Electricity and circuits

Teacher review edition. Ask your teacher if anything is unclear.

Why is the current the same before and after a lamp?

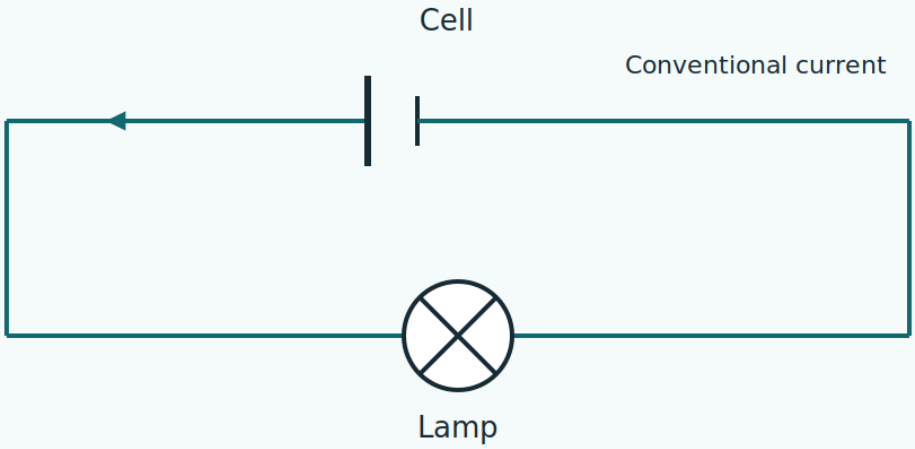
What you will learn

- Explain current, voltage and resistance.
- Connect an ammeter and voltmeter correctly.
- Compare series and parallel circuits.
- Explain how a switched LED circuit and an LDR work.

A complete circuit

A circuit is a conducting path that lets charge flow. A cell or battery supplies energy.

- Closed switch: a complete path allows current to flow.
- Open switch: a gap stops the current in that path.
- In metal wires, moving electrons carry charge.
- Conventional current goes from positive to negative around the outside circuit. Electrons move in the opposite direction.



Low-voltage complete loop. Cell positive terminal is the longer line.

The complete loop allows current to flow. Conventional current goes from the positive terminal around the outside circuit to the negative terminal.

Current and potential difference

Current
The amount of electric charge passing a point each second. Measured in amperes (A).

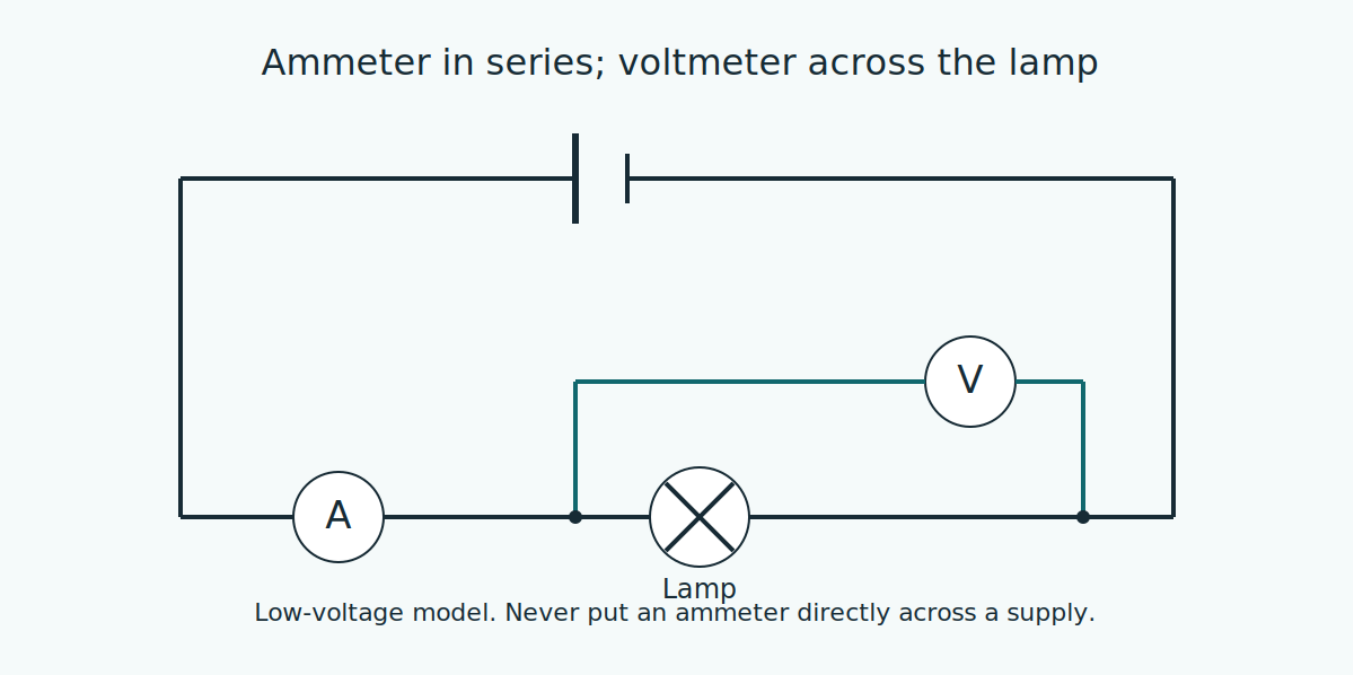
Potential difference
The energy transferred for each coulomb of charge between two points. Also called voltage; measured in volts (V).

- Current: charge passing a point each second, measured in amperes (A). One A = one coulomb each second.
- Potential difference (voltage): energy transferred per coulomb, measured in volts (V).
- A 6 V battery supplies 6 J of energy per coulomb of charge.
- A lamp transfers energy by light and heating. It does not use up charge.
- In a simple series circuit, current is the same before and after the lamp.

Measuring current and voltage

Use the correct meter connection for each measurement.

- Ammeter: connect in series so the current passes through it.
- Voltmeter: connect in parallel, across the component's two ends.
- Switch off before changing connections.
- Never connect an ammeter directly across a battery: it can cause a very large current.



The ammeter is in series with the lamp. The voltmeter is connected across the lamp.

Resistance

Resistance
How strongly a component opposes current. Calculate it by dividing voltage by current; measured in ohms (Ω).

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

- For a fixed voltage, greater resistance gives smaller current.
- Resistance = voltage ÷ current: R = V ÷ I.
- Example: 6 V and 0.20 A give R = 6 ÷ 0.20 = 30 Ω.
- Convert milliamps to amps before calculating: divide by 1000. For example, 2 mA = 0.002 A.

Series and parallel circuits

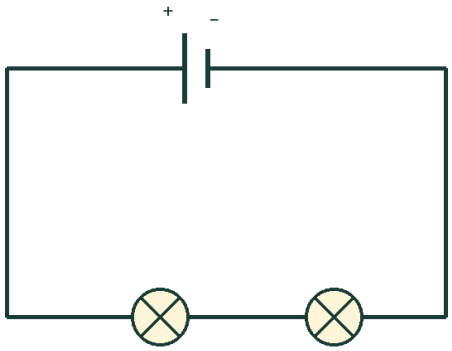
Series circuit
A circuit with one path for the current.

Parallel circuit
A circuit with separate branches for the current.

Feature	Series circuit	Parallel circuit
Current	The same current passes through every component.	Current splits at a junction; the branch currents add to the total.
Voltage	The voltages across components add up to the supply voltage.	Branches connected across the same supply have the same voltage.
One lamp removed	The only path is broken, so the other lamps go out.	Other complete branches can keep working.

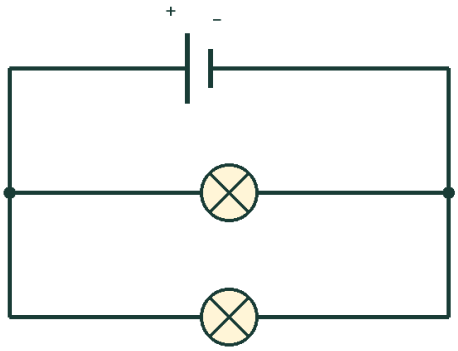
Series and parallel: count the paths

Series: one current path



A break stops both lamps.

Parallel: separate branches



Each lamp is across the cell.

Switch off before changing a classroom circuit. Use a teacher-checked low-voltage supply.

Follow the wires: series has one current path. Parallel has separate branches, with each lamp connected across the cell.

Using an LED

An LED is a light-emitting diode. It lights when current passes through it in the correct direction.

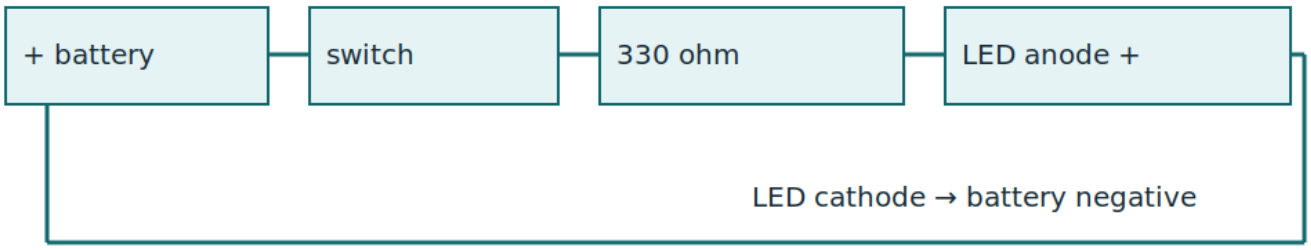
- Its two connections are the anode and cathode.
- Connect the anode towards battery positive and the cathode towards battery negative.
- Use a suitable series resistor to limit current and protect the LED.

Building a switched indicator

This classroom example uses a teacher-checked 3 V battery pack, switch, red LED and 330 Ω resistor.

- Connect in series: battery positive → switch → resistor → LED anode → LED cathode → battery negative.
- Draw the circuit first. Build with power off and have the teacher check the connections and LED rating.
- Closing the switch lights the LED; opening it switches the LED off.
- If the LED has about 2 V across it, the resistor has about 1 V. Current ≈ 1 ÷ 330 A ≈ 0.003 A = 3 mA.
- The exact current depends on the LED. Keep the protective resistor in the circuit.

An LED circuit with one complete path



Switch off before changing connections. Keep the resistor in the circuit.

The protective resistor and LED are in series. The LED must be connected in the correct direction.

Sensing light

> **Sensor circuit**
> A circuit that responds to a change such as a change in light level or temperature.

A light-dependent resistor (LDR) changes resistance with light level.

- Brighter light: usually lower resistance. Darkness: higher resistance.
- LDRs can be used in light-sensitive circuits, such as automatic night-lights.
- An LDR is not an on/off switch by itself. Other components turn its changing signal into a switching action.

Worked examples

A resistor has a potential difference of 6 V across it. The current through it is 0.20 A. Find its resistance.

Work through it

1. Identify the voltage, 6 V, and current, 0.20 A.
2. Use resistance = voltage ÷ current.
3. R = 6 ÷ 0.20 = 30 Ω.

$$\text{resistance} = \frac{6}{0.20} = 30\ \Omega$$

Another example

1. For a red LED with about 2 V across it on a 3 V supply, the resistor has about 3 − 2 = 1 V across it.
2. With a 330 Ω series resistor, current = 1 ÷ 330 ≈ 0.003 A = 3 mA.
3. Use the teacher-approved LED and resistor. Disconnect the supply before checking an LED that does not light.

Common mistakes

Common mistake: Saying a lamp uses up current.

Remember: It transfers energy but does not use up charge. Current is the same around a simple series loop.

Common mistake: Connecting an ammeter across a component like a voltmeter.

Remember: Connect the ammeter in series. The voltmeter goes across the component.

Answering questions

- Trace a complete path through your circuit diagram and check where each meter is connected.
- Before using R = V ÷ I, convert milliamps to amps and identify the voltage across the same component.

Try an investigation

Build a low-voltage circuit with cells, a switch and a lamp. Measure current in series and voltage across the lamp. Then compare series and parallel lamp circuits. Switch off before changing connections and ask your teacher to check them. Use batteries or the approved low-voltage supply, never household mains sockets.

Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.