PHYSICS IN MOTION
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Unit 5E
Current Electricity
Practice Problems TEACHER

Work each of the following problems. SHOW ALL WORK.

1. **How much current is flowing through a wire if 21.5 C of charge passes a point in 6.3 seconds?**

$$q = 21.5\,C$$
$$t = 6.3\,s$$
$$I = \frac{q}{t}$$
$$I = \frac{21.5\,C}{6.3\,s}$$
$$I = 3.4\,A$$

2. **A 210 Ω resistor is connected in a circuit with a 110 V battery. How much charge passes through a point in the circuit in two minutes?**

$$R = 210\,\Omega$$
$$V = 110\,V$$
$$t = 2\,\text{min} = 120\,s$$
$$V = IR$$
$$I = \frac{V}{R}$$
$$I = \frac{110\,V}{210\,\Omega}$$
$$I = 0.52\,A = 0.52\,C/s$$
$$(0.52\,C/s)(120\,s) = 63\,C \text{ of charge}$$

3. **How long would these devices need to be in operation before 1,000,000 C of charge passes through them?**

   a. **LED night light (I = 0.0041 A)**

$$t_{LED} = \frac{1 \times 10^6\,C}{0.0041\,A} = 2.4 \times 10^8\,s = 68{,}000 \text{ hours}$$

$$I = \frac{q}{t}$$
$$It = q$$
$$It = 1 \times 10^6\,C$$
$$t = \frac{1 \times 10^6\,C}{I}$$

   b. **incandescent night light (I = 0.052 A)**

$$t_{inl} = \frac{1 \times 10^6\,C}{0.052\,A} = 1.9 \times 10^7\,s = 5{,}300 \text{ hours}$$

   c. **60 W incandescent light bulb (I = 0.4 A)**

$$t_{60w} = \frac{1 \times 10^6\,C}{0.4\,A} = 2.5 \times 10^6\,s = 690 \text{ hours}$$

   d. **large light fixture (I = 2.1 A)**

$$t_{fixture} = \frac{1 \times 10^6\,C}{2.1\,A} = 4.8 \times 10^5\,s = 130 \text{ hours}$$

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4. **An electric saw at a local hardware store features a motor that supplies 15 A. Find the resistance of the saw when it is plugged into a 110 V outlet.**

$$V = 110\,V$$
$$I = 15\,A$$

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{110\,V}{15\,A}$$
$$R = 7.3\,\Omega$$

5. **Defibrillator machines are used to deliver an electric shock to the human heart and resuscitate a heart that has stopped beating. A current as low as 18 mA can trigger resuscitation. Using 95 kΩ as the resistance, determine the minimum output voltage needed by a defibrillator for it to be effective.**

$$I = 18\,mA = 0.018\,A$$
$$R = 95\,k\Omega = 95{,}000\,\Omega$$

$$V = IR$$
$$V = (0.018\,A)(95{,}000\,\Omega)$$
$$V = 1710\,V$$

6. **A taser sends about 1100 V through the human body, resulting in an average current of 2.5 mA. Using these numbers, estimate the electrical resistance of the human body.**

$$V = 1100\,V$$
$$I = 2.5\,mA = 0.0025\,A$$

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{1100\,V}{0.0025\,A}$$
$$R = 440{,}000\,\Omega = 440\,k\Omega$$

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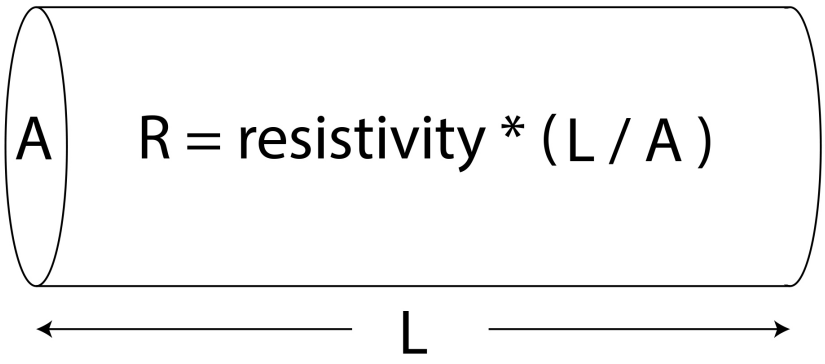
7. Resistivity indicates the overall resistance of a material. It is measured by units of Ωm and depends on material type. To determine the resistivity of a wire, divide its length by its area as indicated in the diagram below:



The wire heating element of an electric toaster is 190 cm long with a diameter of 0.05 cm. If the heating element is made of nichrome, which has a resistivity of 1.1 x 10^{-6} Ωm, what is its overall resistance?

$$resistivity = 1.1 \times 10^{-6}\ \Omega m$$
$$L = 190\ cm = 1.9\ m$$
$$D = 0.05\ cm = 0.0005\ m$$
$$A = \pi\left(\frac{D}{2}\right)^2 = 3.14159\left(\frac{0.0005\ m}{2}\right)^2 = 2.0 \times 10^{-7}\ m^2$$

$$R = \text{resistivity}\left(\frac{L}{A}\right)$$
$$R = 1.1 \times 10^{-6}\ \Omega m\left(\frac{1.9\ m}{2.0 \times 10^{-7}\ m^2}\right)$$
$$R = 10.5\ \Omega$$

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8. You are analyzing an electrical circuit around a battery with a 9 V output. The circuit is designed to carry a maximum current of 2 A. Anything above that and a fuse in the circuit will blow out to keep the circuit from being overloaded. Currently, a 3.2 Ω appliance is the only resistor in the circuit. Will the fuse blow out? If so, what resistance is needed to stay below the 2 A limit?

$$V = 9\,V$$
$$R = 3.2\,\Omega$$

$$V = IR$$
$$I = \frac{V}{R}$$
$$I = \frac{9\,V}{3.2\,\Omega}$$
$$I = 2.8\,A$$

Yes, the fuse will blow out under this current load.

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{9\,V}{2\,A}$$
$$R = 4.5\,\Omega$$

9. A lamp draws a current of 0.34 A from a power outlet that supplies 120 V. What is the resistance of the lamp?

$$I = 0.34\,A$$
$$V = 120\,V$$

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{120\,V}{0.34\,A}$$
$$R = 353\,\Omega$$