11.3 Resistance, Resistivity, and Ohm's Law

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

Build the skills to answer exam questions on **resistance, resistivity, and Ohm's law**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later.

Ohm's law

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

Resistance and resistivity

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

Combining

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

2 Practice

2.1 A 12 V supply drives 3.0 A through a resistor. Find its resistance. [2]

2.2 State how doubling a wire's length changes its resistance (same material and area). [1]

2.3 State the difference between resistivity and resistance. [2]

3 Exam-style questions

3.1 Resistance relates to geometry by [1]

- **A** $\dfrac{\rho A}{L}$
- **B** $\dfrac{\rho L}{A}$
- **C** $\dfrac{L}{\rho A}$
- **D** $\rho L A$

3.2 Resistivity is a property of the [1]

- **A** object's shape
- **B** material
- **C** current
- **D** voltage

3.3 A wire has resistivity $1.7 \times 10^{-8}\ \Omega\,\text{m}$, length 2.0 m, and area $1.0 \times 10^{-6}\ \text{m}^2$.

(a) Find its resistance. [2]

(b) The wire is stretched to twice its length (its volume unchanged, so its area halves). Find the new resistance. [2]

4 Go further

- work through the **11.3 Resistance, Resistivity, and Ohm's Law** lesson on the **Learn** page;
- read the **Electric Circuits** section of the AP Physics C: E&M handout on the **Know** page.

Solutions

2.1 $R = \dfrac{V}{I} = \dfrac{12}{3.0} = 4.0\ \Omega$.

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

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

3.1 B.

3.2 B.

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