

9.3 Resistance and resistivity

Name: _____ Class: _____ Date: _____

Total: 17 marks

KEY WORDS thermistor 热敏电阻 • diode 二极管 • filament lamp 灯丝灯泡
 • resistance and resistivity 电阻率 • resistance 电阻

Objective

Build the skills to answer exam questions on **resistance and resistivity** 电阻率 — Ohm's law, I–V characteristics, and **measuring** resistivity.

You must be able to:

- define **resistance** and state **Ohm's law**
- sketch the I–V graphs of a **metal wire**, a **filament lamp** and a **diode**
- use $R = \rho L/A$, getting A from a **diameter** ($A = \pi d^2/4$)
- describe the **circuit and steps** to measure the resistivity of a wire

1 Worked examples

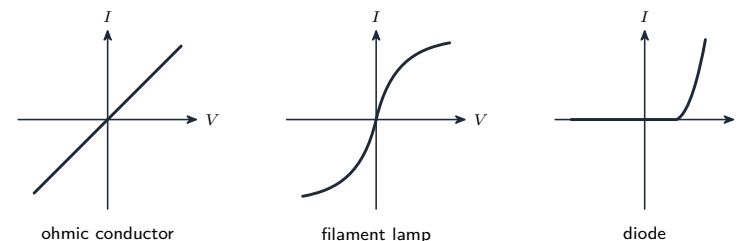
Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Resistance and Ohm's law

$$R = \frac{V}{I} \text{ (}\Omega\text{)}.$$

Ohm's law: for a metal at constant temperature, $I \propto V$, so R is constant (a straight-line I–V graph).

■ I–V characteristics



A **filament lamp's** resistance **rises** as current increases: more current heats the filament, raising its temperature and resistance, so the graph flattens.

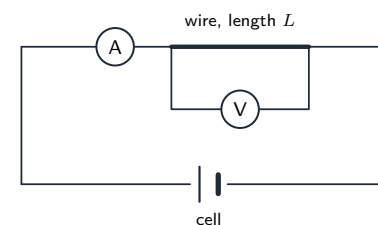
■ Resistivity, LDR, thermistor

$$R = \frac{\rho L}{A}.$$

An **LDR's** resistance **falls** as light gets brighter; a **thermistor's** resistance **falls** as temperature rises.

■ Measuring resistivity

A very common experiment: find ρ for a wire. Connect an **ammeter in series** with the wire and a **voltmeter across** it:



1. Read V and $I \rightarrow$ resistance $R = V/I$.
2. Measure the **diameter** $d \rightarrow$ area $A = \pi d^2/4$ (use the radius $d/2$).
3. Measure the length $L \rightarrow \rho = \frac{RA}{L}$.

Worked example. $V = 1.5 \text{ V}$, $I = 0.45 \text{ A} \rightarrow R = 3.33 \Omega$. Diameter $d = 0.40 \text{ mm} \rightarrow A = \pi(0.20 \times 10^{-3})^2 = 1.26 \times 10^{-7} \text{ m}^2$. Length $L = 0.80 \text{ m}$: $\rho = \frac{RA}{L} = \frac{(3.33)(1.26 \times 10^{-7})}{0.80} = 5.2 \times 10^{-7} \Omega \text{ m}$.

2 Practice

Now apply the methods above.

2.1 Define **resistance**. [1]

2.2 State **Ohm's law**. [1]

2.3 A component has 6.0 V across it and 0.30 A through it. Find its **resistance**. [2]

2.4 A wire has diameter 0.50 mm. Calculate its cross-sectional **area** in m^2 . [2]

2.5 State what happens to a **thermistor's** resistance as its temperature **rises**. [1]

3 Exam-style questions

3.1 Which component has a **straight-line** I–V graph through the origin? [1]

- | | |
|---|---|
| A | B |
| C | D |
- A a filament lamp
B a diode
C a metal wire at constant temperature
D a thermistor

3.2 Explain why the **resistance** of a filament lamp **increases** as the current increases. [2]

3.3 A student measures the resistivity of a metal wire.

(a) Draw a circuit, using an ammeter and a voltmeter, to measure the **resistance** of the wire. [2]

(b) The readings are $V = 1.5 \text{ V}$ and $I = 0.45 \text{ A}$; the wire has length 0.80 m and diameter 0.40 mm. Calculate the **resistivity** of the metal. [4]

3.4 State what happens to the resistance of an **LDR** as the light intensity **increases**. [1]
