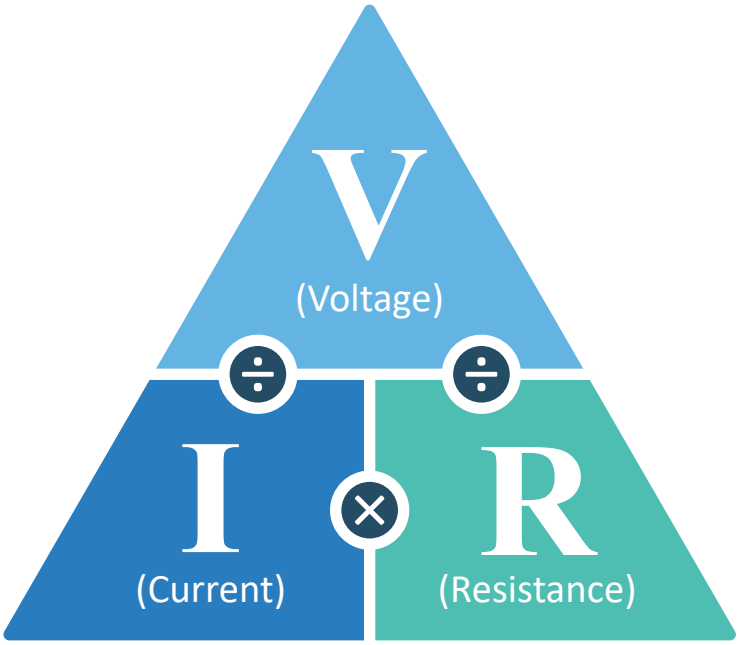
Ohm's Law

Real World, Step by Step Examples

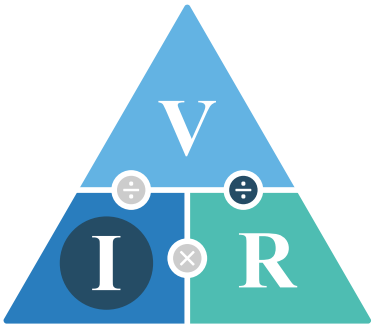
Ohm's Law describes how three basic electrical concepts are related. **Voltage (V)**, measured in volts, is the electrical "push" that drives current. **Current (I)**, measured in amperes, is the flow of electricity through a circuit. **Resistance (R)**, measured in ohms (Ω), is the opposition to that flow. A simple "Ohm's Law triangle" can help you remember the formulas: cover the quantity you want to find, and the other two show you how to calculate it. The examples below show realistic situations with the proper units included at every step.



To find voltage:

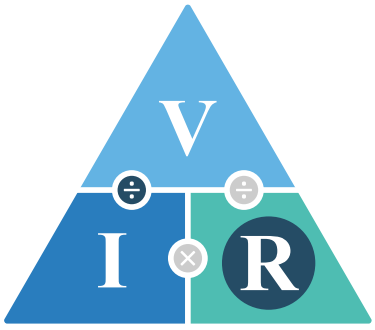
$V = I \times R$

To find current:



$I = V \div R$

To find resistance:



$R = V \div I$

1 Finding Voltage: $V = I \times R$

Scenario: A small flashlight bulb draws **$I = 0.50$ A** when lit. Its hot filament resistance is about **$R = 6.0$ Ω**. What battery voltage is required?

Steps (with units):

1. Write the form: $V = I \times R$
2. Substitute values with units: $V = (0.50\ A) \times (6.0\ \Omega)$
3. Multiply numbers and units: $V = 3.0\ V$

Answer: **$V = 3.0$ V**, which matches two 1.5 V cells in series (a common flashlight).

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2 Finding Current: $I = V \div R$

Scenario: A 12 volt car headlamp has a measured hot resistance of **$R = 4.2$ Ω**. With the battery at **$V = 12.6$ V**, what current does it draw?

Steps (with units):

1. Write the form: $I = V \div R$
2. Substitute values with units: $I = (12.6\ V) \div (4.2\ \Omega)$
3. Divide numbers and units: $I = 3.0\ A$

Answer: **$I = 3.0$ A**, a typical draw for a single automotive lamp.

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3 Finding Resistance: $R = V \div I$

Scenario: You want to power a red LED from a **9 V** battery. The LED drops about **2.0 V** at the desired current of **$I = 20$ mA (0.020 A)**. What resistor is needed?

Steps (with units):

1. First find the resistor value: $V_{(resistor)} = V_{(source)} - V_{(LED\ drop)} = 9.0\ V - 2.0\ V =$ **7.0 V**
2. Write the form for resistance: $R = V \div I$
3. Substitute values with units: $R = (7.0\ V) \div (0.020\ A)$
4. Divide numbers and units: $R = 350\ \Omega$

Answer: **$R = 350$ Ω**, A **350 Ω resistor** is not a standard, commonly manufactured value. Choose the next highest standard value, which is typically **360 Ω**; then the current will be $I = 7.0\ V \div 360\ \Omega = 0.019\ A$ (19 mA), which is safe.

Reality Checks: *Resistances of lamps and heaters change with temperature; battery voltage sags under load; and LEDs have a range of forward voltages. Still, these examples are representative and the math is exactly how you size parts in practice.*