

LESSON SLIDES

# Electric Circuits

Physics · Current, voltage, resistance, and series vs parallel

---

# By the end of this lesson you can

- 🎯 Explain why a circuit must be a complete loop
- 🎯 Describe current, potential difference and resistance
- 🎯 Calculate with  $V = IR$
- 🎯 Compare series and parallel circuits
- 🎯 Explain how homes are wired

# A circuit is a complete loop

- Charge flows only around a complete, unbroken loop
- The cell or battery pushes the charge round
- Opening a switch breaks the loop and the current stops
- Conventional current flows from + to – outside the cell
- Electrons actually drift the other way, from – to +

# Current and potential difference

## Current (I)

- The rate of flow of charge
- Unit: ampere (A);  $1\text{ A} = 1\text{ coulomb per second}$
- Measured with an ammeter
- Ammeter goes in series, in the loop

## Potential difference (V)

- Energy transferred per unit of charge
- Also called voltage; unit: volt (V)
- Measured with a voltmeter
- Voltmeter goes in parallel, across a component

# Resistance and Ohm's law

- Resistance opposes the current in a component
- Unit: ohm ( $\Omega$ );  $1 \Omega = 1$  volt per ampere
- $V = I \times R$
- For a fixed resistance, more voltage means more current
- Copper wires have low resistance; lamp filaments have high resistance

 **Example**

## Worked example: a torch lamp

- 1 A lamp is connected to a 3.0 V battery
- 2 The ammeter reads 0.25 A
- 3  $R = V \div I$
- 4  $R = 3.0 \div 0.25$
- 5  $R = 12 \Omega$

# Series circuits: one path

- All components sit in one loop
- The current is the same at every point
- Supply voltage is shared between components
- Total resistance =  $R_1 + R_2 + \dots$
- If one lamp breaks, the whole circuit stops

# Parallel circuits: several paths

- Each component has its own branch to the supply
- Each branch gets the full supply voltage
- Branch currents add up to the total current
- Adding a branch lowers the total resistance
- Each branch can be switched on or off separately

# Series vs parallel at a glance

## Series

- One path for the current
- Same current everywhere
- Voltage shared between components
- More lamps: each lamp dimmer
- One break stops everything

## Parallel

- Two or more paths
- Current splits, then rejoins
- Same voltage across each branch
- More lamps: each stays bright
- One break stops only that branch

 **Example**

## Worked example: two $6\ \Omega$ resistors, 6 V battery

- 1 Series: total  $R = 6 + 6 = 12\ \Omega$
- 2 Series:  $I = 6 \div 12 = 0.5\ \text{A}$ ; each resistor gets 3 V
- 3 Parallel: each resistor gets the full 6 V
- 4 Parallel: each branch  $I = 6 \div 6 = 1\ \text{A}$
- 5 Parallel: total current  $= 1 + 1 = 2\ \text{A}$

# Why homes are wired in parallel

- Every appliance gets the full mains voltage
- Each light or socket can be switched on its own
- One appliance failing does not switch off the rest
- Mains electricity can kill: never experiment with it
- Fuses and circuit breakers cut off dangerous currents

# Series and parallel on one page

- Series: one path, current the same everywhere, voltage shared. Parallel: several paths, voltage the same across each branch, currents add up.

SCIENCE · PHYSICS

AGES 12–15

Series vs Parallel Circuits

Two ways to connect the same components, with very different results for current, voltage and brightness.

 Series circuit

VS

 Parallel circuit

PATHS FOR THE CURRENT

One loop: every component is on the same path.

Two or more branches, each connected across the supply.

CURRENT

The same at every point in the circuit.

Splits between the branches; branch currents add up to the total.

POTENTIAL DIFFERENCE

Shared between the components; the parts add up to the supply voltage.

Each branch gets the full supply voltage.

TOTAL RESISTANCE

Add them up:  $R = R_1 + R_2 + \dots$

Less than the smallest single resistance.

ADD ANOTHER LAMP

Every lamp gets dimmer.

Each lamp stays as bright; the battery runs down faster.

ONE LAMP BREAKS

The circuit is broken, so every lamp goes out.

Only that branch stops; the others stay on.

WHERE YOU FIND IT

A switch, which must break the loop it controls.

Lights and sockets in a home, so each works on its own.

 Same parts, different results

Two  $6\ \Omega$  resistors on a  $6\ \text{V}$  battery. Series:  $12\ \Omega$ ,  $0.5\ \text{A}$ ,  $3\ \text{V}$  each. Parallel:  $6\ \text{V}$  and  $1\ \text{A}$  each,  $2\ \text{A}$  in total. Check with  $V = IR$ .

 Stay safe

Mains electricity can kill. Do circuit experiments only with low-voltage cells or a school power pack, and never short-circuit a cell.

infographhub.com

Free to share · CC BY-NC 4.0 · Sources at infographhub.com

 InfoGraphHub

 learnbyslides.com

12 / 14

 Quick check

**Two identical lamps are in series with a 6 V battery.  
What is the potential difference across each lamp?**

**A** 6 V

**B** 12 V

**C** 3 V

**D** 0 V

# Key takeaways

- ✓ Current flows only in a complete circuit and is not used up
- ✓ Current in amperes, potential difference in volts, resistance in ohms
- ✓  $V = IR$  links all three
- ✓ Series: same current, shared voltage
- ✓ Parallel: same voltage, currents add up