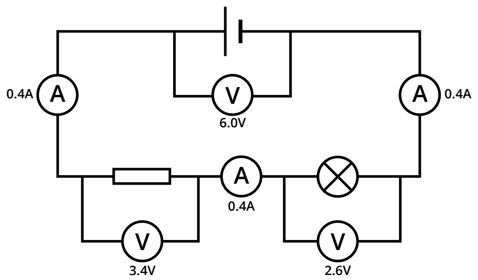
GCE Physics Unit 2.3 D.C. Circuits

Series circuits:



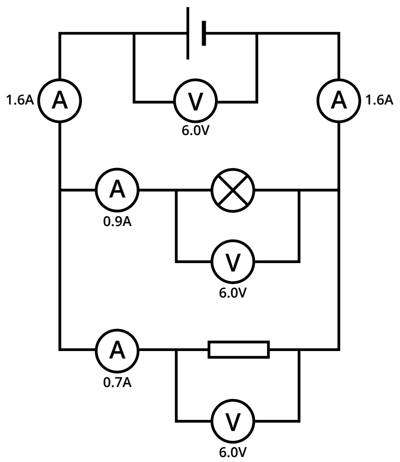
Note:

- The **current is equal** at every point in the circuit. This obeys the law of **conservation of charge**.
- The total potential difference input is **equal to the sum** of the potential differences across the components. This obeys the law of **conservation of energy**.

Parallel circuits:

Note:

- The total current input is equal to the current through each branch of the circuit. This obeys the law of **conservation of charge**.
- The potential difference across each component is equal. This obeys the law of **conservation of energy**.



Conservation of charge:

As current is the rate of flow of charge, the total current through a circuit must be constant as the total charge per second through the circuit is constant.

Resistance of series and parallel circuits:

The resistance of a circuit can be calculated by using Ohm's law;

$$Total\ resistance = \frac{Total\ Potential\ difference}{Total\ current}$$

However, often the resistance must be calculated in order to use Ohm's law. This is possible using these equations.

Series

$$\boldsymbol{R = R_1 + R_2}$$

Parallel

$$\boldsymbol{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}}$$

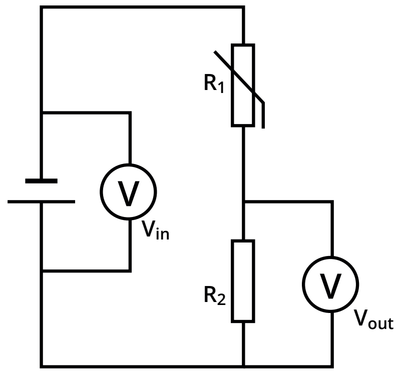
These equations can be used to calculate the resistance of combinations and are often used when there is a combination of series and parallel parts within the same circuit.

Potential dividers:

Potential divider circuits are used when a certain output potential difference is required.

The equation to calculate the output voltage is:

$$\frac{V}{V_{total}} \left[or \frac{V_{OUT}}{V_{IN}}\right] = \frac{R}{R_{total}}$$



Where V is the **output voltage across the resistor R**, in the example above R_2.

These circuits often contain thermistors or LDRs and as such the **total resistance can change**. Remember V_{in} doesn't change, so if the **resistance changes the current will also change**.

EMF (electromotive force):

The emf of a cell or battery is the **energy converted** from chemical energy to electrical energy **per unit charge** that flows through. This is rarely equal to the potential difference measured across components in the circuit as **some energy is lost internally** due to the **internal resistance** of the cell.

This equation can be used to calculate the emf,

$$V = E - Ir$$

- V: Energy transferred to the components per coulomb
- E: Energy transferred into electrical energy in the cell per coulomb
- Ir: Energy lost due to the internal resistance in the cell per coulomb

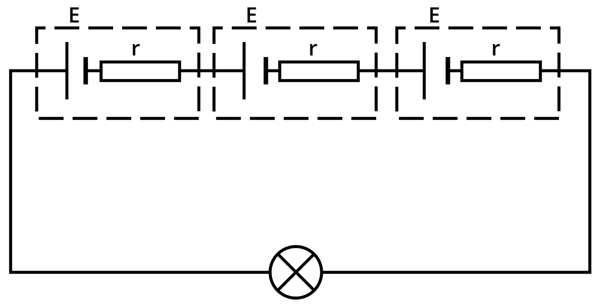
The total current in the circuit can be calculated using this equation.

$$I = \frac{E}{R + r}$$

Combining cells:

If n cells are connected **correctly**, each with emf E and internal resistance r, the total emf will be nE and the total internal resistance nr.

In the example below, the emf will be $3E$ and internal resistance $3r$.



E = emf in V | V = potential difference in V | I = current in A | R = resistance in Ω | r = internal resistance in Ω