

CIRCUITS DAY 3: RESISTANCE, RESISTIVITY & OHM'S LAW

CED 11.3 · Skill 2.B · FRQ: MR

PREDICT

The potential difference across a fixed ohmic resistor doubles. Circle one for its current: $\times\frac{1}{2}$ / **unchanged** / $\times 2$ / $\times 4$. Be ready to defend your choice.

RESISTANCE AND OHM'S LAW

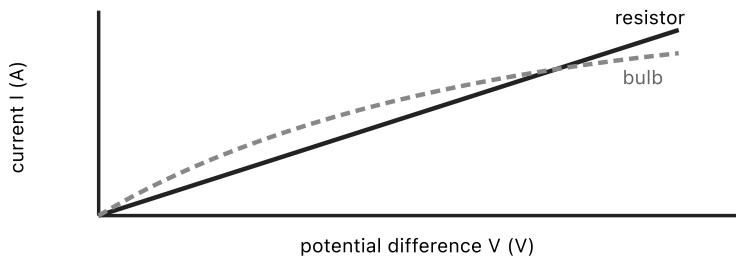
Resistance measures how strongly a circuit element opposes charge motion.

$$V = IR \quad R = \frac{V}{I} \quad 1 \, \Omega = 1 \, \text{V/A}$$

An **ohmic** element has constant resistance over the conditions being considered.

WE DO A $24 \, \Omega$ resistor has $7.2 \, \text{V}$ across it. Find the current.

YOU DO A resistor carries $0.14 \, \text{A}$ when the potential difference is $8.4 \, \text{V}$. Find its resistance.

I–V GRAPHS**SAME AXES, DIFFERENT BEHAVIOR**

Read the axis order before interpreting slope.

For a graph of I vertically against V horizontally,

$$\text{slope} = \frac{\Delta I}{\Delta V} = \frac{1}{R}$$

A steeper line means a smaller resistance on these axes.

WE DO An I–V line passes through (2.4 V, 0.080 A) and (8.4 V, 0.280 A). Find the slope and resistance.

REASON Explain why a bulb's I–V graph bends over as the filament heats.

RESISTANCE FROM MATERIAL AND GEOMETRY**COMPARE LENGTH AND CROSS-SECTIONAL AREA**

WIRE A



length L, area A

WIRE B



longer and thinner

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

- Longer wire $\rightarrow$ larger resistance.
- Larger cross-sectional area $\rightarrow$ smaller resistance.
- Larger resistivity $\rho \rightarrow$ larger resistance.
- For many conductors, resistivity increases as temperature increases.

WE DO Wire B has the same material as wire A, three times the length, and half the cross-sectional area. Find R_B/R_A .

YOU DO A wire's length is doubled and its radius is doubled. Find the factor by which its resistance changes. Use $A = \pi r^2$.

PRACTICE

1. Find the current through a $30\ \Omega$ resistor connected across $12\ \text{V}$.

2. A device carries $0.25\ \text{A}$ at $5.0\ \text{V}$. Find R .

3. An I–V line has slope $0.040\ \text{A/V}$. Find the resistance.

4. A wire of the same material becomes four times as long and twice the cross-sectional area. Find $R_{\text{new}}/R_{\text{old}}$.

5. On blank I–V axes, sketch an ohmic resistor and a bulb whose resistance rises as it heats. Label which is which.

