Exercise walk-through

Resistance, Resistivity, and Ohm's Law ▪ 11.3

eXercise

You must be able to

- state **Ohm's law 欧姆定律**, $V = IR$, and identify ohmic behaviour
- relate **resistance 电阻** to geometry, $R = \dfrac{\rho L}{A}$
- distinguish **resistivity 电阻率** (a material property) from resistance (an object property)
- calculate **equivalent resistance** in series and parallel

Method — Ohm's law

$V = IR$. A device is **ohmic** if R is constant (a straight I-V line).

Method — Resistance and resistivity

$R = \frac{\rho L}{A}$: **resistivity** ρ is a property of the **material**; **resistance** R also depends on the length L and area A of the object.

Method — Combining

Series: $R = R_1 + R_2 + \ldots$; parallel: $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \ldots$

Practice 2.1 ▪ 2 marks

A 12 V supply drives 3.0 A through a resistor. Find its resistance.

Solution 2.1

Worked steps

$$R = \frac{V}{I} = \frac{12}{3.0} = 4.0\ \Omega$$ M1 A1.

Practice 2.2 ▪ 1 mark

State how doubling a wire's length changes its resistance (same material and area).

Solution 2.2

Method: Resistance and resistivity

Worked steps

it doubles ($R \propto L$) B1.

Practice 2.3 ▪ 2 marks

State the difference between resistivity and resistance.

Solution 2.3

Method: Resistance and resistivity

Worked steps

resistivity is a property of the material alone; resistance also depends on the object's length and cross-sectional area B1 B1.

Exam-style 3.1 ▪ 1 mark

Resistance relates to geometry by

A $\dfrac{\rho A}{L}$

B $\dfrac{\rho L}{A}$

C $\dfrac{L}{\rho A}$

D $\rho L A$

Solution 3.1

A $\dfrac{\rho A}{L}$

B $\dfrac{\rho L}{A}$ ✓

C $\dfrac{L}{\rho A}$

D $\rho L A$

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

Resistivity is a property of the

A object's shape

B material

C current

D voltage

Solution 3.2

Method: Resistance and resistivity

A object's shape

B material ✓

C current

D voltage

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

A wire has resistivity $1.7 \times 10^{-8}\ \Omega\,\text{m}$, length 2.0 m, and area 1.0×10^{-6} m^2.
(a) Find its resistance.
(b) The wire is stretched to twice its length (its volume unchanged, so its area halves). Find the new resistance.

Solution 3.3

Method: Resistance and resistivity

Worked steps

(a) $R = \dfrac{\rho L}{A} = \dfrac{(1.7 \times 10^{-8})(2.0)}{1.0 \times 10^{-6}} = 0.034\ \Omega$ M1 A1. (b) length $\times 2$ and area $\div 2$ give $R \times 4 = 0.136\ \Omega$ M1 A1.