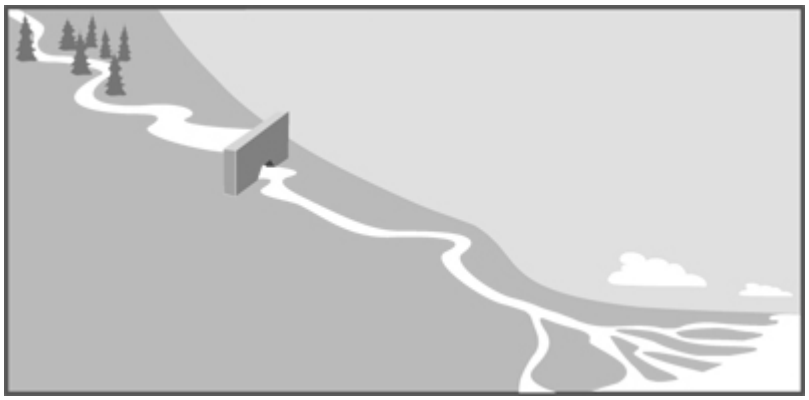
Circuit Logic

What is a Circuit?

Imagine a river (Figure 1). It begins as a small spring high in the mountains, where the water bubbles up from the ground and flows across an alpine meadow. As it tumbles toward the distant sea, always in a downhill direction, it may grow as other streams and rivers merge with it. The river normally follows a single path. It may pass through broad valleys, where water flows easily through a wide river bed, or narrow gorges, where its flow is restricted. The flow may be blocked, temporarily, by one or more dams. The energy of the flow may be harnessed by mills, hydroelectric plants, and other industries. As it approaches the sea, the river may enter a delta, where it splits into many small, constantly shifting, channels. Ultimately, as the river enters the sea, its journey ends.

Figure 1



The river described above serves as a useful analogy for an electric circuit. A river is a path taken by water as it flows from one place to another. A **circuit** is a path taken by electrons as they flow from one place to another. A circuit in which electrons are flowing through a continuous path is said to be a **closed circuit**. The direction water flows is determined by potential difference in height between the river and the sea. Likewise, the flow of electrons, or **current**, depends on the potential difference in charge, or **voltage**, between one part of the circuit and another.

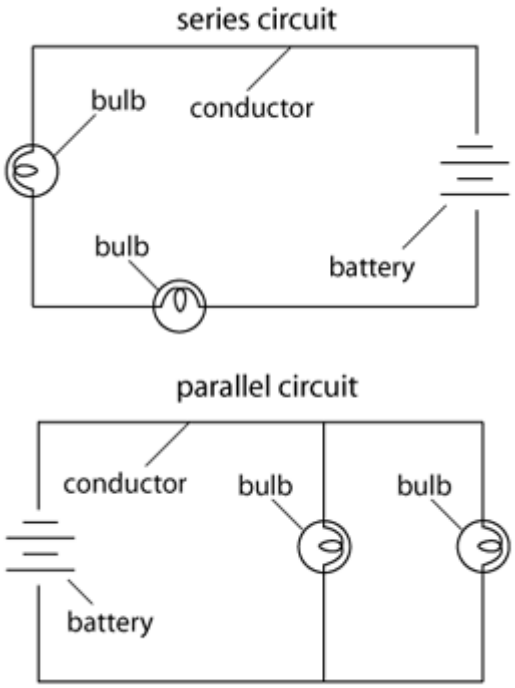
Moreover, both the river and the circuit have specific paths through which water (or current) flow. This path may be broad and easy, providing little **resistance** or opposition to the flow. It may be narrow and restrictive, thus providing greater resistance to the flow. The path may be interrupted, as by a dam on the river, by a **switch** on the circuit, thereby causing the flow to stop. A circuit where the flow of current has been interrupted by a switch (or by simply pulling the plug) is known as an **open circuit**. Finally, the energy of the current flowing through the circuit can be used to do work, just as the energy of flowing water can be harnessed to do work.

What are the differences between a river and a circuit? Unlike the river, an electric circuit is a closed path. Whereas water can enter and leave the stream all along the path, the electric current originates in one place, such as a battery. No additional current enters the circuit at any point along the flow. Also, when functioning properly, a circuit does not lose current, as a river might. Finally, the water in a river almost always flows in one direction only. Electric current may flow through a circuit either in one direction (**direct current**) or in both directions (**alternating current**).

Types of Circuits

Circuits come in two basic types: series and parallel:

Figure 2: Types of Circuits



Current flowing through a **series circuit** has one and only one path through which to travel. A common example of a series circuit is the doorbell found in many homes. Normally, this circuit is kept open. Remember, no current flows through an open circuit. When the button outside of the door is pushed, the circuit is closed, current flows from the power source, through the switch, and through the bell, causing it to ring. The bell continues to ring as long as the switch is held closed.

Old-fashioned strings of Christmas-tree lights offer another example of a series circuit. Current moving through a string of these lights goes through the wire, then through the first bulb, back into the wire, through the second bulb, and so on to the end of the string. These strings had a simple design and were easy and inexpensive to make, but they had a big problem. If one bulb went bad, the current stopped flowing and the entire string of lights would not light up. To get any of the lights to work, the user had to find and replace the bad bulb. You can imagine how frustrating this would have been had *two* bulbs gone bad at the same time!

Can you imagine what life would be like if your house were wired as one long series circuit? Current would flow into the house and through each of the appliances, lights, etc., one at a time. With this arrangement, you would have to turn on every appliance, TV, and light just to use your toaster or clock radio. What do you think would happen if a lightbulb burned out?

Fortunately, our houses (and newer strings of Christmas-tree lights) are wired, not in series, but in parallel circuits. Instead of just one path, **parallel circuits** offer multiple paths

through which current may flow. Because the current splits up and follows each path independently of the other paths, it does not matter if one or more paths are open; current will still flow through the paths that are closed. Thus, you need only turn on the appliances you wish to turn on.