Section 4: Series circuits

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	Common mistakes
Definitions	Students will have met current, voltage and resistance before.	Electricity contains a plethora of variables, symbols, units and equations, some of which are counterintuitive. Mixing up units and symbols is common (plenty of GCSE students seem to think the unit of current is I).
V = IR	Students will be familiar with this equation applied in simple situations from GCSE	Mixing variables as mentioned above. Students are more used to applying $V = IR$ to whole circuits, rather than individual components.

Teaching ideas

Objectives

- Define Current, Voltage and Resistance.
- Discover/Prove the rules for voltage, current and resistance in series.
- Use the equation $V = IR$.

Starter activities

Quantities, units and symbols

This activity is designed to provide students with a clear reference for electricity, to aid them in not getting things mixed up. It can be used in future lessons and learning it could be set for homework.

Use your GCSE knowledge, or a textbook, to fill out this table.

Quantity	Symbol	Unit	Unit Symbol	Relevant Equations	SI Base Units (Optional)
	Q		C		
Current					Amps
		Volt			
	R				
Power					

Electric metaphors

This task will improve students' explanation skills, and get them thinking about what electricity really is.

Without using any technical language, how would you explain what electricity is to a five year old?

Section 5: Parallel circuits

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	Common mistakes
Parallel Circuits	Students will instantly recognise parallel circuits as they have met them at GCSE	Concepts such as increased current with more resistors are counterintuitive. Students frequently mix up the rules for series and parallel
Resistance in Parallel Equation	Some simple checks can be taught for answers, such as is R_t smaller than any of the individual resistances placed in parallel.	Consistently one of the most misapplied equations in A-Level Physics. Students frequently stop on arrival at their R_t^{-1}.

Teaching ideas

Objectives

- Further develop use of $V = IR$.
- Prove/discover the rules for current and voltage in parallel circuits.
- Analyse circuits to find unknown quantities.

Starter activity

Christmas trees

This starter adds mathematical detail to a well known example of series and parallel circuits used in GCSE teaching. You may want to give a hint for part **b** as power is not covered in this lesson or the lesson before.

A set of Christmas tree lights is powered from a 20V source. There are 10 bulbs in series. Each light needs a power of 10W.

a What is the voltage across each bulb? (2 V)

b What is the current be in each bulb? (use Power = IV) (5 A)

c What must the total resistance of the lights be? (4 Ω)

d What is the resistance of each light? There are two ways of working this out... (0.4 Ω)

e If one light was to be powered from a 20 V source what would the current need to be in the bulb? It still needs a power of 10 W. What would the resistance of this new bulb need to be? (0.5 A, 4 Ω)

f What is the advantage of **i)** lower current **ii)** higher resistance? (Less heating in circuit and lower current safer, component easier to make and less fragile.)

g Is there a practical way of giving the full voltage to each bulb? (Parallel)

h What is the additional advantage of this? (One bulb blowing won't put all the lights out.)

Either of the two starters from the last section (whichever wasn't used) would also work here.