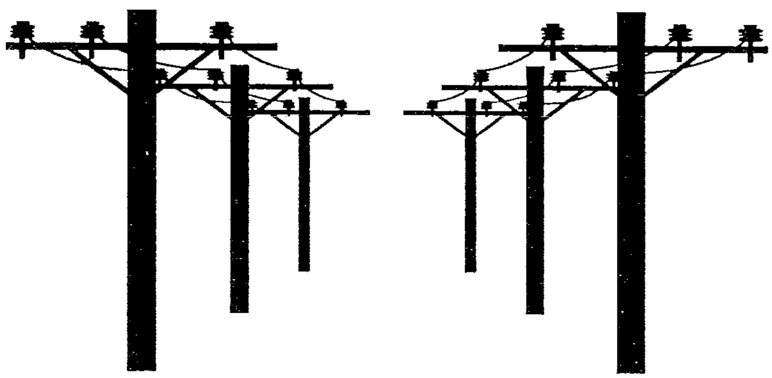
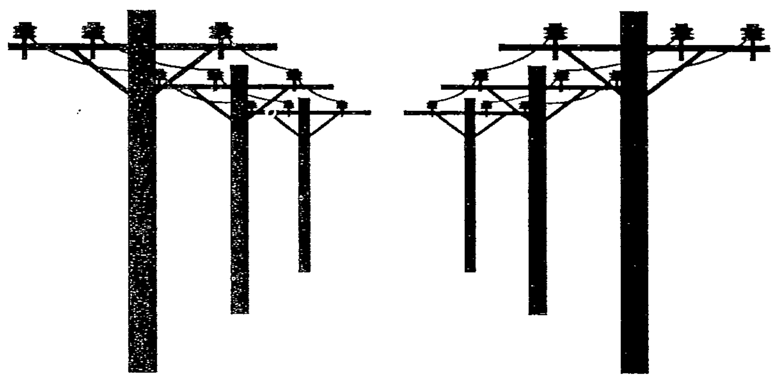
ELECTRICITY



IT'S EASY!

LA ELECTRICIDAD



ES FACIL DE ENTENDER

BACKGROUND INFORMATION

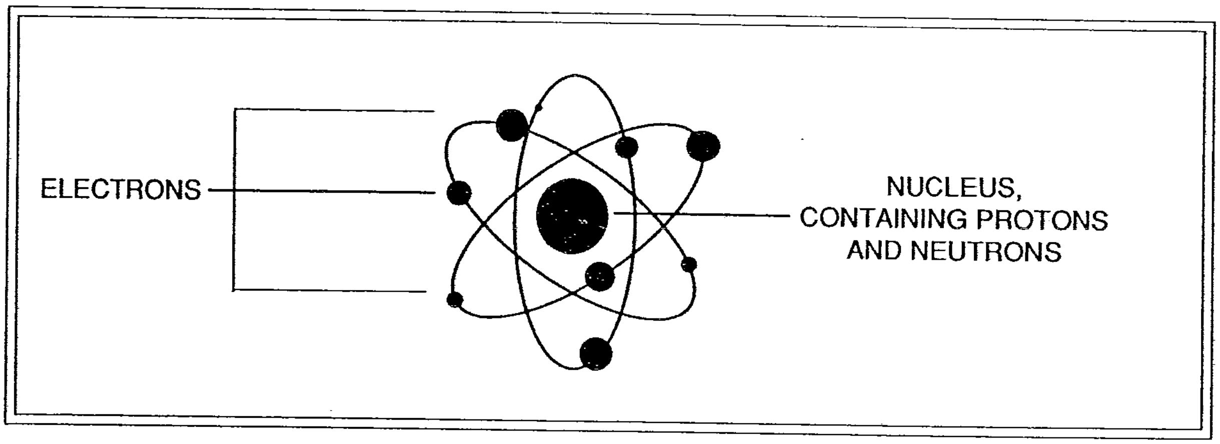
Many of us think of electricity as something dangerous, mysterious, complicated, powerful, and definitely not to be messed with. But it is also something that all of us use every day. Have you ever walked across a rug and then received a *shock* when you reached for a doorknob? Or, received a shock from clothes you just pulled from the dryer? Have you ever marveled at, or perhaps trembled at, nature's show of lightning? These phenomena are the results of exactly the same kind of electricity—just on a different scale! In addition to these "accidental" experiences with electricity, most of us have had many deliberate experiences—and lived to tell about them! Did you turn on the lights in your house last night? Watch TV? Electricity is an essential part of the world in which we live.

ELECTRICAL CHARGE

So, how does electricity work, anyway?

To answer this question, we need to know about the structure of **matter,** which is the name for the *stuff* that makes up all living and nonliving things in the universe. All matter is made up of tiny particles called **atoms.** Atoms look a little like the earth with satellites in orbit around it. Every atom is made up of three kinds of tiny particles, called **protons, neutrons,** and **electrons.**

Simplified Model of an Atom

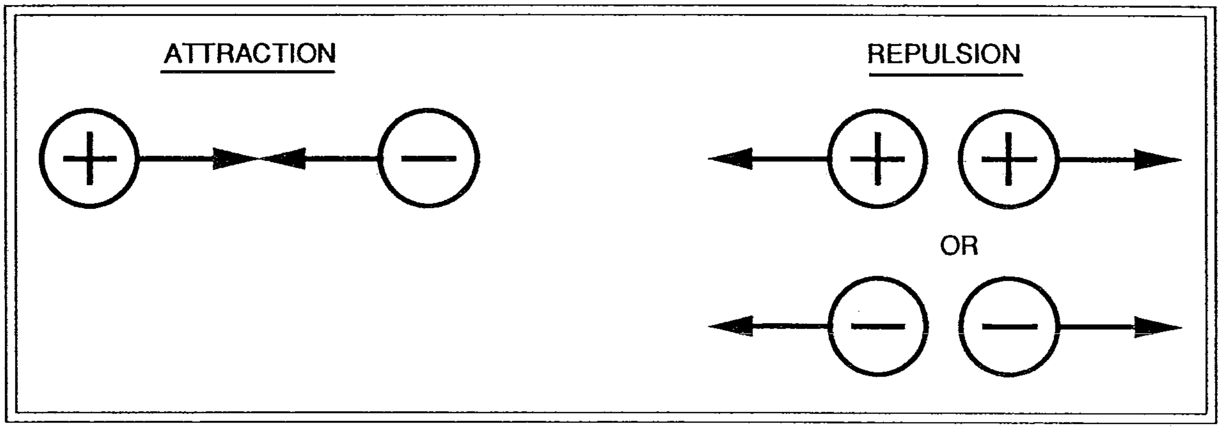


All of an atom's protons and neutrons are concentrated in a central core area, like the earth in the center of its satellites. This core area in the atom is called the **nucleus.** These two kinds of particles are about 2,000 times heavier than electrons, and so most of the *stuff* making up an atom is in its **nucleus.** The electrons of atoms are found outside the nucleus, and are constantly moving around the nucleus very quickly and in many zany paths, rather like a satellite gone crazy. **It is these electrons that are the key to understanding electricity.**

Why don't the electrons just fly away from the nucleus?

As described above, the electrons in atoms are very light and are always flying around the nucleus. Each electron and each proton has an **electrical charge.** The electrical charge on a proton is equal in strength to the electrical charge on an electron. But, the charge on each proton is *positive* and the charge on each electron is *negative,* so they are opposites. In the world of electricity, opposite charges (positive and negative) attract each other and the same kind of charges (such as two positives or two negatives) repel each other. You may have felt a similar kind of attraction and repulsion when playing with magnets.

Since protons in the nucleus and electrons outside the nucleus are opposites, they attract. This is what holds the electrons to the nucleus and keeps them from flying away.



SEPARATION OF CHARGE

Can electrons flying around the nucleus ever break away?

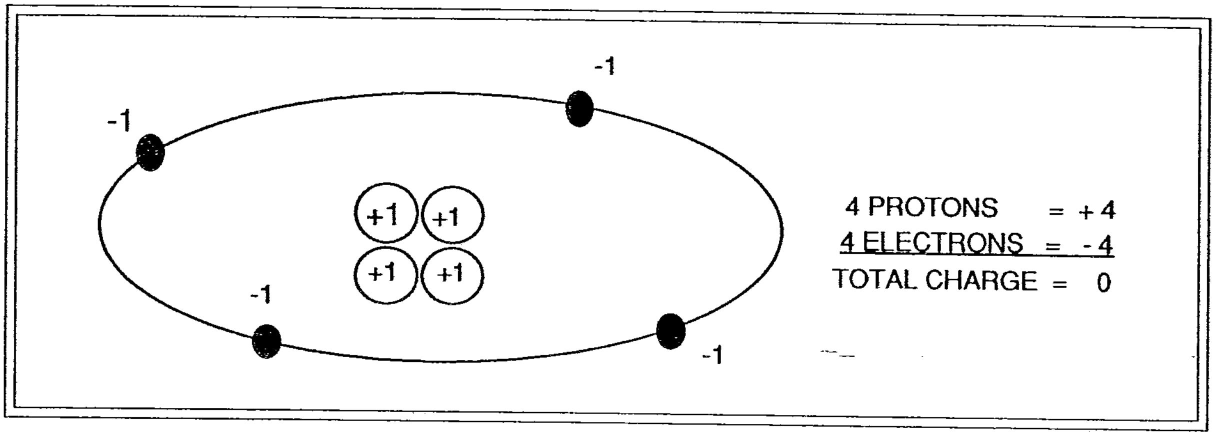
Yes, atoms sometimes can lose one or more of their electrons. Remember, these electrons are much less massive *(lighter)* than the protons and neutrons in the nucleus of the atom. And the electrons are flying around the nucleus very quickly.

When an atom loses some of its electrons, it is also possible for these *lost* electrons to be picked up by another nearby atom, so that the second atom *gains* one or more electrons. This transfer of electrons from one object's atoms to another object's atoms often occurs when the objects are in contact, especially if they are rubbed against each other. **It is this movement of electrons that accounts for electricity.**

In fact, there are two kinds of electricity—**static electricity** and **current electricity.** In static electricity, the electrons can move from one object to another and stay pretty much in one place. In current electricity, electrons move freely from one location to another through materials, in much the same way that water moves through a pipe or hose.

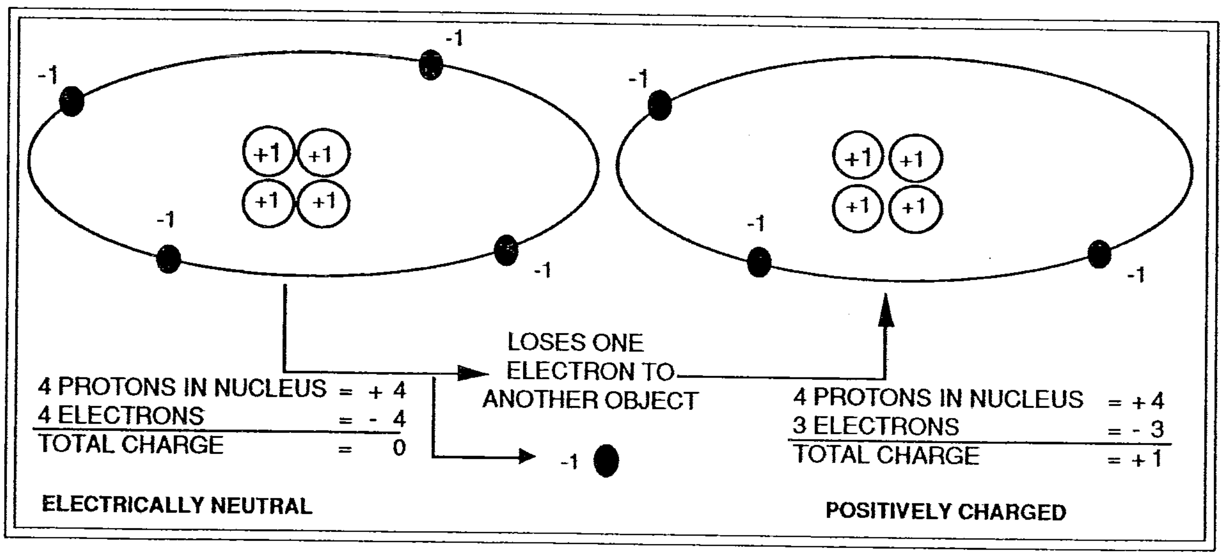
STATIC ELECTRICITY

Under normal circumstances, each atom in an object has the same number of protons and electrons. That means that there are the same number of positive charges as negative charges in the object. Each positive charge is balanced by one negative charge, and so the overall object doesn't have any electrical charge. In that case the object is **electrically neutral.**



What happens when some electrons fly away from the atom?

When some atoms in an object lose one or more of their electrons, the overall object doesn't change its identity. For example, even if your hair loses some electrons from its atoms when you brush your hair in the winter, it is still hair—it just has an electrical charge. But, the balance of electrical charges will be different. If the object *loses* some electrons, it has lost some of its negative charge. But it still has the same number of protons in each nucleus of its atoms. All of the positive charge is no longer balanced by an equal amount of negative charge; there is still some unbalanced positive charge left over. So, if the object loses one or more electrons, the object is left with an overall **positive charge.**



In the same way, if a neutral object *gains* some extra electrons, it will have more electrons than protons, and more total negative charge than it needs to balance the total positive charge. Therefore, it will have an overall negative charge. To summarize:

If an atom:	its resulting electrical charge will be:
loses electrons	positive (+)
gains electrons	negative (-)

Remember, it is *only the electrons, not the protons, that can be transferred from one object to another*. When an object becomes electrically charged by a transfer of electrons as described here, this is called a **static charge.** The transfer of electrons, the build-up of static charge, and the removal of static charge all make up what we know as **static electricity.**

Examples of static electricity

When you walk across a carpet on a cold, dry day, you rub electrons from your shoes or socks onto the nylon rug. You end up with an overall positive charge on your body. When you reach out to touch something metal, such as a doorknob, electrons from the metal are attracted to your positively charged hand and "jump" through the cold, dry air in the form of a spark. This neutralizes your positive charge so you can then touch the doorknob a second time without being shocked.

Lightning works in a similar way. During a thunderstorm, ice particles and raindrops rub against each other and electrons get rubbed off. The thundercloud builds up areas with negative charge and areas with positive charge. Lightning that flashes within a cloud or streaks from cloud to cloud is electrons moving toward positively charged areas. Sometimes these electrons move toward positive charges in the ground, or electrons in the ground move toward positive charges in the clouds: This is what creates the lightning that we see going from the clouds to the earth. Thunder is caused by the rapid expansion of the air around the lightning because of the heat created by the lightning. This expansion causes sound waves that we hear as thunder. The total energy released during a large thunderstorm is far greater than that of an atomic bomb!

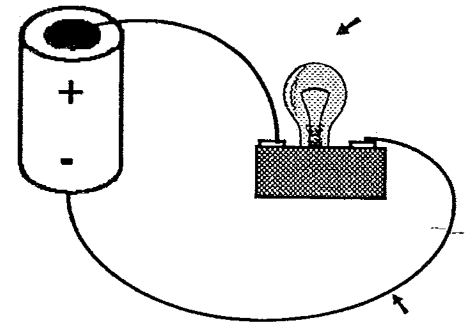
ELECTRICAL CURRENT

What is electrical current?

Static electrical charge can only build up on an object in which the electrons cannot move around easily, such as plastic, rubber, and nylon. Other materials allow electrons to move through them freely and evenly, without accumulating in one place. These materials are called good **conductors** of electricity. Metal wires, such as those in the electrical cords connected to lamps and other appliances, are good conductors. When electrons move through a conductor easily, this type of electricity is called **current electricity,** or **electrical current.** A material through which electrons cannot move easily is a poor conductor, and is called an **insulator.** Most metals, such as copper and aluminum, are good conductors of electricity. Most insulators are nonmetals, such as rubber, wood, or plastic.

CURRENT AND CIRCUITS

In order for an electrical current to flow, there needs to be a path for the electrons to follow. This path for the electrons to follow, along with all of the objects connected to the path, is called an electrical **circuit.** The circuit usually includes three main parts: a source of electrical energy to supply the electrons (such as a battery), some object in the path that is using the electricity (such as a light bulb or a toaster), and conductors connecting everything together (usually metal wire). The diagram below shows a simple circuit.



Why does electrical current flow?

The flow of electrons through a wire is similar in some ways to the flow of water through a hose. In order for water to flow through a hose, there needs to be a difference in pressure between the ends of the hose. The water is pushed from the high-pressure end (at the faucet) toward the low-pressure end (at the nozzle). The same thing is needed for electrons to flow. There needs to be a difference in electrical *pressure* in order for electrons to flow. This difference in electrical potential is what we call **voltage.**

How does a battery supply electricity?

The inside of a battery, such as the one in the last diagram, has chemicals that cause electrons to be built up on the negative *pole* or *end* of the battery, giving it its negative charge. Similarly, electrons are lost from the positive *pole* or *end* of the battery, giving it its positive charge. At the negative terminal, where there is a build-up of electrons, there is a *high* electrical potential (pressure). At the positive terminal, where there is a loss of electrons, there is a low electrical potential (pressure). Because of this difference in concentration of electrons between the two poles of the battery, we say that the battery has a **voltage.**

Why does a battery "go dead"?

Chemicals inside the battery react with the electrons that reach the positive (+) pole through a circuit. These chemical reactions create more electrons at the negative (-) pole. When the chemicals have been used up, the battery cannot produce a voltage any more, and we say the battery is *dead.*

How does electrical current flow through a circuit?

The two poles (ends) of the battery need to be connected in order for the electric charges to flow to produce a current. This is where the conductors (usually metal wires) come in. They provide a *loop* path from the negative pole of the battery, through the light bulb, and back to the positive pole of the battery. As long as the negative and positive poles are connected, there is a difference in electrical potential between the ends of the wire, and the electric current will flow. This is one way in which an electric circuit differs from the water hose. In a water hose, the flow of water is usually just in a straight, one-way path, from one high-pressure end and to the other low-pressure end. In the electric circuit, the path needs to make a complete closed loop in order for the *high-pressure* and *low-pressure* areas to be established and connected in the circuit. Another way to think of the electric current passing through the wire is like a bucket brigade. The atoms of the wire are like people in line, and the electrons in the wire are like the buckets being passed along from one person to another. Metals are particularly good at passing the bucket (negative charge) along.

INFORMACION BASICA

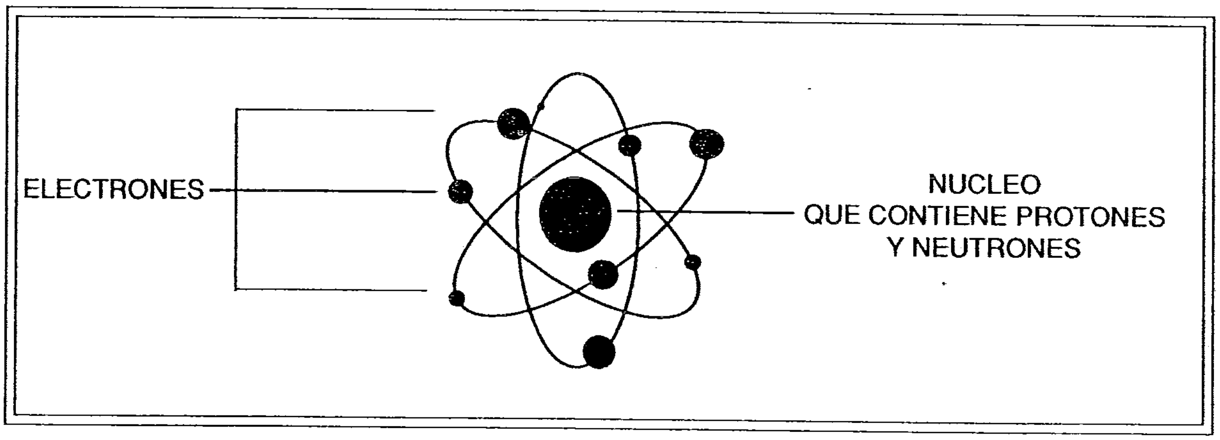
Muchas personas piensan que la electricidad es peligrosa, misteriosa, complicada, poderosa y algo con lo cual no se debe jugar. Sin embargo, la electricidad es algo que usamos todos los días. ¿Alguna vez sintió un choque eléctrico cuando caminaba sobre la alfombra y tocó la perilla de la puerta? ¿Recibió un choque eléctrico producido por la ropa que acababa de sacar de la secadora? ¿Le asombran o le dan miedo los relámpagos? Todos esos fenómenos son producidos por el mismo tipo de electricidad, pero en un nivel diferente. Además de estos pequeños "accidentes" con la electricidad, la mayoría de las personas han sentido choques eléctricos, a veces deliberadamente, y !han sobrevivido para contar su experiencia! La electricidad se ha convertido en una parte esencial del mundo en que vivimos; todas las noches apagamos las luces de la casa, vemos la televisión, etc.

LA CARGA ELECTRICA

Bien, ¿cómo trabaja la electricidad?

Para responder a esta pregunta necesitamos saber cuál es la estructura de la materia, cuál es el nombre del elemento que forma parte tanto de las cosas vivas como de la materia inerte o sin vida que componen el universo. Toda materia está formada de pequeñas partículas llamadas "**átomos.**" Los átomos se parecen a la Tierra con satélites que jirana su alrededor. Cada átomo está compuesto de tres clases de partículas muy pequeñas llamadas **protones, neutrones** y **electrones.**

El Atomo

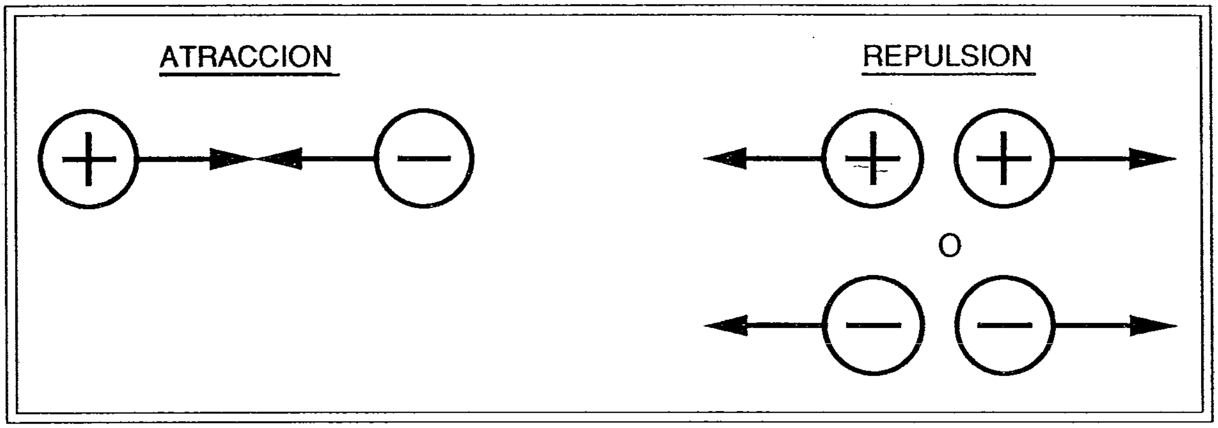


Todos los protones y los neutrones del átomo se concentran en una zona central, lo mismo que la Tierra está en el centro de los satélites. Esta zona central del átomo se llama "**núcleo.**" Los protones y los neutrones son partículas casi 2,000 veces más pesadas que los electrones. Los electrones del átomo se encuentran en la parte de afuera del núcleo y se mueven alrededor del núcleo rapidamente y en todas direcciones, igual que un satellite que se vuelve loco. **Los electrones son la clave para comprender la naturaleza de la electricidad.**

¿Por qué no se alejan los electrones del núcleo?

Como se dijo antes, los electrones del átomo son muy livianos y se mueven constantemente alrededor del núcleo. El electrón y el protón poseen **una carga eléctrica**. La carga eléctrica del protón es igual en fuerza a la carga eléctrica del electrón. Pero, la carga del protón es positiva, y la carga del electrón es negativa, de manera que son cargas opuestas. En el mundo de la electricidad, las cargas opuestas (la positivia y la negativa) se atraen y las cargas iguales (como dos positivas o dos negativas) se repelen. Tal vez ha visto este tipo de atracción y repulsión cuando juega con imanes o magnetos.

Porque son cargas opuestas, los protones dentro del núcleo y los electrones fuera del núcleo se atraen y por eso mismo, los electrones se mantienen alrededor del núcleo y no se alejan.



SEPARACION DE LA CARGA

¿Pueden escaparse los electrones que se encuentran alrededor del núcleo?

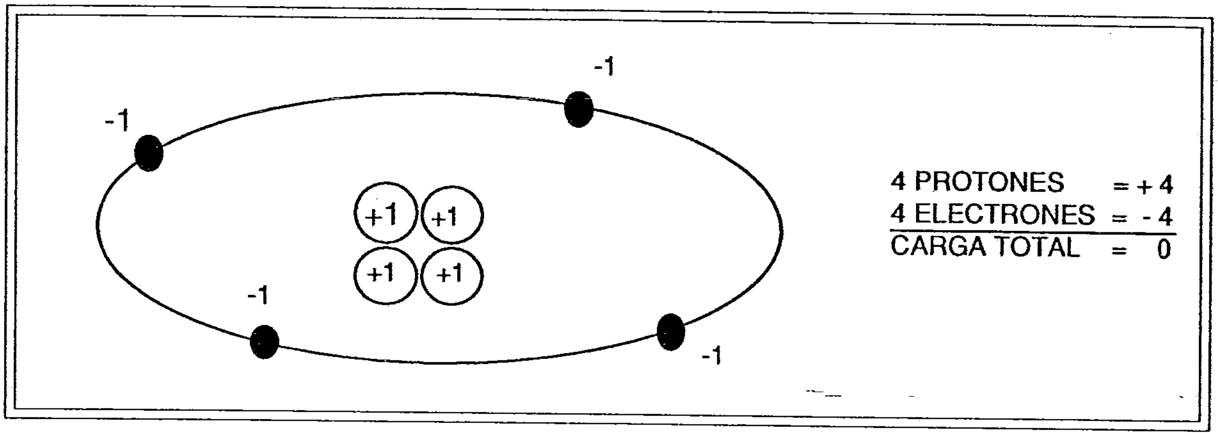
Sí, algunas veces los átomos pueden perder uno o más de sus electrones. Recuerde que los electrones son más livianos que los protones y los neutrones que se encuentran dentro del núcleo del átomo, y que además, los electrones se mueven rápidamente alrededor del núcleo.

Cuando el átomo pierde algunos de sus electrones estos electrones son atraídos por otro átomo que se encuentra cerca, de esta forma, el segundo átomo gana unos electrones. Esta transferencia de electrones, del átomo de un objeto al átomo de otro objeto, ocurre a menudo cuando los objetos entran en contacto, especialmente si estos objetos se frotan el uno contra el otro. **Este movimiento de los electrones es lo que produce la electricidad.**

Hay dos clases de electricidad: **la electricidad estática y la electricidad corriente.** En la electricidad estática los electrones se pueden mover de un objeto a otro o pueden permanecer en un solo sitio. En la electricidad corriente los electrones se mueven libremente de un lugar a otro a través de los elementos o de los materiales, de la misma manera que el agua se mueve o fluye dentro de la tubería o de la manguera.

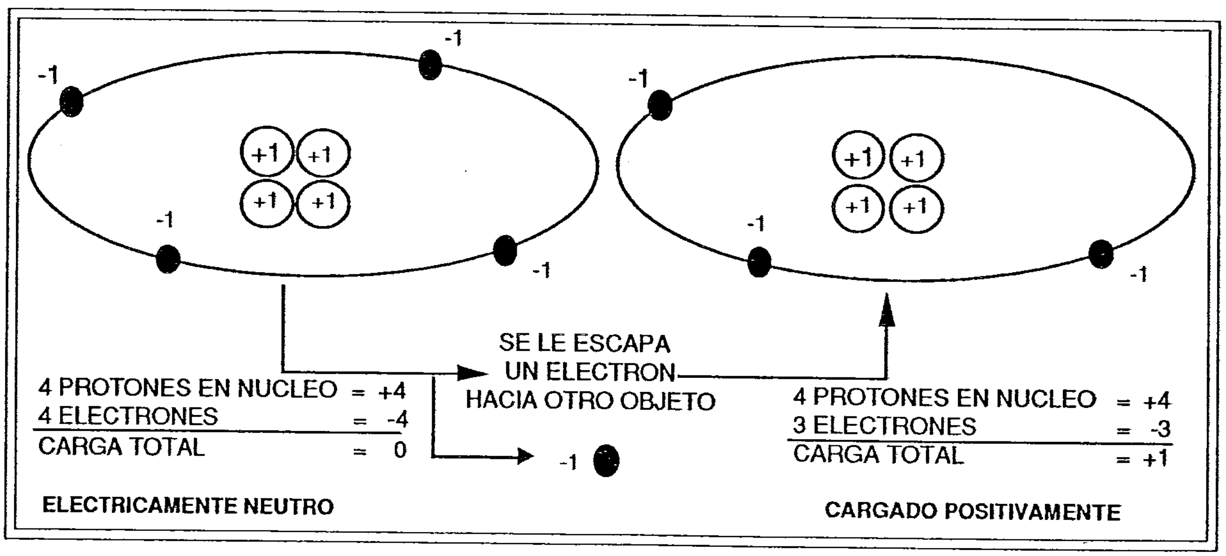
LA ELECTRICIDAD ESTATICA

En condiciones normales cada átomo de un objeto tiene el mismo número de protones y de electrones. Esto quiere decir, que en un objeto hay el mismo número de cargas positivas y de cargas negativas. Cada carga positiva está balanceada por una carga negativa, y así, él objeto no tiene carga eléctrica. Es decir, el objeto es **electricamente neutro.**



¿Qué pasa cuando algunos electrones se alejan del átomo?

Cuando los átomos de un objeto pierden uno o más de sus electrones, el objeto no cambia de identidad. Por ejemplo, cuando se cepilla el pelo durante el invierno los átomos de su pelo pueden perder algunos de sus electrones, pero el pelo permanece igual, solo ha sufrido una carga eléctrica. Sin embargo, el balance de las cargas electricas es ahora diferente. Si el objeto *pierde* electrones, pierde carga negativa, pero tiene todavía el mismo número de protones en el nucléo de sus átomos. Lo que ocurre ahora es que la carga positiva no está balanceada por la misma cantidad de carga negativa; hay una carga positiva no balanceada. De la misma manera, aunque el objeto pierda uno o más electrones todavía posee **carga positiva.**



De la misma forma, si un objeto neutro gana algunos electrones, este objeto tendra más electrones que protones y por tanto tendra más carga negativa de la que necesita para balancear su carga positiva total, y por consiguiente, tendra una carga negativa general. Para resumir:

si un átomo:	su carga eléctrica resultante será:
pierde electrones	positiva (+)
gana electrones	negativa (-)

Recuerde, que son solo los electrones, y no los protones, los que se pueden transferir o mover de un objeto a otro. Cuando el objeto recibe una carga eléctrica por medio de la transferencia de electrones esta carga se llama: **carga estática**. La transferencia de electrones, la formación de corriente estática y la remoción de la carga estática producen lo que se conoce con el nombre de **electricidad estática.**

Ejemplos de electricidad estática

Cuando usted camina sobre la alfombra en un día frío y seco, usted frota electrones que están en sus zapatos o calcetines con la superficie de nylon de la alfombra. Esto hace que su cuerpo se cargue de electricidad positiva. Si usted toca algo metálico, como la manija o perilla de una puerta, los electrones del metal son atraídos a su mano (que está cargada positivamente) y estos "saltan" a través del aire frío y seco en forma de chispas. Cuando esto pasa, la electricidad con la que usted está cargado/a es neutralizada. Si usted toca la manija o perilla por segunda vez, no recibirá otro choque eléctrico.

Este fenómeno es similar a los rayos en una tormenta eléctrica. Durante una tormenta, pequeños pedacitos de hielo y gotas de agua se frotan unos contra otros, asimismo frotando sus electrones. Las nubes forman áreas con carga negativa y áreas con carga positiva. Los rayos que relampaguean dentro de una nube o de una nube a otra, son electrones moviéndose hacia áreas que estén cargadas positivamente. Algunas veces estos electrones se mueven hacia cargas positivas en la Tierra, o electrones en la Tierra se mueven hacia cargas positivas en las nubes. Esto es lo que origina los rayos que vemos relampagueando de las nubes hacia la Tierra. El trueno o estruendo, es causado por la rápida expansión del aire alrededor del rayo y debido al calor creado por el rayo. Esta expansión causa ondas de sonido que son los truenos. ¡El total de la energía que se descarga en una tormenta eléctrica es mayor que el de una bomba atómica!

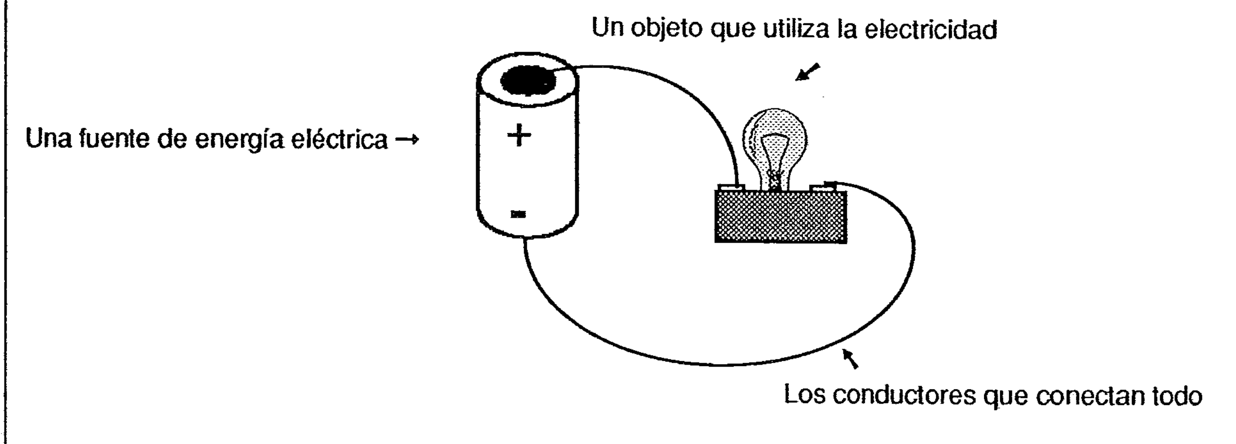
LA CORRIENTE ELECTRICA

¿Qué es la corriente eléctrica?

La carga eléctrica estática solo se produce en los objetos donde los electrones no puedan moverse con facilidad, tal como el plástico, la goma y el nylon. Otros materiales permiten que los electrones se muevan libremente de manera uniforme, sin acumularse en un solo sitio. Estos materiales se llaman buenos conductores de electricidad. Los cables de metal, como los cables eléctricos que se conectan a las lámparas y a otros aparatos caseros, son buenos conductores. Cuando los electrones se mueven con facilida a través del conductor, producen un tipo de electricidad que se llama **electricidad corriente** o **corriente electrica**. Los materiales que no permiten que los electrones se muevan con facilidad son pobres conductores, y se llaman **aisladores**. La mayor parte de los metales, como el cobre y el aluminio, son buenos conductores de electricidad. La mayoría de los materiales aislantes no son metálicos, tal como la goma, la lana y el plástico.

LA CORRIENTE Y LOS CIRCUITOS

Para que la corriente eléctrica pueda pasar tiene que haber una via o una ruta para que los electrones circulen a través de ella. La vía o ruta, junto con todos los objetos que están conectados a esa vía, se llama un **circuito eléctrico**. El circuito está compuesto, por lo general, en tres partes principales: una fuente de energía eléctrica para abastecer a los electrones (tal como una batería), el objeto que utiliza la electricidad (tal como una tostadora o una bombilla eléctrica) y los conductores que conectan todas las cosas (usualmente el cable de metal). El diagrama abajo muestra un circuito simple.



¿Cómo fluye la corriente eléctrica?

Los electrones fluyen o pasan a través del cable de la misma manera que el agua corre dentro de una manguera. Para que el agua fluya, se necesita que exista una diferencia de presión en cada extremo de la manguera. El agua corre desde el extremo de alta presión (la llave o el grifo de agua), hacia el extremo de baja presión (la boquilla de la manguera). Bueno, se necesita lo mismo para que los electrones puedan fluir. Tiene que haber una diferencia en presión eléctrica para que los electrones puedan pasar, y esta diferencia en el potencial eléctrico, es lo que se llama **voltaje**.

¿Cómo suministra electricidad la bateria?

La parte interna de la batería, como se muestra en el último diagrama, tiene susbstancias químicas que hacen que se formen electrones en el polo negativo, es decir, en un extremo de la batería, produciendo la carga negativa. De la misma manera, la pérdida de electrones del polo positivo, es decir, en el otro extremo de la batería, produce la carga positiva. En el polo negativo, donde se forman los electrones, hay un alto potencial eléctrico (presión). Mientras que en el terminal positivo, donde hay una pérdida de electrones, hay un bajo potencial eléctrico (presión). Esta diferencia en la concentración de electrones en los dos polos de la batería es el voltaje.

¿Por qué se descarga la batería?

Las substancias químicas dentro de la batería reaccionan con los electrones que llegan al polo positivo (+) a través del circuito. Esas reacciones químicas crean más electrones en el polo negativo (-). Pero cuando las substancias químicas se acaban, la batería no puede producir más voltaje, y entonces decimos que la batería está descargada.

¿Cómo pasa la corriente eléctrica a través del circuito?

Para que las cargas eléctricas fluyan y produzcan la corriente hay que conectar los dos polos (extremos) de la batería. Aqui es donde los conductores (usualmente los cables de metal) entran a trabajar. Los conductores forman una ruta en forma de lazo, desde el polo negativo de la batería, pasando por el foco de luz y regresando al polo positivo de la batería. Cuando el polo negativo y el polo positivo se conectan, se crea una diferencia en el potencial eléctrico de los extremos del cable y entonces fluye la corriente eléctrica. Esta es una de las diferencias que hay entre el circuito eléctrico y la manguera de agua. En la manguera de agua, el agua fluye derecho en una sola dirección, desde el extremo de alta presión hacia el extremo de baja presión. Mientras que en el ciruito eléctrico, se necesita que la vía tenga la forma completa de un lazo, de manera de establecer las áreas de alta presión y de baja presión y de conectarlas al circuito. Una manera de imaginar cómo trabajan los electrones dentro del cable es imaginar una fila de personas que se pasan un balde de agua para apagar un incendio; bueno, de la misma manera, los átomos del cable son como las personas que forman la línea, y los electrones dentro del cable, son como el balde que pasa de una persona a otra. Los metales son buenos conductores para pasar la corriente negativa, es decir, el balde en el ejemplo que hemos utilizado.

STATIC ELECTRICITY

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To demonstrate that matter, even in common, everyday forms, has an electrical nature, and that static electricity can be produced easily. To demonstrate the basic law of electrostatics—that like charges repel each other and unlike charges attract each other.

Note: Activities involving static electricity will work best on a cool, dry day, most likely in winter. When the air is humid, the extra electrons are attracted easily to water vapor particles in the air so that they do not build up a charge on other objects.

ESTIMATED TIME:

Setting up:	About 5–10 minutes for each
Doing activity:	About 5 minutes or less for each one. Choose several to do, and allow a total time that takes all of them into account
Cleaning up:	About 5–10 minutes

APPROPRIATE AGE GROUPS:

__X__ K–3 __X__ 4–6 __X__ 7–8

DO ACTIVITY IN GROUPS OF: 1–2

MATERIALS NEEDED (per group of 1–2 students):

Many of the same materials are used in several different activities. Also, variations of the activities can be done by mixing and matching materials from the different activities. For example, the charged balloon (A, B, C, D, E, F), comb (D, E, F, G, H, I), and phonograph record (L) all serve the same purpose. Likewise the gelatin (C), Ping-Pong ball (E), tiny pieces of paper (F), bubbles (G), salt and pepper (I), and lightweight pieces of cereal (K) play the same role in their respective activities. You may even think of other materials that can be substituted, based on your own everyday experience with static electricity.

MATERIALS NEEDED: *continued*

A. Stuck-Up Balloon:
balloon; piece of fur or wool (or clean hair on someone's head); a blank space on the wall nearby

B. Dancing Balloon:
2 balloons; 2 pieces of thread or lightweight string (about 2 feet long—exact length is not critical); fur, wool, or hair as in A

C. Gelatin Towers:
about a tablespoon of unflavored gelatin; flat plate; balloon; fur, wool, or hair as in A

D. Dancing Water:
balloon or a hard plastic/rubber comb; fur, wool, or hair as in A; access to a water faucet from which a thin, steady, continuous stream of water will flow

E. Dancing Ping-Pong Ball:
comb or balloon as in D; fur, wool, or hair as in A; Ping-Pong ball; smooth, clear area on a tabletop or on the floor

F. Dancing Paper:
piece of paper about the size of a small fingernail (enough pieces can be obtained by tearing up a small piece of notepaper about 2–3 inches square); or a sheet of notebook-size paper can be cut into 4 squares, 1 for each participant; flat, clear area on a tabletop or on the floor; comb or balloon as in D; fur, wool, or hair as in A

G. Fun with Bubbles:
means of blowing bubbles (commercial bubble solution and blowing rings can be used, or make your own solution by adding 1 cup of dishwashing detergent to 1 gallon of warm water and use straws to blow the bubbles); balloon or comb as in D; fur, wool, or hair as in A

H. Far-Out Hair:
comb or brush; hair (clean and dry)

I. Salt and Pepper:
salt and pepper, about ½ to 1 teaspoon of each; plate (optional); comb; fur, wool, or hair as in A

J. Flying Newspaper:
strip of newspaper about 1 inch (3 cm) wide and 30 to 40 inches (75 to 100 cm) long

K. Snap, Crackle, Pop, and Hop!:
clear plastic box about 1–2 inches (3–5 cm) deep (a food storage box will work); sheet of aluminum foil larger than the opening of the box; pieces of dry puffed rice cereal, enough to make a layer 1 piece deep covering about half of the bottom area of the box

MATERIALS NEEDED: *continued*

L. **Charged Record:**
old phonograph record (one that won't be played anymore); wool (or fur, nylon, polyethylene, or kitchen plastic wrap); dry pieces of puffed rice cereal

M. **Invisible Leg:**
an old nylon stocking either single-leg or double-leg (pantyhose) style; wool

N. **Glowing Tube:**
fluorescent light tube (even a burned-out tube should work); piece of kitchen plastic wrap (wool or fur may also work in this activity)

SAFETY CONSIDERATIONS:

These will vary depending on which activities are done. Most of the activities are harmless. The amount of static electricity generated in these activities is not nearly enough to give anyone a harmful shock. In general:

- Be careful of accidentally popping balloons (A, B, C, D, E, F).
- Be careful of handling any glassware that may be used (plates in C or I or the fluorescent tube in N).
- If the fluorescent tube is broken, an adult should handle the pieces.

ENRICHMENT FOR BILINGUAL STUDENTS:

- Students should predict the results of each of these experiments if they lived in New Mexico, Puerto Rico, or Colombia, where the humidity is high or low.
- Students should repeat the experiments on days with high and low humidity and record and discuss their results with their partners.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Participants with hearing impairments should be able to do these activities without major modifications other than communication.
- Participants with visual impairments may be able to *feel* the effects produced in the activities with their hands, especially in A, B, E, H, J, L, and M. In some of the other activities, touching the objects may cause them to discharge and lose the effect.

NOTES

BEFORE YOU BEGIN:

- ✧ Gather the necessary materials for the activities you have chosen to do.
- ✧ Arrange a place to do the activities where the children will have enough room.
- ✧ For D and G, have towels on hand to clean up wet hands and possible spills.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- ✧ Have you ever been shocked after walking on a carpet or putting on a sweater? Combing your hair? Getting out of a car with cloth seats?
- ✧ What other experiences have you had with static electricity?
- ✧ What kinds of similarities are there between the static electricity in these activities and other experiences you have had?

CLEAN UP:

Most of these materials can be either stored as is after the activity, or discarded (such as the gelatin, salt and pepper, paper, or cereal).

WHERE CAN I GO FROM HERE?

- ✧ The book *Safe and Simple Electrical Experiments* by Rudolph Graf (listed in the Book List) contains an entire chapter with 38 activities on static electricity. Some of them are similar to the ones here, but there are many others that you might like to try.
- ✧ After this activity, go on to some activities involving *current* electricity, such as two in this manual: *Simple Electric Circuits* and *Conductors and Insulators*.

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section.

All of the activities work best on a dry day, most likely winter. When the air is humid, the extra electrons are attracted easily to water vapor particles in the air so that they do not build up a charge on other objects.

In **A**, the ballon should stick to the wall after being *charged* by rubbing. When you rub the balloon with wool, negatively charged particles called electrons from the wool are transferred to the balloon, giving the balloon an overall negative charge. When the charged balloon is brought near the wall, it repels some of the negatively charged electrons in that region of the wall (remember: negative charges repel other negative charges, and positive charges repel other positive charges). Therefore, that region of the wall is left with a positive charge. Then, the negatively charged balloon and the positively charged section of the wall are attracted to each other, and the balloon sticks. The charged balloon will stick to a wide variety of objects (even a person) because of the charge it receives from being rubbed.

In **B**, each of the balloons acquires a negative charge as in A. Because the two balloons have the same charge, they repel each other.

WHY IT HAPPENS: *continued*

In **C** and **F**, the particles of gelatin (C) or pieces of paper (F) are attracted to the balloon or comb in the same way that the balloon is attracted to the wall in A. Some of the particles may jump off the balloon or comb after coming in contact with it. This is because some of the electrons may be transferred to the particles of gelatin or paper after they come in contact with the charged balloon or comb. Then, since the gelatin (or paper) particles and the balloon (or comb) both have negative charges, the particles jump off of the balloon or comb.

In **D**, the charged balloon or comb attracts the water molecules falling in the stream of water, just as it attracted the positively charged section of the wall in A. However, there is a slight difference. The water molecules are made up of the familiar H_2O. In each molecule of water, there is one atom of oxygen (O) that has two atoms of hydrogen (H) bonded to it. The overall structure looks sort of like a teddy bear's head—the oxygen atom makes the head and the two hydrogen atoms are in the place of the two ears. This structure is naturally electrical because the oxygen end of the molecule has a slightly negative charge, and the two hydrogens have slightly positive charges. When the negatively charged comb or balloon is held near the thin stream of water, it naturally attracts the positively charged (hydrogen) ends of the water molecules and naturally repels the negatively charged ends. Because of this, the stream of water can bend in response to the charged comb or balloon.

In **E** and **G**, again we have a separation of charges in the Ping-Pong ball (E) or bubbles (G) caused by the charged comb nearby. The charged comb repels electrons in the side of the bubble or ball near it. The comb then attracts the remaining positively charged side. Because one side of the Ping-Pong ball or bubble becomes attracted to the comb, the comb can be used to pull the ball around the tabletop or to move the bubble. If the comb touches the ball, then the extra electrons from the comb will jump over to the ball until there is an even charge on both the comb and the ball. In that case, there will be no more force of attraction between the comb and the ball. The same thing can happen with the bubbles, but of course, they can also break! The comb will have to be charged again with the wool in order to repeat the activity.

NOTES

Many of us have probably experienced the situation in activity H, especially in winter. When you run a comb through your hair, electrons are transferred from the hair to the comb, leaving the comb negatively charged and the strands of hair positively charged. Since they are opposites, they attract. And, since each of the hair strands has the same kind of positive charge, the hairs repel each other, which is what gives you *fly-away hair*. This will occur more readily when the hair is clean and dry.

In activity **I**, again we have the situation where a charged comb causes the evenly distributed charges in the salt grains to separate, leaving a charged side that is attracted to the comb. As in C and F, some of the salt grains may jump off of the comb after they receive some of the negative charge from the comb. When the charged comb is brought near the mixture of salt and pepper, the pepper grains are probably more easily attracted to the comb because they are lighter. They can be attracted to the comb from a greater distance than the salt.

In activity **J**, by rubbing both strips of newspaper, they both receive the same kind of electric charge. Therefore, they repel each other. It may be necessary to stroke the paper strips more than once (in the same direction each time) in order to build enough charge to cause them to fly apart.

By rubbing the plastic box in activity **K**, the box is given a negative charge. The lightweight pieces of cereal are attracted to the charged cover of the box, so they jump up to the top. When they touch the box, they receive some of the negative charge, and so are repelled back down. Then, when they land on the aluminum foil, the metal foil conducts the charge away from each piece of cereal, leaving the cereal uncharged again. In that condition, each piece of cereal is free to be attracted again to the charged top of the box. And so, there is a cycle that can be repeated as long as you keep rubbing and charging the box! According to Rudolf Graf in his book, *Safe and Simple Electrical Experiments* (p. 30), the process of electrostatic attraction such as this is used in many applications in industry. In one example, paint particles are given high electrostatic charges as they are sprayed from a spray gun. This causes the paint to be attracted to the object being painted and to cover the front, back, sides, top, and bottom of the object very thoroughly. This process is called *electrostatic coating* and is also used in the making of sandpaper, imitation velvet, imitation suede, and other applications. Static electricity is also a very important factor in the way that photocopier machines and laser printers work.

In activity **L**, the record is charged by the wool in the same way that the comb and balloon are charged in activities A through G. The lightweight pieces of cereal are attracted to, and then may jump off of, the record in the same way as the gelatin, pieces of paper, or salt and pepper in activities C, F, and I.

WHY IT HAPPENS: *continued*

By rubbing the nylon stocking with the wool in activity **M**, the entire surface of the stocking receives the same charge. Since like charges repel each other, all sides of the stocking spread as far away from each other as possible, making the stocking appear to *inflate* with an invisible leg.

In activity **N**, the tube should glow, but the light may not be very bright; we suggest doing the activity in a darkened room. The inside of the glass in a fluorescent tube is coated with a white substance called *phosphor*. Rubbing the glass tube gives the glass a positive charge, which attracts electrons from inside the tube to the surface. When electrons hit the phosphor, they cause the phosphor to give off light.

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STATIC ELECTRICITY

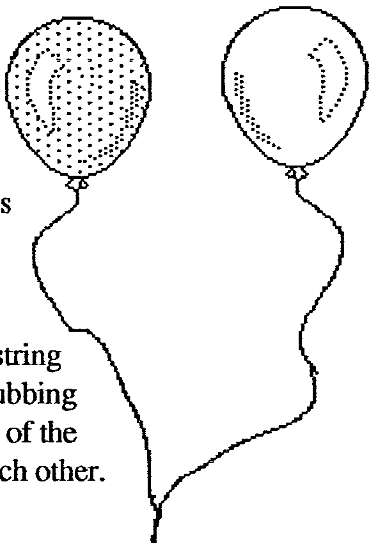
ACTIVITY SHEET

Have you ever walked across a rug and then been *shocked* when you reached to touch a doorknob? If so, then you have experienced static electricity. There are many easy and fun demonstrations of static electricity that can be done with simple materials. However, most of these activities work best only on days when the humidity is very low, such as in winter on a cold day inside a warm room. Here are some things to try. See if you can think of others after you do some of these.

In activities that call for rubbing with wool, you can use a sweater, sock, scarf, rug, or anything else you have that is made out of wool.

In the activities that call for a balloon, you can usually substitute a comb with the same results. And vice versa, when an activity calls for a comb, a balloon usually may be substituted.

A. **Stuck-Up Balloon:**
Blow up a balloon and tie the end so that the balloon stays inflated. Without doing anything else, hold the balloon up to the wall and see if it will stick. What happens? Briskly rub the balloon across a piece of fur or wool or on your hair (works best if your hair is clean and dry). For wool, you can use a sweater, sock, scarf, or a rug. Does it stay? Can you explain what happened?



B. **Dancing Balloon:**
Blow up two balloons and tie each one closed. Tie a long thread or string onto the end of each balloon. Give each balloon a static charge by rubbing it with fur, wool, or your hair as in A. Hold the balloons by the ends of the thread, let them hang down, and try to bring the balloons close to each other. What happens?

C. **Gelatin Towers:**
Spread some unflavored gelatin powder evenly onto a flat plate. Blow up a balloon, tie it, and charge it as you did in activities A and B. Touch the charged area of the balloon to the dish of gelatin. Then gently raise the balloon straight up. What happens?

D. **Dancing Water:**
Rub an inflated balloon or a comb (hard rubber or plastic) with fur, wool, or your hair to charge the balloon as you did in A, B, and C. Turn on a faucet so that a thin, steady stream of water comes out. Bring the balloon or comb near the stream of water. What do you see happening? Can you explain why?

E. Dancing Ping-Pong Ball:

Charge a comb or a balloon as in A, B, C, and D above. Place a Ping-Pong ball on a level surface such as a table top or smooth, bare floor. Bring the charged comb or balloon near the ball. What happens?

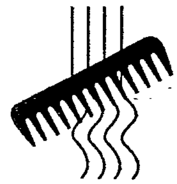
F. Dancing Paper:

Tear a sheet of paper into small pieces about the size of the fingernail on your pinky. Place the pieces of paper on a table. Charge a comb or a balloon as in A or D. Bring the charged comb or balloon near the pieces of paper. What happens?

G. Fun with Bubbles:

Blow a bubble, and then catch it on your bubble blower. Move a charged balloon or comb around near the bubble. What happens? Or, blow the bubble into the air, and then bring the charged balloon or comb near the bubble. What happens? Can you get the bubble to follow your comb or balloon around in the air?

H. Far-Out Hair:

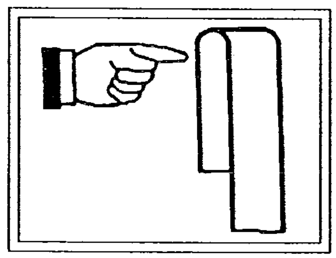


Run a comb or brush through your hair on a cold, dry winter day. What happens to your hair when your hold the comb or brush near it? Can you explain why?

I. Salt and Pepper:

Sprinkle some salt onto a plate or a table top. Bring a charged comb near the salt. What happens? Then, sprinkle some pepper onto the table so that you have a mixture of salt and pepper. How do you think you might be able to separate the salt from the pepper? Bring your charged comb near the pile of salt and pepper particles. What happens? Which pieces were picked up more easily? Is this a good way to separate salt and pepper if they get accidentally mixed?

J. Flying Newspaper:



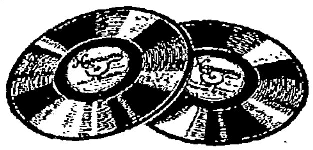
Starting at the fold, tear across the bottom edge of a full sheet of newspaper so that you'll have a strip about 1 inch (2.5 cm) wide and 30–40 inches (75–100 cm) long (or whatever is the width of the newspaper). Hang the newspaper strip over one finger at the fold, with the two ends dangling freely. Quickly pull the newspaper strip up between two fingers of the other hand. Watch the dangling strips of newspaper. What do they do?

K. Snap, Crackle, Pop, and Hop!:

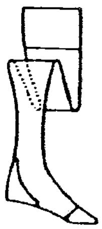
Place a thin layer of dry puffed rice breakfast cereal on a sheet of aluminum foil. Then put a clear plastic box (about 1–2 inches, 3–5 cm, deep) upside-down over the cereal. Vigorously rub the upper outside surface of the box (the bottom of the box since it's upside-down) with a piece of wool or nylon. What happens to the cereal underneath the box?

L. Charged Record:

If you have an old phonograph record, try this activity. Don't use someone else's record for this activity without their permission! Rub the record with a piece of wool. Then hold the edge of the record above some dry pieces of puffed rice cereal. What happens? A record also may become statically charged when you take it in and out of its paper cover with normal use. When this happens the record is more likely to attract dust and dirt particles, which are heard as popping sounds when you play the record.



M. Invisible Leg:



Get a ladies' nylon stocking (not the kind with elastic in it). Hold the toe of the stocking in one hand. Place a piece of wool (a scarf, sweater, or sock will work) in your other hand and wrap it around the stocking near the hand that is holding the stocking. Pull the stocking quickly through the wool several times, all in the same direction. Then put the wool down and hold the opening of the stocking in the hand that was holding the wool. What happens to the stocking?

N. Glowing Tube:

Ask an adult to help you remove a small fluorescent light tube from its socket or fixture. In a dark room, rub the tube carefully, but quickly, with a piece of kitchen plastic wrap. What happens?

LA ELECTRICIDAD ESTATICA

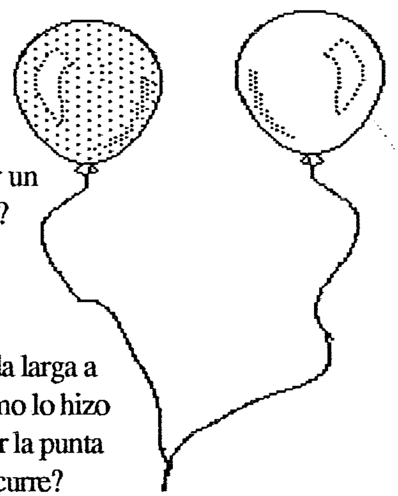
HOJA DE ACTIVIDADES

¿Sintió alguna vez un choque eléctrico cuando caminaba sobre la alfombra y tocó la perilla de la puerta? Si lo sintió, entonces ha experimentado el efecto de la electricidad estática. Hay muchas maneras fáciles y entretenidas de mostrar la electricidad estática utilizando materiales sencillos. Sin embargo, la mayor parte de esas actividades dan mejores resultados cuando la humedad es muy baja, el día es frío y estamos en un cuarto caliente, como sucede en invierno. Vamos a ver algunas de las cosas que podemos hacer. Luego, cuando termine, vea si puede hacer otras cosas.

En las actividades en que se debe usar un pedazo de lana para frotar, puede utilizarse también un sweater, una media, una bufanda, una alfombra, o cualquier otra cosa que esté hecha de lana.

En las actividades en las que se usa un globo, se pueden obtener los mismos resultados utilizando un peine. De igual manera, cuando se necesite un peine se puede substituir por un globo.

A. **El Globo Atrapado:**
Infle un globo y cierre la boca del globo para que quede inflado. Ponga el globo contra la pared, ¿Se pega a la pared? ¿Qué pasó? Frote el globo con un pedazo de lana o con su mismo pelo (trabaja mejor cuando el pelo está limpio y seco). Puede substituir la lana por un sweater, una media, una bufanda o una alfrombra. ¿Se pega el globo? Explique lo que pasó.



B. **El Globo Qué Baila:**
Infle dos globos y cierre la boca de cada uno. Amarre un hilo o una cuerda larga a cada globo. Frote los globos con un pedazo, de lana o con su pelo, tal como lo hizo en el experimento A para producir la carga estática. Agarre los globos por la punta del hilo o de la cuerda y trate de acercar los globos el uno al otro. ¿Qué ocurre?

C. **Las Torres de Gelatina:**
Ponga un poco de gelatina en polvo sin sabor sobre la superficie de un plato. Infle un globo y cierre la boca del globo. Haga que el globo se cargue de la misma manera que lo hizo en los experimentos A y B. Haga que la parte cargada del globo toque el plato con la gelatina. Suavemente, eleve el globo en forma recta. ¿Qué ocurre?

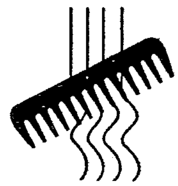
D. **Es Agua Que se Mueve:**
Frote un globo inflado o un peine (de goma dura o de plástico) contra un pedazo de piel, de lana o contra su pelo para cargar el globo; igual que lo hizo en los experimentos A, B y C. Abra el grifo de agua de manera que salga un chorro de agua delgado. Ponga el globo o el peine cerca del chorro de agua. ¿Qué pasa? ¿Puede explicar la razón?

E. **La Bola de Ping-Pong Que Baila:**
Cargue de electricidad un peine o un globo de la misma forma que lo hizo en los experimentos A, B, C y D. Coloque una bola de Ping-Pong sobre una superficie plana, como la mesa o el suelo liso. Ponga el peine o el globo cargado cerca de la bola de Ping-Pong. ¿Qué ocurre?

F. **El Papel Que Baila:**
Rompa una hoja de papel en pedazos pequeños del tamaño de la uña de su dedo pequeño. Coloque los pedazos de papel sobre la mesa. Cargue un peine o un globo, como lo hizo en el experimento E. Coloque el peine o el globo cargado cerca de los pedazos de papel. ¿Qué pasa?

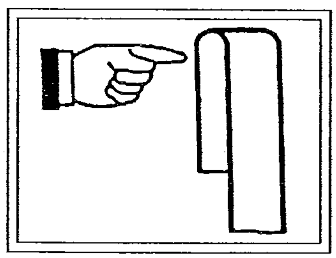
G. **Diviertase Con Las Burbujas:**
Sople una burbuja y atrápela con el soplador de burbujas. Coloque un globo o un peine cargado cerca de la burbuja. ¿Qué ocurre? Sople la burbuja en el aire y luego coloque el globo o el peine cargado cerca de la burbuja. ¿Qué pasa? ¿Puede hacer que la burbuba siga al peine o al globo en el aire?

H. **El Pelo Que Se Para:**
En un día frío y seco de invierno pásese un peine o un cepillo por el pelo. ¿Qué le pasa al pelo cuando sostiene el peine o el cepillo cerca de él? Explique por qué.



I. **Sal y Pimienta:**
Ponga un poco de sal sobre un plato o sobre la superficie de la mesa. Coloque el peine cargado cerca de la sal. ¿Qué ocurre? Ponga un poco de pimienta sobre la mesa y mezcle la sal con la pimienta. ¿Cómo puede separar la sal de la pimienta? Coloque el peine cargado cerca de las partículas de sal y pimienta. ¿Qué pasa? ¿Qué partículas se mueven con más facilidad? ¿Cree que es una buena manera de separar la sal de la pimienta cuando se han mezclado por accidente?

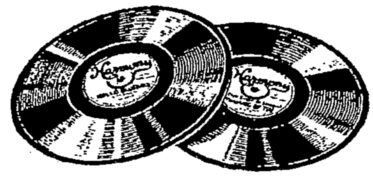
J. **El Periódico Que Vuela:**
Comenzando en el pliegue de una hoja de periódico corte de la parte de abajo una tira de 1 pulgada (2.5 cm) de ancho por 30–40 pulgadas (75–100 cm) de largo (o cualquiera que sea el ancho de la hoja de periódico). Agarre la tira del periódico por el pliegue y colóquela sobre su dedo, de manera que las dos puntas del periódico cuelguen libremente. Jale rápidamente la tira de periódico, haciéndola pasar por entre dos dedos de su otra mano. Observe las puntas colgantes del periódico. ¿Qué hacen?



K. **Brinca, Salta y Cruje:**
Ponga una capa de cereal de arroz inflado, del que come en el desayuno, sobre una hoja de papel de aluminio. Coloque una caja de plástico transparente (de 1 a 2 pulgadas de alto) de manera que la boca de la caja cubra el cereal. Frote vigorosamente la parte de arriba de la caja (que es en realidad la parte de abajo de la caja, pues la caja está invertida) con un pedazo de lana o de nylon. ¿Qué le pasa al cereal que se encuentra debajo de la caja?

L. Un Disco Cargado:

Si tiene un disco viejo, puede utilizarlo para hacer este experimento. (No utilice un disco que pertenezca a otra persona, menos que tenga permiso para hacerlo). Frote el disco con un pedazo de lana y coloque el filo del disco sobre un poco de cereal de arroz inflado. ¿Qué pasa? El disco también puede cargarse de electricidad estática durante su uso normal cuando lo saca y lo mete en su cubierta de papel. Cuando esto ocurre, el disco atrae más partículas de polvo y de suciedad, que se oyen como chasquidos cuando coloca el disco en el toca-discos.

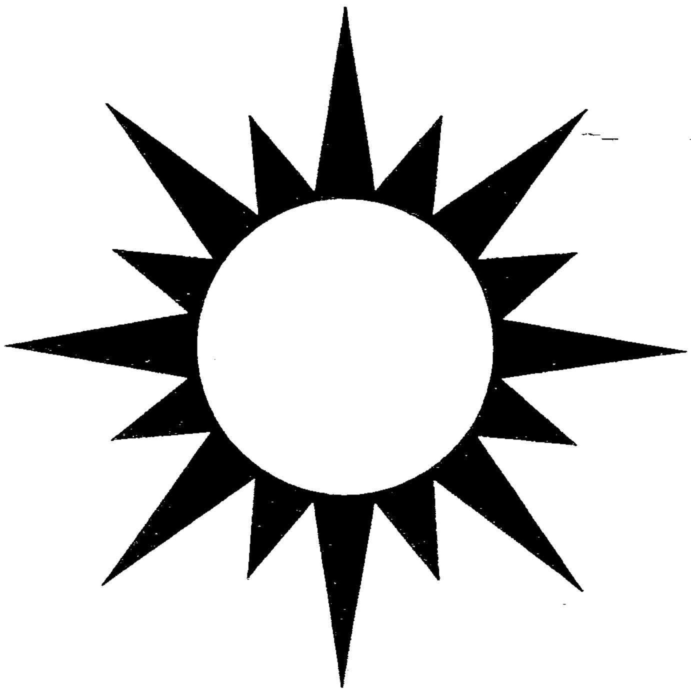


M. La Pierna Invisible:

Consiga una media de nylon de dama (sin elástico). Sostenga la media por el pie; con la otra mano, agarre un pedazo de lana (una bufanda, un sweater o una media) y colóquelo alrededor de la media, cerca de la mano que la sostiene. Rápidamente, pase la media por el pedazo de lana varias veces en una misma dirección. Ponga el pedazo de lana a un lado. Sostenga la boca de la media con la misma mano que sostenía el pedazo de lana. ¿Qué le pasa a la media?

N. El Tubo Que Resplandece:

Pídale a una persona adulta que le ayude a quitar un tubo pequeño de luz fluorescente del porta-tubo. En un cuarto oscuro, frote el tubo de luz fluorescente, rápidamente y con cuidado, contra un pedazo de papel plástico del tipo que se usa para envolver. ¿Qué ocurre?



SIMPLE ELECTRIC CIRCUITS

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To demonstrate that a battery is a source of energy (electricity) that can make a light bulb turn on, and that the electricity has to follow a particular type of path (a complete circuit) in order for the bulb to light. Also, to demonstrate that there is more than one way to make a complete circuit.

ESTIMATED TIME:

Setting up:	Variable amounts of time to gather materials, cut foil or wires
Doing activity:	About 45 minutes with younger students. Less time for older children
Cleaning up:	About 10 minutes

APPROPRIATE AGE GROUPS:

_X_ K–3 _X_ 4–6 _X_ 7–8

DO ACTIVITY IN GROUPS OF: 1 (individually)

MATERIALS NEEDED:

Per group

- ✧ Large drawing of a bulb and battery (use drawing on page 37 as a guide)
- ✧ A few extra batteries and bulbs of the types described below

Per Person

- ✧ 1 size D battery (alkaline or regular)
- ✧ 1 flashlight bulb (about 3-volt rating). An alternative is to use a #47 or #48 light bulb. These are 6-volt bulbs that last longer but won't get very bright with one size D battery. (Suggestion: take a D battery with you to test the light bulbs at the store.)
- ✧ 2 strips of aluminum foil, about 1 inch (3 cm) wide by 5-6 inches (13–15 cm) long; (For older children, you may want to substitute 2 pieces of insulated copper wire, about 5–6 inches, 13–15 cm, long.)
- ✧ a rubber band and/or masking tape

MATERIALS NEEDED: *continued*

For step 4 investigation

- 2 6-inch (15-cm) insulated wires per person
- 2 batteries per person
- 2 bulbs per person
- 1 3-volt buzzer or "singing chip"
- 1 1.5-volt electric motor with fan blade

SAFETY CONSIDERATIONS:

- First, remember that the voltage of 1 (or 2 or 3) size D batteries will not hurt you! There is not enough electricity in the battery to be dangerous. However, emphasize (especially to younger children) that the electric wall outlets found at home can be dangerous and should not be used for experimentation.
- If using copper wires, warn children to be careful so that their sharp ends don't poke someone in the eye (or anywhere else).
- If children create a short circuit (by connecting the positive terminal of the battery directly to the negative terminal without the bulb in the path), then the foil or wire may get warm. Chances are good that the students won't leave them connected long enough for the wire to get too hot, but be aware of this.

ENRICHMENT FOR BILINGUAL STUDENTS:

- Students can bring in other items that are operated by batteries and explore the circuits of items working in pairs.
- Each student should draw the circuits as in the *Simple Electric Circuits Activity Sheet.*
- Students from other countries and/or with relatives in other countries should explore the type of current (direct or alternating) used in their country.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

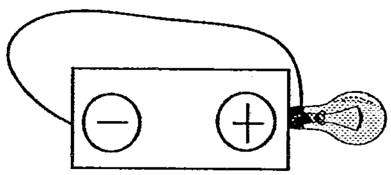
- Participants with visual or hearing impairments can manipulate the materials in the activity just as well as non-disabled students. Team participants with visual impairments with non-disabled participants to report when the light bulb is lit.
- For children with visual disabilities, use a device that makes a sound instead of a light bulb. Some hobby shops or electronics shops, such as Radio Shack™, may carry small beepers or buzzers that can run from voltage of 1 (1.5 volts) or 2 (3 volts) batteries. A good source of low-cost buzzers is American Science and Surplus, 601 Linden Place, Evanston, IL 60202; Phone (708) 475-8440. Call or write for a catalog.

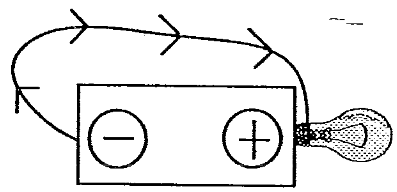
BEFORE YOU BEGIN:

- Make a simple circuit yourself with a fresh battery and a fresh bulb, in order to see how brightly the bulb will light. Later, you can use this as a comparison to see if the batteries have gotten low and need to be replaced. Or use one of the new battery testers distributed by Duracell™.
- Cut pieces of aluminum foil or copper wire to the appropriate sizes.
- Arrange for a place to work where participants can sit with their materials at tables.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

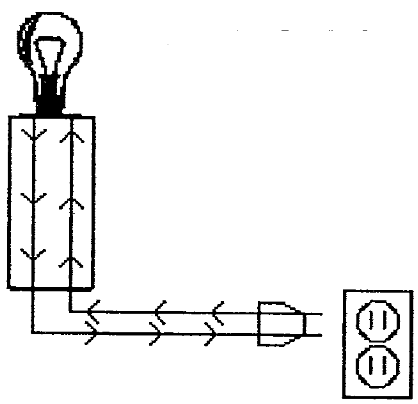
- Does it matter whether the bulb touches the positive or negative end of the battery?
- What happens to the aluminum foil when you create a *short circuit*?
- If the electricity is running through the foil, why don't you get a shock when holding the foil?
- What happens to the brightness of the lit bulb if you use two batteries? Three batteries? What would happen if you kept stacking up more and more batteries? Try it on one bulb!
- Why do you think there are two wires in an extension cord or electrical appliance cord? Why are there two prongs on the electrical plug at the end of the cord?
- Can you draw arrows on the diagram to show how the electrons flow in a simple circuit?





ANSWER

- Can you draw a diagram to show how electricity flows through a lamp in your home?



- How do you think the switch works on your lamp? Open one up and see! Be sure the lamp is unplugged first.

NOTES

CLEAN UP:

- Check the batteries to see if any need to be replaced. They will eventually wear out, but probably not in just one session of doing this activity.
- Replace any broken or burned-out bulbs.

WHERE CAN I GO FROM HERE?

See the *Conductors and Insulators* activity. For more advanced activities with electricity, check the book *Safe and Simple Electrical Experiments.* This book has an entire chapter of 31 activities on current electricity and electromagnetism.

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section.

Inside the battery, there are chemical reactions going on that cause negatively charged particles to accumulate on the bottom (-) end of the battery and positively charged particles to be more abundant on the top (+) end. This sets up a difference in electrical potential *(pressure)* between the two ends, since the negative charges are attracted toward the positive terminal of the battery. But because of the construction of the battery, the negative charges cannot just flow toward the positive charges on the inside or outside of the battery. There needs to be some kind of connection made on the outside of the battery that links the two ends so that the negative charges can flow and produce a current. When the positive and negative ends are connected by a complete, uninterrupted path, the difference in electrical potential *(pressure)* between the two ends causes the current to flow through the path. This path is called a **circuit**. When the circuit is complete and is allowing current to flow through it, it is described as a **closed circuit.** If the path is interrupted in any way, such as by the wire becoming disconnected, then the current will not flow. That is called an **open circuit.**

When the light bulb is connected as part of the circuit, it has to be connected so that the current still has a complete, uninterrupted pathway between the two terminals of the battery. When this happens, the current will still flow, and the light bulb will light (if it's not burned out). In order for the light bulb to be connected to form a closed circuit, the metal parts of the bulb have to be part of the circuit. The electrons will not flow through the glass or plastic in the bulb.

The light bulb works because it contains a tiny filament of wire that has a very high *resistance* to electricity flowing through it. This resistance in the filament is similar to friction that occurs when you rub your hands together briskly. When you do this, the friction produces heat. Since the atoms in the filament resist, or oppose, the flow of electrons through them, some of the electrical energy gets converted into heat, and the filament gets so hot that it begins to glow. Other devices that purposefully *waste* electrical energy like this to produce heat and/or light include toasters, irons, and space heaters, or the heating elements (burners) on an electric stove. If the ends of the battery are connected by a conducting path without any device in the circuit to use the

WHY IT HAPPENS: *continued*

current (such as the bulb in this activity), then a larger amount of current will flow. This situation is called a **short circuit**. In the case of this activity, that means that the battery will die out more quickly, and the wire or foil may get warm. Most (larger) circuits are designed so that a certain amount of resistance is supposed to be part of the circuit. When this resistance is present, the right amount of current will flow in the circuit, and not too much heat will be produced. If the resistance in the circuit is too low, then too much current may flow through the circuit. When too much current flows, then too much heat can be produced. This is why a short circuit in a home electrical system can be very dangerous. If the wires get too hot, they could cause a fire. Again, this is not a danger with this activity because the source of the electricity we are using (batteries) does not have enough voltage to produce a dangerously high current. The current that flows from the battery in these experiments is called **direct current** because it only flows in one direction. The current from the electrical outlets in your home is called **alternating current** because it flows first in one direction, then stops and reverses direction. It repeats this back forth and motion constantly and very quickly—100 times per second! The change is so fast you can't see the fraction of a second when the electricity isn't flowing. Not all countries use alternating current; some use direct current to supply homes and businesses.

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Abruscato, J., and J. Hassard. 1977. *The whole cosmos catalog of science activities*. Glenview, IL: Scott, Foresman.

Brown, R. J. 1984. *333 science tricks and experiments*. Blue Ridge Summit, PA: TAB Books.

Goldman, J. F. 1988. *The curiosity shop: A science sampler for the primary years*. Minneapolis, MN: T. S. Denison.

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Thomas Alva Edison Foundation. 1988. *The Thomas Edison book of easy and incredible experiments*. New York: Wiley.

NOTES

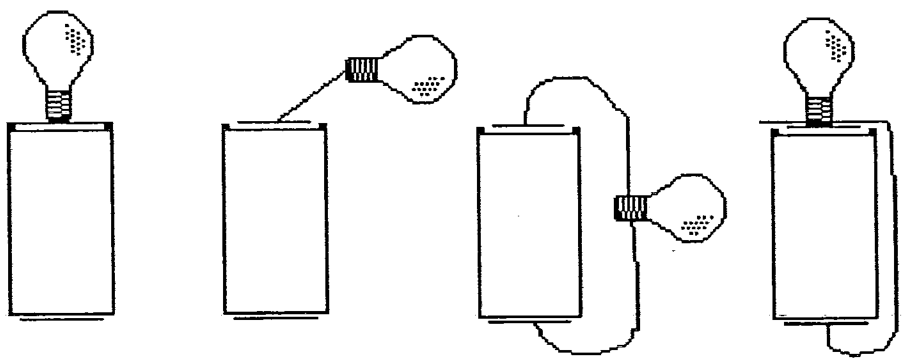
SIMPLE ELECTRIC CIRCUITS

ACTIVITY SHEET

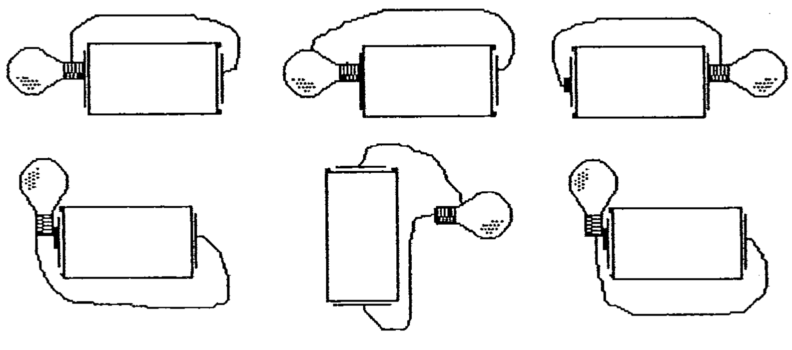
1. Look at your battery. What differences are there between the two ends? If you've used batteries before, in flashlights for example, then you may be familiar with this difference. Look at the labeling on the battery to determine which end is positive (+) and which end is negative (-).

2. Look at your light bulb. What kinds of materials are put together to make the light bulb? How do you suppose the materials and the way they are put together are related to making the bulb work?

3. Take your battery, light bulb, and one strip of aluminum foil (or copper wire if that is what you are given) and try to connect them so that the bulb will light. Try as many different ways of connecting them as you can. When the bulb lights, the path that you have made with your connections is called a **circuit**. Some possible circuits to try are shown below and on the next page. Before you try them, predict whether each one will cause the bulb to light. Then see whether or not you are right.



HERE ARE SOME MORE CIRCUITS TO TRY:



Now make up your own circuits to try, and draw them here.

4. After you have made one or more successful circuits with just one piece of foil (or wire), try to make some circuits with two pieces of foil (wire) and/or two batteries and/or two bulbs. Again, make a prediction first and then try it out. Use the space here to draw the circuits that you try.

5. Now try to make:

- ✏ a circuit where the bulb does not directly touch the battery

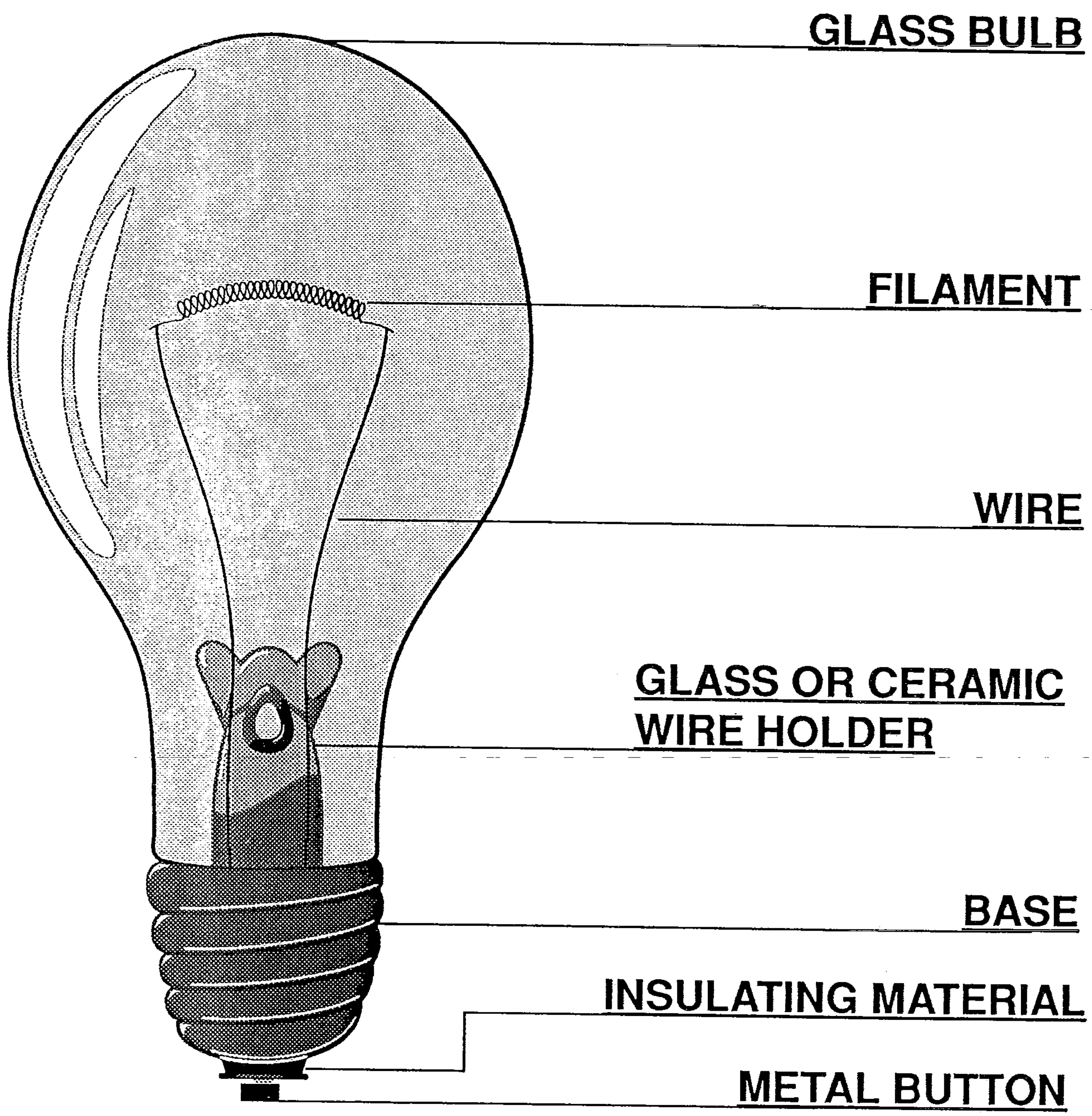
- ✏ a circuit that lights two bulbs

- ✏ a flashlight that uses two batteries

- ✏ a circuit using two batteries and a 3-volt buzzer or three batteries and a "singing chip"

- ✏ a circuit using one battery, a 1.5-volt electric motor, and a fan blade. What happens if you use two batteries instead of one?

ELECTRIC LIGHT BULB



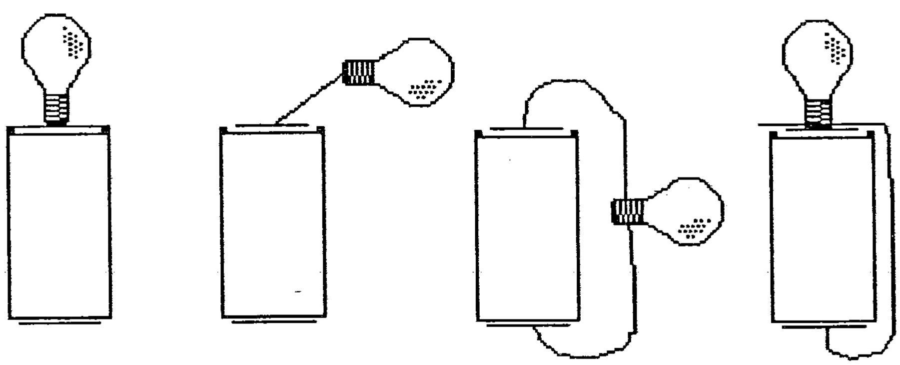
CIRCUITOS ELECTRICOS SENCILLOS

HOJA DE ACTIVIDADES

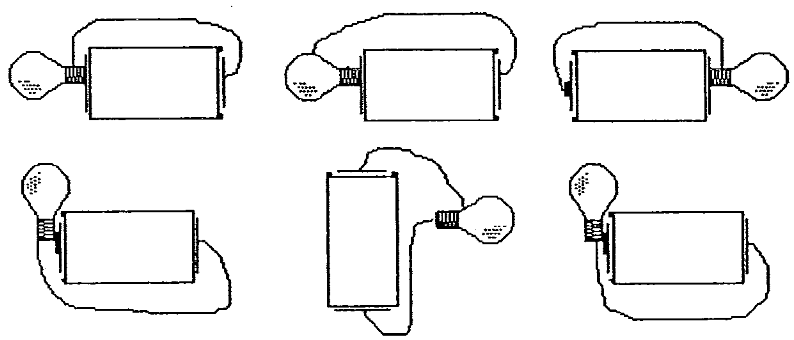
1. Mire su batería. ¿Qué diferencias hay entre los dos extremos? Si ha usado baterías antes, en las linternas por ejemplo, entonces está familiarizado con esta diferencia. Lea las instrucciones que vienen con la batería para identificar el polo positivo (+) y el polo negativo (-).

2. Mire la bombilla de luz. ¿Qué clase de material se necesita para hacer una bombilla de luz? ¿Cual es la relacion entre los materiales y el asamblaje de una bombilla que hacen que esta produzca luz?

3. Usando la batería, la bombilla de luz y el pedazo de papel de aluminio (o el cable de cobre), trate de conectarlos para encender la bombilla de luz. Trate de conectarlos de varias maneras. La vía o la ruta que se conecta para prender la bombilla se llama **circuito**. En esta página se muestran algunos circuitos que puede probar. Sin embargo, antes de probarlos díganos ¿Cuál circuito hará que se encienda la bombilla de luz? Luego, fíjese si escogió el circuito correcto.



CIRCUITOS PARA PROBAR:



Ahora, construya sus propios circuitos, pruébelos y dibújelos en este espacio.

4. Después de haber construído algunos circuitos con un pedazo de papel de aluminio (o de cable), trate de hacer otros circuitos utilizando dos pedazos de papel de aluminio (o cable) y/o dos baterías, y/o dos bombillas de luz. Nuevamente, señale los circuitos que cree que funcionarán y haga la prueba. Dibuje en este espacio los circuitos que va a probar.

5. Ahora trate de construir:

✏ un circuito donde la bombilla no toque directamente la batería

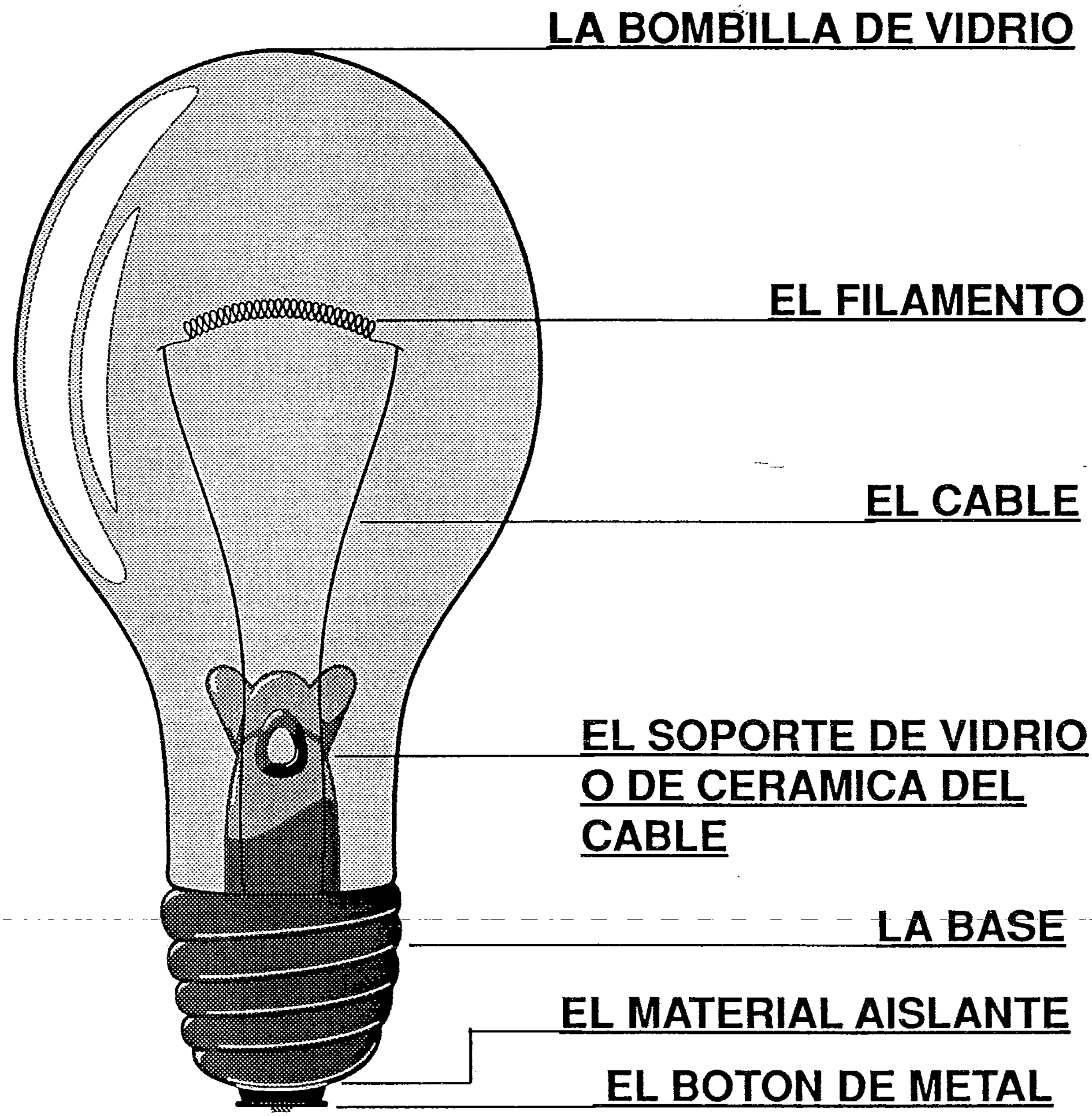
✏ un circuito que encienda dos bombillas de luz

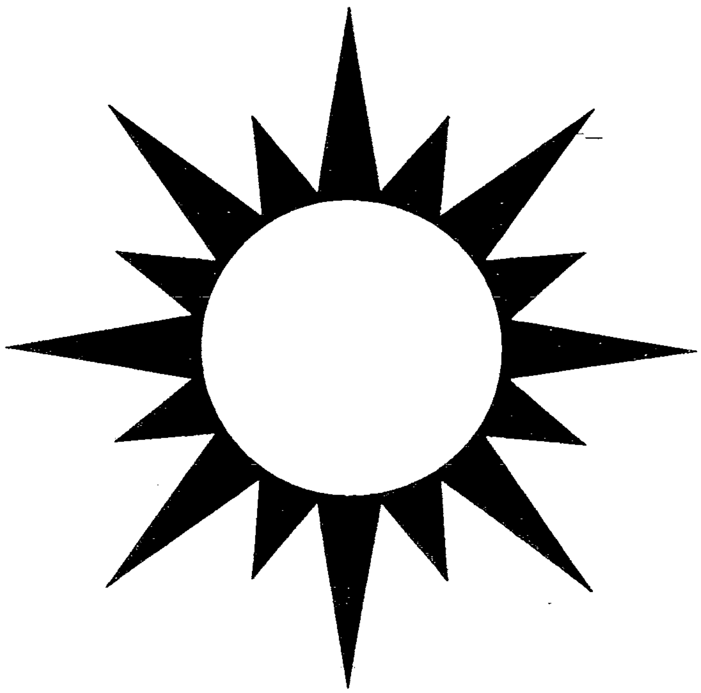
✏ una linterna que use dos baterías

✏ un circuito que requiera dos baterías y un timbre de 3-voltios, o tres baterías y un "chip" musical

✏ un circuito que requiera una batería, un motor eléctrico de 1.5-voltios y un ventilador pequeño. ¿Qué ocurre cuando usa dos baterías en lugar de una?

LA BOMBILLA ELECTRICA





CONDUCTORS AND INSULATORS

SUGGESTIONS FOR TEACHERS

Before doing this activity, do the *Simple Electric Circuits* activity in this manual.

WHAT'S THE POINT?

To demonstrate that electricity will only travel through certain materials, known as *conductors,* and that most conductors are metals, while most *insulators* (nonconductors) are nonmetals.

ESTIMATED TIME:

Setting up:	Time for gathering the materials, plus about 10 minutes for setting up
Doing activities:	About 45 minutes
Cleaning up:	About 10 minutes

APPROPRIATE AGE GROUPS:

__X__ K–3 __X__ 4–6 __X__ 7–8

DO ACTIVITY IN GROUPS OF: 2

MATERIALS NEEDED (per group of 2 students):

- 1 size D battery (alkaline or regular)
- 1 strip of aluminum foil about 1 inch wide by 6 inches long
- 1 flashlight bulb (see *Supplies and Suppliers*)
- clothespin
- piece of masking tape about 6 inches (15 cm) long
- conductor/insulator card

Things to test (These can vary, but here are some suggestions. Have at least 3 things that are metal as conductors, and 3 things that are nonmetal, as insulators.)

- plastic bag for prepackaging the materials (optional)
- piece of copper wire about 6 inches (15 cm) long, insulated or noninsulated
- steel wool
- rubber band
- piece of sponge

MATERIALS NEEDED: *continued*

- piece of wood, such as a toothpick, pencil, or popsicle stick (if using a pencil, encourage students to try all different parts of the pencil, such as the wood, then the eraser, then the metal band holding the eraser to the pencil, then the graphite tip)
- piece of string
- coin
- paper clip
- nail, bolt, or screw
- piece of plastic, such as a plastic fork, plastic clothespin, parts of toys, or soda pop cap
- candle
- strip of clear tape or masking tape
- a marble or other piece of nonsharp glass

SAFETY CONSIDERATIONS:

- First, remember that the voltage of 1 (or 2 or 3) size D batteries *will not hurt you*! There is not enough electricity in the battery to be dangerous. However, emphasize (especially to younger children) that the electric wall outlets found at home can be dangerous and should not be used for experimentation.
- As with the *Simple Electric Circuits* activity, warn students to be careful so that the sharp ends of their wires don't poke someone in the eye (or anywhere else). See the *Simple Electric Circuits* activity for comments about a short circuit. If you use Christmas bulbs, be careful: They can get hot very quickly!

ENRICHMENT FOR BILINGUAL STUDENTS:

- Students should first make a prediction and then test their clothing/jewelry/shoes and list the items that are conductors and insulators.
- Students should explain why each item is a conductor or insulator and why/how some items (some jewelry) can be classified under both.
- Students can explore the differences in materials used in American and non-American products utilizing the conductors and insulators test.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- Children with hearing impairments can do this activity easily with the appropriate modifications in communicating the instructions.
- For students with visual impairments, use a device that makes sound instead of a light bulb. Some hobby shops or electronics shops, such as Radio Shack™, may carry small beepers or buzzers that can run on 1 or 2 batteries (See *Simple Electric Circuits*).

BEFORE YOU BEGIN:

- ✧ If you wish, prepackage the materials into small plastic bags (zipper-locking closures are handy) for each team of students.
- ✧ Cut pieces of aluminum foil or copper wire to the appropriate sizes.
- ✧ Test batteries and bulbs or buzzers to be sure they are still in working order.
- ✧ Duplicate the conductor/insulator card for each team.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- ✧ How did you make your predictions about which things would conduct and which would insulate? Did all of your predictions prove to be correct? Which ones weren't? Do you know why?
- ✧ Did some items have parts that would conduct and parts that wouldn't? (Hint: Try a wooden clothespin that has a metal spring.)
- ✧ Why do you think people who work with electrical wiring often wear rubber gloves or rubber-soled shoes?
- ✧ Is water a conductor or an insulator? Why is it dangerous to be wet or standing in water when you're working with something electrical? Why is it OK to be wet while working with a size D battery? (Hint: Try adding several teaspoons of table salt to a ½ cup of water. If you set up your tester with 3–4 batteries it will probably be able to conduct electricity through this very salty water.)

CLEAN UP:

- ✧ Check for damaged or broken materials, such as torn aluminum foil strips, broken bulbs, etc., and replace as needed.
- ✧ Put all materials back in their plastic bags.
- ✧ Check the batteries to see if any need to be replaced.
- ✧ Check for broken or burned-out bulbs.

WHERE CAN I GO FROM HERE?

For more activities with electricity, check the book *Safe and Simple Electrical Experiments* by Rudolf Graf. This book has an entire chapter of 31 activities on current electricity and electromagnetism, including directions for making another kind of conductivity tester.

NOTES

WHY IT HAPPENS:

First, be sure to read the background information in the introduction to this section.

The ability of a material to carry, or conduct, electricity is related to the structure of atoms, as described in the introduction to this section. All materials contain electrons, and so the labels of *conductor* and *insulator* are not absolutely exclusive. In other words, a material that is a good conductor, can also be called a poor insulator, and a material that is a poor conductor can also be called a good insulator. The materials that are the best conductors are usually metals. This is because the metals have a particular atomic structure that makes them *pass along* their electrons easily. A metal wire can be thought of as an efficient bucket brigade. The atoms that make up the wire are like the people standing in line in the brigade, and the electrons are like the buckets that get passed easily down the line. Insulators don't pass the buckets (electrons) as efficiently. Their atoms tend to hold onto their own buckets (electrons). The list below includes some conductors and insulators arranged in order. The closer a material is to the top of the Conductors list, the better a conductor (or poorer an insulator) it is. And, the closer a material is to the top of the Insulators list, the better an insulator (or poorer a conductor) it is.

<u>Good Conductors</u>

- ✧ silver
- ✧ copper
- ✧ gold
- ✧ aluminum
- ✧ brass
- ✧ iron
- ✧ lead
- ✧ mercury
- ✧ graphite
- ✧ water containing dissolved materials

<u>Good Insulators</u>

- ✧ amber
- ✧ hard rubber
- ✧ nylon
- ✧ porcelain
- ✧ beeswax
- ✧ glass and wood
- ✧ shellac
- ✧ very pure water
- ✧ air

The amount and type of insulation needed around wires depends on the amount of electric current going through the wire. Therefore, wiring that brings the electricity into a building from the street (which carries a lot of current) has much thicker insulation around it than does wire that brings electricity into a lamp or a hair dryer.

REFERENCES:

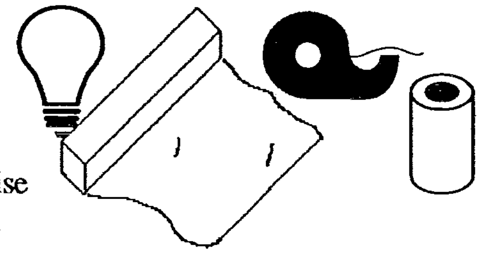
Graf, R. 1964. *Safe and simple electrical experiments.* New York: Dover.

Strongin, H. 1985. *Science on a shoestring.* Menlo Park, CA: Addison-Wesley.

Thomas Alva Edison Foundation. 1988. *The Thomas Edison book of easy and incredible experiments.* New York: Wiley.

CONDUCTORS AND INSULATORS

ACTIVITY SHEET



Build a tester

1. Fold a 6-inch strip of aluminum foil lengthwise until it is no more than ½ inch (1.2 cm) wide.

2. Wrap one end of the foil strip around the base of the bulb. Clip a wooden clothespin around the foil to hold it in place against the bulb.

3. Use some tape to fasten the other end of the aluminum foil securely to one end of the battery.

4. Test the circuit by touching the bottom tip of the bulb against the other end of the battery. The bulb should light. (Make adjustments if needed to make it light.)

Use the tester

1. You should have a bag or pile of materials on your table that you can test to find out whether they conduct electricity (that is, electricity passes through them easily) or insulate (that is, they stop the flow of electricity). Before using your tester, predict which materials will be conductors and which will be insulators. Separate them into two piles on your conductor/insulator card based on your predictions. Now get ready to test your hypotheses!

2. How do you think your tester can be used to find out what things will conduct electricity? Try to test a small extra piece of aluminum foil with your tester to get the bulb to light. Figure out how to put this extra piece of foil into your circuit so that the circuit will work.

3. Once you have figured out how to hold the extra piece of foil to make a complete circuit, try your other materials in place of the extra foil. Try the materials one at a time to see which materials will conduct electricity (make the bulb light) and which materials will not conduct electricity (won't make the bulb light, even when connected properly). Were all of your predictions correct?

4. Based on your tests, divide your materials into two new groups—those that conduct electricity and those that do not. Look at the materials that do conduct electricity. Do those materials have anything in common? What? Now look at the other group, the materials that do not conduct electricity (the insulators). Do those materials have anything in common?

5. Now look at your light bulb again. Can you locate parts of the light bulb that are conductors and parts that are insulators?

Other things to try

1. When you find a conductor, reverse the direction of the battery in your circuit to see if it makes a difference which end of the battery you connect to the wires in the circuit.

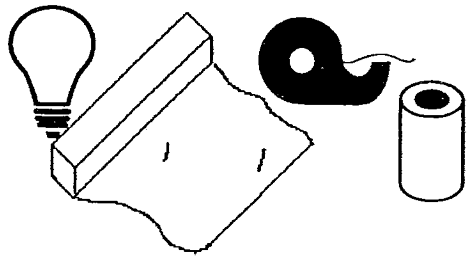
2. If you have more than one battery, see what difference it makes (if any) when you connect more than one battery in the circuit.

CONDUCTOR

INSULATOR

CONDUCTORES Y AISLADORES

HOJA DE ACTIVIDADES



CONSTRUYA UN PROBADOR

1. Doble a lo largo una franja de papel de aluminio de 6 pulgadas de largo por ½ pulgada de ancho.

2. Coloque una punta de la franja de papel de aluminio alrededor de la base de la bombilla, y coloque una pinza de ropa sobre el papel de aluminio para que se sostenga pegado a la bombilla.

3. Use la cinta de pegar para fijar la otra punta del papel de aluminio al extremo de la batería.

4. Pruebe el circuito tocando el botón en la parte de abajo de la bombilla con el otro extremo de la batería. La bombilla debe encenderse (si no enciende haga los ajustes necesarios).

UTILICE EL PROBADOR

1. Ponga sobre la mesa una bolsa con los materiales que va a probar para saber si son conductores de electricidad (es decir, si la electricidad puede pasar con facilidad a través de ellos) o, si son aisladores (es decir, la electricidad no puede pasar a través de ellos). Antes de utilizar el probador, señale los materiales que cree son conductores y los materiales que cree son aisladores. Luego, separe los materiales en conductores y aisladores. Ahora, está listo para probar su hipótesis.

2. ¿Cómo puede utilizar el probador para saber cuáles son los materiales que conducen electricidad? Utilice el probador y haga la prueba con un pequeño pedazo de papel de aluminio para encender la bombilla de luz. Ahora, busque la manera de poner el pedazo de papel de aluminio en el circuito para hacerlo funcionar.

3. Cuando coloque el pedazo de papel de aluminio y complete el circuito, pruebe con otros materiales que no sean el papel de aluminio. Pruebe los materiales, uno por uno, para ver cuáles son los materiales que conducen electricidad (enciende la bombilla de luz), y cuáles son los materiales que no conducen electricidad (la bombilla de luz no prende aunque estén conectados de la manera correcta). ¿Estuvo correcto en su elección de materiales?

4. Tome como base las pruebas que hizo y divida los materiales en dos nuevos grupos, los materiales que conducen electricidad y los que no conducen electricidad. Ahora, vamos a ver cuáles son los materiales que conducen electricidad. ¿Tienen esos materiales algo en común? ¿Qué? Luego, vea el otro grupo de materiales, los materiales que no conducen electricidad (materiales aislantes). ¿Tienen esos materiales algo en común? ¿Qué?

5. Ahora mire la bombilla de luz. Puede nombrar las partes de la bombilla de luz que actúan de conductores y las partes que actúan de aisladores?

Puede probar otras cosas

1. Cuando encuentre el conductor, invierta la dirección de la batería en el circuito, para ver si hace diferencia en qué extremo o polo de la batería se conectan los cables al circuito.

2. Si tiene más de una batería, vea que diferencia hay cuando se conecta más de una batería al circuito.

CONDUCTORES

AISLADORES

CIRCUITS AND MAPS: A SPECIAL CODE

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To help students become familiar with equipment such as insulated wire and bulb holders and to learn how to draw and interpret simple electrical circuits.

ESTIMATED TIME:

Setting up:	Time to cut wires, strip wire ends, and distribute materials
Doing activities:	45–60 minutes
Cleaning up:	10–15 minutes

APPROPRIATE AGE GROUPS:

__X__ K–3   __X__ 4–6   __X__ 7–8

DO ACTIVITY IN GROUPS OF: 2–3

MATERIALS NEEDED (per group of 2–3 students):

- 2 size D (1.5-volt) batteries (either alkaline or heavy duty)
- 2 flashlight bulbs (see *Simple Electrical Circuits* for description)
- 2 bulb holders
- 3 pieces of insulated wire with ends stripped ½ inch on each end
- masking tape and/or rubber bands to hold circuit together
- paper clip

TEACHER MATERIALS:

You may want to use the diagram of a bulb in *Simple Electrical Circuits* to illustrate the flow of electricity through the bulb.

SAFETY CONSIDERATIONS:

Batteries and wires can become warm if students form short circuits. Warn students that the ends of the copper wires are sharp.

ENRICHMENT FOR BILINGUAL STUDENTS:

Contact Hispanic organizations such as the Society of Hispanic Professional Engineers (SHPE) and invite a Hispanic electrical engineer or electrician to visit the class/school. The engineer/electrician can discuss and present materials used in house/apartment/school wiring and explain circuits/symbols used in circuit maps.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

For students with visual impairments, use a buzzer or other sound-generating device rather than a light bulb and holder. The student may wish to use three-dimensional models of circuit symbols to demonstrate his/her understanding of circuit drawings. These could be easily made from cardboard and yarn, tape, or wire.

BEFORE YOU BEGIN:

- Students should do the *Simple Electrical Circuits* activity before this activity. Even if they have done it before, it will refresh their memory about building electrical circuits and some of the activities refer back to circuits they build in the *Simple Electrical Circuits* activities.
- Before the class, test the batteries and bulbs to make sure they are still working. To test both batteries and bulbs, build a simple circuit. Batteries can also be tested with one of the free testers that come with Duracell™ batteries. Cut pieces of wire (approximately 10 inches or 25 cm long) and strip ½ inch (1.2 cm) of insulation from each end, using a wire stripper.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- Does it matter which wire is attached to the positive end of the battery? If you reverse the wires, does it make any difference?
- Why is there insulation on the wires? What is the insulation made of?
- Why do you think they developed a code to draw electrical circuits? Can you think of a time when you might need to recognize the parts of a circuit map?

CLEAN UP:

- Check the batteries and bulbs to see if any need to be replaced.
- Store batteries and wire separately so that accidental short circuits cannot occur in the storage bin; they can get very warm and could melt nearby plastic.

WHERE CAN I GO FROM HERE?

See the other activities in the *Electricity: It's Easy* section. Also check out the Book List at the end of the manual.

WHY IT HAPPENS:

See the information provided at the beginning of the chapter and the "Why It Happens" section of *Simple Electrical Circuits.*

NOTES

REFERENCES:

Kent, A., and A. Ward. 1983. *Introduction to physics*. London: Usborne.

Marson, R. 1983. *TOPS learning systems—electricity*. Canby, OR: TOPS Learning Systems.

Reuben, G. 1960. *Electricity experiments for children*. New York: Dover.

CIRCUITS AND MAPS: A SPECIAL CODE

ACTIVITY SHEET

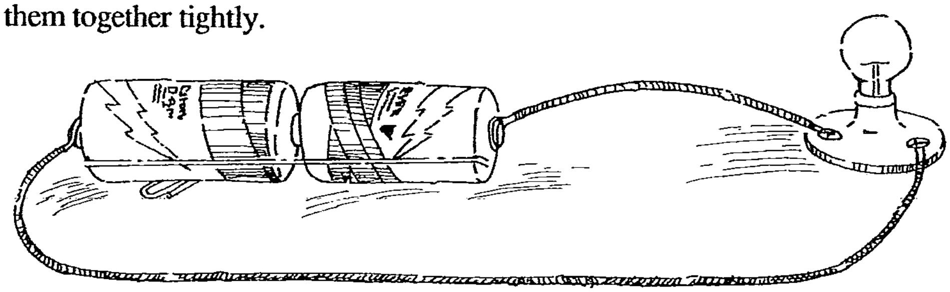
In this activity, we'll be learning to build some simple electrical circuits and to draw pictures of circuits by using a special set of symbols.

1. Work with a partner.

2. Each pair of students should gather the following materials:

   2 size D (1.5 volt) batteries
   2 flashlight bulbs
   2 bulb holders
   3 pieces of insulated wire
   masking tape and/or rubber bands to hold circuit together
   1 paper clip

3. Make a battery pack by taping the two batteries together. Remember that the batteries should be stacked end to end and that the (+) end of one battery should touch the (-) end of the other battery (see the diagram below). Be sure that your tape holds the batteries together tightly so that the batteries touch in the middle. You may want to put a rubber band around the batteries lengthwise to hold them together tightly.



4. Now lay your pack on its side and tape a paper clip to it so that it acts as a "foot" and your pack won't roll around.

5. Carefully screw the bulb into the bulb holder. The bottom of the bulb should touch the metal clip at the bottom.

6. Check the ends of your wires. Each should have ½ inch (1.2 cm) of the colored insulation stripped away so only the bare copper wire is left.

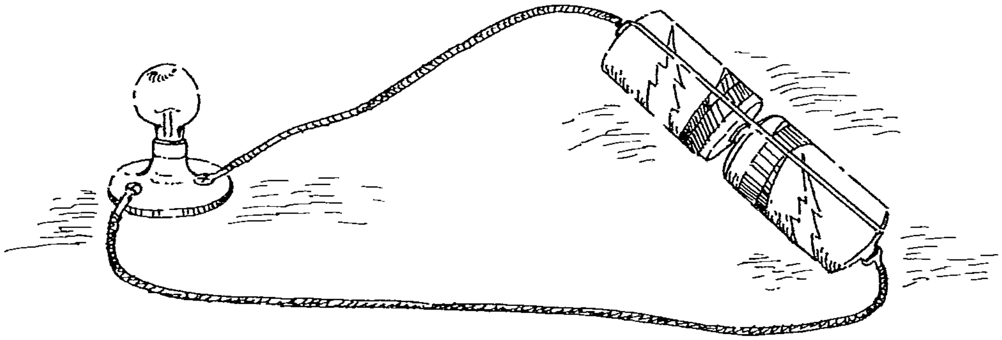
7. Attach one bare end of each wire to clips on the bulb holder. To open the clip, just push down on the tab; then you can slip the bare end of the wire through the hole.

8. Attach the other end of each wire to the ends of the battery pack (see diagram above). Did your bulb light up? If not, make sure that

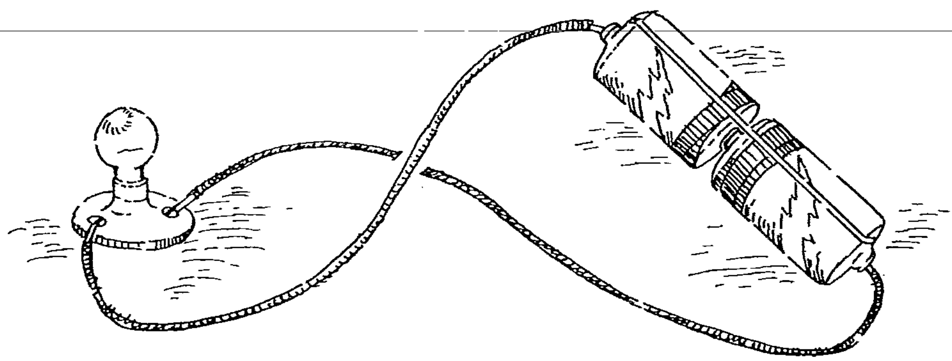
    a. batteries are touching in the middle of the pack;
    b. bare ends of wires are in the clips;
    c. bulb is screwed down into the holder so it touches the bottom metal;
    d. bare ends of the wires are touching the metal ends of the battery pack.

    If you are still having trouble, check with your teacher.

9. Trace the path of the electricity going through the circuit you have created. Be able to explain to another pair of students where the electrons (or electricity) start and end up and how they get there! Use both your circuit and the diagram below to explain.



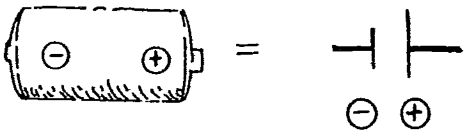
10. Now reverse the wires, so the electrons travel in the opposite direction through the bulb (see diagram). Does it matter which way the electricity moves, that is, does the bulb still light up?



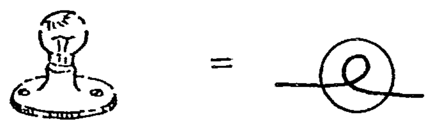
In the activity, *Simple Electrical Circuits*, you built several different circuits. Some used one battery and others used several. Some had one or two lights. Others had buzzers. You can see that drawing pictures of light bulbs and buzzers for each of these circuits could require a lot of time. What if you had to draw the wiring plan for your whole school? Your drawings would get pretty complicated!

To help solve this problem, electrical engineers and electricians came up with a kind of "shorthand" or code to represent different parts of a circuit. Some of the symbols are shown below:

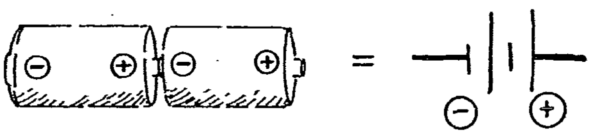
One battery



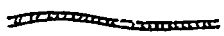
Bulb



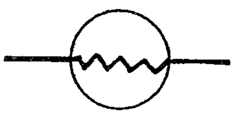
Two batteries



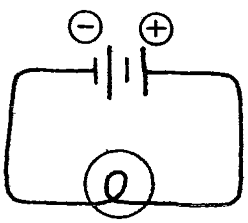
Wire



Buzzer or other resistor



Therefore, the circuit that you just built would look like this when drawn as a circuit map:



11. Which way do the electrons move in this circuit? Draw arrows to show which way they move.

12. Now build and then draw a circuit map for a circuit that has one battery and two bulbs.

13. In *Simple Electrical Circuits*, you built a number of circuits. Look back at the drawings you made. Now draw a circuit map for a circuit using two batteries and a buzzer.

14. Finally, create a new circuit map for a circuit that would use the materials you have on hand. Trade your map with another group. See if you can use their map to build a circuit while they see if they can interpret your map!

CIRCUITOS Y MAPAS

HOJA DE ACTIVIDADES

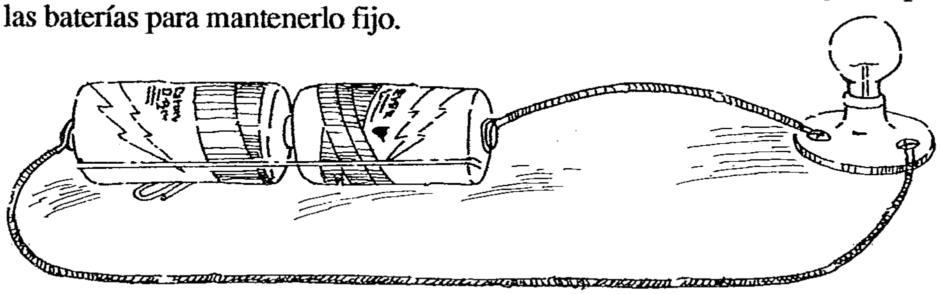
En esta actividad vamos a aprender a construir y a dibujar circuitos eléctricos sencillos utilizando un grupo especial de símbolos.

1. Trabaje junto con otro compañero.

2. Cada pareja de estudiantes debe tener los siguientes materiales:

   2 baterías D-cell de 1.5 voltios
   2 bombillas para linterna
   2 sostenedores o soportes para las bombillas
   3 pedazos de cable aislante
   cinta adhesiva o ligas elásticas para sujetar el circuito
   presillas o "clips"

3. Haga una pequeña estructura o paquete conectando las baterías. Recuerde que las baterías deben ir unidas, de manera que los dos extremos positivos (+) se encuentren en la misma dirección (vea el diagrama abajo). Asegúrese de que la cinta adhesiva sostenga las baterías firmemente, de forma que se toquen en el medio. Es conveniente colocar una liga elástica a lo largo del paquete que forman las baterías para mantenerlo fijo.



4. Ahora, coloque la estructura o paquete que ha formado con las baterías descansando de un lado y ponga una presilla o clip sujeta con cinta adhesiva a las baterías, de manera que el clip actúe como una base o pie, y las baterías no se caigan.

5. Con mucho cuidado enrosque la bombilla en el soporte. La parte inferior de la bombilla, debe tocar el botón de metal que se encuentra en el fondo del soporte.

6. Revise las puntas de los cables. Remueva la cubierta de color, ½ pulgada (1.2 cm) de cada uno de los cables, de manera que el cable de cobre quede desnudo.

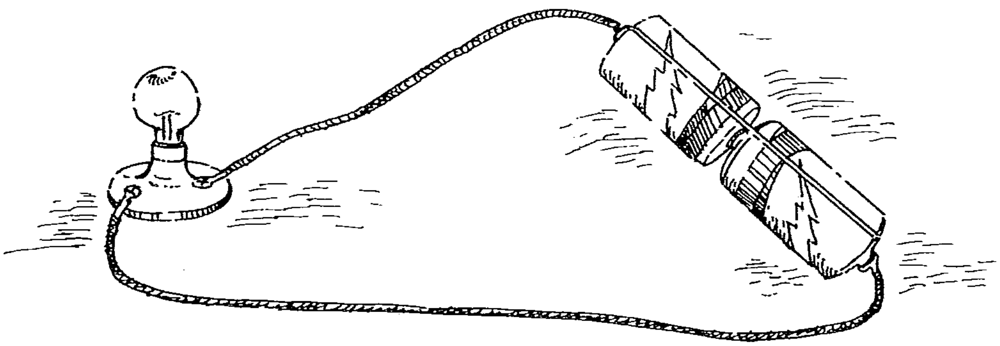
7. Conecte cada uno de los cables desnudos de cobre a los clips que se encuentran en el soporte de la bombilla. Para abrir el clip, empuje la aleta hacia abajo y pase la punta del cable a través de la abertura.

8. Conecte las otras puntas del cable a cada uno de los extremos de la estructura que forman las baterías (vea el diagrama abajo). ¿Se encendió la bombilla? Si no se enciende, asegúrese si:

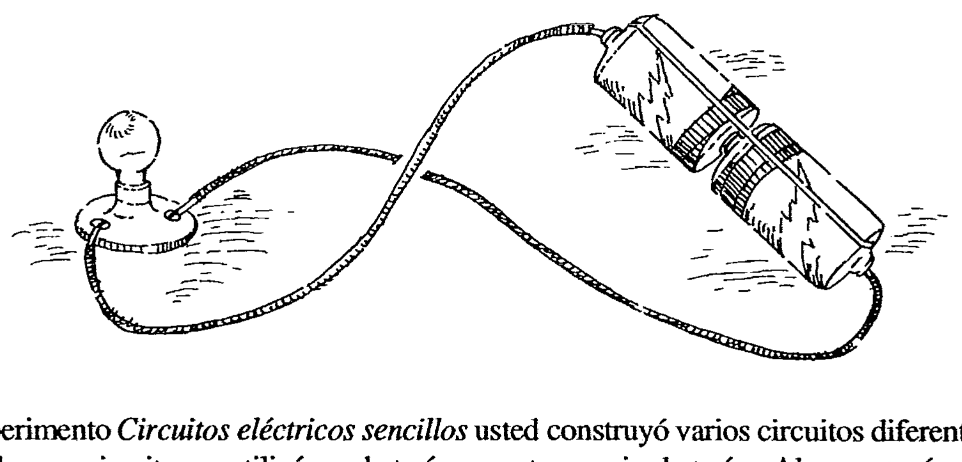
    a. las baterías se tocan en el medio de la estructura;
    b. las puntas desnudas del cable están conectadas a los clips;
    c. la bombilla está bien enroscada en el soporte, de manera que toque el botón de metal que se encuentra en el fondo del soporte, y
    d. las puntas desnudas del cable tocan los extremos de metal de la estructura que forman las baterías.

    Si todavía tiene problemas, informe al profesor.

9. Observe la ruta que sigue la electricidad a través del circuito que ha creado. Señale a la otra pareja de estudiantes dónde comienzan los electrones (o la electricidad) y dónde terminan y cómo llegan hasta ese punto. En su explicación, utilice el circuito y también el diagrama que se encuentra abajo.



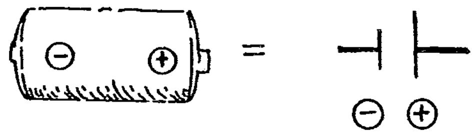
10. Ahora invierta la dirección de los cables, de manera que los electrones en la bombilla vayan en dirección opuesta (vea el digrama). ¿Tiene alguna importancia la dirección en que fluye la electriciad? Es decir, todavía se enciende la bombilla?



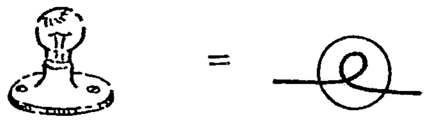
En el experimento *Circuitos eléctricos sencillos* usted construyó varios circuitos diferentes. En algunos de esos circuitos se utilizó una batería y en otros varias baterías. Algunos tenían una luz, otros dos, y otros tenían timbre. Como verá, dibujar las bombillas de luz y los timbres para cada uno de estos circuitos toma mucho tiempo. ¿Qué pasaría si tuviera que dibujar el diagrama de instalación de cables para toda su escuela? ¡El dibujo se complicaría bastante!

Para resolver este problema, los ingenieros eléctricos y los electricistas elaboraron un código que representa las diferentes partes del circuito. Algunos de los símbolos se muestran mas abajo:

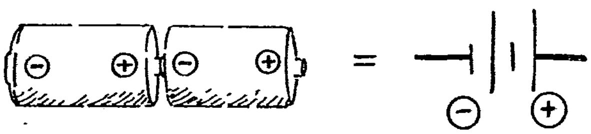
Una batería



La bombilla

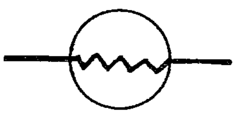


Dos baterías

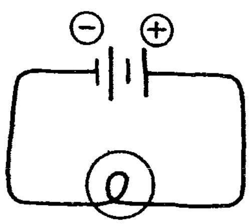


El cable

El timbre o
la resistencia



Por lo tanto, el mapa del circuito que construyó se asemeja al siguiente dibujo:

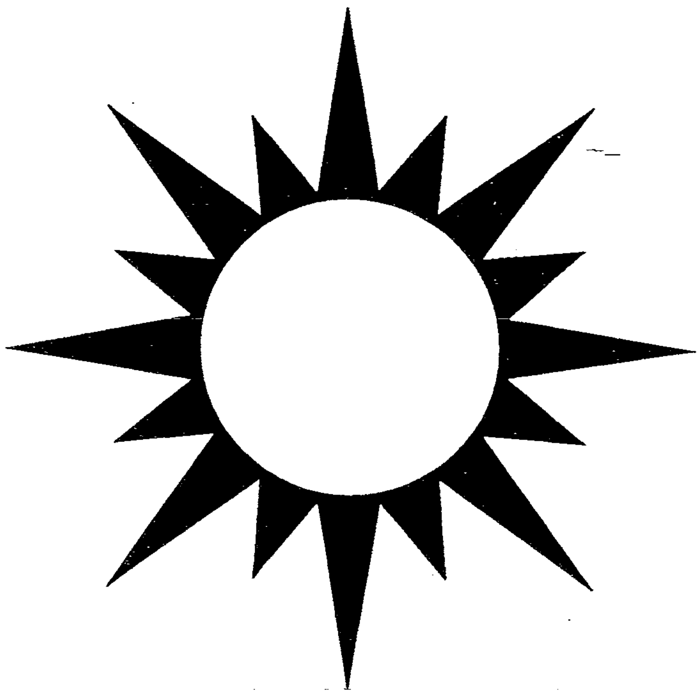


11. ¿En qué dirección fluyen los electrones en este circuito? Dibuje flechas para indicar la ruta en que se mueven los electrones.

12. Ahora, construya y luego dibuje el mapa de un circuito que use una batería y dos bombillas de luz.

13. En el experimento *Circuitos eléctricos sencillos* usted construyó varios circuitos. Revise los dibujos que hizo. Luego, dibuje el mapa de un circuito que requiera dos baterías y un timbre.

14. Por último, elabore otro mapa de un circuito que use los materiales que tiene a la mano. Intercambie su mapa con otros miembros del grupo. Utilice el mapa de sus compañeros para construir un circuito, mientras ellos tratan de entender el mapa que usted elaboró.



CIRCUITS IN SERIES AND IN PARALLEL: WHAT'S THE DIFFERENCE?

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To help students understand what the differences are between circuits built in series and circuits built in parallel. To help students learn the advantages and disadvantages of each kind of circuit.

ESTIMATED TIME:

Setting up:	About 10 minutes
Doing activity:	20 minutes
Cleaning up:	15 minutes

APPROPRIATE AGE GROUPS:

_____K–3 _____4–6 __X__7–8

DO ACTIVITY IN GROUPS OF: 2–3

MATERIALS NEEDED (per group of 2–3 students):

- ✧ 2 size D (1.5 volt) batteries
- ✧ 2 flashlight bulbs
- ✧ 2 bulb holders
- ✧ 4 pieces of insulated wire with ends stripped ½ inch (1.2 cm) on each end
- ✧ masking tape and/or rubber bands

SAFETY CONSIDERATIONS:

Students should be careful with the sharp ends of the wires.

ENRICHMENT FOR BILINGUAL STUDENTS:

- ✧ Students can bring from home appliances and other items that are examples of circuits built in series and circuits built in parallel.
- ✧ In small groups, students can discuss how to test item(s) to see whether it is a circuit in series or in parallel.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

- ✧ Students with hearing impairments should be able to do this activity without any modifications other than for communicating the instructions.
- ✧ Students with visual impairments may want to use buzzers rather than bulbs. If so, they will need extra batteries since buzzers require additional voltage.
- ✧ Students with mobility impairments may need to work with a partner.

BEFORE YOU BEGIN:

- ✧ Cut wires and strip ends.
- ✧ Check batteries and bulbs to make sure they are in good working order.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- ✧ Where do the electrons flow through the circuit?
- ✧ What happens to the circuit when you unscrew a bulb?
- ✧ Why does one bulb remain lit in the parallel circuit?
- ✧ What is one disadvantage of wiring a string of lights in parallel? (Note: They usually cost more because they require more wire).

CLEAN UP:

- ✧ Check batteries and bulbs to see if they are still in working order.
- ✧ Clean all tape off of batteries.

WHERE CAN I GO FROM HERE?

See the other activities in this section. For more activities on electricity, see the Book List for books by the Thomas Alva Edison Foundation and Robert Graf.

WHY IT HAPPENS:

In series wiring, there is only one path for the electrons to follow. They must travel through both bulbs to reach the positive end of the battery. If one bulb is disconnected, the circuit is incomplete (open) and both bulbs go out. Also, the **resistance** in the circuit is greater because you have **two bulb filaments** resisting the flow of electrons, therefore, the bulbs do not glow as brightly.

WHY IT HAPPENS: *continued*

In parallel circuits, the electrons have more than one path in which they can travel. They flow through both bulbs and, therefore, both bulbs light. When one bulb is disconnected, the other path is not broken, therefore, the circuit remains open, and the other bulb remains lit. Also, since each path in the parallel circuit has to pass through only one bulb, the resistance is similar to that in a simple circuit with only one bulb. Therefore, both bulbs remain brightly lit.

Parallel wiring obviously has many advantages. In our homes, it allows each appliance to receive a full allocation of electrical power. If our homes were wired in series, as we turned on more and more lights, each would become dimmer and dimmer. It also allows other appliances to work even when one is turned off or burned out! One disadvantage of parallel wiring is that it requires more wire than does series wiring.

Series wiring is advantageous when you need to conserve on wire or when you want all appliances to come on or go off from one switch. When appliances, such as lights, are wired in series, it is more difficult to determine which one has burned out or is out of order.

NOTES

REFERENCES

Thomas Alva Edison Foundation. 1988. *The Thomas Edison book of easy and incredible experiments.* New York: Wiley.

Marson, R. 1983. *TOPS learning systems—electricity.* Canby, OR: TOPS Learning Systems.

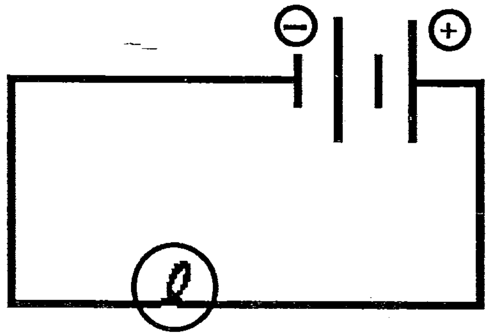
CIRCUITS IN SERIES AND IN PARALLEL: WHAT'S THE DIFFERENCE?

ACTIVITY SHEET

For circuits that have more than one bulb, there are two ways to build the circuit—*in series* and *in parallel*. This activity will help you learn how to build both kinds of circuits and learn how their differences lead to using them in different ways.

1. Work with a partner.

2. First, let's build a circuit with only one bulb. You have already done this in a previous activity. Here's the circuit map for a simple circuit with one bulb.



✏ How many batteries will you need to build this circuit? __________

✏ How many bulbs will you need? __________

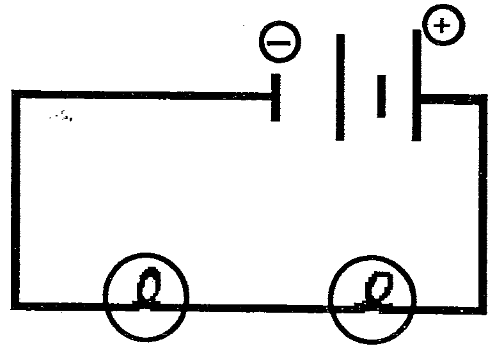
✏ How many pieces of wire will you need? __________

✏ What other materials will you need to hold your circuit together? __________

3. Gather your materials and build this circuit. Note how brightly the bulb lights. Now unscrew the bulb slightly so that the bottom of the bulb does not touch the holder. Describe what happens to the bulb? ______________________________

Now draw a map to represent this circuit with the bulb unscrewed. Remember to show the break in the circuit to show that the bulb is unscrewed.

4. Now let's build a circuit with two bulbs **in series.** Screw the bulb back down into the bulb holder and build a circuit as directed in this map.



- ✏ How many batteries will you need?__________
- ✏ How many bulbs and bulb holders will you need? __________
- ✏ How many pieces of wire?__________
- ✏ What other materials will you need?__________

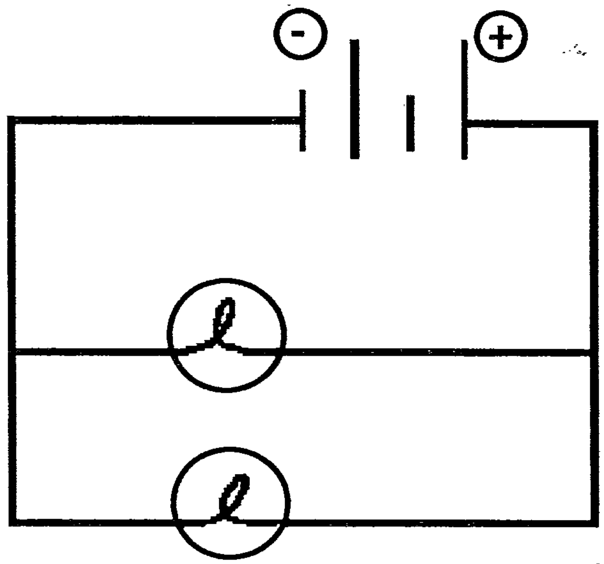
Can you trace the flow of electrons from the negative end of the battery pack to the positive end? Draw arrows on your circuit map (above) to show the flow of electrons.

5. Gather the materials you need and build this circuit with your partner. How brightly do the bulbs light?

Now, unscrew one bulb. Describe what happens to the other bulb. ____________________
If the lights in your home were wired this way, what would be the advantages and disadvantages?

ADVANTAGES	DISADVANTAGES

6. Finally, let's build a circuit **in parallel**. Look at the circuit map below.



PARALLEL CIRCUIT

How is this circuit different from the one in series? How can you wire this circuit? How many batteries, bulbs, bulb holders, and wires do you need? Gather your materials and build this circuit.

After you have your parallel circuit working, both bulbs should be lit. If you're not sure you have done it correctly, ask your teacher to check it. How brightly do these two bulbs shine? Compare them to the ones in the series circuit—are they brighter or dimmer?

Draw arrows on the circuit diagram above to show the flow of electrons through the circuit. Remember that electrons are flowing through both bulbs!

7. Now, unscrew one bulb. What happens to the other bulb? Is this different from what happened in the series circuit? How can you explain this? Redraw the circuit diagram in the space below, showing the break where you disconnected the bulb. Draw arrows on this circuit diagram to show the flow of electrons through the circuit. Do you still have a complete circuit?

8. Next, screw the first bulb back in and unscrew the second bulb. What happens now? Draw a circuit diagram below to show how the circuit looks now. Mark the flow of electrons through this circuit.

9. If you had a string of Christmas lights plugged in and one bulb burned out, tell what would happen to the other bulbs if your lights were wired in series?

10. What would happen to the other bulbs if your lights were wired **in parallel?**

11. How do you think the lights in your home are wired? Explain why you think this.

12. Summarize the advantages and disadvantages of electrical wiring done in parallel:

ADVANTAGES	**DISADVANTAGES**

13. Do the same for electrical wiring done in series:

ADVANTAGES	**DISADVANTAGES**

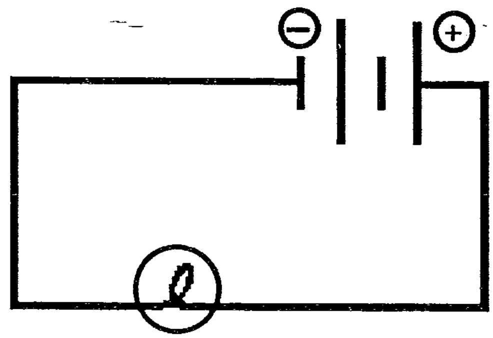
CIRCUITOS EN SERIE Y EN PARALELO
¿CUAL ES LA DIFERENCIA?
HOJA DE ACTIVIDADES

Los circuitos que tienen más de una bombilla o foco, se pueden construir de dos maneras: circuito—*en serie* y en *paralelo*. Esta actividad, los ayudará a aprender cómo construir esos dos tipos de circuito y cómo sus diferencias permiten utilizarlos de maneras diferentes.

1. Trabaje con un compañero.

2. Primero, vamos a construir un circuito con una sola bombilla. Usted lo ha hecho en una actividad anterior. Aquí se presenta el mapa de un circuito simple con una sola bombilla.

   - ¿Cuántas baterías necesita para construir este circuito?________
   - ¿Cuántas bombillas necesita? ________
   - ¿Cuántos pedazos de alambre necesita?_________
   - ¿Qué otro material necesita para construir su circuito?________

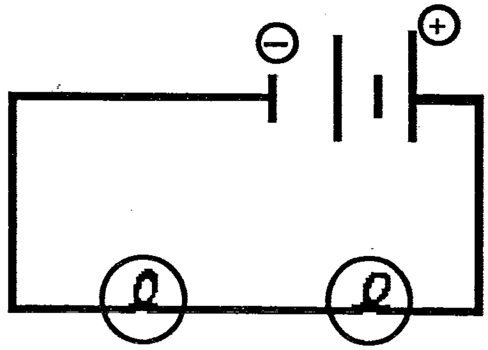


3. Reúna los materiales y construya el circuito. Vea como las bombillas se encienden. Descríbalo. Ahora, desenrosque la bombilla de manera que el extremo inferior no toque el soporte o zócalo. ¿Qué ocurre? ____

   Ahora, dibuje un mapa que represente el circuito con la bombilla sin enroscar. Recuerde señalar la interrupción en el circuito para mostrar que la bombilla no está enroscada.

4. Ahora vamos a construir un circuito **en serie** con dos bombillas. Enrosque la bombilla nuevamente en el soporte y construya un circuito tal como se muestra en el siguiente mapa:

- ¿Cuántas baterías necesita? ________
- ¿Cuántas bombillas y sostenedores necesita? ________
- ¿Cuántos pedazos de alambre? ________
- ¿Qué otro tipo de material necesita? ________



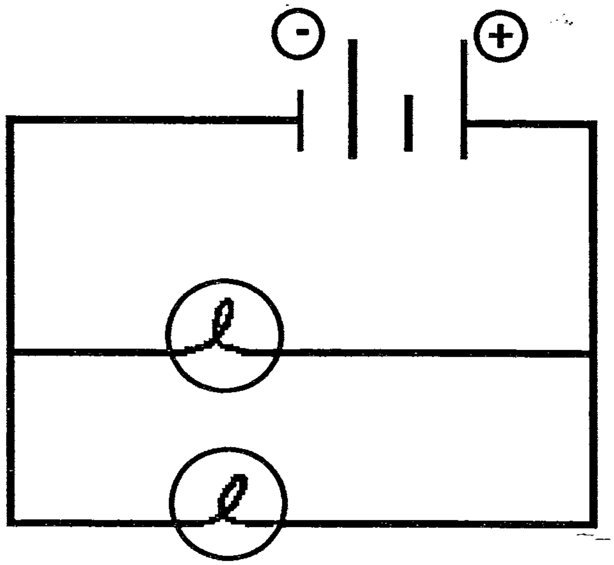
¿Puede trazar el flujo de electrones desde el polo negativo al polo positivo del paquete de batería? Utilice flechas en el mapa del circuito para mostrar el flujo de los electrones.

5. Usando los materiales necesarios, construya este circuito junto con su compañero. ¿Se enciende intensamente la luz en las bombillas?

Ahora, desenrosque una bombilla. ¿Qué le pasa a la otra bombilla? ____________________
Si las luces en su casa estuvieran instaladas de esta manera, ¿cuáles serían las ventajas y las desventajas?

VENTAJAS	DESVENTAJAS

6. Por último, vamos a construir un circuito **en paralelo.** Observe el circuito que se muestra en el dibujo.



CIRCUITO EN PARALELO

¿Qué diferencia hay entre este circuito y el circuito en serie? ¿Cómo puede instalar este circuito? ¿Cuántas baterías, bombillas, zócalos y alambre necesita? Reúna los materiales y construya este circuito.

Cuando el circuito paralelo trabaja, las dos bombillas deben encenderse. Si no está seguro que lo ha hecho correctamente, pídale al maestro que revise el circuito. ¿Están encendidas completamente las dos bombillas? Compare estas bombillas con las del circuito en serie. ¿Brillan igualmente o menos?

Dibjue flechas en el circuito del diagrama que se presenta mas arriba, para mostrar el flujo de electrones a través del circuito. ¡Recuerde que los electrones fluyen a través de las dos bombillas!

7. Ahora, desenrosque una bombilla. ¿Qué le pasa a la otra bombilla? ¿Es diferente de lo que ocurre en el circuito en serie? ¿Cómo puede explicarlo? Dibuje nuevamente el circuito en el diagrama de arriba, y muestre la interrupción donde desconectó la bombilla. Dibuje flechas en el diagrama del circuito para mostrar el flujo de electrones a través del circuito. ¿Tiene aún un circuito completo?

8. Después, enrosque nuevamente la primera bombilla y desenrosque la segunda bombilla. ¿Qué ocurre? Dibuje un diagrama para mostrar como se ve ahora el circuito. Trace el flujo de electrones a través del circuito.

9. Cuando tiene una hilera de lucecitas de Navidad enchufada y una de las bombillas se quema, ¿Qué pasa con las otras bombillas cuando las luces están instaladas **en serie?**

10. ¿Qué pasa con las otras bombillas cuando las luces están instaladas **en paralelo?**

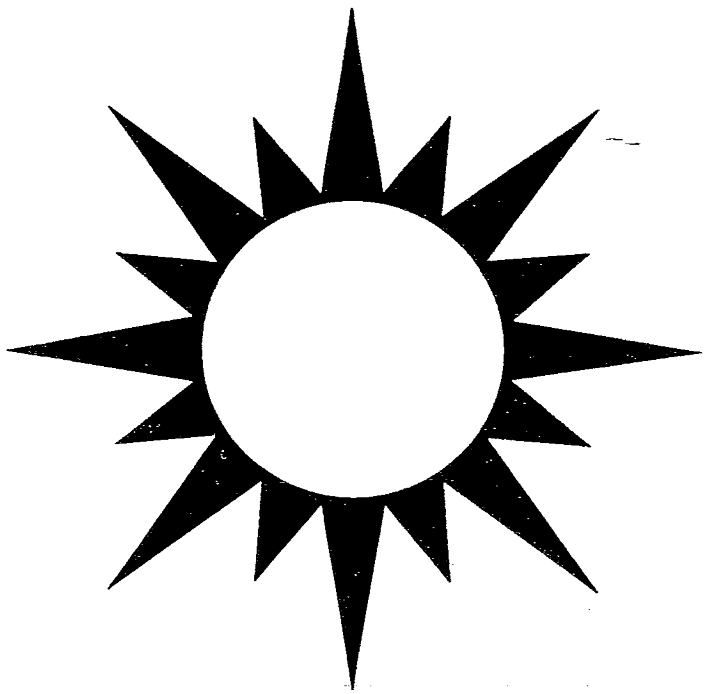
11. ¿Cómo están instaladas las luces de su casa? Explique por qué piensa así.

12. Resuma las ventajas y desventajas de la instalación eléctrica en paralelo:

VENTAJAS	**DESVENTAJAS**

13. Diga cuáles son las ventajas y desventajas de la instalación eléctrica en serie:

VENTAJAS	**DESVENTAJAS**



HOW MUCH ENERGY DO YOU USE?

SUGGESTIONS FOR TEACHERS

WHAT'S THE POINT?

To help students understand the applications of alternating current and direct current in everyday life. To help students understand the relationship between the power use of different appliances, their energy consumption, and their cost to use.

ESTIMATED TIME:

Setting up: Minimal time

Doing activity: Homework plus 20 minutes of whole class discussion and/or 15 minutes for small groups to discuss their results together

APPROPRIATE AGE GROUPS:

_____K–3 _____4–6 __X__7–8

DO ACTIVITY IN GROUPS OF: 1

(Discussion groups can be 3–5 students.)

MATERIALS NEEDED (per student):

- data collection sheets
- calculators

SAFETY CONSIDERATIONS:

Students should be careful when handling appliances to read the amps required. They should unplug the appliance before turning it around to read the back cover. For heavy appliances, such as the television, they should ask for assistance from an adult.

ENRICHMENT FOR BILINGUAL STUDENTS:

- Students can locate on a world map the countries that use alternating current (AC), and those that use direct current (DC), flagging or marking each with different colors to symbolize AC or DC.
  In small groups, students can discuss the reasons for the differences.

ADAPTATIONS FOR PARTICIPANTS WITH DISABILITIES:

Students with visual or mobility impairments may need assistance from a partner to gather the information on appliances.

BEFORE YOU BEGIN:

- Call your local power company to learn the per-kilowatt-hour rate.
- Work through a sample calculation with students before they take their sheets home to collect data.

QUESTIONS TO ASK AS YOU DO THE ACTIVITY:

- Which appliances use more amperes (current)?
- Realistically, how could you reduce energy use in the appliances that you use?
- Can you change the amount of current that the appliance uses each hour?
- Can you change the amount of time it is used?
- What about a refrigerator? Since we cannot turn it off or on, how can we reduce energy use in a refrigerator? (Buy energy efficient models that have better insulation; don't open the door as often; don't keep the door open.)

CLEAN UP:

No clean up is required.

WHERE CAN I GO FROM HERE?

This activity can lead to a number of other energy activities. These suggestions are drawn from Jerry De Bruin's *Creative, Hands-on Science Experiences:*

Conduct a survey at a busy corner near your school to find out how many people are in each car that passes by. Graph your results (number of cars versus number of people). How can car pools and public transportation reduce the use of energy and your cost to get to school or work?

Conduct a survey at the same corner of the number of cars that have windows rolled up on warm days (that is, are using air-conditioning). Record the temperature of the day versus the number of cars. Do this on several days. Are there days when it seems that air-conditioning is not really needed, but is being used by a large number of cars?

Record the electric-meter readings at your school for two months. Then have your class begin an energy awareness campaign for the school to encourage electrical energy conservation. (Your local utility company should have some literature available and may have posters and stickers for distribution.) Chart the electric meter readings over the next few months to see if your campaign is having an effect! This can help students realize that they are active participants in either energy waste or energy conservation.

WHY IT HAPPENS:

Different electrical appliances use different amounts of electricity and different *types* of electricity. Some appliances use **direct current** from batteries; these include portable radios, electric or digital watches, toys, hearing aids, flashlights, and portable CD or tape players. Other appliances use electrical current provided by utility companies through the wiring in our homes. In the U.S., we use **alternating current** to power refrigerators, toasters, coffeemakers, and hair dryers. Most larger appliances run on alternating current because changing batteries would either be inconvenient, expensive, or both.

In order to decrease our use of electricity (and our subsequent costs for batteries and utilities) we can either

1. decrease the amount of electricity an appliance uses (that is, make it more energy efficient); and/or
2. decrease the amount of time we use it.

Some appliances, like refrigerators, must run their motors a certain amount of time to keep the inside at a set temperature. We reduce costs of these types of appliances by using better insulation in the walls and doors (to minimize transfer of heat) and by limiting the amount of time the door is kept open!

For appliances such as televisions and stereos, electricity use can be limited by reducing the amount of time the appliance is used and reducing the volume.

Pose this question to students: How can electricity use be reduced for the following appliances: electric hot water heater (better insulation, lower temperature, less water usage); clothes-washing machine (full loads); dryer (full loads, lower temperature). How about CD players, radios, curling irons, and clothes irons?

REFERENCES:

De Bruin, J. 1986. *Creative, hands-on science experiences using free and inexpensive materials.* Carthage, IL: Good Apple.

Girls, Inc. 1990. *The power project: Operation SMART activity guide.* New York: Girls, Inc.

Kutscher, E. 1988. *Physics research activities.* Annapolis, MD: Alpha.

NOTES

HOW MUCH ENERGY DO YOU USE?

ACTIVITY SHEET

We all use electricity every day. This activity will help you see how you use electricity and how much electricity you buy each month! To do this, we are going to gather data at home and analyze it here in class.

First, let's look at how we use electricity in our homes! There are two types of appliances we use in our homes. Some use **direct current** (batteries) while others use **alternating current** (from the electrical outlets). Go through each room in your home and list as many electricity users as you can. For each, tell whether it uses batteries (DC) or is plugged into the wall (AC).

ROOM	ELECTRICAL APPLIANCE	AC OR DC?
KITCHEN		
BEDROOM(S)		
BATHROOM(S)		
LIVING OR FAMILY ROOM		

Which rooms had the most electricity users? ______________________________

Which rooms had the fewest? ____

Were there more AC or DC electricity users in your home? __________________

Did you notice a difference in the **size** of AC versus DC appliances? What seems to be the size difference? Why don't you think we run a refrigerator on batteries?

Now you have an idea of the variety of electricity users in our homes. But how much electricity do they use? How much does it cost? Let's look at some of the electricity users and find out.

The electric company charges by the **kilowatt hour.** That means that how much you owe depends upon two things: how much current (watts) your appliances use and how long you use them. To get an idea of how much it costs to use some of the appliances in your home, we need to find out the following:

1. how many watts an appliance uses (you can find this on the nameplate of the appliance, which is usually on the back—UNPLUG THE APPLIANCE BEFORE MOVING IT AROUND!);

2. how many hours each day you use this appliance (ask an adult to help you estimate this, then multiply it by 30 to get an estimate of how many hours you use it in a month);

3. how much your local electric company charges for each kilowatt hour (your teacher will provide this information).

For the six AC appliances listed in the following table, estimate the number of hours each is used in your home in one month. If you don't use these appliances in your home, cross them out and write in other appliances. Look for the watts [or the amps (Ω) and volts (V)] on the back of the appliance. Record this information on your data sheet. Also, find the same information for four additional AC appliances in your home. Suggestions include a radio, lamp, electric blanket, stereo, or AC tape player.

Use this equation to figure the number of kilowatt hours:

$$\frac{(\textbf{Watts x hours used})}{\textbf{1,000}} = \textbf{kilowatt hours}$$

Which appliance on your list uses the most watts per hour? ______________________

Which appliance uses the fewest watts per hour? ______________________

Which appliance do you use the most hours each month? ______________________

Which appliance do you use the fewest number of hours each month? ______________________

Which appliance costs you the most money each month? ______________________

Which appliance costs you the least each month? ______________________

Do any of these appliances use electricity when no one is really using them? (For example, is the television left on when no one is watching?)

List at least three appliances that you could use for fewer hours each month to save on energy consumption and monthly costs. Give practical examples!

1.
2.
3.

Challenge: Be an energy watcher for the next month! Monitor these three appliances and turn them off when they are not in use!

HOW MUCH ENERGY DO YOU USE? DATA COLLECTION SHEET					
APPLIANCE	OPERATING WATTS *	HOURS USED PER MONTH	TOTAL KILOWATT HOURS	PRICE PER KILOWATT	TOTAL PRICE
TELEVISION					
VACUUM CLEANER	630				
IRON	1,100				
TOASTER	1,100				
ELECTRIC CLOCK	2				
HAIR DRYER (HAND HELD)	1,000				

*If your appliance gives volts (V) and amps (Ω), you can calculate watts since

watts = volts x amps.

CUANTA ENERGIA GASTA?

HOJA DE ACTIVIDADES

Todos usamos la electricidad diariamente. Esta actividad lo ayudará a ver cómo usa la electricidad y ¡cuánta electricidad gasta mensualmente! Para esto, vamos a recoger la información en la casa y analizarla durante la clase.

Primero, ¡vamos a ver cómo usamos la electricidad en nuestra casa! Usualmente, se utilizan dos tipos de artefactos en el hogar. Los que utilizan **corriente directa** (baterías), y los que usan **corriente alterna** (de los enchufes eléctricos). Vaya a cada cuarto de su casa y haga una lista de todos los artefactos que utilizan electricidad. En cada uno, indique si usa baterías (CD) o está enchufado en la pared (CA).

CUARTO	ARTEFACTO ELECTRICO	¿CA ó CD?
COCINA		
DORMITORIOS		
BAÑOS		
SALA O SALON PRINCIPAL		

¿Cuáles cuartos tienen más artefactos eléctricos? ____________________

¿Cuáles cuartos tienen menos? ____________________

¿Qué se usa más: artefactos eléctricos or artefactos que usan CD? ____________________

¿Notó diferencias en el tamaño de los artefactos que utilizan CA en comparación con los artefactos que utilizan CD? ¿Cuál es la diferencia en tamaño? ¿Por qué no utilizamos baterías en el refrigerador?

Ahora tiene una idea de la variedad de artefactos eléctricos que se utilizan en la casa. Pero, ¿cuánta electricidad gastan? ¿Cuánto cuesta? Vamos a examinar algunos artefactos eléctricos para saber cuánta electricidad gastan.

La compañía de electricidad cobra por hora/kilovatio. Esto indica que lo que usted debe pagar depende de dos cosas: cuánta corriente (vatios) usan los artefactos y cuánto tiempo los utiliza. Para tener una idea de cuánto cuesta utilizar algunos de los artefactos en el hogar, tenemos que saber:

1. Cuántos vatios utiliza el artefacto (esto lo indica la placa del nombre del artefacto, que generalmente se encuentra en la parte de atrás). DESENCHUFE EL ARTEFACTO ANTES DE VOLTEARLO.

2. Cuántas horas al día utiliza ese artefacto (pídale a una persona adulta que lo ayude a estimar el tiempo, luego multiplique el tiempo por 30 para obtener un estimado de las horas que utiliza el artefacto mensualmente).

3. Cuánto cobra la compañía de electricidad de la localidad por cada hora/kilovatio (el maestro le dará esta información).

Haga un estimado del número de horas que se utiliza cada uno de los seis artefactos, durante un mes. Si no utiliza esos artefactos, substitúyalos por otros artefactos. Escriba esos datos en su hoja de información. Asimismo, busque la misma información para otros cuatro artefactos en su casa que utilizan CA. Por ejemplo, la secadora de ropa, radio, lampará, manta/colcha eléctrica, estéreo, grabadora electrica, etc.

UTILICE ESTA ECUACION PARA CALCULAR EL NUMERO DE HORA/KILOVATIOS:

$$\frac{\text{(Vatios x horas uso)}}{1{,}000} = \text{HORAS/KILOVATIO}$$

¿Cuáles son los artefactos en la lista que utilizan mayor cantidad de vatios por hora? ______

¿Cuáles artefactos utilizan menos cantidad de vatios por hora? ______

¿Cuáles son los artefactos que usted utiliza más mensualmente? ______

¿Cuáles utiliza menos durante el mes? ______

¿Cuáles son los artefactos que cuestan más al mes? ______

¿Cuáles son los artefactos que cuestan menos al mes? ______

¿Gastan electricidad algunos de esos artefactos cuando no se están utilizando? (por ejemplo, ¿se deja la televisión prendida cuando nadie la está viendo?)

Mencione tres artefactos, por lo menos, que podría utilizar menos para economizar energía y dinero mensualmente. De ejemplos prácticos.

1.
2.
3.

RETO: ¡conviértase en vigilante de la energía el próximo mes. Vigile estos tres artefactos y apáguelos cuando no los utilice!

CUANTA CORRIENTE ELECTRICA GASTA? HOJA DE RECOLECCION DE INFORMACION					
ARTEFACTO	VATIOS*	HORAS USADAS POR MES	TOTAL DE KILOVATIOS/ HORA	COSTO POR KILOVATIO	COSTO TOTAL
TELEVISION					
ASPIRADORA	630				
PLANCHA	1,100				
TOSTADOR	1,100				
RELOJ ELECTRICO	2				
SECADORA DE CABELLO	1,000				

*Para calcular voltios (V) y Amperios (Ω) use la fórmula:

VATIOS = voltios x amperios