

ELECTRIC CIRCUITS

LESSON 05 RESISTANCE OF A WIRE

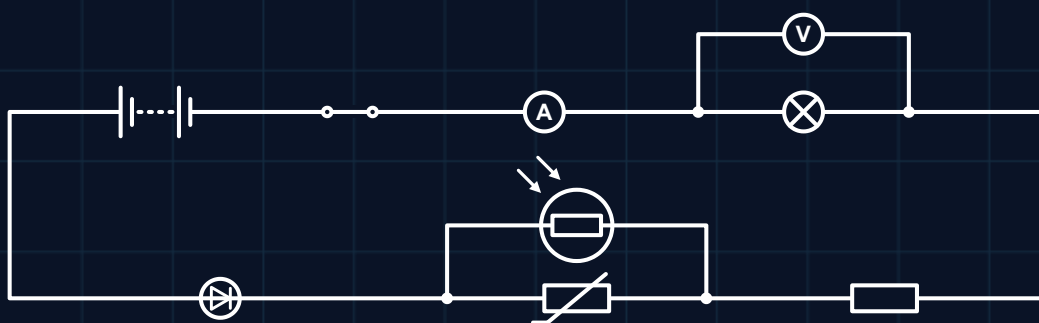
REQUIRED PRACTICAL

If you double the length of a wire, what happens to its resistance?

IN THIS LESSON YOU WILL

- set up a circuit to find resistance from V and I
- identify and control the variables
- record, process and graph results
- write a conclusion using evidence

ANSWER EDITION FOR TEACHERS AND SELF-MARKING



NAME

CLASS

TEACHER

TARGET GRADE

HOW THIS BOOKLET WORKS

This is the booklet for **Lesson 5** 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**
Required practical: how the length of a wire affects its resistance

07 Resistors in series and parallel **RP**

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

RESISTANCE OF A WIRE

AQA Combined RP 15; Physics RP 3; Part A

BIG QUESTION If you double the length of a wire, what happens to its resistance?

BY THE END YOU CAN

- set up a circuit to find resistance from V and I
- identify and control the variables
- record, process and graph results
- write a conclusion using evidence

independent variable

dependent variable

control variable

anomaly

line of best fit



RETRIEVE

DO NOW

From earlier lessons. No notes!

1

Calculate R for 1.2 V and 0.40 A.

$$R = 1.2 \div 0.40 = 3.0 \, \Omega$$

2

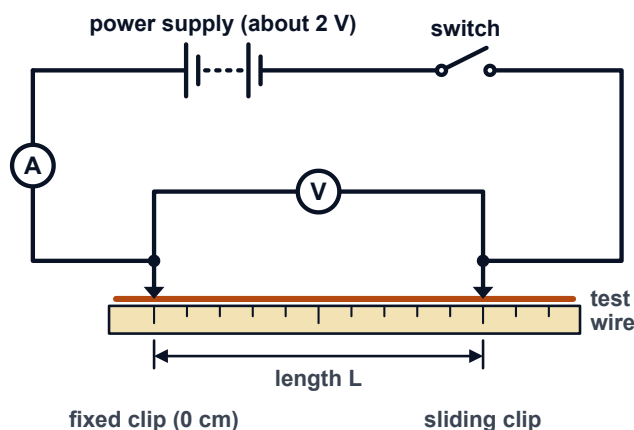
Why does heating change a wire's resistance?

ions vibrate more, so
more collisions: R
increases.

3

Draw the symbols for an ammeter and a voltmeter.

Circles containing A and
V.



The test wire is taped along a metre ruler. Only the length L between the clips is in the circuit, and the voltmeter is connected across it.

One crocodile clip stays at 0 cm; you slide the other to change the length. The ammeter measures the current *through* the wire; the voltmeter measures the p.d. *across* the length between the clips. Then $R = V \div I$.

1 Complete the variables table.

Independent variable (what you change)	Length of wire between the clips
Dependent variable (what you find)	Resistance (calculated from $V \div I$)
Control variables (keep the same)	Material of the wire; diameter (thickness) of the wire; temperature

METHOD

- 1 Set up the circuit. Fix one clip at 0 cm.
- 2 Put the sliding clip at 10 cm. Switch on.
- 3 Quickly read the ammeter and voltmeter. Switch off.
- 4 Move the clip to 20 cm and repeat, up to 100 cm.
- 5 Calculate $R = V \div I$ for each length.
- 6 Repeat any reading that does not fit the pattern.

STAY SAFE

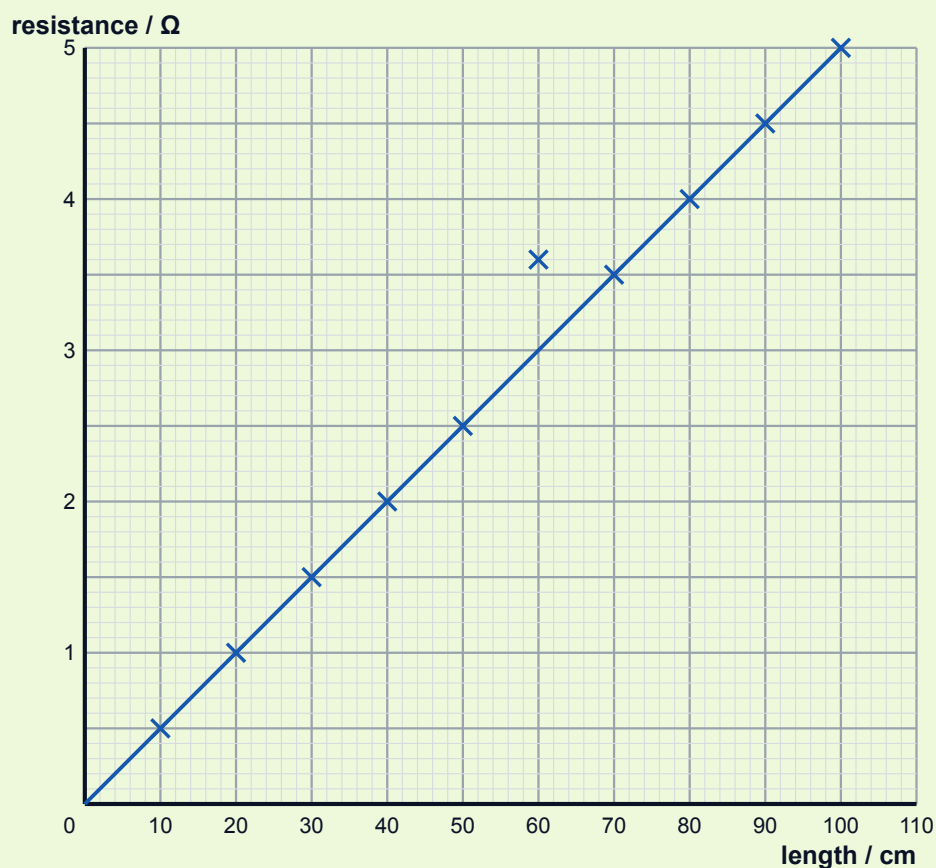
- The thin wire can get hot enough to burn. Do not touch it while the current is on.
- Switch off between readings. This also stops the wire heating up, which would change its resistance.
- Keep the p.d. low.



- 7 Record your readings and calculate the resistance.

Length / cm	p.d. / V	current / A	$R = V \div I / \Omega$
10	0.50	1.00	0.50
20	0.80	0.80	1.0
30	0.99	0.66	1.5
40	1.14	0.57	2.0
50	1.25	0.50	2.5
60	1.44	0.40	3.6 (anomaly)
70	1.40	0.40	3.5
80	1.45	0.36	4.0
90	1.49	0.33	4.5
100	1.55	0.31	5.0

- 8 Plot resistance (up the side) against length (along the bottom). Draw a line of best fit.





- 2 Describe the pattern shown by your graph.

As the length increases, the resistance ...

increases. The line is straight and passes through the origin, so resistance is directly proportional to length.

- 3 Use your graph to find the resistance of 75 cm of the wire.

About 3.75 Ω (from the example line).

- 4 Circle any anomalous result in your table. Suggest one possible cause.

e.g. 60 cm in the example. Causes: the wire heated up; a poor clip contact; the length or a meter was misread.

- 5 Why is the circuit switched off between readings? Tick **one** box.

☐

to save the battery

☒

to stop the wire heating up and changing its resistance

☐

to reset the ammeter

☐

to make the voltmeter more accurate

- 6 A student's line of best fit crosses the resistance axis a little above zero. Suggest why.

The clips and connections add a small extra resistance to every reading (or the length was not measured from the contact point of the fixed clip): a systematic error.



Get the marks: A 6-mark method covers: the circuit, what you change and how, what you measure, how you calculate R , how you keep it fair and safe, and what you do with the results.

9

Describe how you would investigate how the resistance of a wire depends on its length.

[6 marks]

Any six: ammeter in series with the wire and voltmeter across the measured length (circuit); change the length by moving a clip along a metre ruler; record V and I for each length; calculate $R = V \div I$; keep material and diameter the same; keep p.d. low and switch off between readings so the temperature stays constant; repeat readings and plot R against length.

**SUMMARY**

- Resistance of a wire: $R = V \div I$, ammeter in series, voltmeter across the wire.
- Change the length. Keep material, diameter and temperature the same.
- Resistance is **directly proportional** to length.
- Switch off between readings so the wire does not heat up.

COVER THE PAGE AND ANSWER

1 What are the independent and dependent variables?

.....

2 Why keep the current small?

.....

3 How does resistance change with length?

.....

4 Name two control variables.

.....

I CAN...

draw and set up the circuit to find a resistance



name the independent, dependent and control variables



plot a graph and draw a line of best fit



spot an anomaly and suggest a cause



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 $R = V \div I$

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

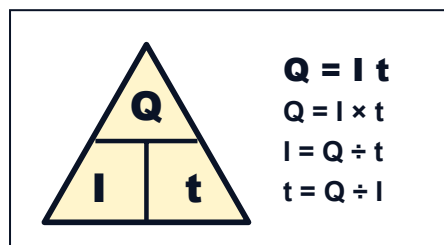
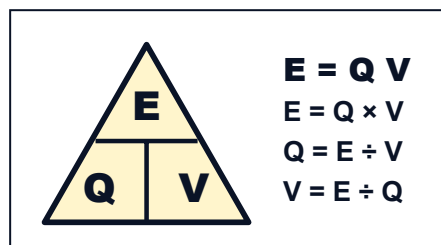
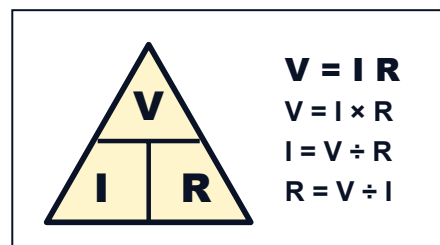
Give the answer with a unit. Ask: is it sensible?

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.



REFERENCE

KEY WORDS FROM THIS LESSON

Learn the meaning and spelling. In exams, precise words earn marks: say “p.d. across” and “current through”.

Anomaly: A result that does not fit the pattern of the others.

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. $R = 1.2 \div 0.40 = 3.0 \Omega$
2. Ions vibrate more, so more collisions: R increases.
3. Circles containing A and V .

COVER THE PAGE

1. Length; resistance.
2. To stop the wire heating (R would increase).
3. Directly proportional.
4. Material; diameter (thickness).