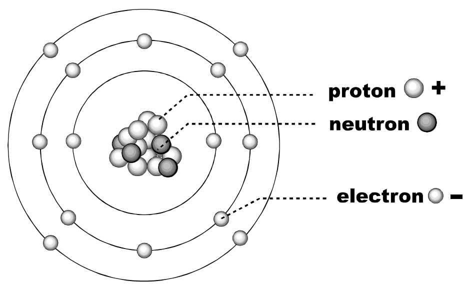
Introduction

It is difficult to imagine what our lives would be like without **electricity**. As little as 100 years ago, there was no electricity in homes and factories. Today, we depend on electricity to run everything from small radios to satellite tracking stations. Some of the general properties of electricity will be introduced in this unit.

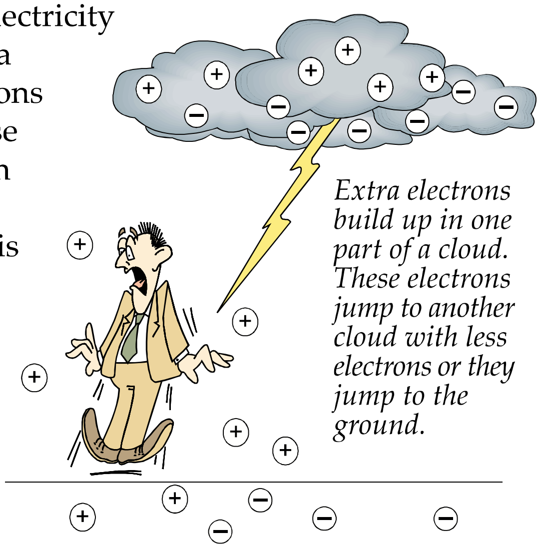
What Is Electricity?

Electricity is a form of energy. All matter contains some electricity. Matter is made from atoms. Atoms contain protons that have a positive charge (+), neutrons that are neutral or have no charge, and electrons that carry a negative charge (-). Most matter has the same number of protons as it does electrons; this makes the matter neutral. An atom can gain or lose electrons. If an atom gains extra electrons, it will become negatively charged (-). A loss of electrons will create a positive charge. Between any objects with charge, there is always electrical force. In fact, it is these electrical forces within molecules and atoms that cause most observable forces. Your ability to throw a ball, the blooming of a flower, and the working of your car are examples of forces in action. Each of these can be traced back to electrical force. This idea is fundamental to most sciences. This unit will discuss how the flow of electrons causes electric **current**. Electricity is electrons in motion. Electrons move from a place that has gained electrons to a place that has lost electrons. We can say this another way: electrons move from areas of negative charge to areas of positive charge.



Electrons Orbiting a Nucleus

When matter becomes positively or negatively charged, we sometimes call this **static electricity**. Run a brush through your hair. Take a nylon shirt out of a dryer. What happens? A small shock is felt or a crackle is heard. This indicates *static electricity*. At first, there was a charge, but the electrons did not move. Then, when you heard the crack or felt the shock, the electrons moved. The electricity did not move in a path. Because it does not move along a path, static electricity cannot run appliances. Lightning is a form of static electricity. Extra electrons build up in one part of a cloud. These electrons jump to another cloud with less electrons or they jump to the ground. When this happens, the air is heated and the sky is filled with bright light. Lightning is dangerous and kills or disables hundreds of people every year.



Extra electrons build up in one part of a cloud. These electrons jump to another cloud with less electrons or they jump to the ground.

Wires that carry electric power can be dangerous. If you touch bare wires, enough charge may flow through your body to hurt you. You may even be **electrocuted** by it. Electrocution means death by exposure to electricity. You have not been electrocuted, but you may have been shocked. Electricity at home must be used with care. Never use anything with loose or broken electric wires. When there is lightning outside, stay off the telephone and away from electrical appliances. The lightning can send an electric current through these various wires and then through you!

Most usable electricity is different from static electricity. It moves along a path. It is a flow or a stream, and it is the kind of electricity that we use to run appliances.

Producing Electricity

There are many different sources of electricity. Some electricity comes from **cells** or batteries. A cell is a device that uses chemical reactions to store and produce electricity. The kind of **battery** used in a flashlight is formed from two or more cells. These cells are usually dry. That is to say that the chemicals in them are not dissolved in water. A dry cell has a carbon rod set in the center of a zinc can. The rest of the can is filled with a special paste or gel. The chemicals in the paste react with the zinc. Electrons are released and flow to the carbon rod. This flow of electrons is electricity.

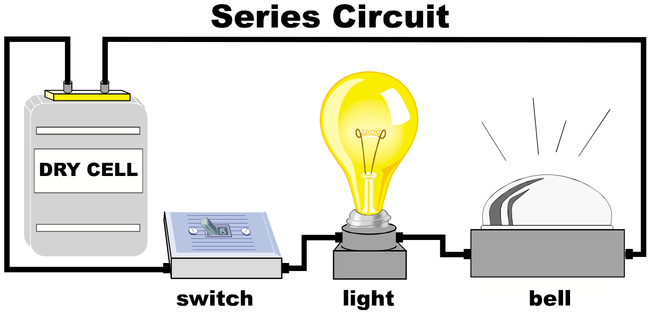
A **generator** also produces electricity. It contains magnets and a large coil of wire called an **armature**. The armature turns between the magnets. As the armature turns, it moves across the magnetic field, producing electrical current in the coil. This process is called **electromagnetic induction**. Generators rely on the fact that electricity and magnetism are two aspects of the same force. Just as we use magnets to produce electricity, we use electricity to make magnets. Generators change the mechanical energy of different sources into electricity. They can be turned by different sources of energy, such as steam, solar, atomic, and even water. When a generator stops turning, it no longer produces electricity.

Circuits

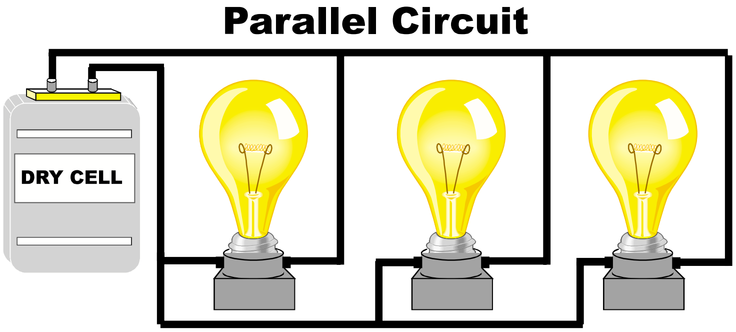
You know that electricity is a flow of electrons. Current electricity must follow a path. The path a current follows is called a **circuit**.

An electric circuit can be either *open* or *closed*. A **closed circuit** will allow electricity to move through it. A closed circuit is a complete path. An **open circuit** will not allow electricity to move through it. An open circuit is an incomplete path. Turn on the light switch in the room. The circuit is complete and electricity will flow. Turn the light switch off. The circuit is open and no electricity will flow.

There are two basic kinds of circuits. Circuits may be either series or parallel. In a **series circuit**, electricity only has one path to follow. Connect a switch, a light, and a bell to a battery. Close the switch. The bell and the light will work. What happens if the light burns out? The circuit will be open. The electricity cannot get past the burned-out light. The bell will not work. When one thing in a series circuit burns out, everything else in the series will also stop working. They are not damaged; however, no electricity will flow, so they still will not work. Imagine what would happen if everything in your school was connected to one series circuit.



A **parallel circuit** has more than one path for electricity to follow. The current splits up to flow through different branches. Parallel circuits have the advantage that when one branch of the circuit is opened, such as when you turn off a light, the current continues to flow through the other branches. If one thing on a parallel circuit burns out, the rest of the things will keep working. It is the kind of circuit used in homes and offices.

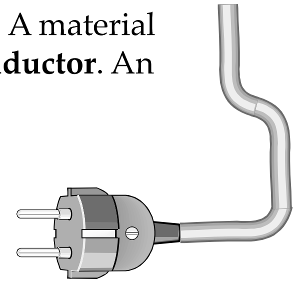


Currents

There are two kinds of currents. One type is **direct current** (*DC*). The second type is **alternating current** (*AC*). A direct current flows in only one direction. A dry cell or battery produces a direct current. Direct currents can lose power if they travel long distances through a wire. Remember that electromagnetic induction produces a current using a magnetic field. The magnetic field produced by a DC current is aligned in only one direction. If you use a compass, you can detect the direction in which the field is aligned. When you place the compass along the path the electrons follow, it will always point the same way.

Alternating currents (AC) change direction many times every second. This is the type of current used in homes and offices. Most household current changes direction 60 times each second. This means that the charges change 60 times each second. Alternating currents can be sent long distances through wires without losing much power. The magnetic fields produced by AC currents are different from those of DC. Because the direction of the current changes, so does the direction of the magnetic field. The result of this is that the field moves away from the wire in first one direction and then another. This varying direction of the electricity and the magnetic field creates an electromagnetic wave. This form of energy moves away from the circuit. Because it moves away from its source, we say it radiates. We will discuss electromagnetic waves of many sorts in "Unit 20: Waves."

Conductors and Insulators



Electricity flows. Can it go everywhere? No, it cannot. A material that allows electricity to pass through it is called a **conductor**. An **insulator** will not allow electricity to flow through it.

Think about the wire that carries electricity to your television set. What keeps the electricity in the wire? The rubber coating around the wire is a good insulator. It resists the flow of electricity through it. Glass, rubber, and plastic are good insulators. There is no perfect insulator, however, so remember to use caution.

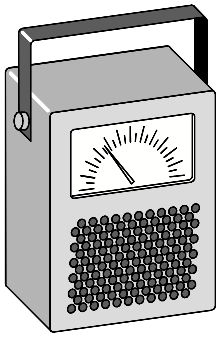
Electricity will travel through a conductor. Copper wire is a good conductor. Silver wire also conducts electricity very well, but is more costly to use than copper. Most metals will conduct electricity. Air and water will also conduct electricity.

Measuring Electricity

Electricity can be measured. Electric current flows through wires. **Amperes**, or *amps,* tell how much current is flowing. Amps measure the number of electrons that move past a point in one second. An **ammeter** is used to measure amps.

Electricity moves. You know that some type of force is needed to make things move. **Electromotive force** *(EMF)* moves electricity. Electromotive force is measured in **volts**. The current in a house is usually being pushed by 110 to 120 volts. A dry cell used to run a flashlight has about 1.5 volts.

an ammeter is used to measure amps



Moving objects usually have to overcome some form of **resistance**. Resistance is the force that slows down electron flow. Electricity also meets resistance. Resistance measures how hard it is for an electric current to pass through a material. A unit of resistance is called an **ohm**. A large amount of resistance will lower the number of amps that can flow through a wire. This means that the current will be less. High resistance also produces heat. The burner coils on an electric stove have a high resistance. When you turn the knob to control the heat, you are really controlling how much current enters the coil. The more current, the more heat.

A volt tells how much force is used to push the current through a wire. An amp tells the rate of the current's flow. An ohm tells how much resistance the conductor is giving the current. An ohm is the unit of measure of the conductor's resistance.

Summary

Electricity is caused by a flow of electrons. Static electricity is caused by (+) or (-) charged materials. Electrical forces exist between charged objects. Current electricity moves along a path or circuit. A direct current (DC) only moves one way. Alternating current (AC) moves back and forth. Alternating currents cause electromagnetic waves. A circuit can be either series or parallel.