Principles of Electric Circuits: Conventional Current

Tenth Edition, Global Edition
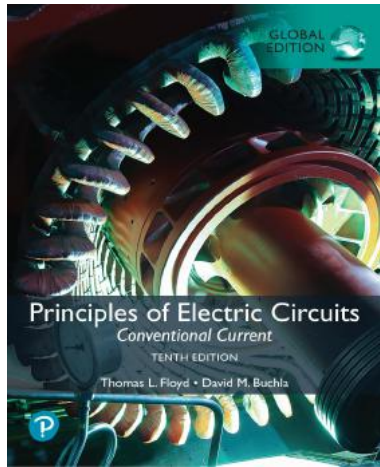
Principles of Electric Circuits
Conventional Current
TENTH EDITION
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Chapter 3

Ohm's Law

Summary: Review of *V, I*, and *R*

Voltage is the amount of energy per charge available to move electrons from one point to another in a circuit.

Current is the rate of charge flow and is measured in amperes.

Resistance is the opposition to current and is measured in ohms.

Summary: The most important fundamental law in electronics is Ohm's law, which relates voltage, current, and resistance
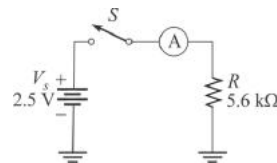
Georg Simon Ohm studied the relationship between voltage, current, and resistance and formulated the equation that bears his name. In terms of current, Ohm's law states

$$I = \frac{V}{R}$$

Example

After the switch is closed, what should be the reading on the ammeter?

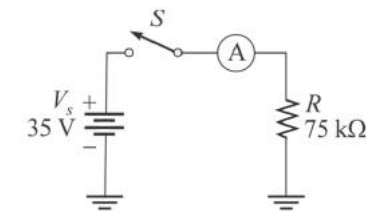$$I = \frac{V}{R} = \frac{2.5\ \text{V}}{5.6\ \text{k}\Omega} = 0.45\ \text{mA}$$

Summary: Ohm's law (1 of 3)

Question:

After the switch is closed, what should be the reading on the ammeter? 0.47 mA

Question:

The hot resistance of a 75.0 W bulb is 192 Ω. How much current will be in the bulb when it is plugged into a 120 V source? 625 mA

Summary: Ohm's law

If you need to solve for voltage, Ohm's law is $V = IR$.

Questions:

1. What is the voltage across a 680 Ω resistor if the current is 26.5 mA? 18 V

2. A 5.0 mΩ sense resistor has a current of 20 A. What voltage is developed across the sense resistor? 100 mV

3. A 270 kΩ resistor has 11.1 A of current. What is the voltage across the resistor? 3.0 V

Summary: Ohm's law

If you need to solve for resistance, Ohm's law is $R = \dfrac{V}{I}$
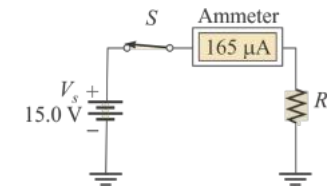
Example

For the circuit shown, $R = \dfrac{V}{I} = \dfrac{15.0\ \text{V}}{165\ \text{A}} = 90.9\ \text{k}\Omega$

Questions:

1. What is the value of the resistance if 5.0 V across it causes a current of 333 μA? 15 kΩ

2. What is the value of the resistance if 66 mV across it causes a current of 200 μA? 330 Ω
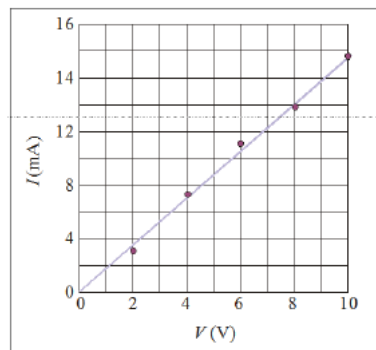

Summary

A student takes data for a resistor and fits the straight line shown to the data. What is the conductance and resistance of the resistor?

The slope represents the conductance.

$$G = \frac{14.8\ \text{mA} - 0\ \text{mA}}{10.0\ \text{V} - 0\ \text{V}} = 1.48\ \text{mS}$$
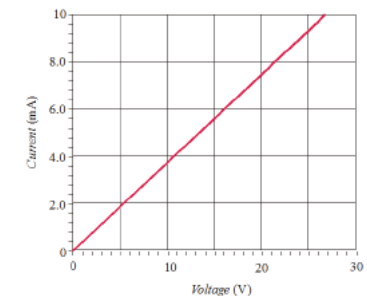

The reciprocal of the conductance is the resistance:

$$R = \frac{1}{G} = \frac{1}{1.48\ \text{mS}} = 676\ \Omega$$

Summary: Graph of Current versus Voltage

Notice that the plot of current versus voltage for a fixed resistor is a line with a positive slope. What is the resistance indicated by the graph? 2.7 kΩ
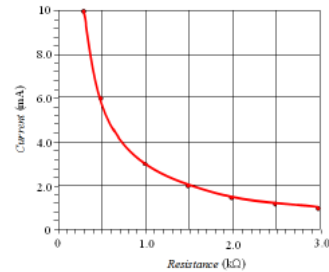

What is its conductance? 0.37 mS

Summary: Graph of Current versus Resistance

If resistance is varied for a constant voltage, the current verses resistance curve plots a hyperbola.
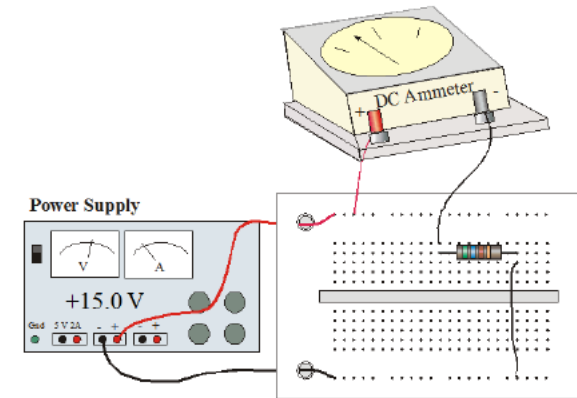
Question:

What is the curve for a 3.0 V source?
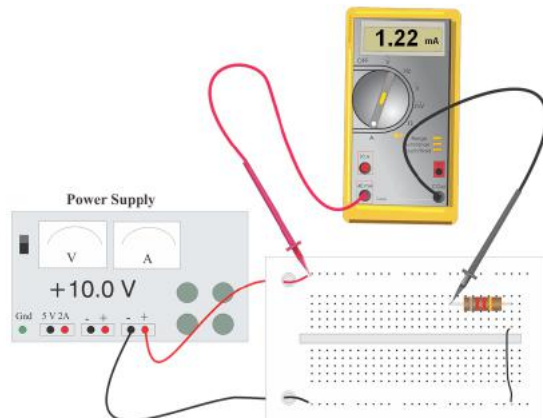
Summary: Application of Ohm's law

The resistor is green-blue brown-gold. What should the ammeter read? 26.8 mA

Summary (2 of 2)

Question:

What current should you expect? 1.22 mA

Summary: Troubleshooting (1 of 3)

Some questions to ask before starting any troubleshooting are:

1. Has the circuit ever worked?
2. If the circuit once worked, under what conditions did it fail?
3. What are the symptoms of the failure?
4. What are the possible causes of the failure?

Summary: Troubleshooting (2 of 3)

Plan the troubleshooting by reviewing pertinent information:

1. Schematics
2. Instruction manuals
3. Review when and how the failure occurred.

Summary: Troubleshooting (3 of 3)

You may decide to start at the middle of a circuit and work in toward the failure. This approach is called half-splitting.

Based on the plan of attack, look over the circuit carefully and make measurements as needed to localize the problem. Modify the plan if necessary as you proceed.

Selected Key Terms

Linear   Characterized by a straight-line relationship.

Ohm's law   A law stating that current is directly proportional to voltage and inversely proportional to resistance.

Troubleshooting   A systematic process of isolating, identifying, and correcting a fault in a circuit or system.

Quiz (1 of 11)

1. Holding the voltage constant, and plotting the current against the resistance as resistance is varied will form a

   a. straight line with a positive slope

   b. straight line with a negative slope

   c. parabola

   d. hyperbola

Quiz

2. When the current is plotted against the voltage for a fixed resistor, the plot is a

   a. straight line with a positive slope

   b. straight line with a negative slope

   c. parabola

   d. hyperbola

Quiz

3. For constant voltage in a circuit, doubling the resistance means

   a. doubling the current

   b. halving the current

   c. there is no change in the current

   d. depends on the amount of voltage

Quiz

4. A four-color resistor has the color-code red-violet-orange-gold. If it is placed across a 12 V source, the expected current is

   a. 0.12 mA

   b. 0.44 mA
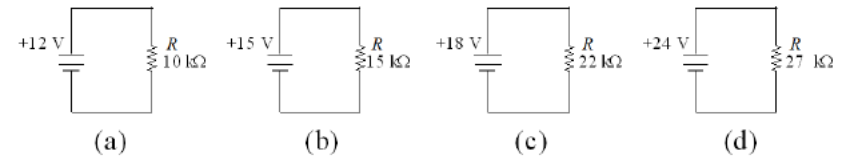
   c. 1.25 mA

   d. 4.44 mA

Quiz

5. If the current in a 330 Ω resistor is 15 mA, the applied voltage is approximately

   a. 5.0 V

   b. 22 V

   c. 46 V

   d. 60 V

Quiz (6 of 11)

6. The current in a certain 4-band resistor is 22 mA when the voltage is 18 V. The color bands on the resistor are

   a. blue-gray-red-gold

   b. red-red-brown gold

   c. gray-red-brown-gold
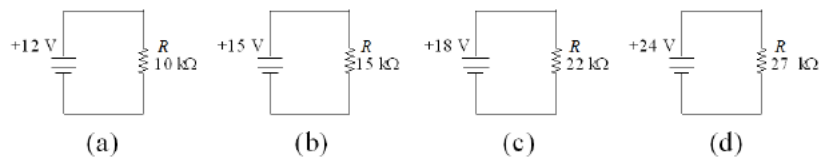
   d. white-brown-red-gold

Quiz (7 of 11)

7. The circuit with the largest current is

   a. (a)

   b. (b)

   c. (c)

   d. (d)

+12 V R 10 kΩ   +15 V R 15 kΩ   +18 V R 22 kΩ   +24 V R 27 kΩ

(a)   (b)   (c)   (d)

Quiz (8 of 11)

8. The circuit with the smallest current is

   a. (a)

   b. (b)

   c. (c)

   d. (d)

+12 V R 10 kΩ   +15 V R 15 kΩ   +18 V R 22 kΩ   +24 V R 27 kΩ

(a)   (b)   (c)   (d)

Quiz (9 of 11)

9. Before troubleshooting a faulty circuit you should find out

   a. If the circuit ever worked

   b. The conditions that existed when it failed

   c. The symptoms of the failure

   d. All of the above

Quiz

10. A troubleshooting method that starts in the middle and works toward a fault is

   a. short-circuit testing

   b. comparison testing

   c. half-splitting

   d. resistance testing

Quiz

Answers:

1. d

2. a

3. b

4. b

5. a

6. c

7. a

8. c

9. d

10. c

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