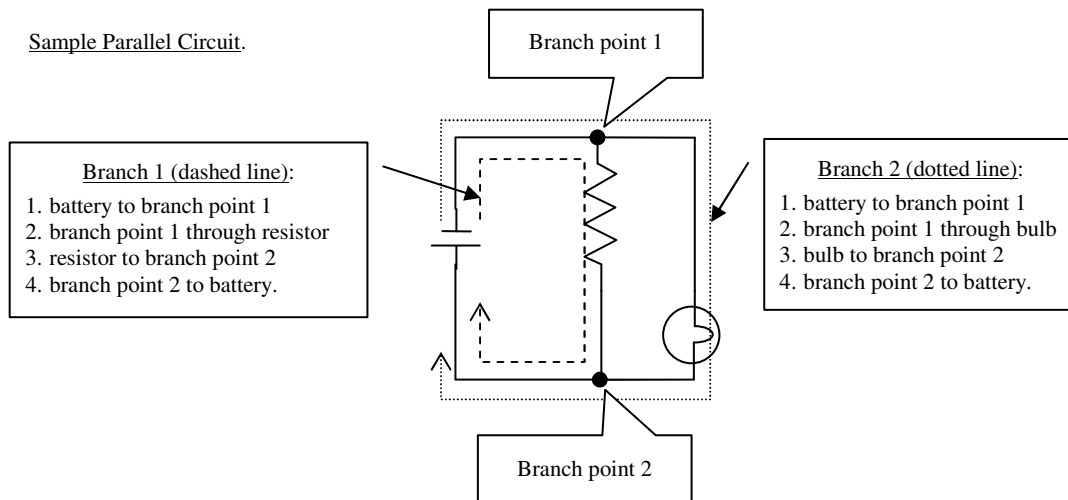


Name: \_\_\_\_\_ Date : \_\_\_\_\_

# Parallel Circuits

In a parallel circuit, the current has two or more possible paths for current to flow through to complete a loop. Each possible loop path that the current could flow through is called a **branch**. Below is an example of a parallel circuit with 2 branches.



Any point at which current could go in more than one direction is called a **junction** or a **branch point**.

## Voltage in Parallel Circuits

In parallel circuits, the voltage present in each branch of the circuit is the same. In a sense, the battery pushes the current with equal “oomph” through all branches of the circuit at the same time. Since voltage is the “push,” this means that the voltage will be the same in each branch.

## Current in Parallel Circuits

All of the current that enters a branch point must also leave that branch point. This little rule is called **Kirchoff's Current Law**. Whatever flows in must flow out!

This means that the total current in the circuit is the sum of the current in all of the branches of the parallel circuit.

$$I_{total} = I_1 + I_2 + I_3 + \dots$$

## Resistance in Parallel Circuits

Though it may seem odd, adding more branches to a parallel circuit will actually *decrease* the total resistance of the circuit!

Imagine that you are trying to get from one classroom to another. If there is only one hallway to go through, and it's crowded, you will encounter a lot of resistance. However, if you have several possible paths to choose from, you won't have much problem finding some way to your next class. Parallel circuits, with their branches, offer moving charges (electrons) those types of options, decreasing the difficulty (resistance) of flowing through the circuit.

To calculate the total resistance in a parallel circuit, add the reciprocals of the resistances of each device in the circuit together to find the reciprocal of the total resistance.

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

Once you have this value, you will, of course, need to take its reciprocal to find  $R_{total}$ .

### **Example: Finding Total Resistance in a Parallel Circuit**

In the sample parallel circuit diagram on page 1: the resistance of the resistor is  $10 \Omega$ ; the resistance of the bulb is  $1.5 \Omega$ . What is the total resistance of the circuit?

$$\begin{aligned} \frac{1}{R_{total}} &= \frac{1}{R_{resistor}} + \frac{1}{R_{bulb}} \\ \frac{1}{R_{total}} &= \frac{1}{10 \Omega} + \frac{1}{1.5 \Omega} = 0.77 \\ R_{total} &= \frac{1}{0.77} = 1.3 \Omega \end{aligned}$$

## Ohm's Law in Parallel Circuits

Ohm's law applies to each branch of the circuit, as well as to the circuit as a whole.

**Remember:** the voltage through each branch of a parallel circuit is the same.

For this class: our parallel circuits will have only one device on each branch of the circuit.

### **Using Ohm's Law on a Single Branch of a Parallel Circuit**

If you wish to find something out about a single branch, use the resistance of the device on the branch, along with the current only in that branch, and the circuit voltage (which is the same on every branch).

$$V = I_{branch} \times R_{branch} \qquad I_{branch} = \frac{V}{R_{branch}} \qquad R_{branch} = \frac{V}{I_{branch}}$$

### **Using Ohm's Law on a Whole Parallel Circuit**

When you wish to find something about the whole circuit, make sure that you use Ohm's law and the total current and the total resistance, and not just the current or resistance in a single branch of the circuit.

$$V = I_{total} \times R_{total} \qquad I_{total} = \frac{V}{R_{total}} \qquad R_{total} = \frac{V}{I_{total}}$$