Electrical Circuits
Electrical Circuits

What is an electrical circuit?

- Circuit components
- Building an electrical circuit
- Summary activities
What is an electric circuit?

When **electrical components** are joined together so that **charge** can flow, they form an **electric circuit**.

The movement of charge in a circuit is called an **electric current**.

For a current to flow in a circuit, there needs to be:

- a source of **potential difference**
  
  This provides the energy needed to push charge around the circuit.

- a **complete** loop
  
  The circuit cannot have any gaps or breaks in it.
How can we model electric circuits?

A *model* can help to understand how electric circuits work.

In this model, the moped riders represent the flow of *charge* and the pizzas represent the electrical *energy* carried around the circuit.

What do the pizza shop and the house of party-goers represent?
What are the units of charge, current and time?

- Charge, $Q$, is measured in **coulombs** (C).
- Current, $I$, is measured in **amperes**, or amps (A). A current of 1 ampere means that 1 coulomb of charge is flowing every second.
- Time, $t$, is measured in **seconds** (s).

**Current** is the amount of charge flowing per second. The size of the current is given by the formula:

$$I = \frac{Q}{t}$$

or

$$\text{current} = \frac{\text{charge}}{\text{time}}$$
A light is switched on for an hour. During that time, 1800 coulombs of charge passed through the bulb. What was the current?

**Step 1** Choose the right formula:

\[
\text{current} = \frac{\text{charge}}{\text{time}}
\]

**Step 2** Convert to the right units:

1 hour = 3600 seconds

**Step 3** Calculate the answer:

\[
\text{current} = \frac{1800}{3600} = 0.5 \text{ A}
\]
Potential Difference

In a circuit, the potential difference supplied by an energy source, such as a battery, drives the current.

The battery does work pushing the charge around the circuit. It is opposed by the resistance of the wires and any connected components.

The formula for potential difference is:

\[
potential\ \text{difference} = \text{current} \times \text{resistance} \\
V = I \times R
\]

The potential difference of a battery can also be thought of as the amount of energy transferred from it to each coulomb of charge.
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What are circuit diagrams?

To understand how a circuit works, it is important to identify how components are connected to one another.

To make this easier, **circuit diagrams** are drawn with **straight lines** and **symbols**. Each circuit component has an associated symbol.

For example:

The symbol for a **filament lamp bulb** is a circle with a cross in it.

By all using the same set of standard symbols, people are able to communicate what they mean effectively and simply.
### Circuit components

<table>
<thead>
<tr>
<th>component</th>
<th>circuit symbol</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cell</td>
<td><img src="image" alt="Cell Symbol" /></td>
<td>A source of potential difference.</td>
</tr>
<tr>
<td>battery</td>
<td><img src="image" alt="Battery Symbol" /></td>
<td>Multiple cells joined together.</td>
</tr>
<tr>
<td>resistor</td>
<td><img src="image" alt="Resistor Symbol" /></td>
<td>Opposes the flow of charge in a circuit.</td>
</tr>
<tr>
<td>variable resistor</td>
<td><img src="image" alt="Variable Resistor Symbol" /></td>
<td>A resistor whose resistance can change.</td>
</tr>
</tbody>
</table>
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<tr>
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<tbody>
<tr>
<td>switch (open)</td>
<td><img src="image" alt="open switch symbol" /></td>
<td>An open switch breaks a circuit.</td>
</tr>
<tr>
<td>switch (closed)</td>
<td><img src="image" alt="closed switch symbol" /></td>
<td>A closed switch allows current to flow.</td>
</tr>
<tr>
<td>fuse</td>
<td><img src="image" alt="fuse symbol" /></td>
<td>Prevents too much current from flowing.</td>
</tr>
<tr>
<td>thermistor</td>
<td><img src="image" alt="thermistor symbol" /></td>
<td>A resistor that varies with temperature.</td>
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<tr>
<td>diode</td>
<td><img src="image" alt="Diode Symbol" /></td>
<td>Only lets current pass in one direction.</td>
</tr>
<tr>
<td>LED</td>
<td><img src="image" alt="LED Symbol" /></td>
<td>Stands for Light Emitting Diode.</td>
</tr>
<tr>
<td>filament lamp</td>
<td><img src="image" alt="Filament Lamp Symbol" /></td>
<td>Transfers electrical energy into light.</td>
</tr>
<tr>
<td>LDR</td>
<td><img src="image" alt="LDR Symbol" /></td>
<td>Stands for Light Dependent Resistor.</td>
</tr>
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<td>voltmeter</td>
<td><img src="image" alt="V symbol" /></td>
<td>Measures potential difference in a circuit.</td>
</tr>
<tr>
<td>ammeter</td>
<td><img src="image" alt="A symbol" /></td>
<td>Measures current in a circuit.</td>
</tr>
<tr>
<td>motor</td>
<td><img src="image" alt="M symbol" /></td>
<td>Converts electrical energy into movement.</td>
</tr>
</tbody>
</table>

Note that connections between components (usually wires) are always drawn as **straight** lines.
More about components

What components can be used in a circuit?

To make it easier to construct electric circuits, symbols are used to represent the electrical components.

What components do the symbols below stand for?

Click on each symbol to find out more about that component.
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Building a circuit

**Remember**, in order to build a functioning circuit, you need:

- a source of **potential difference**
- a **closed** or complete path for charge to follow.

Circuit components can be connected…

…in series…

…or in parallel.
How does current flow around a circuit?

In circuits like these, the charge carriers are being repelled from one terminal of the cell and attracted to the other.

In order to get from here... ...to here,

...the charge has to flow round the circuit and through the bulb.

The amount of current that leaves the cell is the same as the amount of current that returns. This means that in a single closed loop of a circuit, the size of the current is the same at every point.
How does current flow around a circuit?

What happens if there are **multiple** ways that the current could get from one terminal to the other?

The amount of charge flowing depends on the **resistance** of each path.

In this circuit, the resistance of the first branch is **2Ω**.

The resistance of the second branch is **4Ω**.

Therefore, it is **twice** as difficult for charge to flow in the second branch compared to the first.

What effect do you think this will have?
How does current flow around a circuit?

What happens if there are **multiple** ways that the current could get from one terminal to the other?

![Diagram of a circuit with two branches](image)

The current that leaves the cell travels down to the junction, where it splits.

The first branch has **half** the resistance of the second branch, so it has **twice** as much current.

The **same** amount of current that left the cell returns to it.
What is a short circuit?

If the current has a choice between a very low resistance path and a high resistance path, almost all of the current will flow through the lower resistance path.

The resistance of the wires in a circuit is very low compared to the resistance of components, such as bulbs.

If current can flow along a path without passing through a component, this part of the circuit is called a short circuit.

These circuits both contain a short circuit, so the bulb will not light up.
Before the discovery of the electron, scientists assumed that current was due to positively-charged particles moving from the positive to negative.

This way of representing the direction of current is called conventional current.

However, it is now known that the charge in most circuits is actually carried by negatively-charged electrons, flowing from the negative terminal to the positive terminal. This is the direction of electron flow.
How can the flow of current be represented?

- Conventional current
- Electron flow
Different electricity sources

There are many different possible sources of electricity for use in circuits. For example:

- **Cells**: a cell is a source of **electrical energy**. A chemical reaction takes place inside the cell, which produces a **potential difference** across the cell.

- **Batteries**: a battery consists of **two or more** cells that are joined together. The potential difference across a battery is the **sum** of the potential differences across the cells.

- **Mains**: the UK mains supply is provided by the **National Grid**. The electricity is generated from a variety of sources, from wind turbines to coal-powered plants.
How can battery voltage be increased?

Using more cells in a battery increases the potential difference.

If several cells are connected in series, the total p.d. across the battery can be found by adding the p.d. of each of the cells.

So, if two 1.5V cells are connected together, the p.d. across the battery is 3V.

When three 1.5V cells are connected, what is the potential difference across the battery?
Kris wants to connect a **bulb**, a **battery** and a **resistor** in series. Draw the circuit diagram he should use.

Remember to **complete** the circuit once the components are connected.
Which is the correct circuit diagram?

Circuit diagrams use symbols to represent components and make it easier to build circuits.

Click "start" to see how much you know about circuit diagrams.
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Multiple-choice quiz