YEAR 10 PHYSICS, AQA GCSE, LESSON 8 OF 12

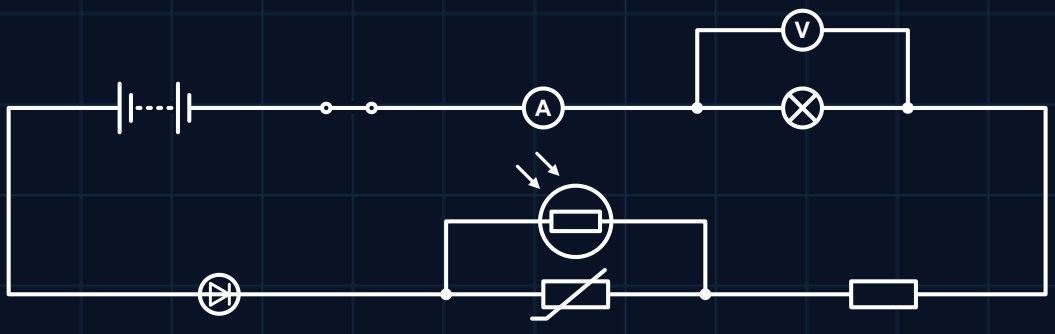
ELECTRIC CIRCUITS

LESSON 08 I–V GRAPHS

Every component has a ‘fingerprint’: the shape of its I–V graph.
Could you identify a component from its graph alone?

IN THIS LESSON YOU WILL

- read an I–V graph, including negative values
- sketch and recognise the graphs for a fixed resistor, a filament lamp and a diode
- calculate the resistance at a point with R = V ÷ I
- explain the shape of each graph



NAME _____ CLASS _____

TEACHER _____ TARGET GRADE _____

START HERE

HOW THIS BOOKLET WORKS

This is the booklet for **Lesson 8** 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

05 Resistance of a wire RP

06 Series and parallel circuits

07 Resistors in series and parallel RP

08 I–V graphs
I–V graphs of a fixed resistor, filament lamp and diode

09 Investigating I–V characteristics RP

10 Thermistors, LDRs and sensors

11 Power and energy transfer

12 Mains, safety and the National Grid

Lesson

08

I–V GRAPHS

AQA Combined 6.2.1.4; Physics 4.2.1.4

BIG QUESTION **Every component has a ‘fingerprint’: the shape of its I–V graph. Could you identify a component from its graph alone?**

BY THE END YOU CAN

- read an I–V graph, including negative values
- sketch and recognise the graphs for a fixed resistor, a filament lamp and a diode
- calculate the resistance at a point with R = V ÷ I
- explain the shape of each graph

I–V characteristic **filament lamp** **diode** **LED** **forward** **reverse**

RETRIEVE

DO NOW

From earlier lessons. No notes!

1

What is an ohmic conductor?

2

Why does a metal's resistance increase when it gets hot?

3

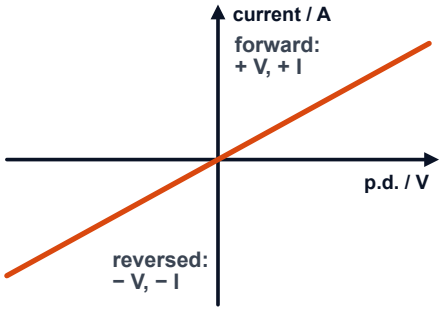
Calculate R for 4.0 V and 0.20 A.

EXPLAIN

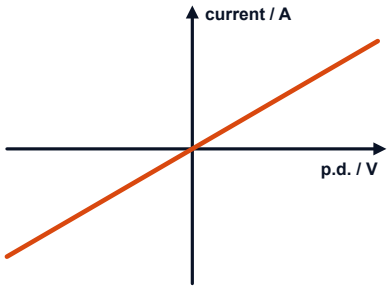
READING COMPONENT FINGERPRINTS

On an **I–V graph**, current (I) goes up the side and p.d. (V) goes along the bottom.

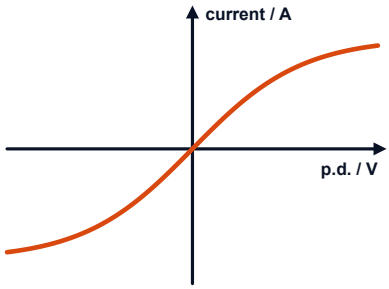
Negative values mean the component is connected **the other way round**, so the current flows the other way.



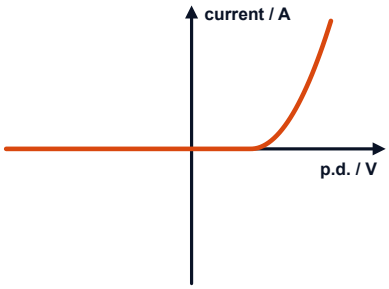
> ! To find the resistance at any point, read V and I and use **R = V ÷ I**. Do not use the gradient.



Fixed resistor: straight line through the origin. Constant resistance (at constant temperature).



Filament lamp: gets less steep. Resistance increases as the filament heats up.



Diode: current flows in one direction only. Very high resistance in reverse.

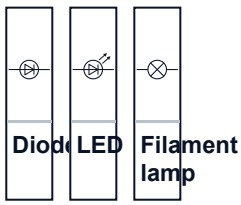
WHY DOES THE LAMP GRAPH BEND?

As the p.d. increases, the current increases. The current **heats the filament**. Hotter metal ions vibrate more, so electrons collide with them more often and the **resistance increases**. Each extra volt adds less current than the one before, so the graph gets less steep. It has the same shape for negative p.d. because the filament heats up whichever way the current flows.

DIODES AND LEDS

A **diode** lets current flow in one direction only: the way its triangle points. In the other direction its resistance is very high, so there is almost no current. Diodes protect circuits, for example if a battery is put in the wrong way round.

An **LED** (light-emitting diode) is a diode that gives out light when a current flows through it.

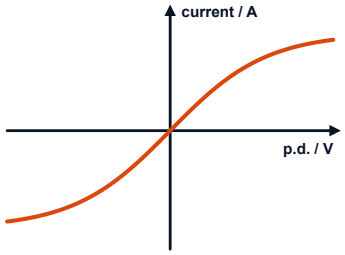


PRACTISE

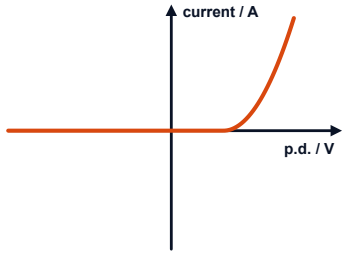
TRY IT

1 Name the component that gives each graph.

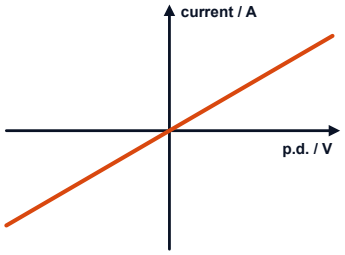
Graph A



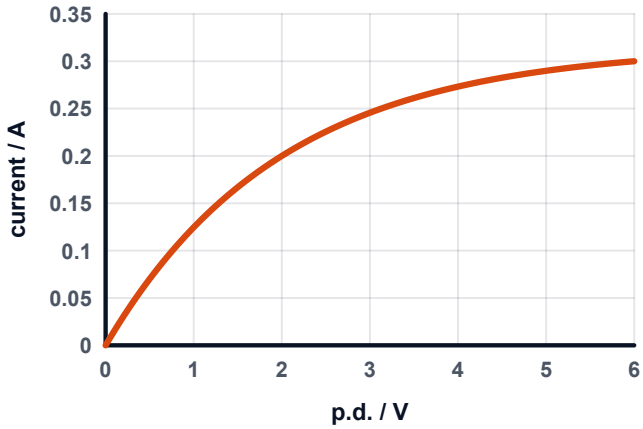
Graph B



Graph C



2 This is the I–V graph for a filament lamp. (a) Read the current at 2.0 V and at 6.0 V. (b) Calculate the resistance at each p.d. (c) Explain why they are different.



3 Number these statements 1–6 to explain the shape of a filament lamp's graph.

- The electrons collide with the ions more often
- The filament gets hotter
- So the I–V graph gets less steep
- The p.d. and the current increase
- The metal ions vibrate more
- The resistance of the filament increases

4 A component carries 0.10 A at 2.0 V and 0.15 A at 4.0 V. Is it an ohmic conductor? Show your working.

5 What happens to the current through a diode when it is connected the other way round? Suggest one use for this.

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AQA-STYLE

EXAM CORNER

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

Get the marks: A sketch needs labelled axes and the right shape in both directions. The explanation needs cause → effect: current → heating → resistance.

6 Sketch the I–V graph of a filament lamp for positive and negative p.d. Then explain its shape. **[4 marks]**

REVIEW LATER

REVISE IT

Use this box after the lesson and before tests.

SUMMARY

- I–V graph: current up the side, p.d. along the bottom. Negative = connected the other way.
- Fixed resistor: straight line through the origin (constant R).
- Filament lamp: gets less steep; the filament heats up, so R increases.
- Diode: current in one direction only; very high resistance in reverse. An LED is a diode that gives out light.
- Resistance at a point: R = V ÷ I.

COVER THE PAGE AND ANSWER

1 Sketch the I–V graph for a fixed resistor.

2 Why does a filament lamp's resistance increase?

3 What does a diode do?

4 How do you find R at a point on an I–V graph?

I CAN…

- read values from an I–V graph, including negative values
- sketch the I–V graphs for a fixed resistor, lamp and diode
- calculate resistance at a point
- explain why the lamp graph curves

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

$R_{total} = R_1 + R_2$

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.

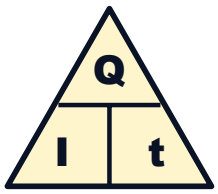
4
Give the answer with a unit. Ask: is it sensible?

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

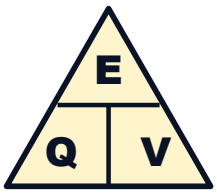
EQUATION TRIANGLES: HELP WITH REARRANGING

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.

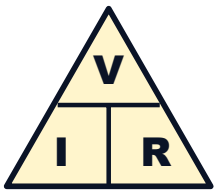
Example: to find I from Q = I t, cover I. Q is above t, so I = Q ÷ t. Triangles only help with rearranging: you still need to learn each equation.



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”.

Diode: Lets current flow in one direction only.

Filament lamp: A lamp with a thin metal filament; its resistance increases as it heats up.

I–V characteristic: A graph of current against p.d. for a component.

LED: Light-emitting diode: a diode that gives out light.

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. Current $\propto$ p.d. at constant temperature (constant resistance).
2. Ions vibrate more, so more collisions.
3. 20 Ω

COVER THE PAGE

1. Straight line through the origin.
2. It gets hotter, so the ions vibrate more and there are more collisions.
3. Lets current flow in one direction only.
4. Read V and I; R = V ÷ I.