WJEC (Eduqas) Physics GCSE

7.1: Current, Potential Difference and Resistance

Detailed Notes

(Content in **bold** is for higher tier **only**)

Current & Charge

Charge

Charge is a property of objects that experience a **force** when placed in an **electric field**. It is measured in **coulombs** (C). Electrons are negatively charged sub-atomic particles that carry current round electrical circuits.

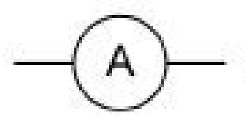
Current

Current (I) is the **flow of electrical charge** in a circuit. The greater the rate of flow of charge (Q), the greater the current:

$$Q = It$$

Q is charge flow in coulombs (C), I is the current in amperes (A) and t is the time in seconds (s)

In a single closed loop such as a series circuit, current has the **same value** at any point and can be measured using an **ammeter** connected in series with the component being measured.



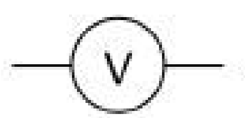
Circuit symbol for an ammeter (adapted from studyrocket.co.uk).

The current through a component depends on both the resistance (R) of the component and the potential difference (V) across the component.

Potential Difference

Potential difference (**p.d.**) is also referred to as **voltage** and is a measure of the 'force' required to move a current around the circuit. It is measured as a **change in voltage** between two parts of a circuit, such as before and after a component.

Voltage is measured in **parallel** to a circuit using a voltmeter. The p.d. in a circuit can be increased by increasing the number of **cells** used.



Circuit symbol for an voltmeter (adapted from studyrocket.co.uk).

Resistance

The components of electrical circuits **restrict the flow of current** in a circuit, known as resistance. The units of resistance are **Ohms** (Ω). Current, potential difference and resistance are related and can be calculated using the equation:

$$V = IR$$

V is voltage in volts (V), I is the current in amperes (A) and R is the resistance in ohms (Ω)

Energy & Power

Energy

The energy transferred from **chemical potential** in batteries to **electrical energy** in wires depends on the charge stored and potential difference. This energy is then transferred to any form of useful energy in the devices they power.

$$E = QV$$

E is energy in joules (J) and Q is charge flow in coulombs (C)

Power

Power is the **energy transferred per unit time** and it is directly proportional to current and voltage.

$$E = Pt$$
$$P = IV$$

E is energy in joules (J) and P is power in watts (W)

Power loss in a component is **proportional** to resistance, and to the **square** of the current.

$$P = I^2R$$

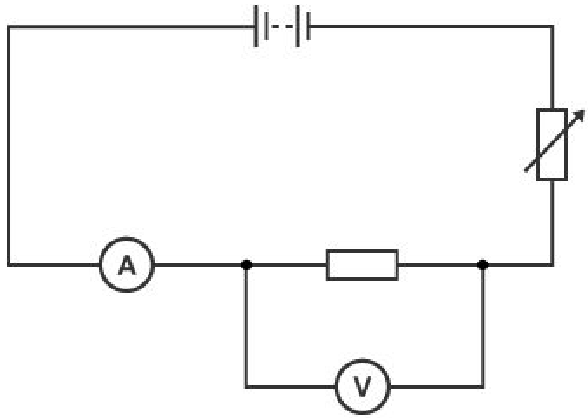
E is energy in joules (J) and P is power in watts (W)

Current-Voltage Characteristics

By observing the relationship between **current** and **voltage**, the I-V characteristic of a component can be analysed. This characteristic is mainly produced by any **resistance** in the circuit.

Measuring Resistance

Resistance of a component can be investigated by monitoring the **current flow** through it and **potential difference** across it. This is done using a **variable resistor** within the circuit that can change the voltage and current.



A circuit to investigate how current changes with voltage for a component (bbc.co.uk)

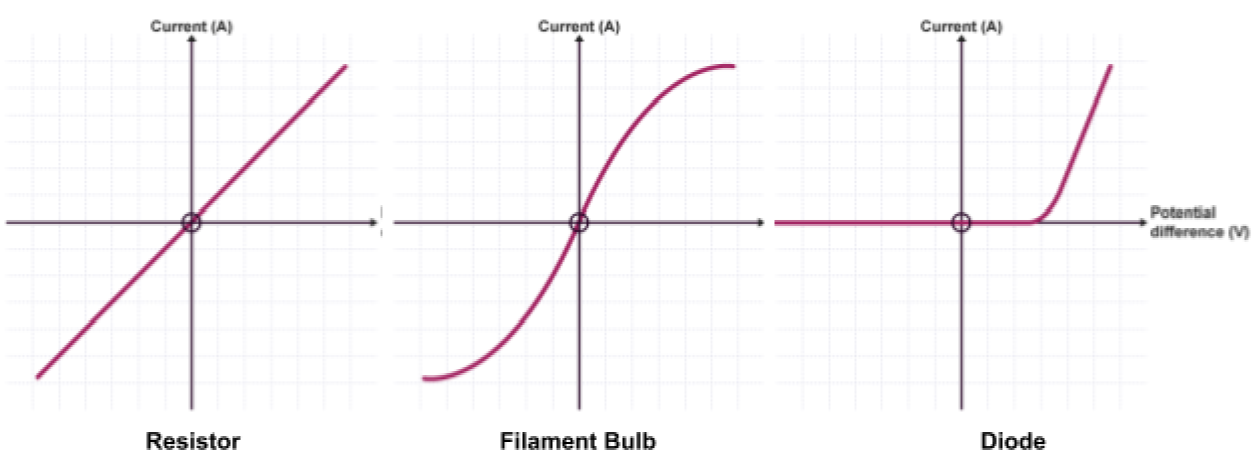
Current-Voltage Graphs

Taking regular measurements of voltage and current at different resistances means a **current-voltage graph** can be produced. If the resistance is constant, the component is described as an **ohmic conductor** where current is **directly proportional** to the potential difference.

Resistance of components such as lamps, diodes, thermistors and LDRs is **not constant** and changes with the current flow through it. This produces a **non-linear** current-voltage graph.

A **filament lamp** has a characteristic curve as its resistance increases as the **temperature** of the filament increases.

Diodes also produce characteristic curves as current only flows in **one direction** through it, as it has a much higher resistance in the reverse direction.



Characteristic current-voltage curves for common components (bbc.co.uk)

Thermistors and LDRs

These are two resistors with very specific current-voltage characteristics. The resistance of a **thermistor** reduces as the temperature increases. This feature means they are often used in temperature detectors and thermostats.

LDRs (Light Dependent Resistors) have changing resistivity depending on the light level. The greater the intensity of light, the lower the resistance. Therefore the resistance is greatest when it is dark. LDRs are often used in automatic night lights.