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Unit 5F
Ohm's Law
Practice Problems TEACHER

Work each of the following problems. SHOW ALL WORK.

1. **Before leaving your house in the morning, you add some stew ingredients to your slow cooker and turn it on low. The slow cooker has a 160 Ω resistor and is plugged into a 120 V outlet. When you come home 8 hours later, how much charge has passed through the slow cooker circuit in that time?**

$$R = 160\ \Omega$$
$$V = 120\ V$$

$$V = IR$$
$$I = \frac{V}{R}$$
$$I = \frac{120\ V}{160\ \Omega}$$
$$I = 0.75\ \text{A}$$
$$I = 0.75\ C/s$$
$$\frac{0.75\ C}{s} \times \frac{3600\ s}{1\ \text{hr}} \times 8\ \text{hr} = 21{,}600\ C$$

2. **A medical imaging device shoots 8 million electrons per second through an Ohmic gas. The electrons are motivated by a 3000 V potential difference. What is the effective resistance of the gas?**

The charge on an electron is 1.6 x 10^{-19} C, so the total charge moving through the gas is:

$$I = (1.6 \times 10^{-19}\ C)(8 \times 10^{6}\ \text{electrons/s}) = 1.3 \times 10^{-12}\ C/s = 1.3 \times 10^{-12}\ A$$
$$V = 3000\ V$$

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{3000\ V}{1.3 \times 10^{-12}\ A}$$
$$R = 2.3 \times 10^{15}\ \Omega$$

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3. **While out in the woods filming a documentary about timber rattlesnakes, your video camera runs out of batteries. Knowing that the camera draws 0.25 A of current and has an overall resistance of 72 Ω, what voltage supply does it need? Will your last six-pack of 9 V batteries do the job?**

$$I = 0.25\ A$$
$$R = 72\ \Omega$$

$$V = IR$$
$$V = (0.25\ A)(72\ \Omega)$$
$$V = 18\ V$$

Two 9 V batteries will supply your camera's needed voltage. The six-pack will let you keep recording!

4. **To help keep cool during the summer months, you decide to design and build your own hand-held fan. The fan's electrical circuit will run on four AA batteries (1.5 V each) and must not exceed 50 mA of current. You search online and find that resistors are sold in five varieties: 5 Ω, 10 Ω, 12 Ω, 20 Ω, and 50 Ω. Each resistor costs 8 cents. What set of resistors should you buy to minimize cost?**

$$V = 4(1.5\ V) = 6\ V$$
$$I = 50\ mA = 0.05\ A$$

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{6\ V}{0.05\ A}$$
$$R = 120\ \Omega$$

Two 50 Ω resistors and one 20 Ω resistor cost 24 cents,

meeting resistance requirements at the lowest cost.

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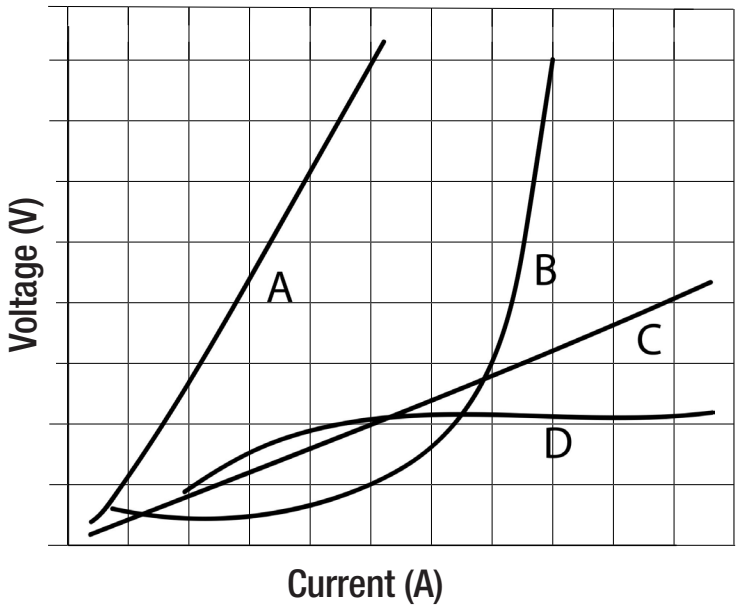
5. As part of a SpaceX engineering team that is designing microcircuitry to control rocket launch angle, you must assess the power budget needed to operate four fin-control systems. Each system requires 0.16 mA for circuits with 3.4 mΩ of resistance. How much total voltage is needed to supply these circuits?

$$I_{fin} = 0.16\,\mu A = 1.6 \times 10^{-7}\ A$$
$$I_{total} = 4(1.6 \times 10^{-7}\ A) = 6.4 \times 10^{-7}\ A$$
$$R = 3.4\ m\Omega = 0.0034\ \Omega$$

$$V = IR$$
$$V = (6.4 \times 10^{-7}\ A)(0.0034\ \Omega)$$
$$V = 2.2 \times 10^{-9}\ V$$

6. Which of the following materials (A, B, C, D) are Ohmic? Circle all that apply.

a. ***A***
b. B
c. ***C***
d. D



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7. In an electrical circuit, what happens to the current flowing through the wire if the initial voltage of 18 V is doubled, and the initial resistance of 35 Ω is reduced by a factor of four?

$$V = 18\,V$$
$$R = 35\,\Omega$$

$$V = IR$$
$$I = \frac{V}{R}$$
$$I_{initial} = \frac{18\,V}{35\,\Omega}$$
$$I_{initial} = 0.51\,A$$

$$I_{final} = \frac{2(18\text{ V})}{(35\,\Omega / 4)}$$
$$I_{final} = 4.1\,A$$

Current increases by a factor of eight.

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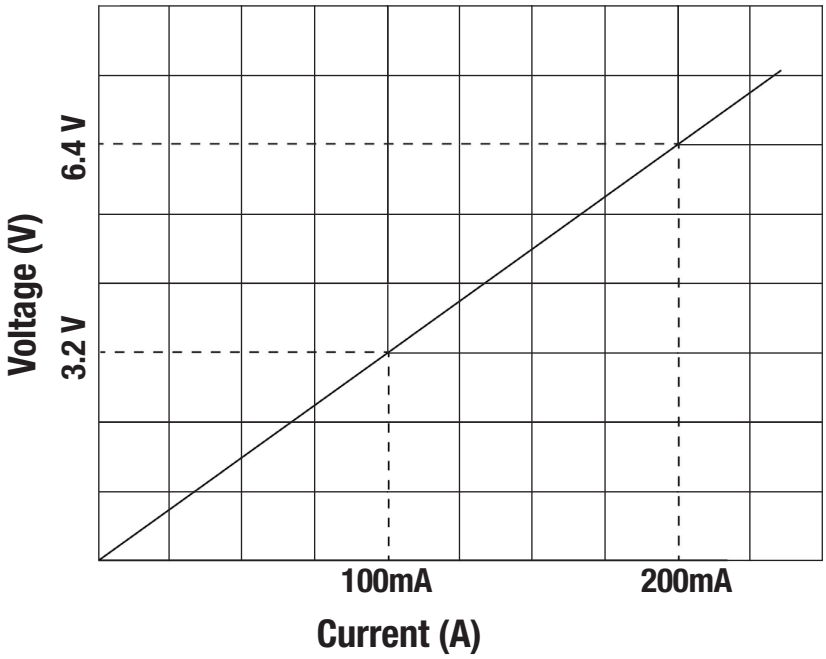
8. This graph shows the relationship between current and voltage for an unknown metal. What is the resistance of the metal?

$$V = 3.2\,V$$
$$I = 100\,mA = 0.1\,A$$

$$V = IR$$
$$R = \frac{V}{I}$$
$$R = \frac{3.2\,V}{0.100\,A}$$
$$R = 32\,\Omega$$



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Work each of the following problems. SHOW ALL WORK.

9. If a current of 1.1 A flows through a 7 Ω resistor of length 3 m, what is the electric field strength inside the resistor?

$$I = 1.1\,A$$
$$R = 7\,\Omega$$
$$d = 3\,m$$

$$V = IR$$
$$V = (1.1\,A)(7\,\Omega)$$
$$V = 7.7\,V$$

$$V = Ed$$
$$E = \frac{V}{d}$$
$$E = \frac{7.7\,V}{3\,m}$$
$$E = 2.6\,V/m$$