

Electricity: Current, Conductors & Circuits

What really happens inside the wires when you switch on a lamp?

+ → lamp → -



Tiny Travellers: Electrons

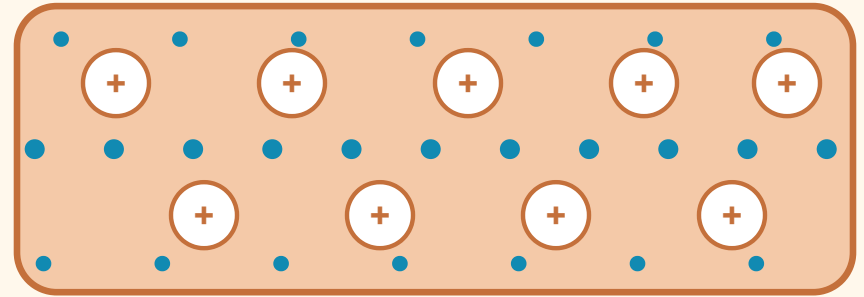
An electric current is a flow of electric charge along a path.

- Everything is made of **atoms**. Around each atom whizz even tinier particles called **electrons**.
- Electrons carry a **negative** electric charge (-).
- In a metal wire, some electrons are **free**: they can hop from atom to atom.
- When a battery pushes them all along the wire, they make an **electric current**.

Measuring current

Current is measured in **amperes** (A). A phone charger gives about 2 A.

Inside a copper wire



● free electron (-)

○ copper atom (stays put)

Think of Water in Pipes

Electricity is invisible, but it behaves a bit like water flowing in a loop of pipes.



BATTERY

= the pump

It pushes the charges around. How hard it pushes is its **voltage**, in volts (V).



WIRE

= the pipe

It gives the charges a path to follow, all the way around and back.



CURRENT

= the flow

How much charge passes each second, in amperes (A).



LAMP

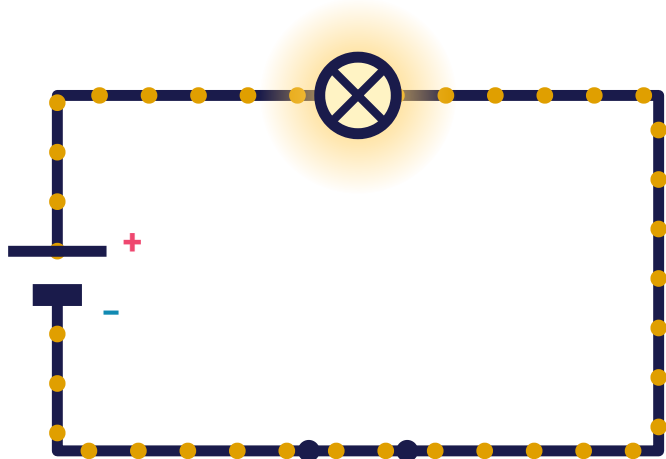
= the water wheel

It uses the energy of the flow, here to make light and heat.

No pump, no flow. A broken pipe, no flow. Electricity is the same!

A Circuit Is a Loop

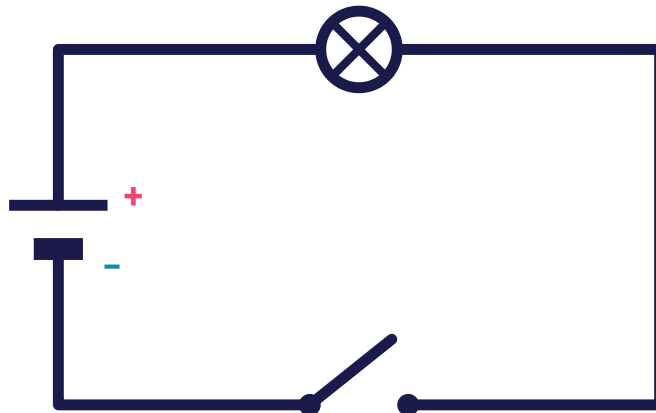
Current only flows when there is a complete path from one end of the battery back to the other.



switch closed

CLOSED CIRCUIT – LAMP ON

The loop is complete: current flows all the way round.



switch open

OPEN CIRCUIT – LAMP OFF

A switch opens a gap. The path is broken, so nothing flows anywhere.

Conductors and Insulators

Some materials let current through. Others stop it dead.

CONDUCTORS

Let electric current flow through them.

- copper (inside cables)
- aluminium (foil, cans)
- steel (paper clips, spoons)
- gold (computer connectors)
- graphite (pencil lead)
- salt water — and your body!

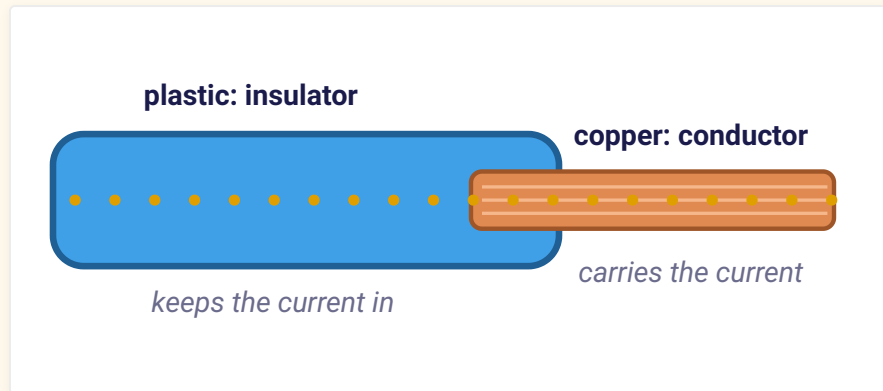
INSULATORS

Block electric current.

- plastic (cable coating, toys)
- rubber (boots, gloves)
- glass (windows, bottles)
- dry wood
- ceramic (plates, mugs)
- air, paper, fabric

Why? In **conductors**, electrons are free to move. In **insulators**, they are held tightly by their atoms.

A Team: Copper Inside, Plastic Outside



Every electric cable uses **both**: a conductor to guide the current, and an insulator wrapped around it so the current can't escape into you.

Surprising conductors

Graphite, the grey "lead" in a pencil, is not a metal, but it conducts!

Tap water and **salt water** conduct too, and so does the human body, which is full of salty water.

That's why...

you must never touch switches or sockets with wet hands, or use a hair-dryer near the bath. Air is an insulator... until lightning is strong enough to jump right through it!

[More in the lesson on materials →](#)

Which Way Does It Flow?



Outside the battery, electric current flows **out of the + terminal**, around the circuit, and **back into the - terminal**.

Inside the battery, it is pushed back from - to +, ready for another lap.

A Mix-up From History

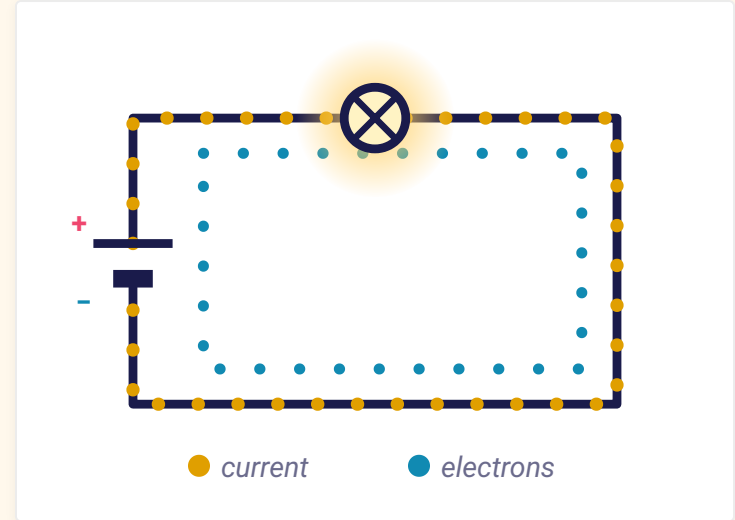
- Around **1750**, Benjamin Franklin guessed that electricity flows from **+** to **-**. Everybody followed his choice.
- In **1897**, J. J. Thomson discovered the electron... and electrons are negative, so they really travel the other way: from **-** to **+**!
- Scientists kept Franklin's rule anyway. So today:

CURRENT

drawn from **+** to **-**

ELECTRONS

move from **-** to **+**



When the Direction Matters

A lamp works both ways round. Some parts don't!



DIODE

A one-way street for current. It only lets current pass in the direction of its arrow, and blocks it the other way.



LED

A diode that lights up. Its **long leg** goes to +. Put it in backwards and it stays dark.



BATTERIES

Look for the + and - marks in the battery box of your toys. The wrong way round, the toy won't work.

In the Circuit Maze game, diodes will only let the current through if they point from A (+) towards B (-).

Drawing Circuits Like a Scientist

Instead of drawing real objects, we use simple symbols everybody understands.



Wire
a path for
current



Battery
long line = +



Lamp
lights up



Motor
turns and
moves



Resistor
slows the
current



Open switch
gap: no current



Closed switch
current flows



Diode
one way only



LED
a diode that
shines



Europe



America

Resistor: two ways to draw it

A resistor makes it **harder** for the current to flow, like a narrow part in a water pipe. More resistance means **less current**: a lamp in series with a resistor shines more dimly. Lamps and motors resist the current too.

Series Circuit: One Single Path



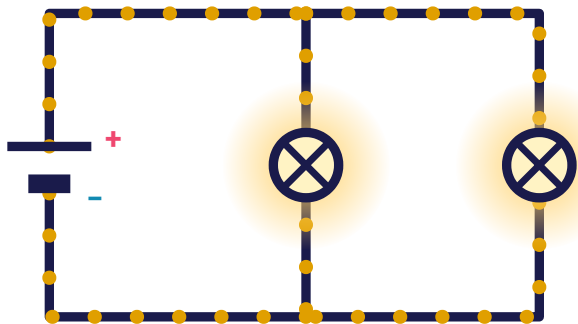
lamps one after the other

- The parts are connected **one after the other**, like wagons behind a train.
- There is only **one path**, so the **same current** flows through every lamp.
- The lamps share the battery's push: with two lamps, each one is **dimmer**.
- If one lamp breaks, the loop is open and **all the lamps go out**.

Where you find it

Old Christmas lights: one dead bulb and the whole string went dark!
Batteries stacked in a torch are in series too.

Parallel Circuit: Several Paths



each lamp on its own branch

- The current **splits** into several branches, then joins up again before going back to the battery.
- Each lamp gets the **full push** of the battery, so each shines **brightly**.
- If one lamp breaks, the other branch is still a complete loop: **the other lamps stay on**.
- But more current leaves the battery, so it runs out **faster**.

Where you find it

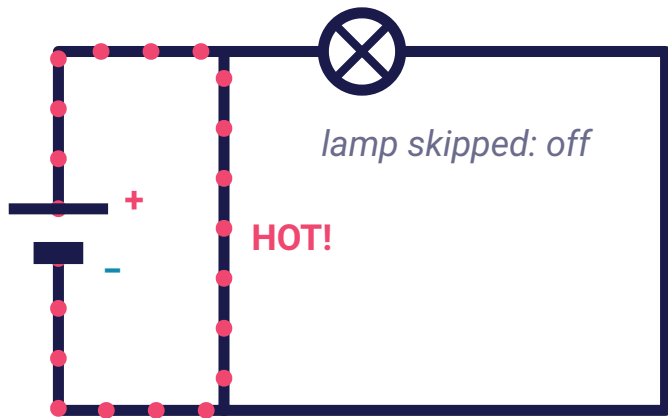
In your house! Every lamp and socket is in parallel, so switching off the kitchen light doesn't switch off the fridge.

Series or Parallel?

	SERIES	PARALLEL
Paths for the current	Only one	Several branches
Current	The same everywhere in the loop	Splits between the branches, then joins again
Two lamps	Both dimmer: they share the push	Both bright: each gets the full push
One lamp breaks	Everything goes out	The others keep shining
Examples	Old Christmas lights, batteries in a torch	Lights and sockets in a house

Many real circuits mix both: some parts in series, others in parallel.

Short Circuits and Safety



A **short circuit** is an easy shortcut that skips the lamp. A huge current rushes through, the wires get hot, and batteries can leak or even catch fire.

Golden rules

- Only experiment with **small batteries** (1.5 V to 9 V).
- **Never** poke anything into a wall socket: its 120 V (230 V in Europe) can kill.
- Keep electricity **away from water**, and never touch a switch with wet hands.
- Stay far from **power lines** and substations, and never fly a kite near them.
- Never join the + and - of a battery with just a wire.

THREE BIG IDEAS

What You've Learned

1

Conductors & insulators

Metals and graphite let current through.
Plastic, rubber, glass and wood block it.

2

Current flows + $\rightarrow$ -

Around a complete loop. Electrons go
the other way. Diodes care about
direction!

3

Series or parallel

One path: lamps share the push.
Several paths: each lamp gets it all.

Play the Circuit Maze!

Play Lamp Detective!

[Next lesson: Materials, conductors & insulators \$\rightarrow\$](#)

[⚡ Meet Étienne: a real circuit on rails](#)