

ELECTRIC CIRCUITS

LESSON 07 RESISTORS IN SERIES AND PARALLEL

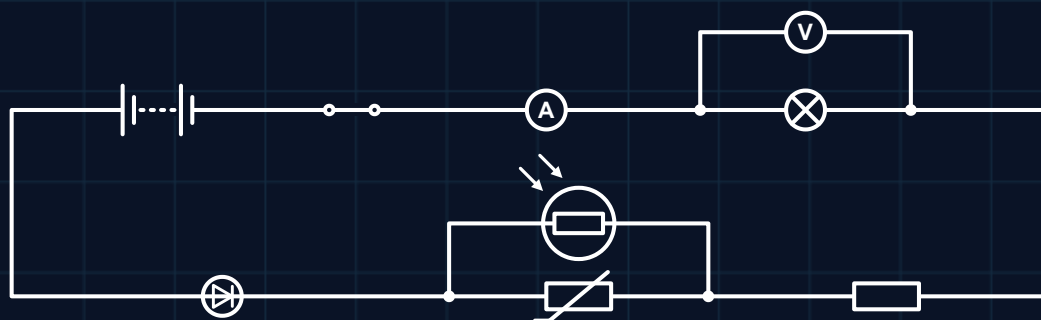
REQUIRED PRACTICAL

Two identical resistors, three ways to connect them. Which arrangement lets the most current flow?

IN THIS LESSON YOU WILL

- measure the total resistance of resistors in series and in parallel
- compare results with $R_{\text{total}} = R_1 + R_2$
- explain the results using paths and current
- evaluate the measurements

ANSWER EDITION FOR TEACHERS AND SELF-MARKING



NAME

CLASS

TEACHER

TARGET GRADE

HOW THIS BOOKLET WORKS

This is the booklet for **Lesson 7** of the Electric Circuits unit. It builds on the lessons before it; the “Do now” questions and the quick answers at the back help you check what you remember. Keep it: it is your classwork book *and* your revision guide.



DO NOW

Quick questions from earlier lessons. Remembering again is what makes it stick.



LEARN IT

The explanation, diagrams and worked examples. Read this again when you revise.



TRY IT

Practice that builds up: first with support, then on your own.



LAB

Record measurements from a virtual lab or a required practical.



EXAM CORNER

An AQA-style question with a tip on how the marks are given.



REVISE IT

Summary, cover-and-answer questions and an “I can” check to colour in.



Revising at home? (1) Read the Learn it pages. (2) Cover them and answer the “Cover the page” questions in Revise it. (3) Check with the quick answers at the back.

THE ROUTE THROUGH THE UNIT (THIS LESSON IS HIGHLIGHTED)

01 Complete circuits and symbols

03 Potential difference

05 Resistance of a wire **RP**

07 **Resistors in series and parallel** **RP**
Required practical: measure total resistance of two resistors in series and in parallel

09 Investigating I–V characteristics **RP**

11 Power and energy transfer

02 Current and charge

04 Resistance and $V = IR$

06 Series and parallel circuits

08 I–V graphs

10 Thermistors, LDRs and sensors

12 Mains, safety and the National Grid

RESISTORS IN SERIES AND PARALLEL

AQA Combined RP 15; Physics RP 3; Part B

BIG QUESTION Two identical resistors, three ways to connect them.
Which arrangement lets the most current flow?

BY THE END YOU CAN

- measure the total resistance of resistors in series and in parallel
- compare results with $R_{\text{total}} = R_1 + R_2$
- explain the results using paths and current
- evaluate the measurements

total resistance

prediction

uncertainty

resolution

evaluate



RETRIEVE

DO NOW

From earlier lessons. No notes!

1

Total resistance of 10 Ω and 15 Ω in series?

25 Ω

2

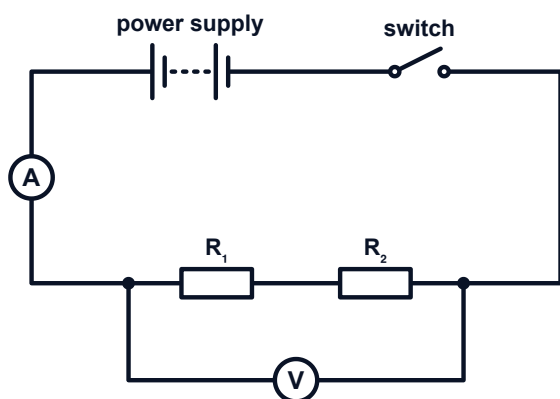
In parallel, what is the same for each branch?

The p.d.

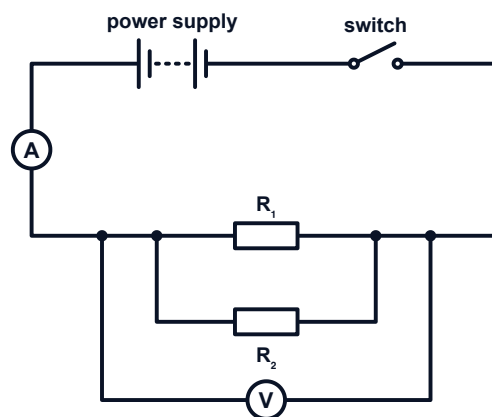
3

The supply current is 0.9 A. One branch carries 0.4 A. What does the other carry?

0.5 A



Series: the voltmeter goes across both resistors.



Parallel: the voltmeter goes across the pair.

Measure the p.d. **across the whole combination** and the current **from the supply**. Then the total resistance is $R = V \div I$.

- 1 Connect R_1 on its own. Measure V and I . Repeat for R_2 on its own.
- 2 Connect R_1 and R_2 in series. Measure V across both, and I .
- 3 Connect R_1 and R_2 in parallel. Measure V across the pair, and the supply current.
- 4 Calculate $R = V \div I$ for each arrangement.

STAY SAFE

- Resistors can get hot. Switch off between readings.
- Keep the p.d. low, and check the circuit before switching on.

- 1 **Predict** before you measure. Rank R_1 alone, series and parallel from the *largest* to the *smallest* total resistance.

series > one resistor > parallel



INVESTIGATE RESULTS

Answer edition: example results with two $10\ \Omega$ resistors at 3.0 V .

- 6 Record your readings.

Arrangement	p.d. / V	current / A	$R = V \div I / \Omega$
R_1 on its own	3.0	0.30	10
R_2 on its own	3.0	0.30	10
R_1 and R_2 in series	3.0	0.15	20
R_1 and R_2 in parallel	3.0	0.60	5.0



PRACTISE ANALYSE AND EVALUATE

- 2 Compare your series result with $R_1 + R_2$. Do they agree?

Series $\approx 20\ \Omega$ and $R_1 + R_2 = 10 + 10 = 20\ \Omega$, so they agree (within measurement error).

- 3 Explain why the total resistance in parallel is *less* than either resistor on its own.

Adding a second branch gives the charge ...

... another path. At the same p.d. the supply current increases (0.60 A instead of 0.30 A).

$R = V \div I$, so the total resistance is smaller.

- 4 Suggest one source of error in the measurements and one way to reduce it.

e.g. resistance of the leads and connections, or the resolution of the meters, or the resistors warming up. Use tight, short connections, meters with better resolution, and switch off between readings.

5

EXTRA PRACTICE

Resistors of $5.0\ \Omega$, $10\ \Omega$ and $15\ \Omega$ are connected in series with a $6.0\ \text{V}$ supply. Calculate the current.

TOTAL R	$5.0 + 10 + 15 = 30\ \Omega$	
EQUATION	$I = V \div R$	
SUBSTITUTE	$I = 6.0 \div 30$	
ANSWER	$0.20\ \text{A}$	unit:



AQA-STYLE

EXAM CORNER

Write in full sentences. Show every step of a calculation.

Get the marks: 'Explain' needs a chain: another path $\rightarrow$ more current at the same p.d. $\rightarrow$ lower total resistance.

7

Two identical resistors each have a resistance of $12\ \Omega$. (a) Calculate their total resistance in series. (b) A student measures $6.0\ \Omega$ when they are connected in parallel. Explain why this is less than $12\ \Omega$. (c) State one variable the student should keep the same for a fair comparison. **[5 marks]**

(a) $12 + 12 = 24\ \Omega$ (1). (b) Parallel gives another path for the charge (1), so at the same p.d. the total current is larger (1), and $R = V \div I$ is smaller (1). (c) The supply p.d., the same resistors, or the temperature (1).



SUMMARY

- Find total resistance from the **supply current** and the **p.d. across the combination**: $R = V \div I$.
- Series: the total is the sum ($R_1 + R_2$): bigger than either.
- Parallel: the total is smaller than either resistor.
- Evaluate by naming a specific source of error and a specific improvement.

COVER THE PAGE AND ANSWER

1 How do you find the total resistance of a combination in the lab?

2 Two $10\ \Omega$ resistors in series?

3 Is two $10\ \Omega$ in parallel more or less than $10\ \Omega$?

4 Give one source of error in this practical.

I CAN...

set up series and parallel combinations with the meters in the right places



calculate total resistance from V and I



explain why series adds and parallel lowers resistance



suggest a specific improvement to a practical



EQUATION TOOLKIT

The equations you have met so far. You will meet these one at a time. Learn each equation **in words** as well as symbols: AQA gives you an equation sheet in the exam (it does not include $R_{\text{total}} = R_1 + R_2$), but knowing the equations by heart makes every question faster.

$$Q = I t$$

Lesson 2

charge flow = current × time

C, A, s

Rearranged: $I = Q \div t$ and $t = Q \div I$

$$E = Q V$$

Lesson 3

energy transferred = charge ×
p.d.

J, C, V

Rearranged: $V = E \div Q$ and $Q = E \div V$

$$V = I R$$

Lesson 4

p.d. = current × resistance

V, A, Ω

Rearranged: $I = V \div R$ and $R = V \div I$

$$R_{\text{total}} = R_1 + R_2$$

Lesson 6

total resistance in series

Ω

Rearranged: (series only)

FOUR STEPS FOR EVERY CALCULATION

1

Write down what you know, with units.
Convert units first
(minutes → seconds,
kW → W, mA → A).

2

Write the equation you will use, in symbols.

3

Substitute the numbers, then rearrange if needed.

4

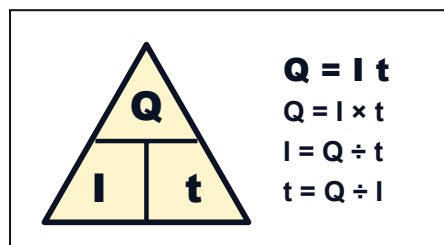
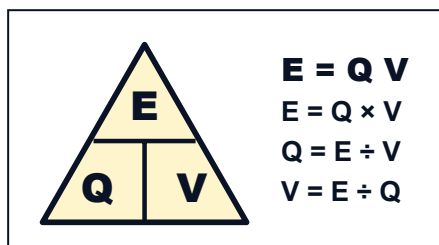
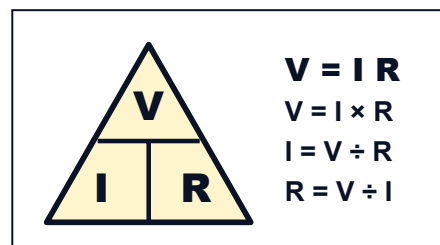
Give the answer with a unit. Ask: is it sensible?

CONVERT	HOW	EXAMPLE
minutes → seconds	× 60	3.0 min = 180 s
hours → seconds	× 3600	2.0 h = 7200 s
milliamps (mA) → amps (A)	÷ 1000	250 mA = 0.25 A
kilowatts (kW) → watts (W); kilohms (k Ω) → ohms (Ω)	× 1000	2.2 kW = 2200 W
kilovolts (kV) → volts (V)	× 1000	400 kV = 400 000 V

■ EQUATION TRIANGLES: HELP WITH REARRANGING

- 1 Cover the quantity you want to find.
- 2 The two left **side by side**? **Multiply** them.
- 3 One **above** the other? **Divide** the top by the bottom.

Example: to find I from $Q = I t$, cover I . Q is above t , so $I = Q \div t$. Triangles only help with rearranging: you still need to learn each equation.



CHECK YOURSELF

QUICK ANSWERS

Answers to the “Do now” and “Cover the page” questions, so you can check yourself when revising. Answers to the longer questions are in your teacher's answer edition.

DO NOW

1. 25Ω
2. The p.d.
3. 0.5 A

COVER THE PAGE

1. $R = V \div I$, with V across the combination and I from the supply.
2. 20Ω
3. Less (it is 5Ω).
4. Resistance of leads; meter resolution; heating.