YEAR 10 PHYSICS, AQA GCSE, LESSON 4 OF 12

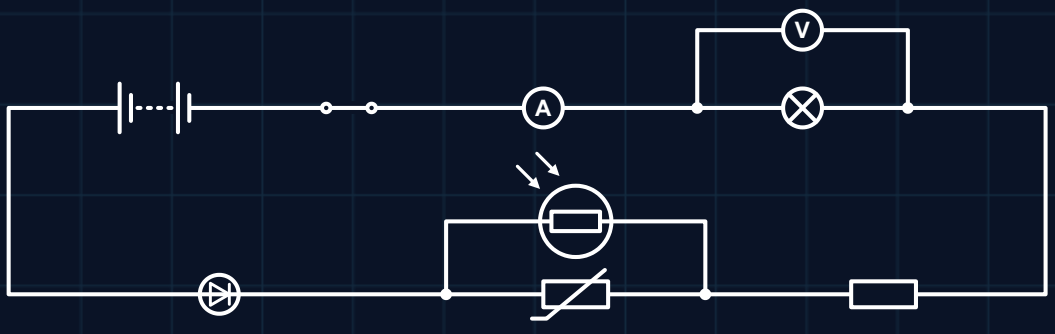
ELECTRIC CIRCUITS

LESSON 04 RESISTANCE AND V = I R

A dimmer switch makes a lamp glow less brightly. What is it actually changing?

IN THIS LESSON YOU WILL

- describe resistance and its unit, the ohm (Ω)
- use V = I R, including mA and kΩ
- recognise an ohmic conductor from data or a graph
- explain why heating a metal increases its resistance



NAME _____ CLASS _____

TEACHER _____ TARGET GRADE _____

START HERE

HOW THIS BOOKLET WORKS

This is the booklet for **Lesson 4** 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

02 Current and charge

03 Potential difference

04 Resistance and V = I R
Resistance, V = I R, ohmic conductors, why heating raises resistance

05 Resistance of a wire RP

06 Series and parallel circuits

07 Resistors in series and parallel RP

08 I–V graphs

09 Investigating I–V characteristics RP

10 Thermistors, LDRs and sensors

11 Power and energy transfer

12 Mains, safety and the National Grid

Lesson

04 RESISTANCE AND V = I R

AQA Combined 6.2.1.3–6.2.1.4; Physics 4.2.1.3–4.2.1.4; Virtual Lab 3

BIG QUESTION **A dimmer switch makes a lamp glow less brightly. What is it actually changing?**

BY THE END YOU CAN

- describe resistance and its unit, the ohm (Ω)
- use V = I R, including mA and kΩ
- recognise an ohmic conductor from data or a graph
- explain why heating a metal increases its resistance

resistance **ohm (Ω)** **ohmic conductor** **directly proportional** **variable resistor**

RETRIEVE

DO NOW

From earlier lessons. No notes!

1

What does ‘6 V across a lamp’ mean?

2

Which meter measures p.d., and how is it connected?

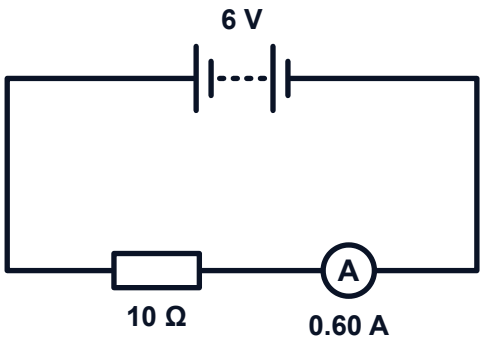
3

Two lamps are in series with a 6 V battery. One has 2 V across it. What is across the other?

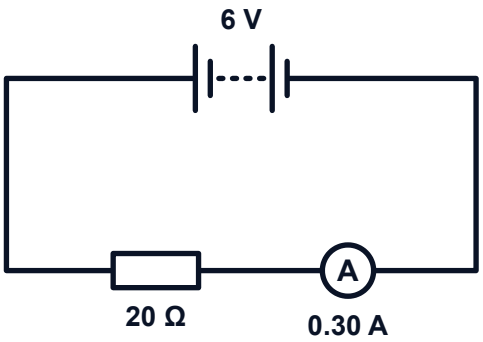
EXPLAIN

CONTROLLING THE CURRENT

Resistance is how much a component **opposes the current**. For the same p.d., a bigger resistance means a smaller current. Resistance is measured in **ohms (Ω)**. A **resistor** has a chosen resistance, such as 10 Ω, to control the current. A **variable resistor** (the dimmer) lets you change it.



Smaller resistance, bigger current.



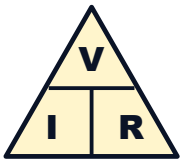
Double the resistance, half the current.

V = I R

potential difference = current × resistance

V in volts (V), I in amperes (A), R in ohms (Ω)

Rearranged: I = V ÷ R and R = V ÷ I



WORKED EXAMPLE

A resistor has 6.0 V across it and a current of 0.30 A through it. Calculate its resistance.

KNOW	V = 6.0 V, I = 0.30 A
EQUATION	R = V ÷ I
SUBSTITUTE	R = 6.0 ÷ 0.30
ANSWER	**R = 20 Ω**

YOUR TURN

A lamp has 12 V across it and 0.40 A through it. Calculate its resistance.

KNOW

EQUATION

SUBSTITUTE

ANSWER

WORKED EXAMPLE

A 150 Ω resistor has 3.0 V across it. Calculate the current in milliamps (mA).

EQUATION	I = V ÷ R
SUBSTITUTE	I = 3.0 ÷ 150
ANSWER	I = 0.020 A
CONVERT	**0.020 × 1000 = 20 mA**

YOUR TURN

A 500 Ω resistor has 2.0 V across it. Calculate the current in mA.

EQUATION

SUBSTITUTE

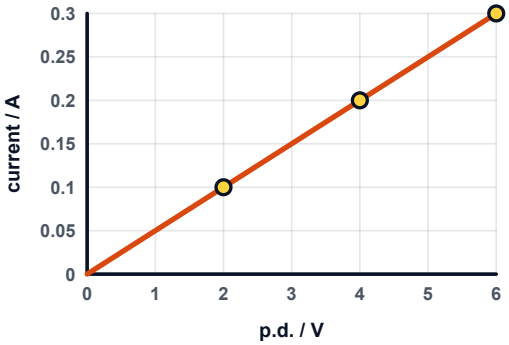
ANSWER

CONVERT

OHM'S LAW: OHMIC CONDUCTORS

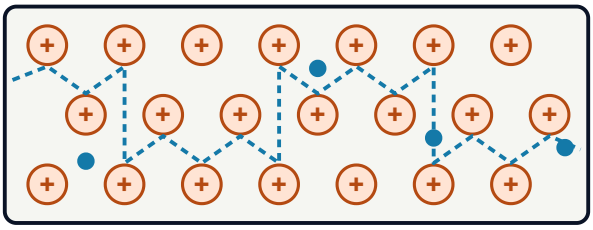
For a **fixed resistor at constant temperature**, the current is **directly proportional** to the p.d.: double the p.d. and the current doubles. The resistance stays the same.

A component like this is an **ohmic conductor**. A graph of current against p.d. is a **straight line through the origin**.



A 20 Ω resistor: straight line through the origin.

WHY IS THERE RESISTANCE?



A free electron collides with the ions as it moves through the wire: this is resistance.

Free electrons keep **colliding with the ions** in the metal. This opposes the flow of charge: resistance.

When the metal gets **hotter**, the ions vibrate more, so there are more collisions and the **resistance increases**. That is why Ohm's law needs 'at constant temperature'.

PRACTISE

TRY IT

1 Two circuits have the same 6 V battery. Circuit A has a 10 Ω resistor; circuit B has a 30 Ω resistor. Tick **one** box.

- ☐ Circuit A has the bigger current.
- ☐ Circuit B has the bigger current.
- ☐ Both have the same current.
- ☐ You cannot tell.

2 SUPPORTED Calculate the resistance of a component with 12 V across it and 0.60 A through it.

EQUATION	
SUBSTITUTE	
ANSWER	unit:

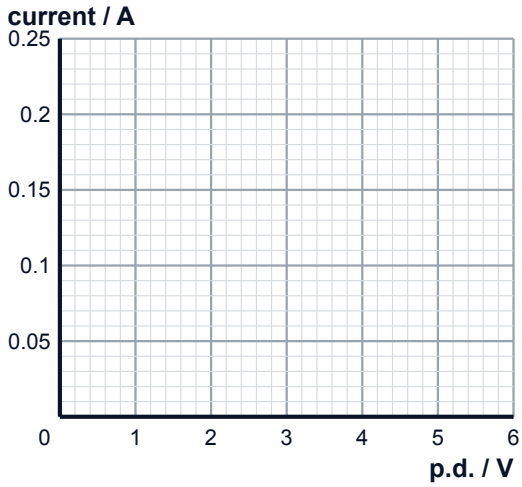
3 SUPPORTED A current of 0.20 A flows through a 15 Ω resistor. Calculate the p.d. across it.

EQUATION	
SUBSTITUTE	
ANSWER	unit:

4 **ON YOUR OWN** A 220 Ω resistor has 5.5 V across it. Calculate the current in mA.

5 A student measures a component. Complete the table, plot the points and draw a line of best fit.

p.d. / V	current / A	V ÷ I / Ω
1.0	0.05	
2.0	0.10	
3.0	0.15	
4.0	0.20	



Is the component an ohmic conductor? Use the table and the graph.

6 Explain why a resistor only has a constant resistance if its temperature stays the same.

If the resistor gets hotter, the ions …

INVESTIGATE

VIRTUAL LAB 3: DISCOVER THE RESISTANCE RULE

Full steps: Virtual Labs worksheet pp. 11–14.

Set the resistor to **10 Ω**. Change only the battery setting. Measure the p.d. across the resistor and the current.

7 Record and calculate.

Battery setting / V	p.d. / V	current / A	V ÷ I / Ω
2			
4			
6			
8			
10			
12			

8 What happens to the current when the p.d. doubles? What stays constant?

AQA-STYLE

EXAM CORNER

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

> **Get the marks:** In part (b) use your answer to (a). Quick check: 3 × the p.d. should give 3 × the current if R is constant.

9 A fixed resistor has a p.d. of 2.0 V across it and a current of 0.10 A through it. Calculate its resistance. **[2 marks]**

EQUATION	
SUBSTITUTE	
ANSWER	unit:

10 The p.d. is increased to 6.0 V. The temperature stays constant. Calculate the new current. **[2 marks]**

REVIEW LATER

REVISE IT

Use this box after the lesson and before tests.

SUMMARY

- Resistance opposes the current. Unit: **ohm (Ω)**.
- **V = I R**. Convert mA → A (÷ 1000) and kΩ → Ω (× 1000).
- Ohmic conductor: $I \propto V$ at constant temperature; the graph is a straight line through the origin.
- Hotter metal → ions vibrate more → more collisions → higher resistance.

COVER THE PAGE AND ANSWER

1 What is the unit of resistance?

2 Write the equation linking p.d., current and resistance.

3 What does an ohmic conductor's I–V graph look like?

4 What happens to a metal's resistance as it heats up?

I CAN…

- describe resistance and state its unit
- use V = I R and its rearrangements
- convert mA and kΩ
- decide from data or a graph whether a component is ohmic
- explain why heating increases resistance

REFERENCE

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 $R_{total} = R_1 + R_2$), 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 ÷ t and t = Q ÷ I

$E = Q\,V$

Lesson 3

energy transferred = charge × p.d.

J, C, V

Rearranged: V = E ÷ Q and Q = E ÷ V

$V = I\,R$

Lesson 4

p.d. = current × resistance

V, A, Ω

Rearranged: I = V ÷ R and R = V ÷ 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.

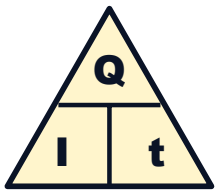
4
Give the answer with a unit. Ask: is it sensible?

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 (kΩ) → ohms (Ω)	× 1000	2.2 kW = 2200 W
kilovolts (kV) → volts (V)	× 1000	400 kV = 400 000 V

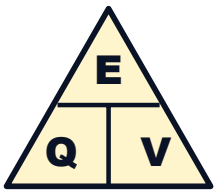
EQUATION TRIANGLES: HELP WITH REARRANGING

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.

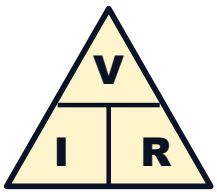
Example: to find I from Q = I t, cover I. Q is above t, so I = Q ÷ t. Triangles only help with rearranging: you still need to learn each equation.



Q = I t
Q = I × t
I = Q ÷ t
t = Q ÷ I



E = Q V
E = Q × V
Q = E ÷ V
V = E ÷ Q



V = I R
V = I × R
I = V ÷ R
R = V ÷ I

REFERENCE

KEY WORDS FROM THIS LESSON

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

Directly proportional: If one quantity doubles, the other doubles. The graph is a straight line through the origin.

Ohm (Ω): Unit of resistance.

Ohmic conductor: Current is directly proportional to p.d. at constant temperature.

Resistance (R): How much a component opposes the current. Unit: ohm (Ω).

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. 6 J of energy is transferred per coulomb.
2. Voltmeter, in parallel (across).
3. 4 V

COVER THE PAGE

1. Ohm (Ω)
2. V = I R
3. A straight line through the origin.
4. It increases.