Name: _____

# Skill Sheet 7-B   Voltage, Current, and Resistance

This skill sheet reviews the role of voltage, current, and resistance in an electrical circuit, and provides practice in calculating these values using Ohm's Law. Understanding these three terms will greatly enhance your understanding of electricity. Let's begin our review!

1. What is voltage?

Water flows from high energy (height) to lower energy.

High energy

Flow

Energy lost
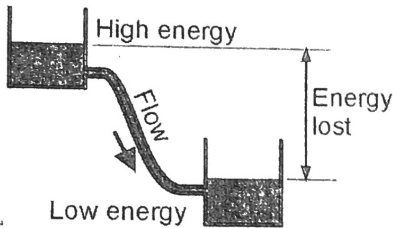
Low energy

Electric charge flows from high energy (voltage) to lower energy.

High energy
+1.5 V

Flow

1.5 V

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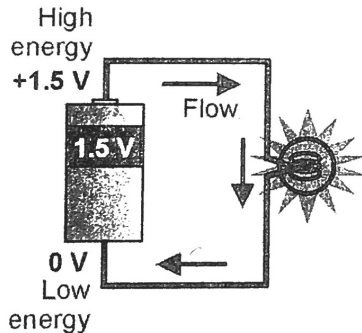
You know that water will flow from a higher tank through a hose into a lower tank. The water in the higher tank has greater potential energy than the water in the lower tank. A similar thing happens with the flow of charges in an electrical circuit.

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 the difference between placing a 1.5-volt battery in a circuit and a placing a 9-volt battery in a circuit?

A battery with a larger voltage can create a greater energy difference. The battery has greater potential difference & therefore greater energy to contribute to the circuit.

2. What is current?

A 9V battery has 6 times more energy than a 1.5 V battery.

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. Resistors slow the flow of current. Adding voltage causes the current to speed up.

Skill Sheet 7-B Voltage, Current, and Resistance

1. What could you do to a closed circuit consisting of a battery, a light bulb, and a switch that would *increase* the amount of current flow? Explain your answer.

   - Increase # of batteries →increase total voltage
   - replace light bulb → lower resistance
   - thicker wires to decrease resistance

2. What could you do to a closed circuit consisting of a battery, a light bulb, and a switch that would *decrease* the amount of current flow? Explain your answer.

   - replace battery for lower voltage
   - replace bulb for ↑ resistance
   - thinner, longer wires to ↑ resistance

3. What is resistance?

Resistance is the measure of how easily charges flow through a circuit. High resistance means it is difficult for current to flow. Low resistance means it is easy for current 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.

Describe one thing that you could do to the wire used in a circuit to *decrease* the amount of resistance presented by the wire.

Cut wires shorter — shorter wire has less resistance than longer wire.
or thicker gauge wire

4. How are voltage, current, and resistance related?

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 electrical 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:

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

In your own words, state the relationship between resistance and current, as well as the relationship between voltage and current.

current is directly related to voltage
inversely ~~rese~~ related to resistance

5. Solving problems

Now you will have the opportunity to demonstrate your understanding of the relationship between current, voltage and resistance. Answer each of the following questions and show your work. The first problem is done for you.

1. In a circuit, how many amps of current flow through a resistor such as a 6-ohm light bulb when using four 1.5-volt batteries as an energy supply?

$$\text{Current} = \frac{4 \times 1.5 \text{ volts}}{6 \text{ ohms}} = \frac{6 \text{ volts}}{6 \text{ Ohms}}$$

$$\text{Current} = 1 \text{ amp}$$

2. How many amps of current flow through a circuit that includes a 9-volt battery and a bulb with a resistance of 6 ohms?

    1.5 Amps

3. How many amps of current flow through a circuit that includes a 9-volt battery and a bulb with a resistance of 12 ohms?

    0.75 amps

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

    50 volts

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

    12 ohms

Skill Sheet 8-A   Ohm's Law

Building and testing series circuits has helped you understand the relationship between voltage, resistance, and current. You know that if the voltage (energy) in a circuit increases, so does the current (flow of charges). You also understand that if the resistance increases, the current flow decreases. A German physicist, Georg S. Ohm, developed this mathematical relationship, which is present in most circuits. This relationship is known as Ohm's law:

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

This skill sheet will provide you with an opportunity to test your knowledge of Ohm's law.

1. Using Ohm's Law to understand circuits

To work through this skill sheet, you will need the symbols used to depict circuits in diagrams. The symbols that are most commonly used for circuit diagrams are provided to the right.

All of the circuits discussed in this skill sheet are **series** circuits. This means the current has only one path through the circuit. Later you will learn about another kind of circuit in which the current has more than one possible path. This type of circuit is called a **parallel** circuit.

Note: For convenience, the symbol for battery is used to represent one *or more* batteries. The batteries you have used to build circuits are 1.5 volt batteries. Dividing the total voltage by 1.5 volts will tell you the number of batteries present in the circuit.

For example, the total voltage in the second diagram on the right is 6 volts. Divide 6 volts by 1.5 volts to find the number of batteries in the circuit. $6 \div 1.5 = 4$. There are four batteries in the circuit.

Wire

Battery

Bulb

Switch

1.5 V

6 V
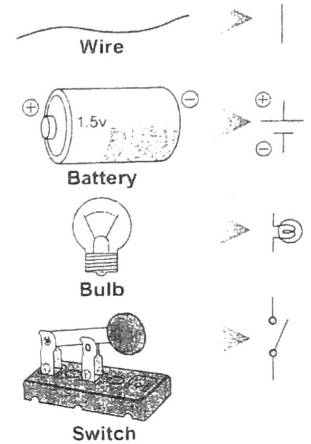
2. Solving problems

In this section, you will find some problems based on diagrams and others without diagrams. In all cases, you should show your work.

1. If a toaster produces 12 ohms of resistance in a 120-volt circuit, what is the amount of current in the circuit?
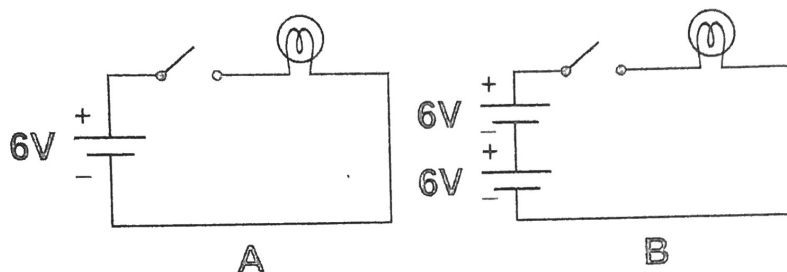
    10 Amps

2. 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.)

  3 ohms

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

  120 Volts

4. Use the diagram below to answer the following problems.

  a. What is the total voltage in each circuit?

  A: 6 Volts   B: 12 Volts

  b. How much current would be measured in each circuit if the light bulb has a resistance of 6 ohms?

  A: 1 Amp   B: 2 Amps

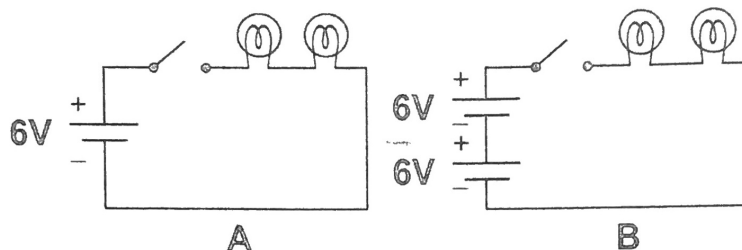 c. How much current would be measured in each circuit if the light bulb has a resistance of 12 ohms?

  A: 0.5 Amps   B: 1 Amp

  d. What would happen to the brightness of the bulb if voltage is increased?

  ↑ voltage, brightness of bulbs will increase

2

5. Use the diagram below to answer the following problems.

a. How much current would be measured in each circuit if each light bulb has a resistance of 6 ohms?

A: 0.5 Amps   B: 1 Amp

b. How much current would be measured in each circuit if each light bulb has a resistance of 12 ohms?

A: 0.25 Amp   B: 0.5 Amp

c. What happens to the brightness of each bulb as you add bulbs to a series circuit? (Hint: Compare these diagrams to the diagrams in question 4 above.)

Voltage remains same, adding bulbs in series circuit decreses brightness of bulb

6. What happens to the amount of current in a series circuit as the number of batteries increases?

Current ↑

7. What happens to the amount of current in a series circuit as the number of bulbs increases?

current ↓