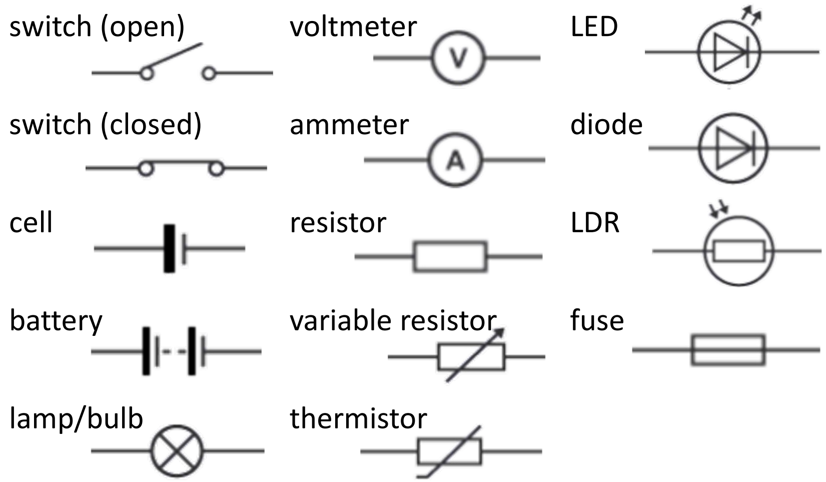
Circuit Electricity 1

1. Circuit symbols

You must be able to remember the circuit symbols for these components, and use them when drawing a circuit:



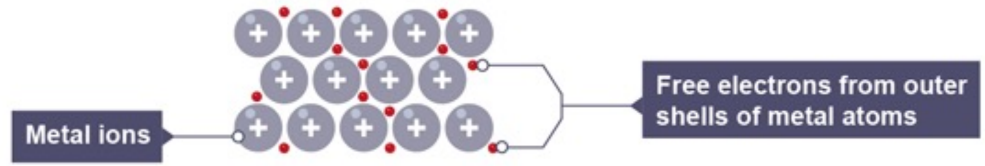
Remember: when you draw a circuit diagram, the lines (wires) must be straight and the circuit must be complete!

2. Charge

- **Metals are conductors** of electricity
- Non-metals are insulators (poor conductors)
- This is due to their bonding:

Metallic bonding creates a '**sea of delocalised electrons**' that can carry energy around a circuit.

- The unit of charge flow is the **coulomb (C)**. This represents a specific large number of electrons. 1 coulomb is equal to 6 x 10^{19} electrons.



3. Current

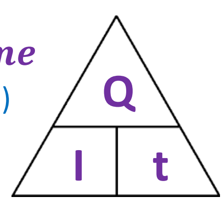
- Current is the **flow of electrical charge** around a circuit.
- It's measured in **amps (A)** using an **ammeter connected in series with the component.**
- A circuit must include a **source of potential difference** (a power source) in order for current to flow.

We can calculate the charge flow using:

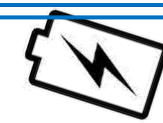
$$charge\ flow = current \times time$$

Learn (C) (A) (s)

You can use the equation triangle to re-arrange this:



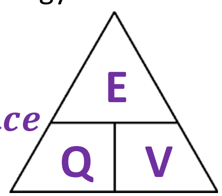
4. Potential difference



- Potential difference (or voltage) is the driving force that **pushes** the charge around a circuit. It is the difference in energy between two points on a circuit.
- Potential difference is the energy per unit of charge:

$$energy = charge\ flow \times potential\ difference$$

(J) Learn (C) (V)



- It's measured in **volts (V)** using a **voltmeter connected in parallel over the component.**
- Potential difference can be supplied using a **power source** (e.g. a battery)

5. Resistance

- Resistance is something that **slows down** the current.
- It's measured in **ohms (Ω).**
- The **bigger the resistance** of a component, the **less current gets through.**

You can calculate the total resistance in a series circuit using:

total resistance

add together the individual resistances

$$R_{total} = R_1 + R_2 + \dots$$

Learn

- In parallel the total resistance of two resistors is less than the resistance of the smallest individual resistor.

Circuit Electricity 2

6. Ohm's Law

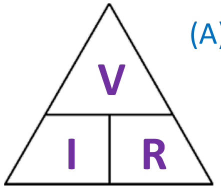
- The current through a circuit depends on the **potential difference** and **resistance**.
- If the potential difference is constant, then the **current will decrease** as **resistance is increased**.
- **Ohm's Law** states that current is **directly proportional** to potential difference for an ohmic conductor (if the temperature remains constant)

The following equation is used to link potential difference, current and resistance:

$$potential\ difference = current \times resistance$$

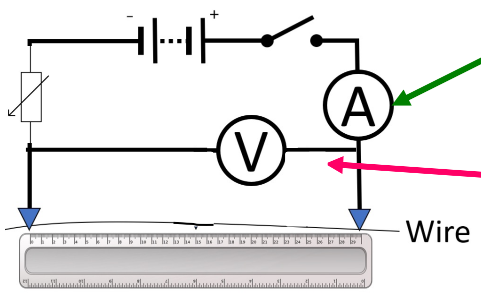
(V) (A) (Ω)

Learn



7. Required Practical: How does the length of a wire affect its resistance?

- You can calculate the resistance of a wire if you **measure the current and potential difference**.
- **Changing the length** of the wire and taking measurements will allow you to see if the resistance changes.



The **ammeter** measures the current through the circuit.

The **voltmeter** measures the potential difference across the wire.

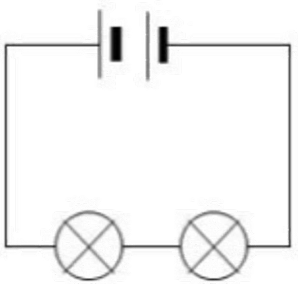
As the current increases, the wire **heats up** which causes its resistance to **increase**. This reduces the **accuracy** of the experiment.

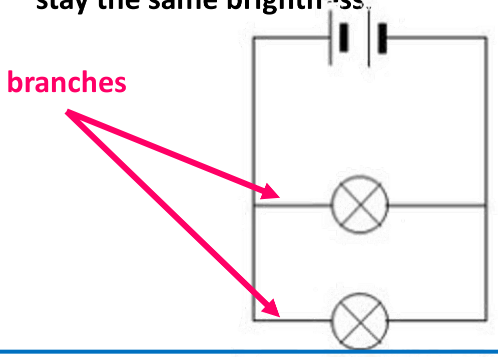
- You can increase the **accuracy** by:
  1. **stopping the current between readings** to let the wire cool
  2. using a **low current** to stop the wire heating up.
- You can increase the **precision** by using **pointed contacts** to connect to the wire so the uncertainty of the measurement is reduced.

8. Series and parallel circuits

There are two types of circuit: series and parallel.

Series Circuits	Parallel Circuits
All the components are connected in **one loop.**	The components are connected in **more than one loop.**
If one bulb breaks, the **whole circuit stops working.**	If one bulb breaks, the **other branches will continue to work.**
The current is **the same everywhere.**	The current is **shared between each branch.**
The potential difference is **shared between components.**	The potential difference is **the same across each component.**
The total resistance is the **sum** of all the individual resistances.	The total resistance is **less than** the smallest individual resistance.
If you add more bulbs, they all **get dimmer.**	If you add more bulbs, they all **stay the same brightness.**





Circuit electricity 3

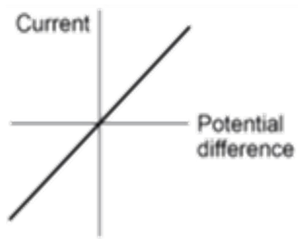
9. Required Practical: I-V characteristics of different components

There are two types of conductor:

Ohmic

- The resistance remains **constant** when you change the current
- The current is **directly proportional** to the potential difference
- If you drew a graph of I against V, it would be a **straight line through (0,0)**

Example: a resistor at constant temp.

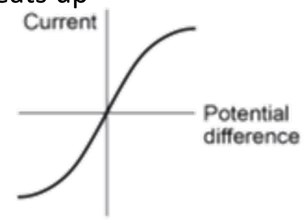


Non-Ohmic

- The resistance **does** change with current

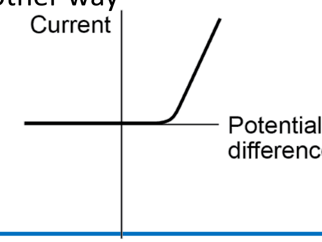
Example 1: a filament lamp

The resistance increases as it heats up

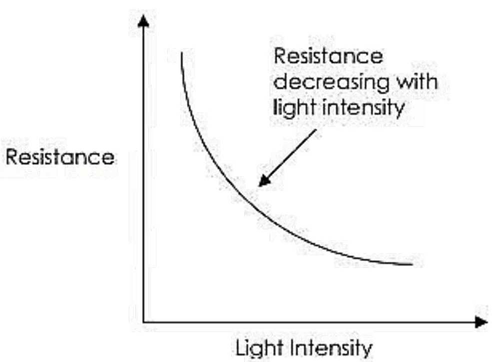


Example 2: a diode

Current can only flow in one direction, so resistance is very high the other way



10. Thermistors and LDRs



Light Dependent Resistor

As light intensity increases the resistance decreases.

They are **not** inversely proportional, it is an inverse square relationship.

$$light\ intensity = \frac{1}{distance^2}$$

Light Dependent Resistor (LDR)

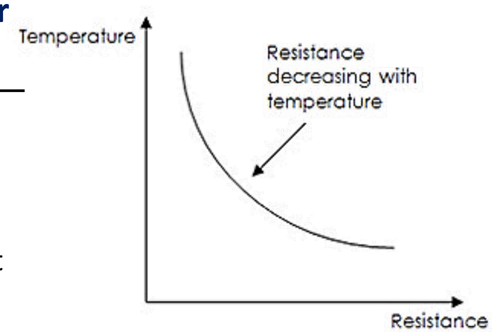
The resistance **decreases** as the light gets **brighter**.

Example: **street lights** use these so they turn on when it gets dark

Thermistor

The resistance **decreases** as temperature **increases**.

Example: used in **thermostats** to turn on the heating when it gets cold



Thermistor

Temperature is inversely proportional to resistance.

This can be proved using the table of results.

The product of the IV x DV will be the same for every row of data.

Applications

As both an LDR and thermistor have low resistance at high temperature or light intensity, a parallel circuit is needed to use them to turn on lights or heaters.