

Resistors

4.2.1.4 · Electricity · revision notes

How the resistance of ohmic conductors, filament lamps, diodes, thermistors and LDRs behaves, their I–V characteristics, and how thermistors and LDRs are used in circuits.

Expect graph sketching and reading, 'explain the shape' questions and the I–V characteristics required practical.

Key facts

- Ohmic conductor (constant temperature): $I \propto V$, constant resistance, straight line through the origin
- Filament lamp: resistance increases as the filament's temperature increases
- Diode: current in one direction only; very high resistance in reverse
- Thermistor: temperature up $\rightarrow$ resistance down
- LDR: light intensity up $\rightarrow$ resistance down
- Resistance at a point on an I–V graph: $R = V \div I$
- I–V graph: current on the y-axis, pd on the x-axis

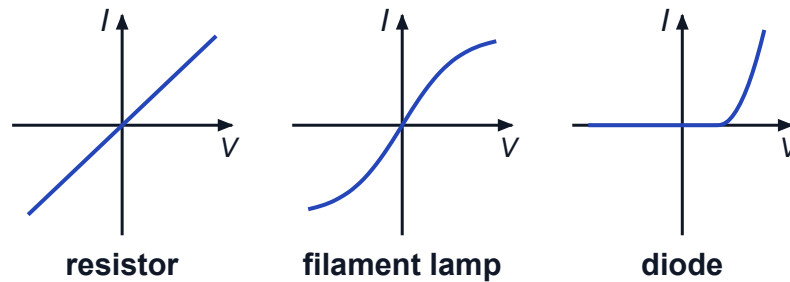
Notes

Ohmic conductors

- For an **ohmic conductor** (such as a fixed resistor) at **constant temperature**, the current is directly proportional to the potential difference.
- Its resistance stays the same as the current changes, so its I–V graph is a straight line through the origin.
- For lamps, diodes, thermistors and LDRs the resistance is **not constant**: it changes as the current through them changes.

I-V characteristics (current on the y-axis, pd on the x-axis)

- **Resistor at constant temperature:** a straight line through the origin, the same shape for negative values.
- **Filament lamp:** a curve through the origin that gets less steep as the pd increases (in both directions). As the current increases the filament gets hotter, and its resistance increases as its temperature increases.
- **Diode:** current flows in one direction only. In the forward direction the current stays almost zero until the pd reaches a small value, then rises steeply. In the reverse direction the diode has a very high resistance, so the current is (almost) zero.

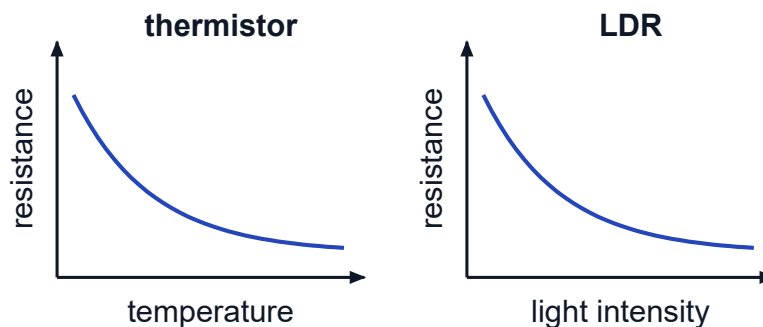


I-V characteristics: current (I) up, potential difference (V) across.

- For a straight line through the origin, a steeper line means a smaller resistance. For a curve, work out $R = V \div I$ at the point you need.

Thermistors and LDRs

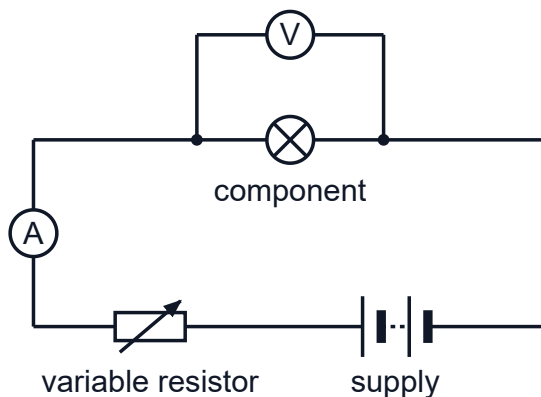
- **Thermistor:** resistance decreases as temperature increases. Used as a temperature sensor, e.g. in a thermostat that switches a heating system on and off.
- **LDR:** resistance decreases as light intensity increases. Used as a light sensor, e.g. in lights that switch on automatically when it gets dark.



Thermistor and LDR: resistance falls as temperature or light intensity rises.

Required practical: I-V characteristics

- Connect the component in series with an ammeter, a variable resistor and the supply, with a voltmeter in parallel across the component.



Change the variable resistor to get a range of readings; reverse the component for negative values.

- Adjust the variable resistor to get a range of pd values, and record V and I each time.
- Reverse the connections to the component to get negative values of V and I .
- Plot I against V . Do this for a resistor at constant temperature, a filament lamp and a diode.

How to answer each type of question

Sketch or identify an I–V graph

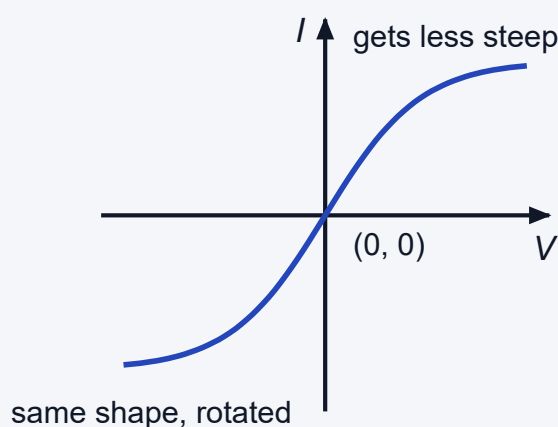
1 to 3 marks

Grade 5

1. Label the axes: current (y) and potential difference (x), crossing at the origin.
2. Resistor: straight line through the origin. Lamp: S-shaped curve that flattens at both ends. Diode: current only for positive pd, rising steeply after a small pd.
3. Show negative values if the question asks for them.

Example. Describe the shape of the I–V graph for a filament lamp, for positive and negative values of potential difference.

Model answer.



The curve passes through the origin (1). The curve gets less steep (flattens) as the pd increases (1). The graph has the same shape for negative values, as if rotated half a turn about the origin (1).

Don't lose marks

- ✗ Using the gradient of a curved I–V graph as the resistance. Use $R = V \div I$ at the point.
- ✗ Saying a thermistor's resistance increases with temperature (it decreases).
- ✗ Saying the lamp's resistance changes 'because the current changes' without mentioning the temperature of the filament.
- ✗ Drawing a diode graph with current flowing in both directions.
- ✗ Swapping the axes: on an I–V graph, current goes on the y-axis.

More tips

Memory tricks

- Both sensors go DOWN: more light (LDR) or more heat (thermistor) means less resistance.
- Lamp and thermistor are opposites: a hotter filament has MORE resistance, a hotter thermistor has LESS. Learn them as a pair.
- A diode is a one-way valve for current.
- Straight line through the origin = ohmic = constant resistance.

Exam technique

- In 'explain' questions link cause and effect with 'so': the current increases, so the filament gets hotter, so its resistance increases.
- When sketching, label the axes, draw through the origin and show both quadrants if negative values are asked for.
- For sensor circuits, go step by step: condition changes → resistance → current → pd across each component.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Recall that an LDR's resistance falls in light

The resistance of an LDR decreases as light intensity increases.

Grade 4

Recall that a thermistor's resistance falls when hot

The resistance of a thermistor decreases as temperature increases.

Grade 5

Identify an ohmic conductor from its graph

At constant temperature, current is directly proportional to pd, so the I–V graph is a straight line through the origin.

Grade 5

Describe how a diode controls current

Current flows in one direction only; the diode has a very high resistance in the reverse direction.

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