Electric Excitement

4-H ELECTRIC SERIES

National 4-H Curriculum
BU-06848

Electric 1

Magic of Electricity

Photo Courtesy Science First Inc.

Project Activity Guide

Name _____

County _____

REVIEWED & RECOMMENDED
National 4-H Curriculum

Acknowledgments

2002 Electric Revision Design Team

Design Team Members: Lori Marsh, Virginia Polytechnic Institute and State University; George Duncan, University of Kentucky; Roger Tormoehlen, Purdue University; Dominion Electric Power, and Wayne Newhart, Tipmont REMC

Design Team Liaison: Kathleen Jamison, Virginia Polytechnic Institute and State University

Writer: Laurie W. DeMarco, Science Education Consultant, Salem, VA

Design and Production: Northern Design Group, White Bear Lake, MN

1997 Electric Design and Review Team

Principal Author: George Duncan, Extension Agricultural Engineer, University of Kentucky

Design Team: Roger Tormoehlen, Purdue University; Richard Spray, Clemson University; Lori Marsh, Virginia Polytechnic Institute and State University; S. Dee Jepsen, The Ohio State University; Randall Reeder, The Ohio State University; Robert Horton, The Ohio State University; Ed Maxa, North Carolina State University; Mike Nolan, Huron County, Ohio; Tom Zurcher, University of Minnesota Extension; engineers from electric utilities including American Electric Power, Ohio Edison

Funding: National 4-H Curriculum

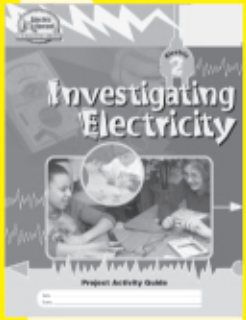
Source Citations: The following sources were helpful in developing the Electric Excitement Series:

The Story of Electricity and Magnetism by Bernard Seeman, 1967, Harvey House, Inc., New York

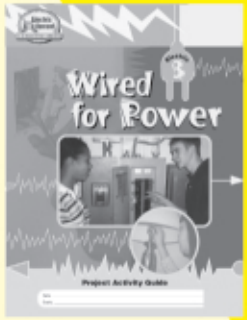
Science Projects About Electricity and Magnets by Robert Gardner, 1994, Enslow Publishers, Inc. Springfield, NJ.

For more on Electriciy, look for these other guides in this set.

Magic of Electricity



Investigating Electricity



Wired for Power

Electric Helper's Guide

Revised 2008—Copyright 2002 National 4-H Council. All rights reserved. Reproduction without permission of National 4-H Council is strictly prohibited.

Magic of Electricity

Contents

Note to the Electric Project Helper

Welcome to *Electric Excitement*! You will enjoy helping youth demystify the "magic" of electric circuits, magnetism, motors and electronics. From building burglar alarms to learning how to select stereo equipment, this curriculum contains dozens of hands-on, useful and fun projects. These activities can be used in a variety of settings such as in the classroom, with special interest clubs, after school groups or community clubs, or one-on-one.

You will be a key individual with whom young people can share the experiences outlined in this activity guide. You will provide encouragement and recognition, as they develop technical and scientific electrical literacy. In addition, these young people will learn important life skills such as creative thinking, decision making, problem solving and participating as members of a team.

Your Role

- **Review this guide and the Electric Group Activity Guide**
- **Support the youth in his or her efforts to set goals and complete the Planning Guide and Electric Achievement Program**
- **Help select electric projects to construct, give assistance in doing the activities and answer questions**
- **Help the young person to think about why something happened the way it did**
- **Serve as a resource person to help connect the young person with the community, resource materials and others knowledgeable about electricity**

The Electric Excitement Series

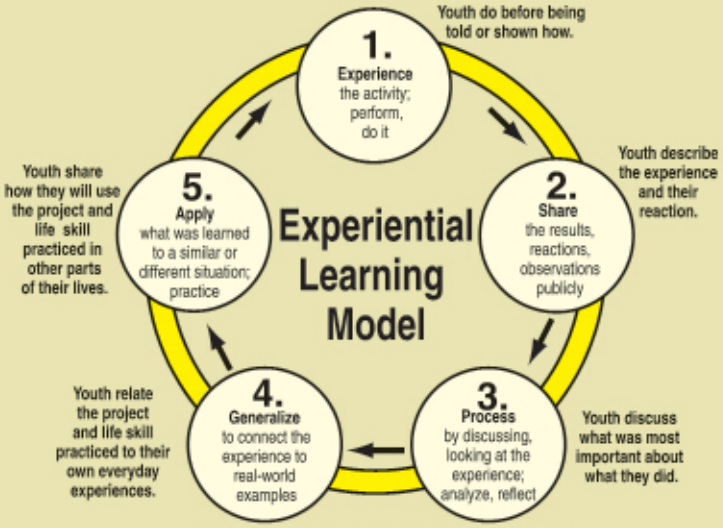
This is the first of four Electric Excitement Series activity guides.

Activity Guide	Level	Age	Grade
Magic of Electricity	1	9–11	4–5
Investigating Electricity	2	11–13	6–7
Wired for Power	3	13–16	8–9
Electronics I	4	16–18	10–12

These activity guides may be used by youth at any grade-level based on their electric skills, knowledge and expertise. A fifth activity guide, the *Electric Group Activity Guide*, provides additional group activities that can be adapted to the family, classroom or youth group. These activities strengthen understanding of electrical concepts and reinforce electrical skills.

The Experiential Learning Model

The experiential learning model is used in each activity as a means to help the young person gain the most from the experience.



Pfeiffer, J.W., & Jones, J.E., "Reference Guide to Handbooks and Annuals" © 1983 John Wiley & Sons, Inc. Reprinted with permission of John Wiley & Sons, Inc.

The five steps in this learning model encourage the young person to try to do the activity before being told or shown how. The activity is the experience part of the cycle. Use the questions listed in the *Making Connections* section of each activity to encourage the young person to think about what he or she has learned from the experience. The reflect and application questions ask the youth to **share** what they did; **process** what was most important about the experience; **generalize** the life skill and electric skill practiced to their own lives; and think through how they could **apply** the life skill or science process skill to a new situation.

To fulfill the experiential learning process, you must complete all the steps, including the review questions in *Making Connections*. The experiential model enhances learning and adjusts to a wide variety of learning styles.

Evaluating the Experience

1. By asking the questions under *Making Connections* you can evaluate your youth's understanding of the key concepts and life skills practiced in each activity. Listening to and encouraging consideration of each question resulting in conclusions and opportunities for further application. In addition, the *Success Indicator* shown in the introduction of each activity will help you evaluate the experience.
2. You will find a leader assessment sheet *Evaluating the Impact* in the *Electric Group Activity Guide*. Use this sheet to help you evaluate your youth's understanding of magnetism and electricity as he or she completes these activities.
3. Youth and volunteer helper assessments of the Electric Excitement series can be found on page 35, *Electric Group Activity Guide*.

How This Book Works

The Magic Starts Here!

Are you ready to experience the magic of electricity? Let's get started! Each activity in *The Magic of Electricity* is designed to help you learn something about electricity. Invite a family member or a friend to work with you on these activities and projects. These projects can even be done with your classmates or in a special interest club, after school group or community club. Sometimes it is more fun and interesting to explore new things together.

The Activities
Each activity in the Electric Excitement series is designed to help you learn something new about electricity. These activities also provide opportunities to practice a life skill that you can use every day. Here is a quick look at the various sections of each activity.

Skills
Each activity lists electric skills, science process skills and life skills that you will learn and use. You will practice these types of skills when you answer the questions and discuss each activity with your electric helper.

Success Indicators
Can you do what these say, and can you do it more than once? If so, you have mastered this skill. If you have trouble with this skill, just keep practicing until you can.

Tools
These are the materials you'll need to complete the activity. By organizing and planning for each activity you'll be practicing an important skill.

Power Up
This is the "do" part of the activity. You will usually get to share part of what you do with others.

Closing the Circuit
Here is an extra activity which will help you understand or practice what you have learned in each activity.

Making Connections
This is where you and your helper get together to see what you have learned about electricity. You will use these questions to help you discuss what you learned, what you did, what was important about what you did, what it meant to you and how you could use what you learned in the future. The *Making Connection* questions are found at the end of each chapter. Check the box after talking over each question with your helper or recording in your journal.

Light Bulb Icon
Here you will find tips to help you complete the activity or general information about electricity.

Brain Boosters
These are more challenging activities for you to do. They will help you expand your knowledge and skills to other areas. Each time you successfully complete one of these, record it on your achievement program page and have your helper initial and date it.

Safety Icon
These are helpful hints to keep you safe when working with electricity. The activities in this guide are designed to be safe, but remember you are dealing with electricity, which can be dangerous.

Kite Icon
Check the kite for interesting facts and trivia about the magic world of electricity.

Glossary Words
All definitions for the words listed here are found in the glossary on page 35.

Journal
Use a journal to record your answers to *Making Connections* found at the end of each chapter.

Your Project Helper

Your electric project helper is an important part of your overall experience in the electric project. The choice of a helper is yours. This person may be your project leader or advisor, troop leader, teacher, family member, neighbor, friend or anyone who has the interest to work with you to complete the electric achievement program for this guide. Involve your helper as you set your goals, discuss the questions following each activity and sometimes work together on an activity.

My Project Helper _____

Phone # _____

E-mail address _____

Magic of Electricity

Planning Guide

My Plans

- Select an electric project helper
- Complete all four steps of the *Magic of Electricity* Planning Guide
- Do at least seven activities each year
- Take part in at least two leadership experiences each year

My Name _____

My Project Helper _____

Helper's Phone Number _____ E-mail Address _____

1 My Electric Project Goals

I plan to complete my *Magic of Electricity* activity book by _____.

2 Leadership Experiences

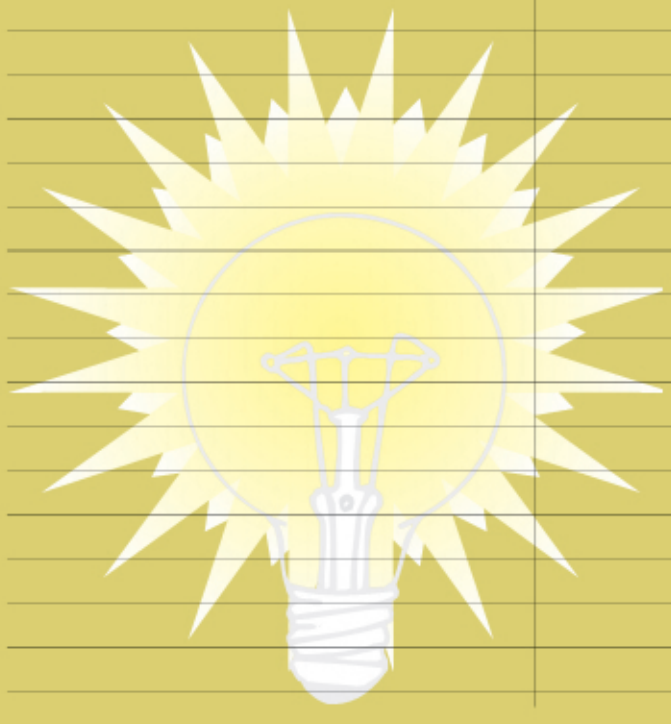
Participate in at least two of these experiences each year. Put a check mark by the ones you plan to do.

Experience	Plan To Do	Date Completed
Give an electric demonstration		
Teach someone something about electricity		
Encourage a friend to be a part of the electric project		
Exhibit an electric project		
My own activity:		
My own activity:		

3 Electric Project Highlights

List and record the date every time you do and learn something exciting in *Magic of Electricity.*

	Date



4 Electric Project Review

Once you have completed what you planned, arrange to talk with your helper about what you have learned. You will want to have your planning guide, achievement program and the *Making Connections* section of this guide up-to-date.

Magic of Electricity

Achievement Program

Guidelines

- Do at least three main Activities and four Brain Boosters Activities this year and check them off.
- Have your electric helper date and initial this log as you complete the activities

Required Activities			Optional Activities (Brain Boosters)			
Activity Name	**Date Completed**	**Helper's Initials**	**Page/No.**		**Date Completed**	**Helper's Initials**
Plugging In						
Getting It Together						
Bright Lights						
Control the Flow						
Circuit Sense						
Conducting Things						
Is There a Fork in the Road?						
May the Force Be With You						
A Passing Force						
Attract or Repel?						
Earth Attractions						
Sense the Current						
Make It Spin						

Electric Excitement
4-H ELECTRIC SERIES

Magic of Electricity

Achievement Program Certificate

I certify that _____
has successfully completed the requirements of Electric Excitement: *Magic of Electricity*

Helper's Signature _____

Date _____

Activity 1

Plugging In

Activity:	*Identify how you use electricity*
Life Skill:	*Acquiring/Evaluating Information—Selecting and interpreting information*
Electric Skill:	*Appreciating electricity*
Science Process Skill:	*Observing, classifying and communicating*
Success Indicator:	*Names daily activities that use electricity*
National Science Standard:	*Electricity in circuits can produce light, heat, sound, and magnetic effects*

Tools — *Pencil*

Look around! **Electricity** is everywhere! It makes things happen. In this activity you will explore just how much you depend on electricity to do the things you like to do. You may be surprised by the results. You will also practice communicating with others what you have learned.

Power Up

Think of the things that you really like to do. Talk with your partner and come up with as many ideas as you can. List ten of these activities in the chart. Put a check mark next to the activities that need electricity to work. Remember, if an activity uses batteries, it is using electricity.

FAVORITE THINGS I LIKE TO DO	does it use ELECTRICITY?	WHAT Does the Electricity do in this activity?
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Closing the Circuit

Find the everyday things we use that depend on electricity for their use, production, or manufacture. You will be surprised how much electricity is part of our everyday lives!

L B S J G R D E Y E G L A S S E S Y
P O S E H S I D U H P Q L T V A G L
C D E J D R D B S L O J R D S A B I
A U O M I C R O W A V E L L I N A G
M S H B S L L O U J N J S E L A B H
C K S B B A S K E T B A L L S A B T
T R A C E E C S V J R J I S W W G B
Z E L I T O A S T E R C T A A H W U
C F C J L F U S H J N T A K H E I L
R R I C O M P U T E R F L U R V N B
C I U L A M K F P J A U O F O O D L
O G Z S S C L I N A E R D R E V O S
T E L E P H O N E U L N T R S E W L
J R R H T E L E V I S I O N C N O L
Y A U T O M O B I L E T V W U L C L
G T C O Y X C H I C K U G U I T A R
O O L L A W N M O W E R Z R A K L T
V R A C Y X C H A C K E N E Z A K L

Word List

Computer
Microwave
Books
Lightbulb
Clock
Pencil
Toaster
Clothes
Eyeglasses
Automobile
Shoes
Dishes
Television
Lawn Mower
Food
Oven
Furniture
Guitar
Refrigerator
Basketball
Window
Telephone

The "Father of Electricity" was William Gilbert (1544-1603) who was the attending physician to Queen Elizabeth I of England. Gilbert found that he could create a force by rubbing different things together, which would attract other materials. He also noticed that sometimes the rubbing created sparks or crackling sounds. Gilbert decided that he was creating a force, which he called "electricity"!

Living with Electricity

Almost everything that we use or do has used **electricity** in some way. Think about a typical day. The alarm clock that wakes you up is **powered** by electricity. You roll over and turn on an electric powered light. The clothes you put on were woven and sewn on machines that are powered by electricity. The orange juice you drank for breakfast was brought to market on a truck that used a battery to get it started and an electric powered refrigerator to cool it. Electricity was used to manufacture the bed you slept in, the chair you sat on and the bus that took you to school! Can you imagine what your life would be like without electricity?

Brain Boosters

1. **Ask your grandparent or other adult over the age of 65 to list the ten things they liked to do most when they were a child. Identify which of the things they listed used electricity.**

2. **Write a poem or short story about a day without electricity. Read your work to both your family and your electric helper.**

3. **Search your house and make a list of everything you can find that uses electricity. Share your list with your helper and talk about what would happen if you had no electricity for 5 days.**

Glossary Words
- **Electricity**
- **Power**

Activity 2

Getting It Together

Activity:	*Obtain materials to conduct Electric 1 activities*
Life Skill:	*Acquiring/Evaluating Information—Selects and obtains information*
Electric Skill:	*Identifying electrical materials*
Science Process Skill:	*Planning and organizing*
Success Indicator:	*Acquires all materials needed*
National Science Standard:	*Tools help scientists make better observations, measurements, and equipment for investigations*
	*Pencil*

Before you can make a flashlight, a compass, a motor, or any of the other activities in this guide, you will need to gather together the necessary materials and supplies. Most of the things that you will need can be found in an electronics store. Some of the items you may already have at home, and a few can be purchased at an office supply store. As you collect these items you will be introduced to an assortment of electronic equipment and the stores that sell them.

Power Up

The chart below includes everything you will need to do the 13 electric activities in this guide. First, determine if you already have an item. If you must purchase an item, determine where you might purchase it and what it will cost.

As you obtain each item, list its source (store name or "already have") and cost. Estimate the costs of items that you already have. To save time, call ahead to a store to see if they have what you need and the cost of the item. If you do not have an electronics store near you, you may need to order by mail, phone or the Internet (Check the *Electric Resources* listing in the back of this book for suggestions).

MATERIAL PLANNING TABLE

ITEM	ACTIVITY USED	AMOUNT NEEDED	ALREADY HAVE?	WHERE YOU FOUND IT	COST
Insulated, solid core, 20, 22, or 24 gauge wire (called "bell" or "thermostat" wire)	4, 5, 6, 7, 12, 13	10 feet			
Flash light bulbs (2 to 2.5 volt)	3, 4, 5, 6, 7	2			
Light bulb holders	4, 5, 6, 7	2			
D-cell batteries	3, 4, 5, 6, 7, 12, 13, 14	2			
D-cell battery holders	4, 5, 6, 7, 12, 13	2			
Metal paper clips	4, 6, 9, 10, 12	1 box			
Brass paper fasteners (brads)	4, 6, 8, 12, 13	4			
Bar magnets	9, 10, 11, 14	2			
Small compass	13	1			
22–26 gauge enamel-coated wire (not copper colored)	14	2 feet			
8, 10, or 12 gauge copper wire	14	1 foot			
Piece of cardboard	4, 6, 13	8 x 12 inches			
Wire stripper	3, 4, 5, 6, 7, 12, 13	1			
Large sewing needles	10, 11	6			
Large iron nail (3 to 4 inches long)	12	1			
Iron nails of different sizes	12	3 to 4 different sizes			
Piece of string or thread	10	2 feet			
Tape (Scotch or masking)	4, 6, 12, 13, 14	1			
Styrofoam cup or plate	11	1			
Sandpaper	14	1 sheet			
Screw driver (should fit the screws on your bulb holders)	4, 5, 6, 7	1			
Non-metal bowl	10, 11	1			
Pencil	14	1			
Piece of aluminum foil	3	2 inches long			

Since some of the things you need come only in large quantities (for example, wire comes in spools of 50 feet!), you can save money if you shop with a friend or two. You can buy the items together and split everything up to share the expense. It is usually cheaper to purchase large quantities of items when ordering from a catalog. Also, you might have more fun if you do these projects with a friend or a group.

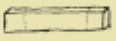
Note to Helper: *Skip this lesson if you are gathering materials for a group. Take the time to show the group the materials you have collected.*

Glossary Words

- Battery
- Gauge
- Insulator
- Static Electricity
- Wire Strippers
- Voltage

Closing the Circuit

Draw a line from the piece of electronic equipment to its name.



battery holder

D-cell battery

light bulb

compass

bar magnet

wire stripper

light bulb holder

wire

In 1678, a German scientist Otto von Guericke made a machine for producing electricity. He took a large ball of sulfur and mounted it on an axle he could turn. As the ball spun around it rubbed against a cloth. This action caused friction and the build up of an electric charge that was very similar to lightning! Electricity formed by rubbing one substance against another is called ***static electricity****.*

Selecting Electrical Equipment

Here are some tips on selecting different electrical materials:

- Wire is sold both bare and with **insulation**. You will want to buy insulated wire. This wire is sold as stranded (made of many small wires twisted together) or as a solid wire (called a 'solid conductor'). Since stranded wires tend to come apart, it is best to select solid conductors for use in these activities. Wire also comes in different sizes, or **gauges**. Oddly, the bigger the number, the smaller the diameter of the wire. A **wire stripper** is used to remove the insulation from the ends of wire.
- Battery holders come in different sizes to hold different sized **batteries**. Some hold only one battery while others can hold two or four batteries. For the projects in this book, you will need two battery holders that are made to hold one **D-cell battery** each.
- Electronics supply stores carry different types of light bulb holders. Some are for bulbs that screw in, while others are for bulbs that you push in and turn (they are held in by little knobs that stick out of the bulb casing). Bulb holders have different ways of connecting wires to them. Most require that you **solder** the wires; however, you can find bulb holders made to connect the wires by placing the wire under a screw.
- There are several kinds of small light bulbs. The most important thing is that the bulb you select matches the bulb holder (screw-in or push-in). You must also check the **voltage** (a measure of electric pressure) rating of the bulb. Be sure the bulbs you select are rated between 2 and 2.5 volts.

Brain Boosters

Batteries come in many sizes and shapes. Large batteries start trucks and cars with an electric charge. Tiny batteries are found in watches and hearing aids. Find out more about different size batteries and their uses. Describe to your helper how and where these different batteries are used.

Activity 3

Bright Lights

Activity:	*Build a flashlight*
Life Skill:	*Solving Problems—Identifying a problem, generating solutions and evaluating results*
Electric Skill:	*Wiring a simple circuit*
Science Process Skill:	*Solving problems through experimentation*
Success Indicator:	*Understands why an incandescent bulb lights up*
National Science Standard:	*Electricity in circuits can produce light*
Tools	*D-cell battery, light bulb, a piece of aluminum foil*

Imagine that you are out in the woods and your flashlight gets smashed on a rock. It is starting to get dark. You take the flashlight apart and discover that the **incandescent light bulb** and the batteries are okay, but the case has been destroyed. In this activity you will see if you can fix the light to use on your camping trip.

Power Up

Night is fast approaching, and you really need to light the bulb since it is your only source of light. You look in your backpack and find a piece of aluminum foil. Using only the battery, bulb and the piece of aluminum foil, see if you can make the bulb light. Brain storm with your helper to come up with ideas on how to make the bulb light. Once you have made the bulb light, take a close look at your set-up. Can you imagine the flow of electricity from the battery, through the bulb filament, and back to the battery? Draw a picture of the path that the electricity follows to light the bulb.

"The Pathway to Light"

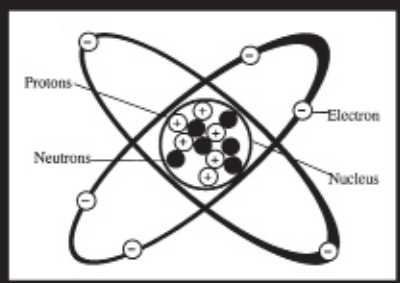
Brain Boosters

1. Using items found around your house, make a flashlight that is easier to use than the one you made in this activity. Demonstrate to your helper how your new flashlight is different from the one you would buy at the store.

2. Think about what other things electrical circuits do other than light up flashlights. Are there circuits in CD players? clocks? doorbells? Explain to your helper how electric circuits run many of the things we use.

What is Electricity

Although we cannot see electricity, we know it exists because we use it every day to run things such as toasters, vacuum cleaners and computers. Scientists have discovered that everything in the world is made of tiny particles called **atoms**. Atoms are made up of even smaller particles called **electrons**, **protons** and **neutrons**. Electrons have a negative charge and protons have a positive charge. Electricity is produced when something upsets the balance between electrons and protons in the atoms, causing the electrons to move from one atom to another. This movement of electrons creates the **energy** that powers your CD player or television!



Glossary Words

- Atom
- Battery Terminal
- Circuit
- Electron
- Energy
- Filament
- Incandescent Light Bulb
- Neutron
- Proton
- D-cell Battery

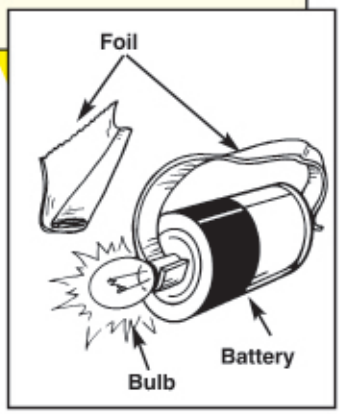
Lighting the Bulb

The light bulb in your flashlight needs electricity to light it up. Electricity is the flow of **electrons**. A battery provides a flow of electrons by pushing electrons out of one end and pulling electrons back into the other end. This flow of electrons will only happen when the electrons are given a path that they can travel along. Metal makes a great path for electrons to travel on, which is why aluminum foil is used in this activity. Air, on the other hand, makes a terrible path! That is why the electrons don't just run out of a battery when the **battery terminals** are touching only air.

The only way to make the bulb light is to make sure that the electrons have to go through the bulb to get back to the battery. Look at the picture of a light bulb. When the electrons go through the filament of the bulb the bulb lights up. To make the electrons go through the filament, you must make sure that the filament is part of the path! To do this you must make sure that one part of the path touches the metal side of the light bulb, and another part touches the light bulb at the very bottom of the bulb.

If there is a path that doesn't include the bulb filament, the electrons will choose that path. The filament is a tight squeeze for the electrons and they will take an easier way if it is available.

Making the Bulb Light



1. Cut the aluminum foil into a strip about 2 inches by 6 inches.
2. Fold the foil over and over along the long edge, until you have a piece that is still six inches long, but only a quarter of an inch wide.
3. Touch one end of the battery to the bottom end of the bulb, and then connect the side of the bulb to the strip of aluminum foil.
4. Connect the strip of foil to the other end of the battery.

You have built your first **circuit**! A circuit needs three things:

- Something to push electrons (in this case, a battery)
- A path for the electrons to follow (aluminum foil and light bulb)
- Something for the electrons to do (like light up a light bulb)

To test your understanding of a circuit, see what happens when you connect the foil to both ends of the battery and then put the bulb on top of the foil strip.
Does the bulb light up? Why?

Making Connections

Share With Your Helper

- ☐ What equipment was needed to make the bulb light?
- ☐ What was the source of electricity used to make the bulb light?

Process What's Important

- ☐ How is your imitation flashlight different than one you would buy at a store?
- ☐ Why is it important to understand how electricity works?

Generalize To Your Life

- ☐ What is another time that you experimented to solve a problem?
- ☐ Describe another time when brainstorming helped you solve a problem.

Apply What You Learned

- ☐ When faced with a new problem, like fixing a flashlight, describe some ways that you could figure out the answer.
- ☐ Describe how technology can help us organize our thoughts and solve problems.

In 1709, an English scientist, Francis Hawksbee, made the first electric light! First, he removed most of the air from a hollow glass ball. Then he spun the ball on an axle with a crank and let it rub against his hand. As a charge of electricity built up in the hollow globe, it began to glow! Bright Lights!