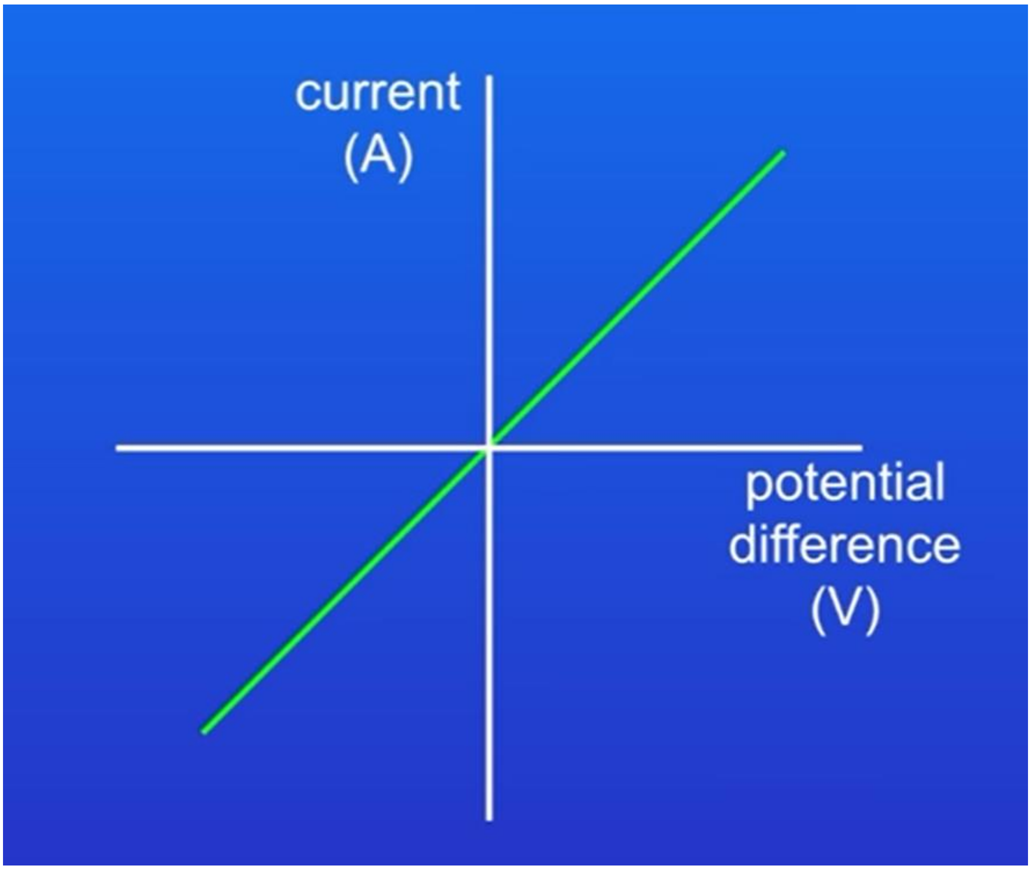
Required practical – I/V characteristics of components:



1. Connect a battery pack to the circuit.

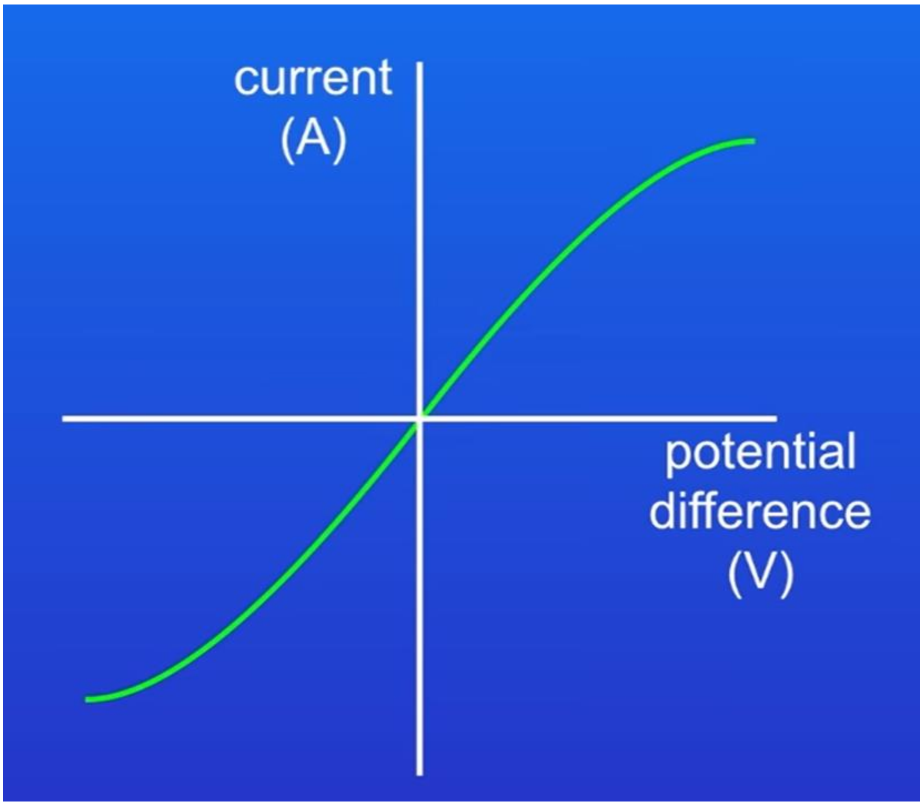
2. Connect an ammeter to measure the current
3. Connect a resistor.
4. Connect a voltmeter which takes readings of the resistor.
5. Connect a variable resistor.
6. Use the voltmeter to read the potential difference across the resistor.
7. Use the ammeter to read the current through the resistor.
8. Record these results in a table
9. Adjust the variable resistor by sliding the slider and record the new readings
10. Do this several times to get a range of readings
11. Switch the direction of the battery
12. There should be negative values now
13. Take several readings of the negative values
14. Plot a graph using the data from the table showing the relationship of the current and the

potential difference:



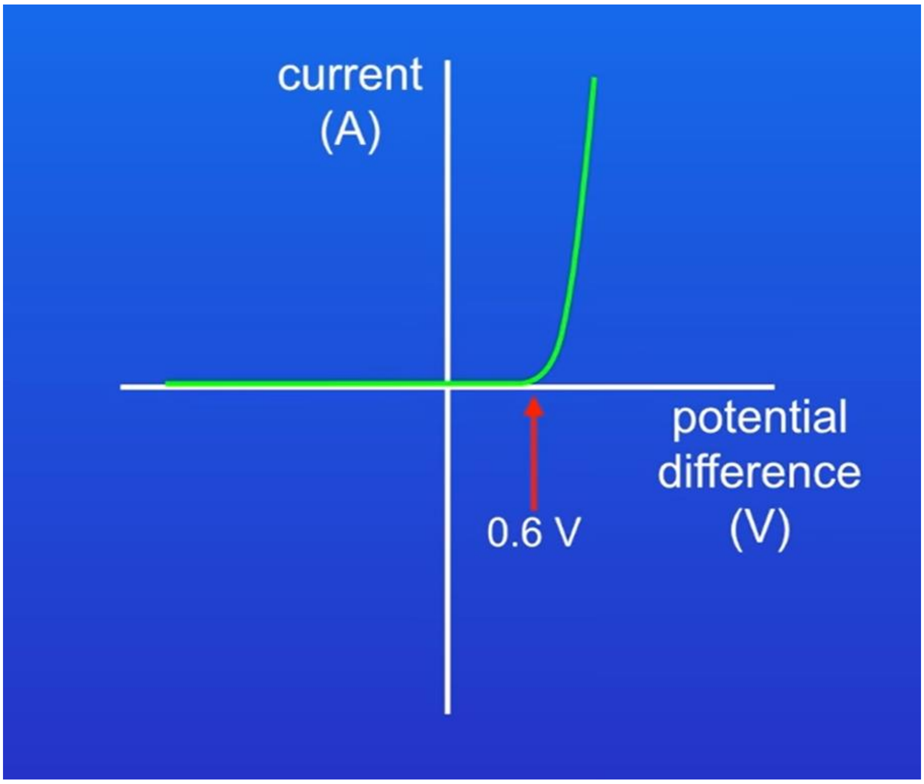
Now replace the resistor with the filament lamp and repeat these steps

The graph for the filament lamp in this practical:



1. Now repeat this experiment with a diode replacing the filament lamp.
2. Add an extra resistor to the circuit – This is because diodes are damaged by high currents. The extra resistor will keep the current low and protect the diode
3. Replace the ammeter with a milliammeter because of the sensitive results
4. Repeat the steps of the first time

The graph for the diode:



There are no negative values because the diode has a high resistance in the reverse direction

Energy transferred by appliances:

Power is the rate at which energy is transferred (1W = 1J)

Appliances which generate thermal energy have a high power rating

Calculate energy transferred:

$E = P \times t$

Energy = Power x time

Power of components:

P = V x I

Power = Potential difference x Current

DC and AC supply:

The current from a cell is DC supply

Mains electricity is AC supply

Benefit – Able to use transformers to increase or decrease potential difference

AC switches directions 50 times a second (50 Hz)

AC has 230 volts

Oscilloscope:

An AC has very different changing potential difference

A DC is just a straight line

Time interval = Time for potential difference to change back (time between two peaks)

Frequency = 1/time interval

Mains electricity:

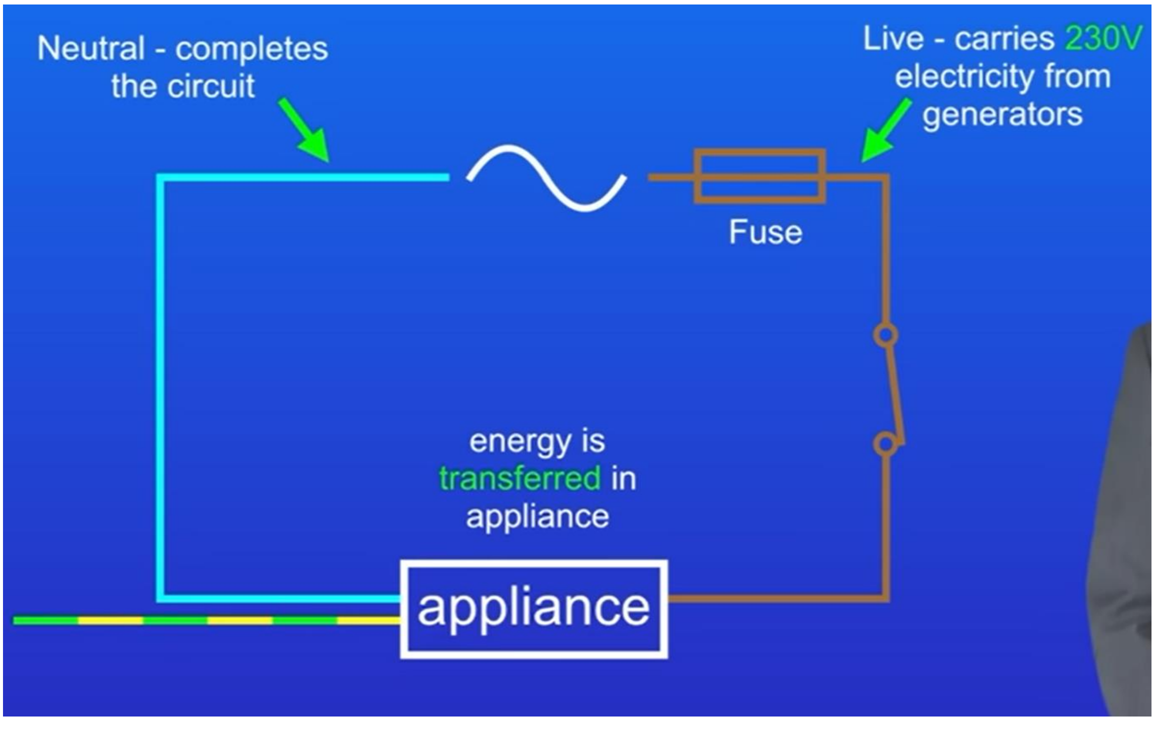
Mains electricity is an AC

Appliances are connected to an AC using three core cables:

- Live wire
    - Carries the alternating potential difference from the supply (brown)
    - Connected to a fuse
    - Dangerous to touch
- Earth wire
    - Safety wire: Connected to the ground with a metal rod (The current flows to the earth wire and goes into the ground and the fuse shuts off the current)
    - Green/yellow striped wire
- Neutral wire
    - Completes the circuit
    - Potential difference is 0v
    - Blue wire

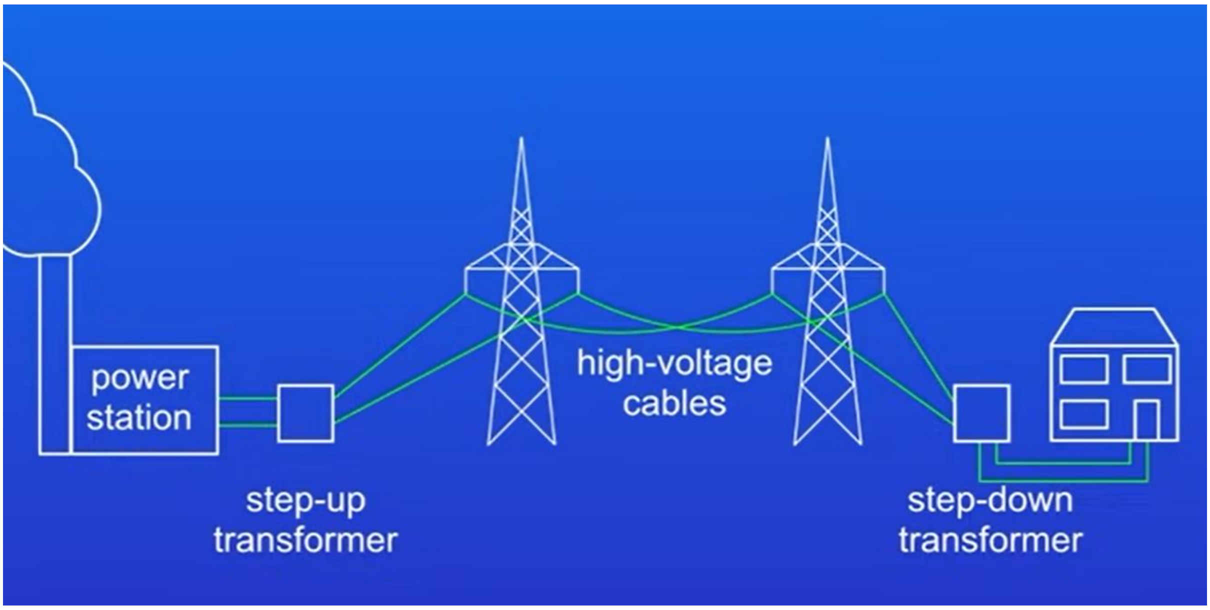
These wires are made out of copper because they are a good conductor of electricity

The coatings are made of plastic which is a good insulator



National Grid:

The national grid system consisting of transformers and high-voltage cables which links power stations to consumers across the UK



Energy is always lost in the power cables due to the resistance of the wires

How the National Grid works:

1. The electricity generated passes through the transformers which increases the potential difference to several hundred thousand volts – less energy is lost in the cables when the potential difference is high
2. The energy is transferred
3. The step-down transformers reduce the potential difference to 230V so it is safe

Static electricity:

When two insulators are rubbed together, electrons can pass from one to another

Metals are good conductors of electricity because electrons can move through easily
Insulators are not good conductors because electrons cannot move through

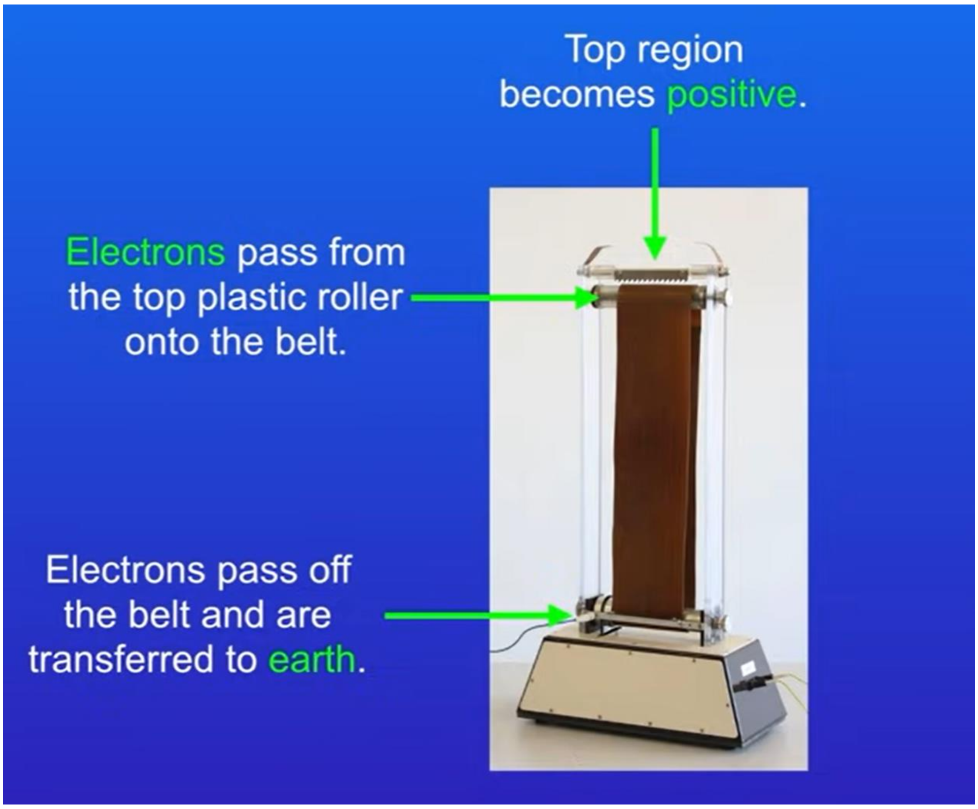
When you rub a plastic rod onto a cloth:

1. The electrons move from the plastic to the cloth
2. The cloth has an overall negative charge because electrons have been gained
3. The rod has a overall positive charge because electrons have been lost
4. Both of these are equal in size

How Van de graafs work:

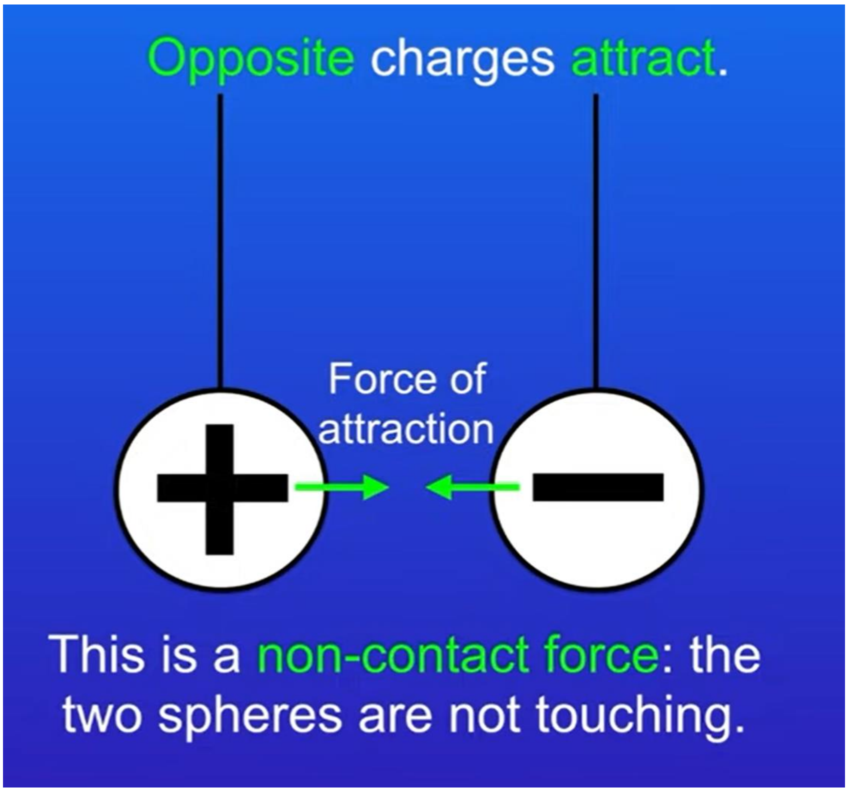
1. Electrons pass from the top plastic roller onto the belt
2. Electrons are transferred to earth as it moves down
3. Over-time, the top region becomes positively charged

4. The dome stores positively charged electrons
5. The hair of the person touching it starts to stick up because the hair is positively charged so both repel



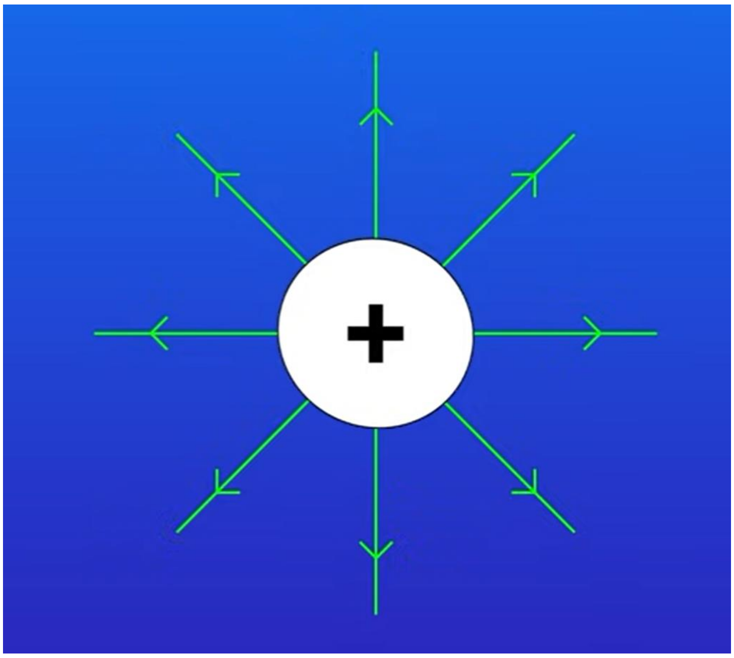
Electric fields:

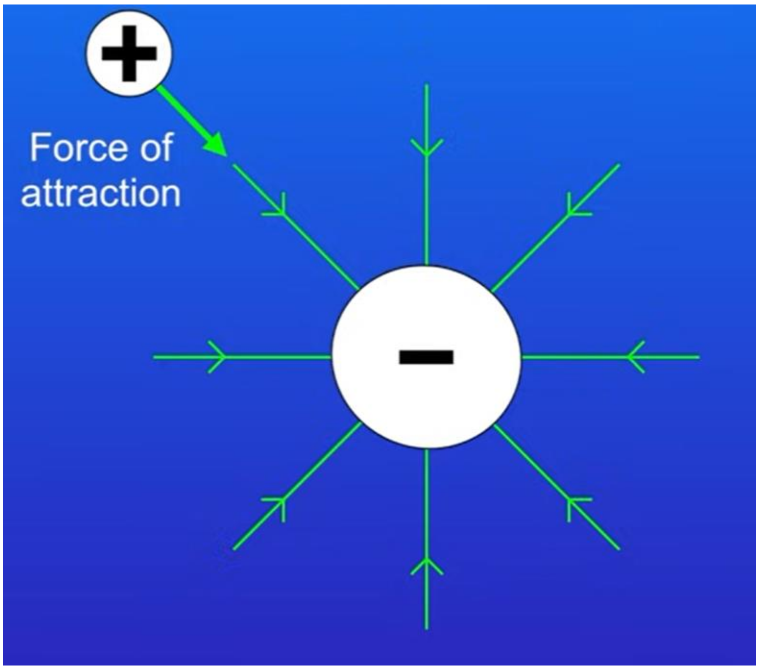
Opposite charges attract between electrons. This is a non contact force because the electrons do not touch.



The same forces repel

Electric fields cause any electrons that are near it to experience:





If you decrease the distance, the forces become stronger