

ELECTRIC CIRCUITS

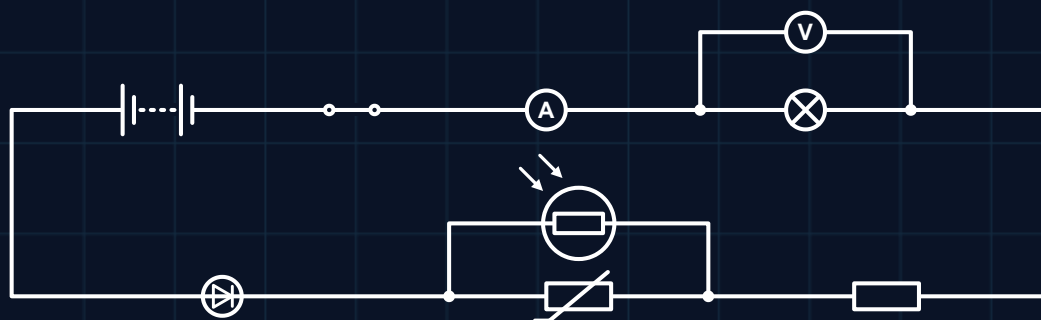
LESSON 10 THERMISTORS, LDRS AND SENSORS

How does a streetlight know it's getting dark, and how does a fire alarm know the room is hot?

IN THIS LESSON YOU WILL

- describe how a thermistor's resistance changes with temperature
- describe how an LDR's resistance changes with light intensity
- predict the current in a sensor circuit
- choose the right sensor for a job

ANSWER EDITION FOR TEACHERS AND SELF-MARKING



NAME

CLASS

TEACHER

TARGET GRADE

HOW THIS BOOKLET WORKS

This is the booklet for **Lesson 10** 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**

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**

How thermistors and LDRs respond to temperature and light, and sensor circuits

12 Mains, safety and the National Grid

THERMISTORS, LDRS AND SENSORS

AQA Combined 6.2.1.4, 6.2.2; Physics 4.2.1.4, 4.2.2

BIG QUESTION How does a streetlight know it's getting dark, and how does a fire alarm know the room is hot?

BY THE END YOU CAN

- describe how a thermistor's resistance changes with temperature
- describe how an LDR's resistance changes with light intensity
- predict the current in a sensor circuit
- choose the right sensor for a job

thermistor

LDR

light intensity

sensor



RETRIEVE

DO NOW

From earlier lessons. No notes!

1

Which component's I–V graph gets less steep?

Filament lamp.

2

At a fixed p.d., what happens to the current if the resistance doubles?

It halves.

3

Draw the symbol for a diode.

A triangle pointing at a bar, on a line.



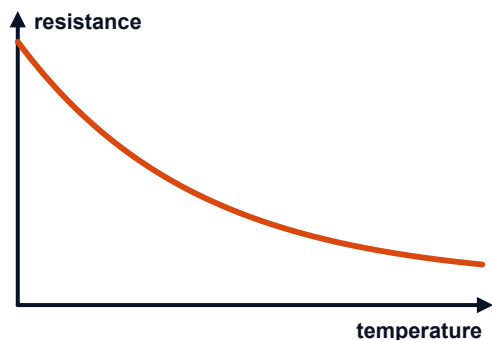
EXPLAIN

COMPONENTS THAT SENSE

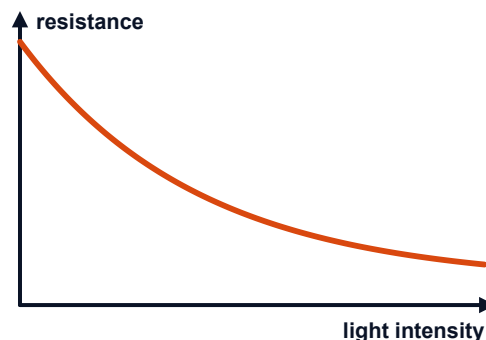
Some resistors change their resistance when their surroundings change. That makes them useful as **sensors**.

A **thermistor** responds to **temperature**. A **light-dependent resistor (LDR)** responds to **light intensity** (how bright it is).





Thermistor: as the temperature increases, its resistance decreases.



LDR: as the light gets brighter, its resistance decreases.

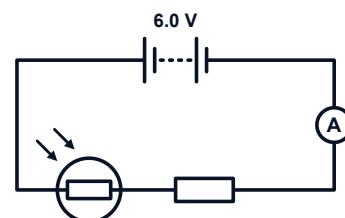
! Both follow **more** → **less**: more heat or more light means less resistance.

	THERMISTOR	LDR
Responds to	temperature	light intensity
When that increases...	resistance decreases	resistance decreases
Used in	thermostats, fire alarms, car engine sensors	night lights, streetlights, security lights

SENSORS IN CIRCUITS

In a series circuit with a fixed supply p.d., the current depends on the **total resistance**. When light shines on the LDR, its resistance falls, so the total resistance falls and the **current rises** ($I = V \div R$).

A change in current (or in the p.d. across the fixed resistor) can be used to switch something on, such as a lamp or an alarm.



An LDR in series with a fixed resistor.

WORKED EXAMPLE

A 6.0 V supply is connected to an LDR and a resistor in series. In bright light the total resistance is 600 Ω. Calculate the current.

EQUATION $I = V \div R$

SUBSTITUTE $I = 6.0 \div 600$

ANSWER $I = 0.010 \text{ A (10 mA)}$

YOUR TURN

In the dark, the total resistance rises to 1500 Ω. Calculate the new current.

EQUATION $I = V \div R$

SUBSTITUTE $I = 6.0 \div 1500$

ANSWER $I = 0.0040 \text{ A (4.0 mA)}$



PRACTISE
TRY IT

- 1 Complete the sentences.

When the temperature of a thermistor increases, its resistance decreases. When the light on an LDR gets brighter, its resistance decreases. So in the dark, an LDR has a high resistance.

WORD BANK

increases

decreases

high

low

- 2 Choose a thermistor or an LDR for each job, and give a reason.

Job	Sensor	Why
Fire alarm	thermistor	detects a rise in temperature
Automatic garden light	LDR	detects when it gets dark
Greenhouse heater that switches on when it is cold	thermistor	detects a fall in temperature
Camera that measures how bright a scene is	LDR	detects light intensity

- 3 A thermistor is in series with an ammeter and a 12 V supply. The thermistor is put into hot water. Describe and explain what happens to the ammeter reading.

The reading increases. The thermistor gets hotter, so its resistance decreases, the total resistance decreases, and $I = V \div R$ increases.

- 4 **SUPPORTED** A 12 V sensor circuit has a total resistance of 300 Ω . Calculate the current.

EQUATION	$I = V \div R$
SUBSTITUTE	$I = 12 \div 300$
ANSWER	0.040 A unit:

- 5 Which change would **increase** the current through a thermistor in a series circuit?

☐ cooling the thermistor

☒ heating the thermistor

☐ covering it with a black cloth

☐ adding another resistor in series



Get the marks: For 'explain', link each step: light → LDR resistance → total resistance → current.

6

A 6.0 V supply is connected to an LDR and a fixed resistor in series. In dim light the total resistance is 1500 Ω. (a) Calculate the current. (b) Explain what happens to the current when the light becomes brighter. **[4 marks]**

(a) $I = V \div R$ (1) = $6.0 \div 1500 = 0.0040$ A (1). (b) The LDR's resistance decreases (1), so the total resistance decreases and the current increases (1).

**SUMMARY**

- Thermistor: temperature up → resistance **down**.
- LDR: light intensity up → resistance **down**.
- In a series circuit at a fixed p.d.: lower total resistance → bigger current.
- Thermistors sense temperature (thermostats, fire alarms); LDRs sense light (streetlights, night lights).

COVER THE PAGE AND ANSWER

1 What happens to a thermistor's resistance as it warms up?

3 Which sensor would you use in a streetlight?

2 What happens to an LDR's resistance in the dark?

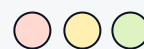
4 Total R falls in a series circuit. What happens to the current?

I CAN...

describe how a thermistor responds to temperature



describe how an LDR responds to light



explain how the current in a sensor circuit changes



choose and justify a sensor for a job



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

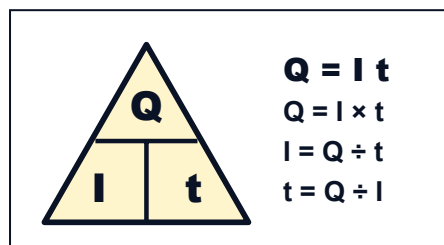
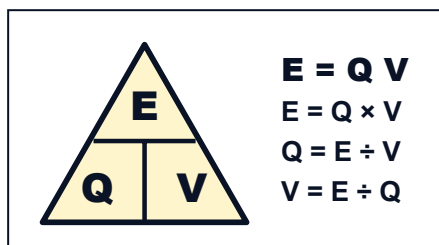
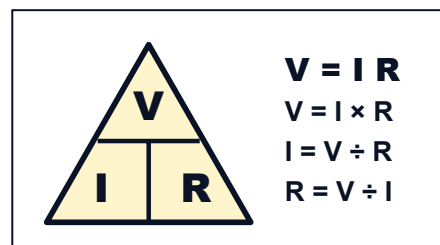
Give the answer with a unit. Ask: is it sensible?

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.



REFERENCE

KEY WORDS FROM THIS LESSON

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

LDR: Light-dependent resistor: resistance decreases as light intensity increases.

Thermistor: Resistance decreases as temperature increases.

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. Filament lamp.
2. It halves.
3. A triangle pointing at a bar, on a line.

COVER THE PAGE

1. It decreases.
2. It increases (it is high).
3. An LDR.
4. It increases.