

ELECTRIC CIRCUITS

LESSON 09 INVESTIGATING I-V CHARACTERISTICS

REQUIRED PRACTICAL

Can you produce the fingerprint graphs of a resistor, a lamp and a diode yourself?

IN THIS LESSON YOU WILL

- set up a circuit to vary the p.d. and measure the current
- take readings in both directions, safely
- plot an I-V graph with positive and negative values
- describe how the method changes for a diode



NAME

CLASS

TEACHER

TARGET GRADE

HOW THIS BOOKLET WORKS

This is the booklet for **Lesson 9** 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**

09 Investigating I–V characteristics **RP**
Required practical: measure the I–V characteristics of a resistor, lamp and diode

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

INVESTIGATING I-V CHARACTERISTICS

AQA Combined RP 16; Physics RP 4

BIG QUESTION Can you produce the fingerprint graphs of a resistor, a lamp and a diode yourself?

BY THE END YOU CAN

- set up a circuit to vary the p.d. and measure the current
- take readings in both directions, safely
- plot an I-V graph with positive and negative values
- describe how the method changes for a diode

variable resistor

protective resistor

reverse

range

interval



RETRIEVE

DO NOW

From earlier lessons. No notes!

1

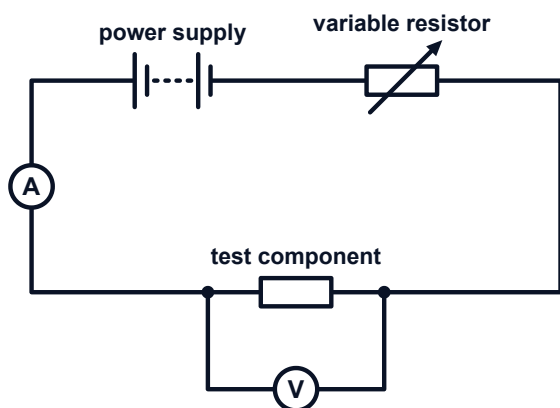
Sketch the I-V graph shape for a diode.

2

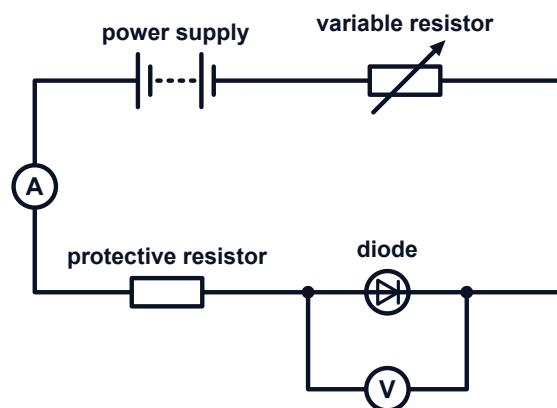
Why does a lamp's resistance increase as the current increases?

3

How is a voltmeter connected to a component?



Resistor first, then swap in the filament lamp.



Diode: add a protective resistor; voltmeter across the diode only.

The **variable resistor** changes the p.d. across the test component. To get negative values, **swap the connections** to the power supply so the current flows the other way, and record those readings as negative.

- 1 Set up the circuit with the fixed resistor as the test component.
- 2 Use the variable resistor to set a range of p.d.s, for example from 0 to 6 V. Record V and I each time.
- 3 Reverse the connections to the power supply. Repeat, recording V and I as negative values.
- 4 Repeat for the filament lamp.
- 5 Repeat for the diode with its protective resistor, taking small steps of p.d. from 0 to about 1 V.

STAY SAFE

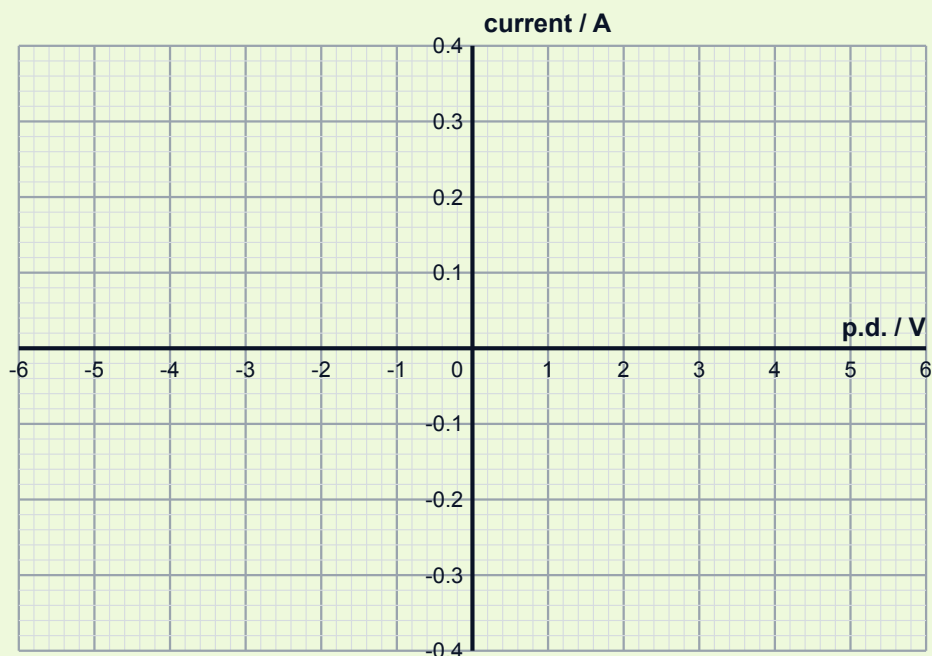
- The lamp gets hot. Do not touch it while it is on or just after.
- Do not go above the lamp's rated p.d. (for example 6 V).
- Always use the protective resistor with the diode, so the current stays small.



- 6 Aim for these p.d.s. Record the actual p.d. if it is slightly different.

p.d. / V	Resistor: current / A	Lamp: current / A
-6.0		
-4.0		
-2.0		
-1.0		
0		
1.0		
2.0		
4.0		
6.0		

- 7 Plot both components on the same axes. Use a different symbol for each, and add a key.

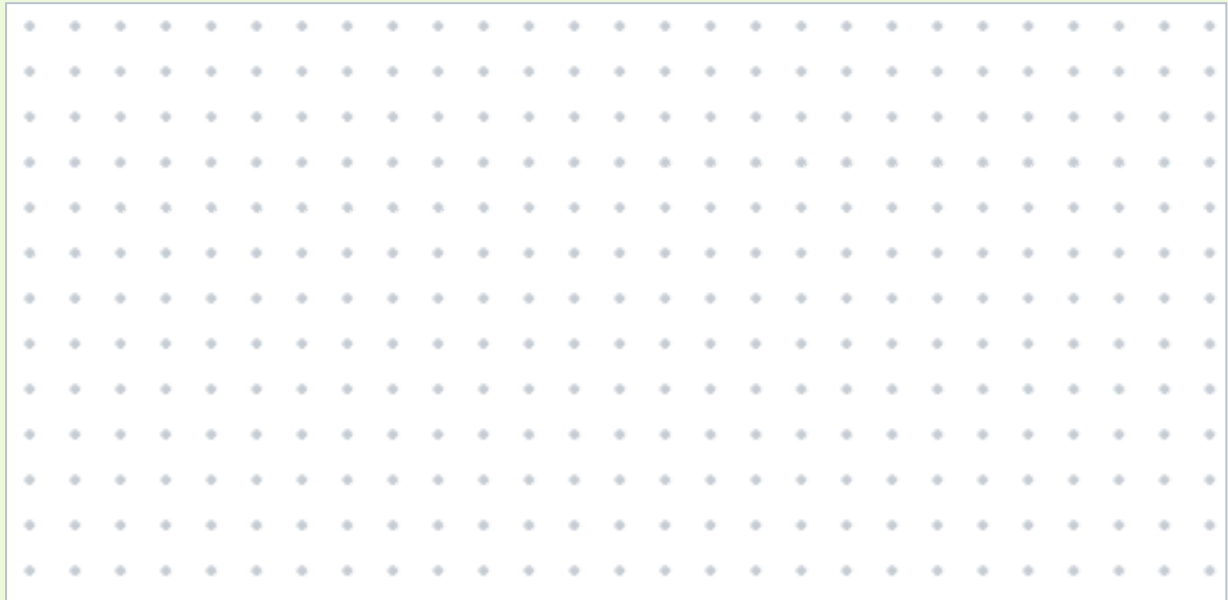


8

Diode (with protective resistor).

p.d. / V	-1.0	0	0.2	0.4	0.5	0.6	0.65	0.7
current / mA								

Sketch the shape of the diode graph from your readings.



PRACTISE

ANALYSE AND EVALUATE

1

Describe the shape of your fixed-resistor graph. What does it show?

2

Use your lamp results to calculate its resistance at 1.0 V and at 6.0 V. Explain the difference.

3

Why is a protective resistor used with the diode? Tick **one** box.☐

to make the diode light up

☐

to limit the current so the diode is not damaged

☐

to measure the p.d.

☐

to reverse the current

4 Why were the diode readings taken in smaller steps of p.d.?

5 A student plots the reversed readings as positive numbers. What will be wrong with the graph?



AQA-STYLE

EXAM CORNER

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

Get the marks: Name the equipment and say what it is for. Cover both directions, safety, and the changes for a diode.

9 Describe a method to obtain the I–V characteristic of a filament lamp for [6 marks]
positive and negative p.d. State two ways the method would change for a diode.



SUMMARY

- Vary the p.d. with a **variable resistor**; ammeter in series, voltmeter across the component.
- Reverse the supply connections for negative readings, and record them as negative.
- Diode: protective resistor, a milliammeter and small steps of p.d.
- Plot I (up) against V (along), with the origin in the middle.

COVER THE PAGE AND ANSWER

1 How do you change the p.d. across the component?
.....

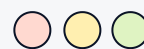
2 How do you get negative readings?
.....

3 Why is a protective resistor used with a diode?
.....

4 Where do reversed readings go on the graph?
.....

I CAN...

set up the I–V circuit and explain each part



take and record readings in both directions



plot an I–V graph with the origin in the middle



describe the extra steps for a diode



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

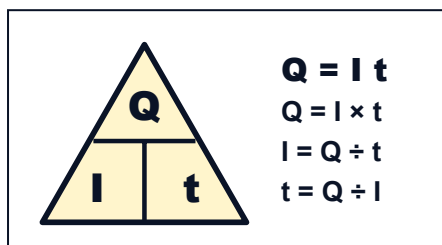
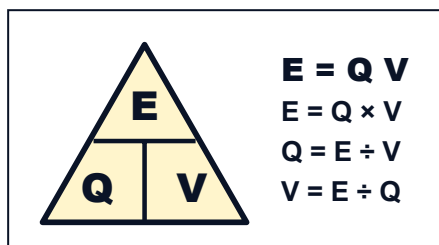
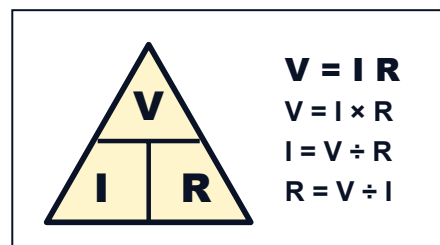
Give the answer with a unit. Ask: is it sensible?

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. Zero current for negative p.d.; almost none until a small positive p.d., then rises steeply.
2. The filament heats up, so more collisions.
3. Across it, in parallel.

COVER THE PAGE

1. Adjust the variable resistor (or variable supply).
2. Swap the connections to the supply.
3. To limit the current and stop damage.
4. In the bottom-left quadrant (negative V and I).