

Ohm's Law

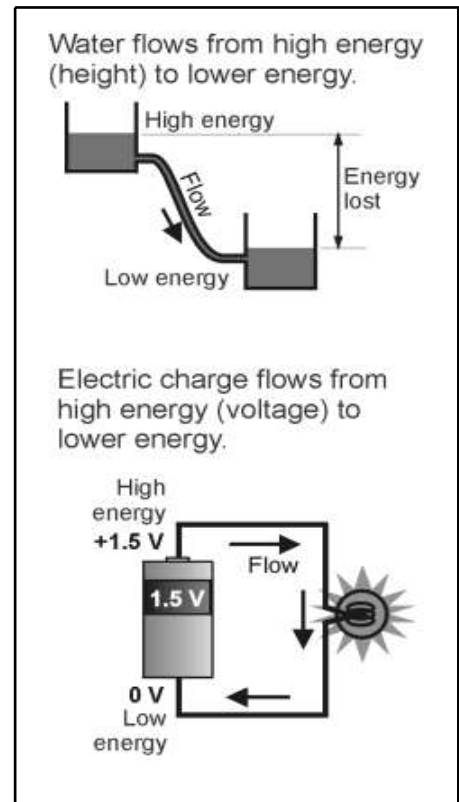
A German physicist, Georg S. Ohm developed a mathematical relationship between **voltage**, **current**, and **resistance** within a circuit.

What is voltage?

You know that water will flow from a higher tank through a hose into a lower tank. The water in the higher tank has greater potential energy than the water in the lower tank. A similar thing happens with the flow of charges in an electric circuit.

Charges flow in a circuit when there is a difference in energy level from one end of the battery (or any other energy source) to the other. This energy difference is measured in **volts**. The energy difference causes the charges to move from a higher to a lower voltage in a closed circuit.

Think of voltage as the amount of “push” the electrical source supplies to the circuit. A meter is used to measure the amount of energy difference or “push” in a circuit. The meter reads the voltage difference (in volts) between the positive and the negative ends of the power source (the battery). This voltage difference supplies the energy to make charges flow in a circuit.



What is current?

Current describes the flow of electric charges. Current is the actual measure of how many charges are flowing through the circuit in a certain amount of time. Current is measured in units called amperes. Just as the rate of water flowing out of a faucet can be fast or slow, electrical current can move at different rates. The type, length, and thickness of wire all effect how much current flows in a circuit. Also, resistors such as a light bulb slow the flow of current. Adding voltage causes the current to speed up.

What is resistance?

Resistance is the measure of how easily charges flow through a circuit. High resistance means it is difficult for charges to flow. Low resistance means it is easy for charges to flow. Electrical resistance is measured in units called ohms (abbreviated with the symbol Ω). Resistors are items that reduce the flow of charge in a circuit. They act like “speed bumps” in a circuit. A light bulb is an example of a resistor.

What is the relationship between voltage, current, and resistance?

When the voltage (push) increases, the current (flow of charges) will also increase, and when the voltage decreases, the current likewise decreases. These two variables, voltage and current, are said to be directly proportional.

When the resistance in an electric circuit increases, the flow of charges (current) decreases. These two variables, resistance and current, are said to be inversely proportional. When one goes up, the other goes down, and vice versa.

The law that relates these three variables is called **Ohm's Law**. The formula is:

$$\text{Current (amps)} = \frac{\text{Voltage (volts)}}{\text{Resistance (ohms, } \Omega \text{)}}$$

or

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

Example: If a toaster produces 12 ohms of resistance in a 120-volt circuit, what is the amount of current in the circuit?

Given The resistance (R) is 12 ohms. The voltage (V) is 120 volts.	Solution $I = \frac{V}{R} = \frac{120 \text{ volts}}{12 \text{ ohms}} = 10 \text{ amps}$ The current in the toaster circuit is 10 amps.
Looking for The amount of current (I) in the circuit.	
Relationships $I = \frac{V}{R}$	

If a problem asks you to calculate the voltage or resistance, you must rearrange the equation $I=V/R$ to solve for V or R . All three forms of the equation are listed below.

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

Calculate

1. How much current is in a circuit that includes a 9-volt battery and a bulb with a resistance of 3 ohms?

SETUP→

ANSWER→

2. How much current is in a circuit that includes a 9-volt battery and a bulb with a resistance of 12 ohms?

SETUP→

ANSWER→

3. A circuit contains a 1.5 volt battery and a bulb with a resistance of 3 ohms. Calculate the current.

SETUP→

ANSWER→

4. A circuit contains two 1.5 volt batteries and a bulb with a resistance of 3 ohms. Calculate the current.

SETUP→

ANSWER→

5. What is the voltage of a circuit with 15 amps of current and toaster with 8 ohms of resistance?

SETUP→

ANSWER→

6. A light bulb has a resistance of 4 ohms and a current of 2 A. What is the voltage across the bulb?

SETUP→

ANSWER→

7. How much voltage would be necessary to generate 10 amps of current in a circuit that has 5 ohms of resistance?

SETUP→

ANSWER→

8. How many ohms of resistance must be present in a circuit that has 120 volts and a current of 10 amps?

SETUP→

ANSWER→

9. An alarm clock draws 0.5 A of current when connected to a 120 volt circuit. Calculate its resistance.

SETUP→

ANSWER→

10. A portable CD player uses two 1.5 V batteries. If the current in the CD player is 2 A, what is its resistance?

SETUP→

ANSWER→

11. You have a large flashlight that takes 4 D-cell batteries. If the current in the flashlight is 2 amps, what is the resistance of the light bulb? (Hint: A D-cell battery has 1.5 volts.)

SETUP→

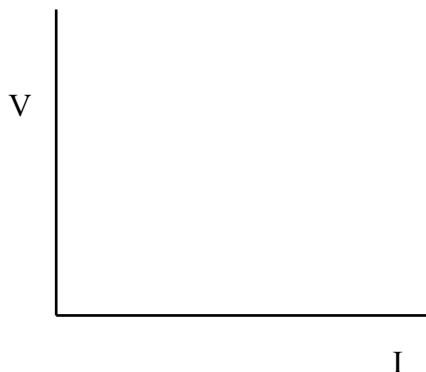
ANSWER→

12. What happens to the current in a circuit if a 1.5-volt battery is removed and is replaced by a 9-volt battery? _____

13. State the relationship between voltage and current in a circuit. _____

continued on back

14. Make a sketch that would correctly describe the relationship between voltage and current.



15. In your own words, state the relationship between resistance and current in a circuit.

_____.

16. If resistance in a circuit remains constant, what can be done in order to increase current? _____.

17. If voltage in a circuit remains constant, what will happen to current if resistance increases? _____.

18. Study the values in the table below. Based on the numbers, does the chart show the relationship between current and voltage, or current and resistance? _____.

Explain how you know. _____.

?	?
0	0
1	0.8
2	1.5
3	2.1
4	2.6
5	3
6	3.3
7	3.6
8	3.8
9	3.9
10	4