Physics – Electricity and Circuits (autumn term)

Key Vocabulary

Parallel circuit - A circuit in which there is more than one path for the current to follow.

Series circuit - A type of circuit with only one loop of wire.

Voltage - The energy transferred to or from a coulomb of electric charge when it flows between two points.

Potential difference - The energy transferred to or from a coulomb of electric charge when it flows between two points.

Charge - Electric charge is a basic property of matter that causes forces between charged particles or objects.

Resistance - A measurement of how difficult it is for electricity to flow through something.

Diode - A component that lets electric current flow through it in one direction only.

Light-dependent resistor (LDR) - A resistor whose resistance gets lower when light shines on it.

Thermistor - A component whose resistance changes as its temperature changes. The thermistors you will meet increase in resistance as the temperature increases.
Work - Work is done when a force moves an object through a distance. So work is done when a charged particle is moved between two points in an electric field. The unit for work is the joule (J).

Important Information

Components in circuits can be connected in **series** or **parallel**. In series circuits there is just one route the current can take around the circuit. In parallel circuits there are junctions that allow the current to take different routes. Diagram D shows circuit diagrams for both series and parallel circuits.

In the series circuit, lamps cannot be switched on and off individually, and if one lamp fails they will all switch off. In the parallel circuit each lamp can be switched separately.

Moving charged particles form an electric current. Electric **charge** is measured in **coulombs** (C). One coulomb is the charge that passes a point in a circuit when there is a current of 1 amp for 1 second.

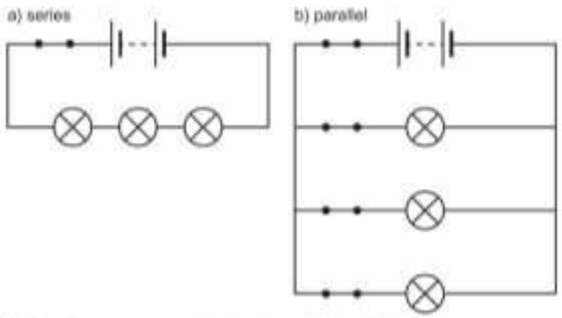
The size of the current at any point in a circuit tells you how much charge flows past that point each second. Electric current is the **rate** of flow of charge.

Graph A shows that when potential difference changes across a fixed resistor, the current changes by the same percentage. The two variables are in **direct proportion**, and the graph forms a straight line going through the origin. This happens because the resistance stays the same.

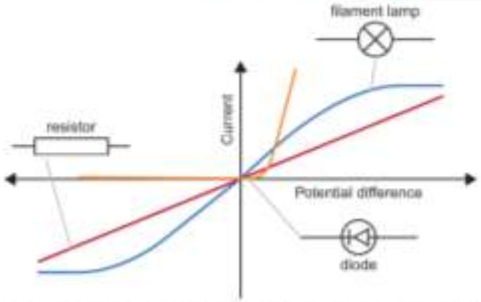
Other components, such as filament lamps and **diodes** (also shown in graph A), have resistances that change when potential difference changes.

Thermistors have high resistances at low temperatures but as the temperature increases the resistance decreases.

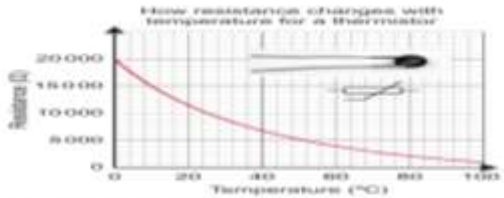
Graphs, Equations and Diagrams



D three lamps connected in a) series and b) parallel



A graph of current against potential difference for a fixed resistor, filament lamp and diode



C The resistance of a thermistor changes with temperature.

Static electricity - Unbalanced electric charges on the surface or within a material.

Electric field/ Electrostatic field - The space around an electrically charged object where it can affect other objects.

Earth wire - A low-resistance path for electric current to flow to earth for safety if there is a fault in an appliance.

Fuse - A safety device containing a length of wire that is designed to melt if a circuit gets too hot.

Live wire - The wire connected to the a.c. supply from the power station. The voltage oscillates between the maximum V in one direction and the maximum V in the opposite direction.

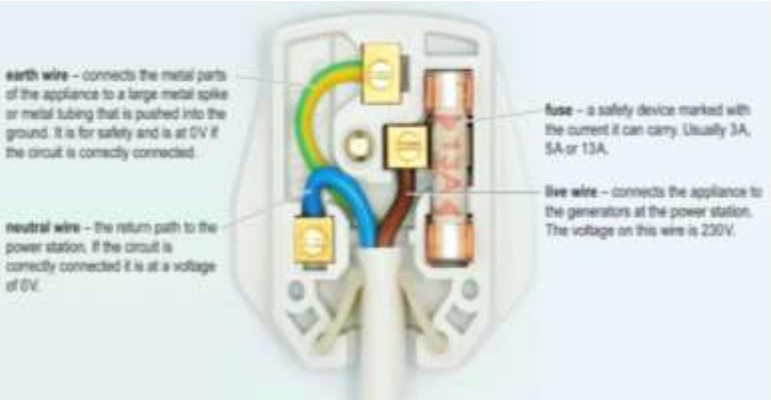
Neutral wire - A neutral wire is held at or near earth potential (0 V). It completes the circuit to the power station and carries current.

Volt (V) - The unit for potential difference (or voltage).

Ampere / amp (A) - The unit for current. Can be shortened to amp.

Coulomb (C) - The unit for measuring charge.

All circuits have some resistance, so they warm up when there is a current. When a current passes through a resistor, energy is transferred because electrical **work** is done against the resistance. The energy is transferred by heating and the resistor becomes warm.



A charged object has a force field around it called an **electric field** (or **electrostatic field**). Another charged object placed in the field will experience a force. The drawings in diagram A show how we represent electric fields around a charge that is at a single point (called a **point charge**). The lines are called **field lines** and they:

- never cross
- show where the field is strongest (which is where the field lines are closest together).
- show the direction of the force on a charge in the field
- start on a positively charged object, for example the point charge, and end on a negative charged object. If there is only one object they keep going, becoming more widely spaced

Calculating the energy transferred

energy transferred (J) = current (A) × potential difference (V) × time (s)

This can also be written as:

$E = I \times V \times t$

To calculate the power, use the equation:

$$\text{power (W)} = \frac{\text{energy transferred (J)}}{\text{time taken (s)}}$$

This can also be written as:

$P = \frac{E}{t}$

Calculating electrical power

The power transfer in a component or appliance is proportional to the potential difference across it and the current through it. This means that:

electrical power (W) = current (A) × potential difference (V)

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

electrical power (W) = current^2 (A^2) × resistance (Ω)