

The Power Of

# ELECTRICITY



## Leader's Guide



# CREDITS AND ACKNOWLEDGEMENTS

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## RESOURCES

Power of Electricity includes materials adapted from:

- *U.S. Department of Energy*
- *Electricity's Silent Partner-Magnetism # CO 003*
- *Behind the Switch - # CO 009*
- *Electricity For Family Living - # CO 007*
- *Exploring Energy - # 4-H 401*
- *Exploring the World of Electricity - CO 001*
- *The Harnessed Atom - DOE/NE 0072*
- *Harper's Beginning Electricity*
- *Teaching Science on a Shoestring*
- *The How's and Why's of Electricity-Members Manual Unit Two*
- *The National Energy Education Development Project*

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## PREFACE

### 4-H POWER OF ELECTRICITY

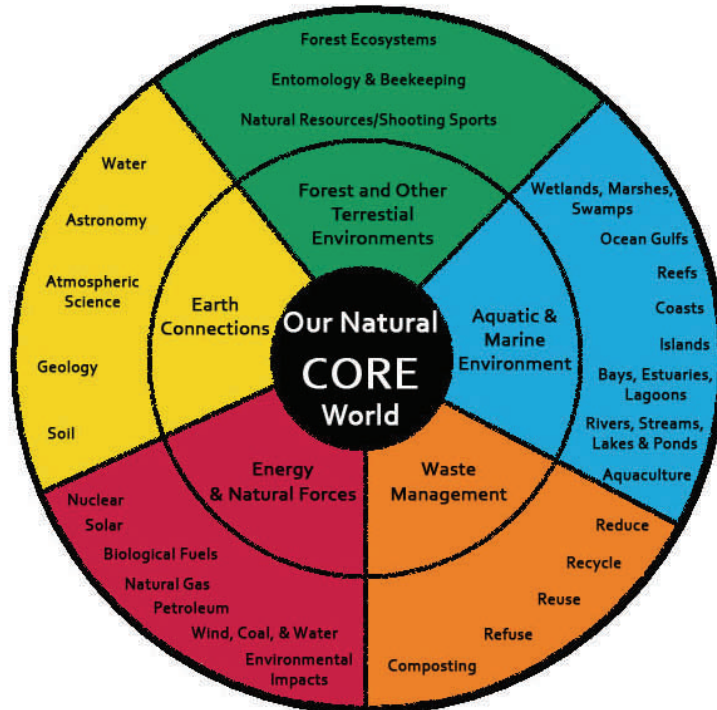
The Florida 4-H Environmental Education curriculum, OUR NATURAL WORLD, includes a basic premise, i.e., our environment is a web of cooperation and interdependence. One of the five key components of the curriculum is "Energy and Natural Forces."

The **4-H POWER OF ELECTRICITY** of OUR NATURAL WORLD, is designed to help 12-14 year old youth understand the environmental and economic issues associated with ENERGY. Additional curriculum packages will be designed for youth in other age ranges and for sequential advancement in energy education.

To the informed Florida citizen, it is not surprising that energy commands a priority within the total 4-H Environmental Education curriculum. An investment in young people's knowledge, understanding and attitudes about energy origins, uses, and conservation issues and their affect on the natural environment can not be ignored now or in the future.

In **4-H POWER OF ELECTRICITY**, we are particularly interested in helping young people develop a personal environmental ethic and understand each person's individual impact on energy's consumption and resource availability.

### 4-H ENVIRONMENTAL EDUCATION CURRICULUM FRAMEWORK



DEPARTMENT OF 4-H & OTHER YOUTH PROGRAMS  
INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES  
UNIVERSITY OF FLORIDA



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# About Power of Electricity

The development of this 4-H Environmental Education Project Kit was driven by two basic principles:

1. Learning about energy can be fun! The kit provides simple and inexpensive, yet fun activities that teach youth about major energy concepts, including the energy sources, energy uses, and energy conservation.
2. 4-H volunteer teaching activities must be ready-to-use. This project includes materials needed to conduct energy education activities into an easy-to-use format. It was designed to be teacher friendly and takes much of the guesswork out of teaching this subject.

## AGE OR GRADE LEVELS

This project was developed for youth ages 12-14. Both group and individual activities encourage participation and action in all aspects of energy education. Teachers and volunteers are encouraged to select learning activities that are most suitable to their youth. The overall intent is to facilitate learning and to spark creativity in both teachers and youth.

## CONTENTS

The following resources are components of the 4-H Energy Program:

- **LEADER'S GUIDE** - This three-ring notebook contains a complete, easy-to-read outline for lessons. Each lesson provides a variety of activities that can be conducted depending upon the time frame devoted to this project. The following activities are a mix of games, experiments, role plays or demonstrations that help to teach the basic principles and concepts in each lesson. The lesson concludes with a review using activity sheets in the youth's Workbook and discussion questions for youth to REFLECT and APPLY.
- **POWER OF ELECTRICITY WORKBOOK** - contains activity sheets for youth that correspond to each lesson. A variety of activities including puzzles, word searches, connect-the-dots, and other instructional activities make up this fun booklet.
- **TEACHING KITS** - containing materials needed for many of the activities. Solar Ovens are also available to enhance teaching (contact your County Extension Service for more information).



# LESSON PROFILES

**IMPORTANT:** It is important that each activity be done in each lesson in the correct order. Each activity teaches "energy" and "electric" concepts that are vital to understanding the next activity. The lessons and activities are designed to provide youth with the knowledge to further enjoy learning about electricity as they proceed through The Power of Electricity.

A brief description of the five Power of Electricity Lessons:

## **LESSON 1 - Understanding Electricity**

Through activities in Lesson 1, youth discover how much they have grown to depend on electricity in their everyday lives. Understanding the basic energy forms is taught to allow youth to understand how electric energy is dependent on many forms of energy. Youth learn about subatomic particles and how important electrons are for electric energy. Youth also discover nature's energy and build a battery.

## **LESSON 2 - How Electricity Travels**

Discovering how electrons flow and that they flow only through certain materials is the key in learning about electricity. Activities in Lesson 2 focus on building an understanding of electron flow and electric circuits. Amps and volts are also important in understanding electron "flow measurements."

## **LESSON 3 - Electricity's Silent Partner**

Taking electron flow a step further in understanding how electricity is generated, magnetism and the use of magnets in generating electricity is explored. Youth apply what they've learned in Lesson Two and Three in making a simple motor.

## **LESSON 4 - Electricity: Energy in Action**

Youth explore how electricity is used while developing an understanding of the importance of taking safety precautions with electricity. Youth calculate the cost of various electrical appliances with regard to KWH cost and watt demands. They explore the energy requirement of many household appliances.

## **LESSON 5 - Electric Environment**

Youth learn how natural resources are used in an electrical power plant as well as how electricity is generated and transported to our homes. They examine the effects that power generation has on the environment.



## The Experiential Process...Steps and Techniques

The 4-H Program has a long history of providing for a cooperative teaching-learning process between adults and youth. The activities in each "Adventure," or project lesson, strive to involve young people in experiences that require them to interact, analyze, question, reflect and transfer what they have learned to personal application. The activity comes first, the "learning" comes from the "discovery" of new knowledge and skills as a result of the experience. This is the 4-H "learn-by-doing" process. However, to end with the experience without building upon it through REFLECTING and APPLYING does not help the young person understand the significance of what he/she saw, heard, or did. It is the transfer of this significance from one experience to another that helps young people apply their "learning" in future situations.

- |                |   |
|----------------|---|
| <b>DO</b>      | Each "Adventure" or lesson topic identifies the activity or series of activities to <b>DO</b> involving youth in a common EXPERIENCE.   |
| <b>REFLECT</b> | At the conclusion of the activity(ies), allow time for the youth to REFLECT (share and process) what they learned from the experience. Each lesson guide outlines some key questions to assist you in this process.   |
| <b>APPLY</b>   | Help youth to APPLY their new knowledge and skill to real life situations. You can do this by helping them to identify key principles that are important for future decisions or personal action. Again, each lesson has outlined a few questions to direct this process. |

### STEPS

This model illustrates the cooperative teaching-learning process that is the goal of 4-H curricula. A further description of the steps in the process may be helpful as you become an active participant in *The Power of Electricity*.

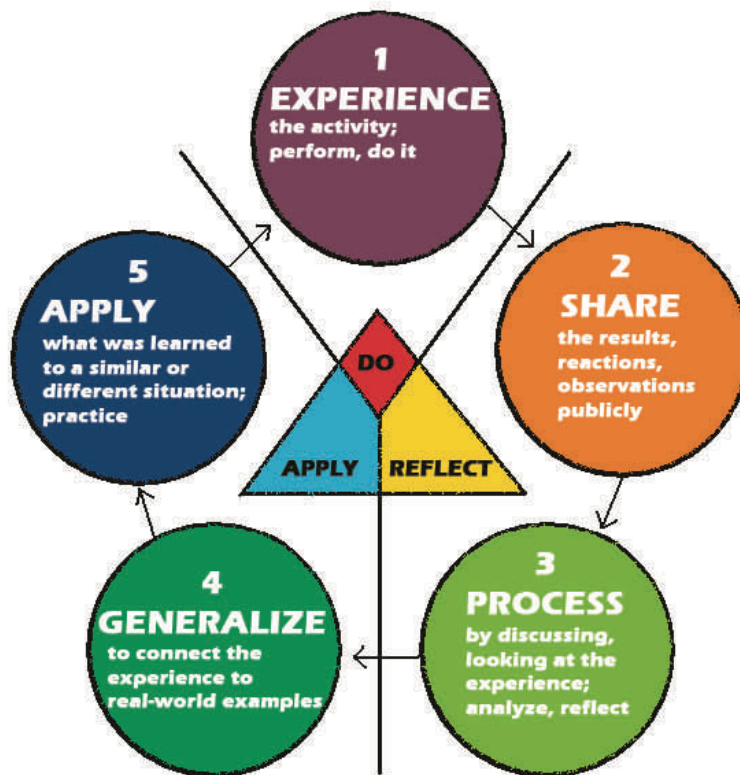
- |                   |   |
|-------------------|---|
| <b>Experience</b> | Begin with concrete experience. This can be an individual activity or a group experience, but it involves "doing something." The learning experience will most likely take place when the experience is unfamiliar or a first-time activity for the learner; pushes the learner beyond any previous performance levels; is uncomfortable; and includes the risk of failure.     |
| <b>Share</b>      | Next, get the participant(s) to talk about the experience. Share reactions and observations. Let the group talk freely. Acknowledge ideas; listing them visually is helpful. Allow time for volunteers to share responses. Encourage group members to answer questions posed by others. Avoid having the leader answer questions.   |
| <b>Process</b>    | Discuss how themes, problems and issues are brought out by the exercise. Speak to specific problems and issues that the group discovers from the exercise or recalls from personal experiences. Look for recurring themes and write them on the newsprint. Have small groups discuss and report back, have a panel discussion, or generate ideas individually on 3" x 5" cards. |



**Generalize** Find general trends or common truths in the experience. Draw out and identify the principles that are important - that apply to "real life," not just the activity. This focuses on the key messages. List key terms that capture the lessons. Identify situations where the principles apply.

**Apply** Concentrate on how the new learning can be applied to everyday situations. Discuss how issues raised by this activity can be useful in the future. Describe how more effective behaviors can grow out of what is learned. Write personal goals for behavior changes, take turns solving problem situations in groups of two or three, or role-play situations that show how new behavior is learned. Each individual should feel a sense of ownership for what is learned.

## THE EXPERIENTIAL LEARNING MODEL





## TECHNIQUES

### Use a Variety of Activities

You might consider any one or a combination of the following: tours, interviews, judging, games, pantomimes, skits, puzzles, demonstrations, problems to solve, experiments, using a specific tool, systematic observations, creating a product, visualization, brainstorming, group initiatives, case studies, simulations, surveys leading to an event or activity, or sharing and presenting to others through talks and exhibits.

### Develop Questions to Ask

The types of questions asked will vary with the activity, some questions may relate to the content but must go beyond it. If a specific life skill is to be enhanced, then the youth should have the opportunity to become as involved with understanding the life skill as understanding the subject related skill. Questions to help move in this direction may be as straightforward as these examples:

#### Sharing Questions

1. What did you do?
2. What happened?
3. How did you feel?
4. How did it feel to...?
5. What was most difficult? Easiest?

#### Processing Questions (Use data generated from sharing questions)

1. What problems or issues seemed to occur over and over?
2. What similar experiences have you had?

#### Generalizing Questions

1. What did you learn about yourself through this activity?
2. What did you learn about (life skill, i.e., making decisions)?
3. How do the major themes or ideas relate to real life and not just the activity?
4. How did you go about making your decision?

#### Applying Questions

1. How can you apply what you learned (making decisions) to a new situation?
2. How will the issues raised by this activity be useful in the future?
3. How will you act differently in the future as a result of this activity?

Each of these general questions could be enhanced by adding specific language referring to the experience in a particular project.





## Understanding Electricity



### KEY CONCEPT:

To become familiar with how electric energy is produced.

### OBJECTIVES:

Youth will be able to:

- ✎ compare and contrast lifestyles and our dependency on electrical energy.
- ✎ identify the forms of energy needed to produce electricity.
- ✎ identify the atomic particles and their relationship to electrical energy.
- ✎ explain the actions that produce electricity.
- ✎ explain how electrons move in a battery.

### ADVANCED PREPARATIONS:

1. Read BACKGROUND BASICS for this lesson.
2. Review activities and choose appropriate one(s) to use.
3. Gather necessary materials as described.

### DO any of these learning activities:

- ✎ Conduct **AMERICAN PIONEER** to discover energy use changes.
- ✎ Discover six forms of energy through **THE MYSTERY OF ENERGY**.
- ✎ Determine which resources are renewable or nonrenewable in **WHAT IS IT?**
- ✎ Discover **ATOMS AND ELECTRICITY**.
- ✎ Discover **ELECTRON ACTION!**
- ✎ In **NATURE'S ELECTRIC ENERGY** discover atmospheric electricity.
- ✎ Discover how electrons move in batteries through **DC-FROM BATTERIES**.
- ✎ Play **ZAPPED!**



### LESSON TIME:

Lesson time will vary upon learning activities selected. Lesson activities also vary depending upon numbers of youth. Most activities are approximately **45 minutes**.



## REFLECT on what was learned and why with these questions:

- ✎ How has our energy use changed over time? ***We have become more dependent on electricity***
- ✎ What are six forms of energy? ***chemical, thermal, radiant, mechanical, nuclear, and electric***
- ✎ What are the atomic particles and how are they different in different atoms? ***protons, neutrons, electrons; atoms have different numbers of each with varying distances from the nucleus***
- ✎ How do electrons move? ***from negatively to positively-charged atoms***
- ✎ How is electricity generated from atoms and the atomic particles? ***movement of electrons from one atom to another***
- ✎ Why does lightning and thunder occur? ***positive and negative charges in the atmosphere***
- ✎ Can lightning effect our use of electrical appliances? ***yes, lighting can provide too much electricity to appliance causing them to "short"***

## APPLY these connections to everyday life:

- ✎ How does the use of electricity affect your life and how is your life different from your grandparents or great-grandparents as a result of electricity?
- ✎ Trace the forms of energy back to their natural resources.
- ✎ Relate what we know about atoms to the composite make-up of the elements.
- ✎ Explain what causes static electricity.
- ✎ How can lightning effect the environment?
- ✎ Identify safety precautions for use during an electrical storm.



# BACKGROUND BASICS: Understanding Electricity

## WHAT IS ENERGY?

*Energy* is everywhere. Energy is a doing, moving, working thing. Energy and its transformations have a profound effect on our everyday lives. Energy moves planes, trains and automobiles. Energy helps us cook and clean. It keeps us warm in the winter and cool in the summer. It helps our bodies grow and our minds think. **All** life is sustained by energy.

**ENERGY** - the rate at which work is done.

**WORK** - the effort to produce or accomplish something.

## FORMS OF ENERGY

*Energy* can appear in many different forms. More often than not, "work" is accomplished energy transforms between several different forms. There are two primary categories of energy forms: potential energy and kinetic energy.

**Potential energy** is stored energy. It is energy waiting to be used and is based on position or condition. Chemical, mechanical, and gravitational energies are all forms of potential energy. This means that these forms are also ways of storing energy.

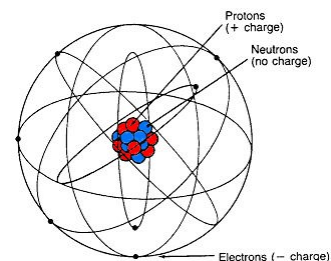
**Kinetic energy** is energy in motion. Things as big as the Earth and things as small as an electron have kinetic energy if they are moving. Radiant, thermal, electrical, and motion energies are all types of kinetic energy.

Within these two categories, there are at least seven different forms of energy. These are:

**Mechanical energy** takes into account the potential energy and kinetic energy that are present when putting an object into motion. A machine uses mechanical energy to do work. Our bodies also use mechanical energy as we throw a ball or move a pencil across a piece of paper.

**Chemical energy** is the energy stored in the molecules of different substances (such as your cells, food, wood, coal, petroleum, and other fuels). During photosynthesis, sunlight gives plants the energy they need to build complex chemical compounds. When these compounds are broken, the stored chemical energy is released in the form of heat or light. What happens to a wood log in a fireplace? Burning the wood breaks the compounds, releasing the stored chemical energy in the form of heat and light.

**Electrical energy** is a special kind of kinetic energy. It is the energy of moving electrons. Everything in the world is made up of tiny particles called atoms. Atoms are made up of even smaller particles called electrons, protons, and neutrons. Electricity is produced when something upsets the balancing force between electrons and protons in atoms. We can use electricity to perform work like lighting the bulb in a lamp, heating a cooking element on a stove, or moving a motor.





**Radiant energy** is commonly called light energy, but light energy is only one kind of radiant energy. All waves emit energy. Radio and television waves are other types of radiant energy. Light waves work by wiggling the receptors in back of our eyes.

**Gravitational energy** is a type of energy that is created due to the position of an object and the force that gravity is having on the object. When placed at the top of a hill, a bicycle has greater potential energy because it is higher (position) and has a greater gravitational pull acting on it.

**Motion energy** is a type of energy that occurs when there is a change in the position or location of an object. This may include a bicycle as it rolls down a hill, the strings of a piano when the hammer hits, or the sound waves that move through the air which are created as the strings vibrate.

**Thermal energy**, or heat energy, is the energy of moving or vibrating molecules. The faster the molecules move, the hotter an object becomes and the more thermal energy it possesses. Thermal energy can do work for us like heating soup on the stove. It can also be the result of doing work. If rubbing your hands together quickly, you will feel heat or thermal energy. When two objects slide against each other they produce friction heat.

## ATOMS and ELECTRICITY

As small as atoms are, they are made of even smaller particles. There are three basic particles in most atoms--*protons* (PRO-tahns), *neutrons* (NYOO-trons), and *electrons* (ih-LEK-TRONS). Protons carry a positive (+) electrical charge. Neutrons have no electrical charge. Protons and neutrons together make a bundle at the center of an atom. This bundle is called the *nucleus* (NYOO-klee-\*ss). We use protons to identify atoms. For instance, an atom of oxygen has 8 protons in its nucleus. Carbon has 6, iron 26, gold 79, lead 82, *uranium* (yu-RAY-nee-\*m) 92, and so on.

Electrons have a negative electrical charge and move around the nucleus. Normally, an atom has the same number of protons and electrons. If the positively charged protons and the negatively charged electrons are equal in number, the positive and negative charges will balance each other. As a result, the atom, itself, has no electrical charge.

Current electricity is the channeled flow of electrons. Electrons (-) circle around the center of the atom in layers. An equal number of electrons and protons creates a stable atom. More protons in an atom create a positive charged atom; more electrons create a negative charged atom. Electricity is created when an outside force causes the electrons to move from one atom to another. Some atoms have many electrons whirling around. Those electrons that are farthest from the nucleus are not very securely attracted to protons in the nucleus. An outside force can sometimes knock the outermost electrons away from the atom.

The fact that some atoms hold their electrons rather loosely is important to us. In some materials, loosely-held electrons can jump with ease from one atom to another within the material. If an atom has too many electrons, the extras are attracted to another atom which may have too few, and so on. When an object has more or less electrons than normal, it has static electricity and is electrically "charged." If electrons have been taken away, it is positively charged, and it leaves behind extra



positively-charged protons. On the other hand, if electrons have been added, then it is negatively charged. Lightning is caused by static electricity. One part of a cloud may build up more negative charges than another. The difference in charge may become so great that the charges seek to get back together. The result is a bolt of lightning.

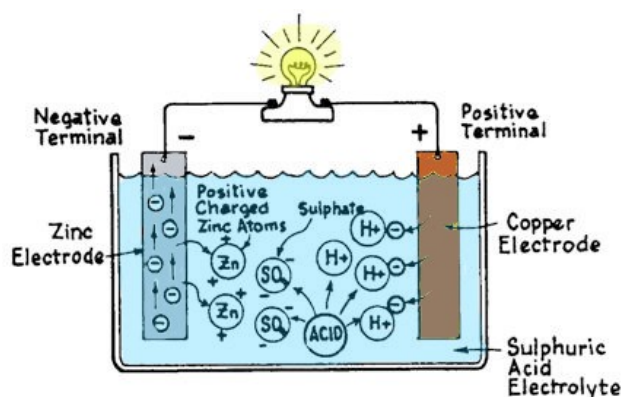
## ELECTRICITY FROM BATTERIES

An electric cell consists of two plates of unlike metals (or a metal and carbon) known as "electrodes," a chemical (usually an acid) called an "electrolyte," and a case or container. The first electric cell was invented by an Italian scientist named Volta, and today simple electric cells are still called "voltaic cells" in his honor. A voltaic cell is also called a "wet cell," because the electrolyte is a liquid.

In one type of voltaic, or wet cell, the positive electrode is zinc, while the negative electrode is copper. The electrolyte, or chemical which surrounds the plates, is sulfuric acid that has been diluted with water. The case for wet cells is usually glass or hard rubber. The electrodes are suspended into the electrolyte-filled case from an insulating cover which separates the electrodes from one another.

### Wet Cell Battery

The acid electrolyte attacks the zinc electrode, and in effect, pulls the atoms of zinc away from the electrode, dissolving the zinc. As the atoms of zinc are pulled away from the zinc strip, they each leave two electrons behind on the strip. These electrons build up as the zinc dissolves, leaving the strip with a negative charge. Meanwhile, the sulfuric acid breaks apart into its components- hydrogen atoms and sulfur and oxygen (which stay stuck together as "sulfate"). This happens in such a way that the hydrogen atoms have too *few* electrons, leaving them with a positive charge.



These positively charged hydrogen atoms then attract electrons off the copper strip, leaving that strip with a positive charge. So, the result is that the chemical action of the electrolyte has left one electrode (zinc) with a negative charge (too many electrons), and the other electrode (copper) with a positive charge (too few electrons).

If a wire is connected between the terminals, an electric current will flow. This will go on as long as the acid has enough strength to keep the action going, and as long as the zinc strip isn't completely dissolved. Current produced like this by a battery will always be DC, or Direct Current - it always flows in one direction. Thus, chemical energy has been converted to electrical energy.

Some wet cells can be "recharged," since the chemical action within the cell can be reversed. This is done by sending an electric current through the cell in the opposite direction from the normal current flow which occurs when the cell is powering some device. Most wet cells commonly used today, like in car batteries, use electrodes of lead and lead oxide.

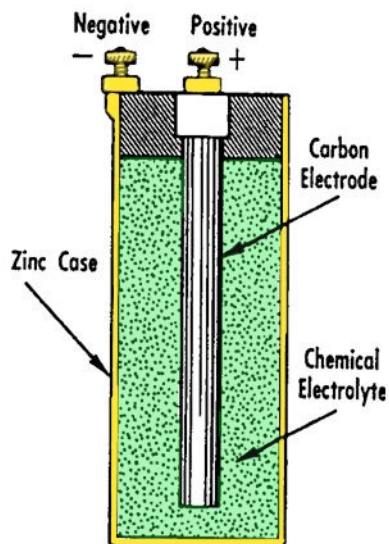


The highest voltage of a wet cell is 2.2 volts. The actual voltage depends on the strength of the acid and the condition of the electrodes. Most batteries we use from day to day, however, are not wet cells. These small batteries, used in things such as flashlights and radios, are called "dry cells."

### Dry Cell Battery

In a dry cell, one electrode is made of carbon. This is the positive electrode, and usually is the center post or center button of the battery. The negative electrode is made of zinc and usually is the outside shell, or case, of the dry cell. The electrolyte or chemical between the electrodes is in the form of a paste, instead of a liquid. In some dry cells, screws are added to the top of each electrode to help in attaching a wire.

The chemical action of dry cells is similar to that of wet cells, except it cannot be recharged easily. Dry cells are intended for short, on-and-off service like flashlights. The highest voltage of such cells is about 1.5 volts, regardless of the size of the cell. However, larger cells can supply electric current for a greater length of time than small ones.



## ADDITIONAL BACKGROUND NOTES:



## Understanding Electricity

Nearly everyone is familiar with the word ENERGY, yet few people know what it really is. **Energy**, simply put, is the rate at which work is done. **Work** is the effort to produce or accomplish something.

Scientists have concluded that the world is made up of atoms. These atoms are made up of sub-components (or subatomic particles) called protons, neutrons, and electrons. **Protons**, which have a positive (+) charge and neutrons, which do not have a charge, make up the core of the atom called the **nucleus**. Atoms with the same number of protons combine together to form unique substances called **elements**. All the known elements have been arranged into a chart called the **periodic table**. Subatomic particles that have a negative (-) charge are called **electrons**. Electrons are in constant orbit around an atom's nucleus.

Electrical energy is created when electrons are being exchanged from one atom to another. The steady movement of electrons is the key to electricity. **Electricity** is called a secondary source of energy because it is produced from many forms of energy. There are seven forms of energy: Mechanical, Chemical, Radiant, Gravitational, Motion, Thermal, and Electrical.

Give an example of each form of energy:

Mechanical

Chemical

Radiant (light)

Gravitational

Motion

Thermal (heat)

Electrical







# ACTIVITY 1 American Pioneer

**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

Have you ever wondered what it was like to live when your great grandparents did? What was their everyday life like? How did they survive? What did they do for shelter, food, fun? Today we're going to go back in time to live like our forefathers.

## DO: Be an AMERICAN PIONEER!

- ✓ Have youth break into groups of four. Each group member will role play a pioneer family member, either mother, father, or each of two children, existing in the mid-1800's (The Old West). Each "family" must discuss what their survival is dependent upon. Each "family" will identify on the AMERICAN PIONEER Activity Sheet what each individual's responsibilities are for survival.
- ✓ Determine how much time each task takes for survival in the mid-1800's.

## REFLECT:

- ✓ How many of the everyday tasks that were performed in the mid-1800's are still done today?
- ✓ How many of the tasks that were necessary for survival in the mid-1800's are not done today? What are they?
- ✓ How has the use of electricity changed the nature of the tasks from the mid-1800's until today?
- ✓ What other advancements do we enjoy today that individuals in the mid-1800's did not enjoy? Which of these are dependent on the use of electricity?
- ✓ How would you survive if you lost all electrical power for 48 hours (two days)? If the outside temperature was 32°F or 99°F?

## APPLY:

- ✓ How much does electrical energy contribute to the amount of "work" that is done today?
- ✓ Why is the use of electricity important for us, our families, our communities, our nation and world?
- ✓ Do you think electrical energy will make life easier or harder in the future? Why?
- ✓ Have youth "role play" the year 2050 and discover what life might be like then?



### OBJECTIVES

Youth will be able to:

- ✓ identify uses of electrical energy.
- ✓ identify the need for electrical energy.

### SETTING:

A large comfortable room for role playing activity.

### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. Copies of AMERICAN PIONEER ACTVIITY PAGE for each youth
2. Pens/pencils



# American Pioneer



Imagine what life was like in the Old West, around the year 1850. Each family member would have been responsible for certain chores around the house.

1. Describe each chore that a pioneer family had to complete. Who was responsible for doing the chore? What was the chore like?
2. Now, think about how those tasks are performed today. How are today's tasks different from those from the past?

Let's look at some of those chores up close. Every family had to think about getting and preparing food, keeping the house clean, and having other necessities like water, light and transportation. Use the chart below to compare pioneer life to life today.

	1850s	Today
Getting Food		
Preparing Food		
Cleaning the House		
Water		
Light		
Transportation		



# ACTIVITY 2 The Mystery of Energy



**LIFE SKILLS:** Working with others, Acquiring, analyzing, and using information

## LEADER INFORMATION:

It is important that you are familiar with the background information on the forms of energy and energy sources for this activity. Electrical energy is a form of energy, however, "electricity" is what is referred to as a secondary source of energy. Other **forms** of energy are used to make electricity. Through the series of questions and illustrations provided, help youth begin to "think" about the various differences in the forms of energy we use in all the things we do daily.

## INTRODUCTION:

What does the word energy mean to you? Where does energy come from? How do we use energy? In the previous activity we discovered our dependency upon electricity today. Electricity is what is called a secondary source of energy. Why do you think electricity is called a secondary source of energy? Clue: How do we get the electricity we use in our homes or school? (From power plants... electricity is created from many other forms and sources of energy at the power plant; therefore, electricity is a secondary source of energy.) Let's find out about all the different forms of energy it takes to produce electricity.

## DO: THE MYSTERY OF ENERGY

- ✓ Place an ENERGY WORD CARD on the wall/board to identify each of the six forms of energy: NUCLEAR, RADIANT, ELECTRICAL, CHEMICAL, THERMAL, AND MECHANICAL
- ✓ Divide youth in groups and using the ENERGY PICTURE AND PHRASE DEFINITION CARDS (a different colored set for each group), have each group tape their pictures and definitions to the appropriate Energy WORD associating the correct form of energy.

## REFLECT:

- ✓ Compare each group's match-up and clarify, discuss and explain the six forms of energy with them using the following illustrations and questions.

### OBJECTIVES

Youth will be able to:

- ✓ identify the six forms of energy.
- ✓ recognize that electricity is a secondary source of energy.
- ✓ distinguish electrical energy from electricity.

### SETTING:

A large comfortable room.

### LESSON TIME:

45 minutes

### ADVANCE PREPARATION

Prepare ENERGY MYSTERY GAME according to instructions.

### MATERIALS

- ✓ Copies of ENERGY PICTURE, DEFINITION, and WORD CARDS for each group
- ✓ Two pieces of scrap paper for each youth
- ✓ One piece of paper and pencil per team
- ✓ Copies of ENERGY MYSTERY SCENARIO CARDS for each group
- ✓ Heavy Book
- ✓ One die per team
- ✓ Timer



## REFLECT: (continued)

✍ Help youth understand the forms of energy.

**CHEMICAL:** Either run in place yourself or select a volunteer to run in place. Ask youth what form of energy is being used. The food we eat is stored energy. Our bodies use food as an energy source by "burning" calories. The use of food by our bodies is a chemical form of energy.

**THERMAL:** Have youth rub their hands together for 30 seconds. How do their hands feel? Warmer. Why? The rubbing together of our hands causes friction or vibration of molecules. The faster the movement or friction, the more thermal energy is produced.

**RADIANT:** Have youth cover their ears. Drop an object (a book) on the floor. Ask youth if they could hear it. With the lights turned off, have youth close their eyes. Turn the lights back on. Ask youth if they could tell when the lights were turned on. These are two forms of radiant energy because they are produced using light waves.

**MECHANICAL/MOTION/GRAVITATIONAL:** Ask youth when dropping the object (book) what form of energy was being used. The total potential and kinetic energy that are present in the moving of the book are mechanical energy.

Drop the book again. Hold the book up and ask the youth what kind of energy does the book have? Potential. Now, ask youth what impact gravity would have on the book falling. This would be the gravitational potential energy that is also acting on the book as it falls. Drop the book. What did the book do? Moved downward until it hit the ground. This is a kind of kinetic energy called motion energy - energy that put something in motion.

**ELECTRICAL:** Electrical energy is a special kind of kinetic energy of moving parts of an atom called electrons. We will learn a great deal more about Electrical Energy in this project "The Power of Electricity".



## DO: ENERGY MYSTERY Game!

- ✎ Divide youth into an even number of teams and group teams for each game of Energy Mystery (group A and B, Group C and D, etc.). Distribute blank pieces of paper and pencils to each team.
- ✎ Explain that each team will take turns and alternate drawing ENERGY MYSTERY Cards from the deck. They will read the scenario at the top of the card to the other team that is then to identify which of the six forms of energy are being used within the time period. (A **double check** by the form of energy in the scenario indicates an advanced concept and is therefore worth double points.) There are also blank cards included for additional scenarios.
- ✎ Each form of energy correctly identified by the team is worth one point and should be recorded on the blank pieces of paper for each team.
- ✎ Explain to the teams that they will roll the die before each round and that if the number on the die is one of the energy forms used for the card and is guessed correctly, the team will receive that many more points. First group to 60 wins.
- ✎ Play Energy Mystery.  
*Note: If a justification can be made for a form of energy not identified on the scenario card, point(s) should be awarded. (i.e., if for the "watching TV" scenario youth identify the electricity as generated by nuclear energy.)*

## REFLECT/APPLY:

- ✎ How many things that we do require only one form of energy? **not many**
- ✎ Which form of energy did we use most often? Why? **chemical; it takes chemical energy for our bodies to move**
- ✎ What forms of energy do we need for survival? What about plants and animals? **answers will vary**
- ✎ Sort the game cards by the things you do often. What kinds of energy are we dependent upon in our daily lives? **answers will vary**
- ✎ Can you trace back these forms of energy to our natural resources? **electrical & chemical energy rely on our non-renewable & renewable natural resources. (coal, wood, sun/solar)**





## LEADER ANSWER KEY: ENERGY DEFINITION CARDS!

1. Puts Objects on the Move! ***Mechanical***
2. Molecules on the Move! ***Thermal***
3. Electrons on the Move! ***Electrical***
4. Waves on the Move! ***Motion***
5. Light Rays on the Move! ***Radiant***
6. Stored Energy Waiting to be Moved! ***Chemical***

## LEADER ANSWER KEY: ENERGY PICTURE CARDS!



MOTION



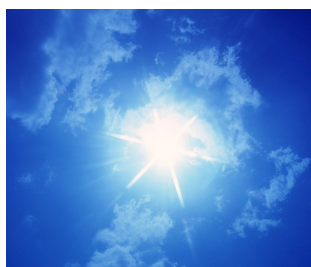
MECHANICAL



CHEMICAL



ELECTRICAL



RADIANT



THERMAL





<b>Radiant Energy</b>	
<b>Nuclear Energy</b>	
<b>Thermal Energy</b>	



**Mechanical  
Energy**

**Electrical  
Energy**

**Chemical  
Energy**



**Waves  
on the Move!**

**Puts Objects  
on the Move!**

**Light Rays  
on the Move!**

**Molecules  
on the Move!**

**Stored Energy  
Waiting to be Moved!**

**Electrons  
on the Move!**





**ENERGY MYSTERY SCENARIO:**  
**Vacuuming Your Room**

**ENERGY FORMS USED**

- |            |                 |
|------------|-----------------|
| 1. Radiant | ✓✓ 4. Chemical  |
| 2. Nuclear | ✓ 5. Mechanical |
| 3. Thermal | ✓ 6. Electrical |

**ENERGY MYSTERY SCENARIO:**  
**Talking on the Telephone**

**ENERGY FORMS USED**

- |              |                  |
|--------------|------------------|
| ✓ 1. Radiant | ✓ 4. Chemical    |
| 2. Nuclear   | ✓✓ 5. Mechanical |
| 3. Thermal   | ✓ 6. Electrical  |

**ENERGY MYSTERY SCENARIO:**  
**Sleeping**

**ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | ✓ 4. Chemical |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:**  
**Playing a Computer Game**

**ENERGY FORMS USED**

- |               |                 |
|---------------|-----------------|
| ✓✓ 1. Radiant | ✓ 4. Chemical   |
| 2. Nuclear    | ✓ 5. Mechanical |
| 3. Thermal    | ✓ 6. Electrical |

**ENERGY MYSTERY SCENARIO:**  
**Sunbathing on Your Favorite Beach**

**ENERGY FORMS USED**

- |               |               |
|---------------|---------------|
| ✓ 1. Radiant  | ✓ 4. Chemical |
| ✓✓ 2. Nuclear | 5. Mechanical |
| 3. Thermal    | 6. Electrical |

**ENERGY MYSTERY SCENARIO:**  
**Writing a Letter**

**ENERGY FORMS USED**

- |               |                 |
|---------------|-----------------|
| 1. Radiant    | ✓ 4. Chemical   |
| 2. Nuclear    | ✓ 5. Mechanical |
| ✓✓ 3. Thermal | 6. Electrical   |



## ENERGY MYSTERY SCENARIO: Riding a Bicycle

### ENERGY FORMS USED

- |              |                 |
|--------------|-----------------|
| ✓ 1. Radiant | ✓✓ 4. Chemical  |
| 2. Nuclear   | ✓ 5. Mechanical |
| 3. Thermal   | 6. Electrical   |

## ENERGY MYSTERY SCENARIO: Riding a Motorcycle

### ENERGY FORMS USED

- |            |                  |
|------------|------------------|
| 1. Radiant | ✓ 4. Chemical    |
| 2. Nuclear | ✓ 5. Mechanical  |
| 3. Thermal | ✓✓ 6. Electrical |

## ENERGY MYSTERY SCENARIO: Watching T.V.

### ENERGY FORMS USED

- |               |                 |
|---------------|-----------------|
| ✓✓ 1. Radiant | ✓ 4. Chemical   |
| 2. Nuclear    | 5. Mechanical   |
| ✓ 3. Thermal  | ✓ 6. Electrical |

## ENERGY MYSTERY SCENARIO: Driving a Car

### ENERGY FORMS USED

- |               |                 |
|---------------|-----------------|
| 1. Radiant    | ✓ 4. Chemical   |
| 2. Nuclear    | ✓ 5. Mechanical |
| ✓✓ 3. Thermal | ✓ 6. Electrical |

## ENERGY MYSTERY SCENARIO: Mowing the Lawn *with a gasoline powered push mower*

### ENERGY FORMS USED

- |            |                 |
|------------|-----------------|
| 1. Radiant | ✓✓ 4. Chemical  |
| 2. Nuclear | ✓ 5. Mechanical |
| 3. Thermal | ✓ 6. Electrical |

## ENERGY MYSTERY SCENARIO: Playing a Video Game

### ENERGY FORMS USED

- |              |                 |
|--------------|-----------------|
| ✓ 1. Radiant | ✓✓ 4. Chemical  |
| 2. Nuclear   | ✓ 5. Mechanical |
| 3. Thermal   | ✓ 6. Electrical |



### ENERGY MYSTERY SCENARIO: Flying a Kite

#### ENERGY FORMS USED

- |               |                 |
|---------------|-----------------|
| ✓ 1. Radiant  | ✓ 4. Chemical   |
| ✓ 2. Nuclear  | ✓ 5. Mechanical |
| ✓✓ 3. Thermal | ✓ 6. Electrical |

### ENERGY MYSTERY SCENARIO: Listening to Your MP3 Player

#### ENERGY FORMS USED

- |              |                 |
|--------------|-----------------|
| ✓ 1. Radiant | ✓✓ 4. Chemical  |
| 2. Nuclear   | ✓ 5. Mechanical |
| 3. Thermal   | ✓ 6. Electrical |

### ENERGY MYSTERY SCENARIO: Playing Basketball Outdoors

#### ENERGY FORMS USED

- |               |                 |
|---------------|-----------------|
| ✓ 1. Radiant  | ✓ 4. Chemical   |
| ✓✓ 2. Nuclear | ✓ 5. Mechanical |
| ✓ 3. Thermal  | 6. Electrical   |

### ENERGY MYSTERY SCENARIO: Getting a Haircut

#### ENERGY FORMS USED

- |            |                  |
|------------|------------------|
| 1. Radiant | ✓ 4. Chemical    |
| 2. Nuclear | ✓ 5. Mechanical  |
| 3. Thermal | ✓✓ 6. Electrical |

### ENERGY MYSTERY SCENARIO: Reading a Book

#### ENERGY FORMS USED

- |               |               |
|---------------|---------------|
| ✓✓ 1. Radiant | ✓ 4. Chemical |
| 2. Nuclear    | 5. Mechanical |
| 3. Thermal    | 6. Electrical |

### ENERGY MYSTERY SCENARIO: Brushing Your Teeth

#### ENERGY FORMS USED

- |            |                  |
|------------|------------------|
| 1. Radiant | ✓ 4. Chemical    |
| 2. Nuclear | ✓✓ 5. Mechanical |
| 3. Thermal | 6. Electrical    |





## ENERGY MYSTERY SCENARIO: Microwaving Popcorn

### ENERGY FORMS USED

- |               |                 |
|---------------|-----------------|
| ✓ 1. Radiant  | 4. Chemical     |
| 2. Nuclear    | ✓ 5. Mechanical |
| ✓✓ 3. Thermal | ✓ 6. Electrical |

## ENERGY MYSTERY SCENARIO: Blow Drying Your Hair

### ENERGY FORMS USED

- |               |                 |
|---------------|-----------------|
| ✓ 1. Radiant  | ✓ 4. Chemical   |
| 2. Nuclear    | ✓ 5. Mechanical |
| ✓✓ 3. Thermal | ✓ 6. Electrical |

## ENERGY MYSTERY SCENARIO: Sitting at a Camp Fire

### ENERGY FORMS USED

- |              |                |
|--------------|----------------|
| ✓ 1. Radiant | ✓✓ 4. Chemical |
| 2. Nuclear   | 5. Mechanical  |
| ✓ 3. Thermal | 6. Electrical  |

## ENERGY MYSTERY SCENARIO: Sharpening Your Pencil *with a manual sharp-ener*

### ENERGY FORMS USED

- |            |                 |
|------------|-----------------|
| 1. Radiant | ✓✓ 4. Chemical  |
| 2. Nuclear | ✓ 5. Mechanical |
| 3. Thermal | 6. Electrical   |

## ENERGY MYSTERY SCENARIO: Skateboarding

### ENERGY FORMS USED

- |              |                  |
|--------------|------------------|
| 1. Radiant   | ✓ 4. Chemical    |
| 2. Nuclear   | ✓✓ 5. Mechanical |
| ✓ 3. Thermal | ✓ 6. Electrical  |

## ENERGY MYSTERY SCENARIO: Getting a Soft Drink *from a vending machine*

### ENERGY FORMS USED

- |            |                 |
|------------|-----------------|
| 1. Radiant | ✓ 4. Chemical   |
| 2. Nuclear | ✓ 5. Mechanical |
| 3. Thermal | ✓ 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

**ENERGY MYSTERY SCENARIO:****ENERGY FORMS USED**

- |            |               |
|------------|---------------|
| 1. Radiant | 4. Chemical   |
| 2. Nuclear | 5. Mechanical |
| 3. Thermal | 6. Electrical |

# ACTIVITY 3 What Is It?

**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

A **renewable** resource is able to be replaced or restored.  
A **non-renewable** resource is *not* able to be replaced or restored.  
Can you think of any renewable resources? How about non-renewable? Today we are going to learn more about these natural resources and their importance in our lives.

## DO: WHAT IS IT?

- ✓ Divide youth into groups of 10 and give each youth in each group one picture or one word card.
- ✓ Have the group "pair" up, one picture and one word card that matches or goes together. Then have each group evaluate the right and wrong answers.
- ✓ Have all the "renewable" pairs group together, and all the "non-renewable" pairs group together.
- ✓ Each group should discuss why their sources belong to that particular group and why they are important. (For example, coal is a non-renewable energy source. Why is it non-renewable? Why is it important for our lives?) Let the two groups share their discussion results with each other.

## REFLECT:

- ✓ What were the renewable resources? ***sun, wind, wood and water***
- ✓ What were the non-renewable resources? ***coal, oil, petroleum, uranium, gasoline, and natural gas***
- ✓ Why was each source in its category? ***either it can be replaced or not***
- ✓ Did you learn anything new? What was it? ***answers will vary***
- ✓ Why is this information important to us? ***answers will vary***
- ✓ Why are we concerned about energy sources and their supply? ***answers will vary***

## APPLY:

- ✓ How does this information impact how you feel about electricity and its sources for production?
- ✓ What other sources of energy might we use?
- ✓ What can we do to reduce the need for non-renewable energy sources?



### OBJECTIVES

Youth will be able to:

- ✓ distinguish between renewable and non-renewable energy sources.
- ✓ explain the importance and significance of each energy source in our lives.

### SETTING:

A large comfortable room with tables and chairs.

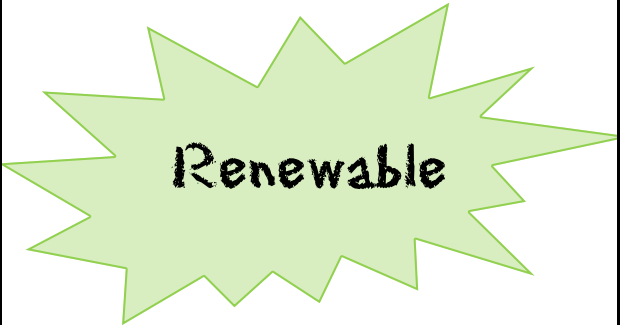
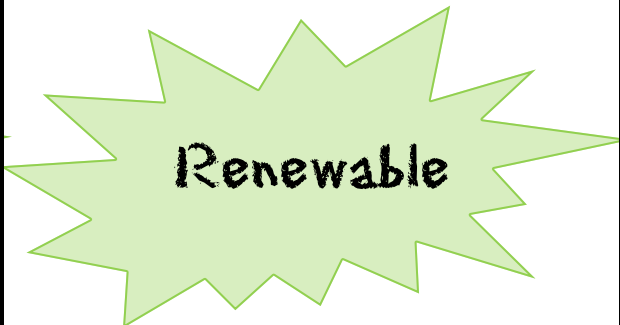
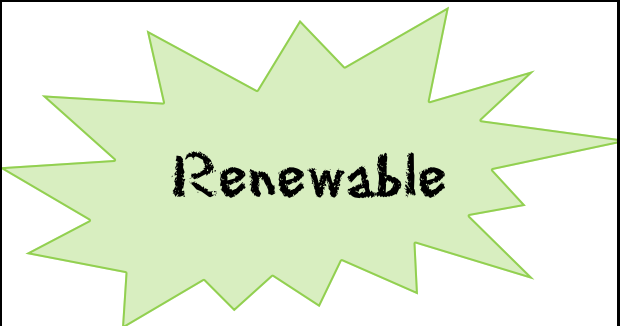
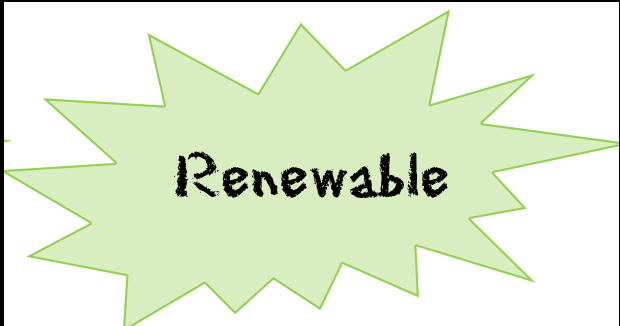
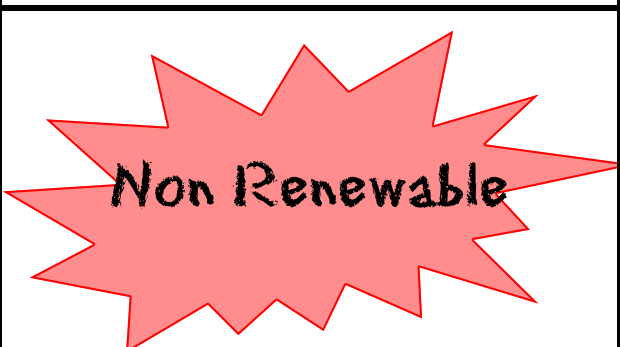
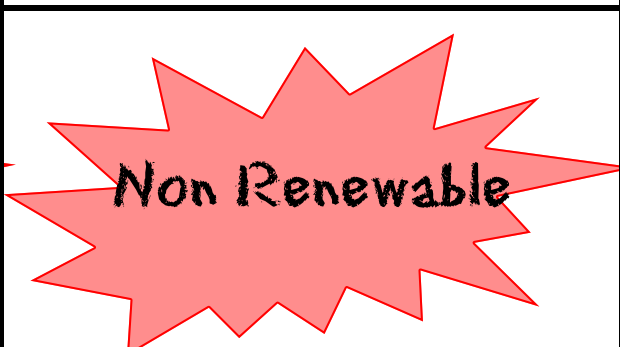
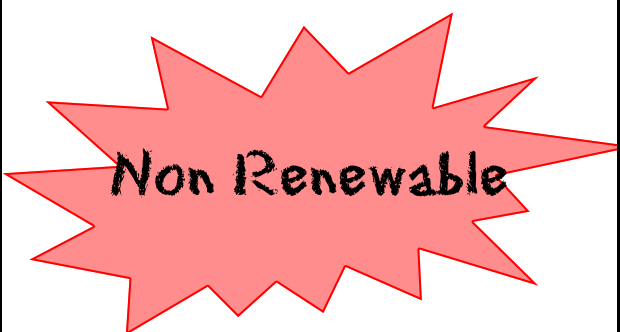
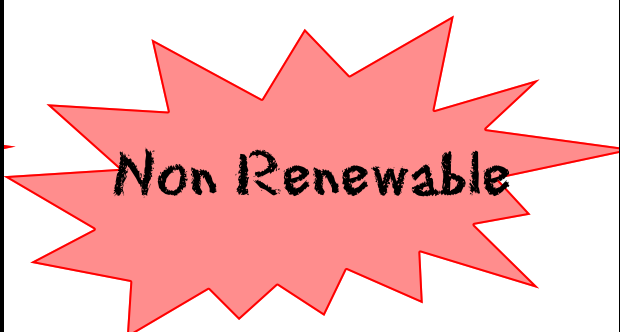
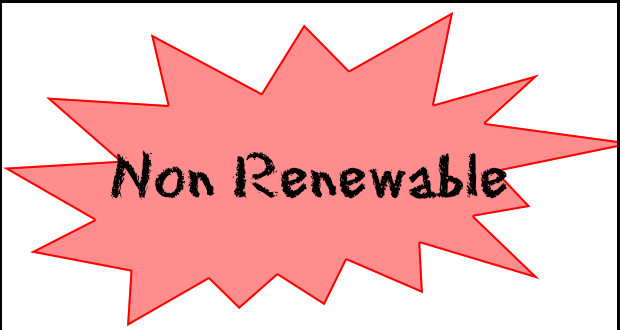
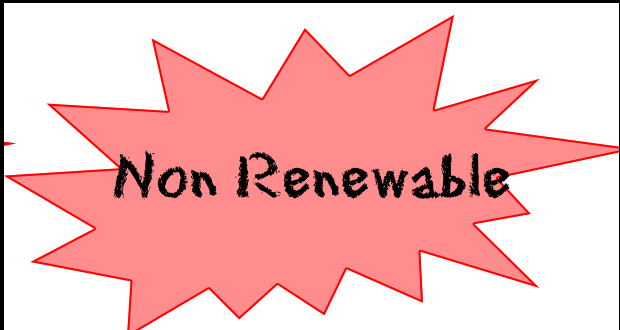
### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. Copies of ENERGY SOURCE PICTURE CARDS for each group
2. Copies of ENERGY SOURCE WORD CARDS for each group



 <p>Renewable</p>	 <p>Renewable</p>
 <p>Renewable</p>	 <p>Renewable</p>
 <p>Non Renewable</p>	 <p>Non Renewable</p>
 <p>Non Renewable</p>	 <p>Non Renewable</p>
 <p>Non Renewable</p>	 <p>Non Renewable</p>



SUN	OIL
WATER	PETROLEUM
GASOLINE	URANIUM
COAL	WOOD
NATURAL GAS	WIND





# ACTIVITY 4 Atoms and Electricity



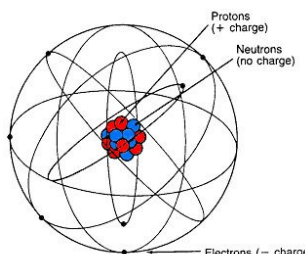
**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

We depend on electricity to heat our water to take a shower, to power the pump that delivers the water, and cool the refrigerator where we store our food. But we take all this for granted. How is electricity generated? Let's find out!

## DO: ATOMS AND ELECTRICITY

- ✦ Divide youth into groups of 3 or 4 and distribute materials.
- ✦ Have group glue 8 black jelly beans (neutrons) evenly across the surface of each Styrofoam ball (atom). Then glue 8 green jelly beans (protons) evenly across the surface of each Styrofoam ball (place around the black beans). This makes up the nucleus of the atom.
- ✦ Insert 8 toothpicks/bamboo skewers of varying lengths with red jelly beans (electrons) attached to the end into each Styrofoam ball (nucleus).
  - Push some electrons closer to the nucleus (into the balls), others stay further away. The electrons circle the protons and neutrons in layers making some electrons easier to pull away from one atom to another.
- ✦ This is the model of an element that is neutral due to an even number of protons and electrons. It can become positively or negatively charged depending on the number of electrons (red).
- ✦ The movement of electrons can be demonstrated by moving the jellybean toothpicks (red) from one ball (atom) to another, creating an imbalance of electrons (red). The atoms then become positively or negatively charged.
  - Have youth create one positively charged atom by subtracting some toothpicks and label it.
  - Then have youth create one negatively charged atom by adding toothpicks and label it.
- ✦ Using approximately twenty neutral Styrofoam atoms, place them side by side in a continuous circle. Remove one electron (jellybean toothpick) from an atom and insert into the atom ahead of it. The electron flow will be in one direction in a continuous circle.



### OBJECTIVES

Youth will be able to:

- ✦ identify the components of an atom.
- ✦ demonstrate positive and negative charges in atoms.

### SETTING:

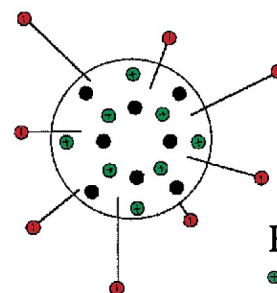
A large comfortable room with tables and chairs.

### LESSON TIME:

45 minutes

### ADVANCE PREPARATION & MATERIALS

1. Copies of a PERIODIC TABLE which can be found in a high school or chemistry book
2. Copies of ATOMS AND ELECTRICITY ACTIVITY PAGE
3. 2-1" Styrofoam balls for each group
4. 16 toothpicks/bamboo skewers of varying lengths for each group
5. 24 jelly beans (8 black, 8 red, 8 green) for each group
6. Note cards
7. Pencils
8. Glue



### KEY

- = proton
- = neutron
- = electron





## REFLECT:

- ✓ Look at the models of the atoms. How do we know which atoms are negative and which are positive besides the labels? **Because of the number of electrons**
- ✓ If there is an equal number of protons and electrons, what type of charge does the atom have? **Creates a stable atom**
- ✓ Take five electrons from one atom and move them to the second atom. What type of charge does each atom have now? Do they attract electrons or repel electrons? **Atom one is positively charged and attracts electrons, atom two is negatively charged and will repel electrons.**
- ✓ Where do we find more information about this? **Answers may vary.**
- ✓ How is this information useful to us? **Answers will vary**

## DO: Part II - ATOMS AND ELECTRICITY

- ✓ Leaving youth in their groups of 3 to 4, hand out a copy of a periodic table to each group.
- ✓ Have each group construct 2 to 4 basic elements using Styrofoam balls, toothpicks and beads.
- ✓ Have each group share with the others which elements they create and the composition of each.

## REFLECT :

- ✓ Relate what we know about atoms to the composite make-up of the elements. **Example: Hydrogen (H)- 1 proton in nuclei of any of its atoms, also called the atomic number**
- ✓ What are elements? **Stable substances that have the same atomic number (number of protons)**
- ✓ How do we use elements? **Answers will vary**

## APPLY:

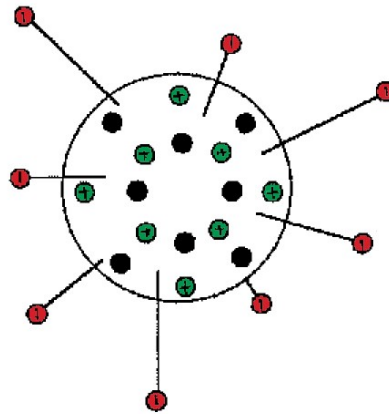
- ✓ Explain what happens when many atoms change the number of electrons they are carrying? Relate this to electricity.
- ✓ How do we use elements?



## Atoms and Electricity

### What You Need:

- ✓ 8 black jelly beans
- ✓ 8 green jelly beans
- ✓ 8 red jelly beans
- ✓ Styrofoam ball
- ✓ Toothpicks/bamboo skewers
- ✓ Glue



### KEY

- ⊕ = proton
- = neutron
- ⊖ = electron

### What You Do:

1. Glue 8 black jelly beans (neutrons) evenly across the surface of each Styrofoam ball (atom). Then glue 8 green jelly beans (protons) evenly across the surface of each Styrofoam ball (place around the black beans). This makes up the **NUCLEUS** of the atom.
2. Insert 8 toothpicks/bamboo skewers of varying lengths with red jelly beans (electrons) attached to the end into each Styrofoam ball (nucleus).
3. Push some electrons closer to the nucleus (into the balls), others stay further away. The electrons circle the protons and neutrons in layers making some electrons easier to pull away from one atom to another.
4. The movement of electrons can be demonstrated by moving the jellybean toothpicks (red) from one ball (atom) to another, creating an imbalance of electrons (red). The atoms then become positively or negatively charged.
  - Create one positively charged atom by subtracting some toothpicks and label it.
  - Create one negatively charged atom by adding toothpicks and label it.





# ACTIVITY 5 Electron Action

**LIFE SKILLS:** Acquiring, analyzing, and using information

## BACKGROUND:

Atoms, and all matter, are made up of the fundamental particles: electrons, protons, and neutrons. Electrons are negatively charged, protons are positively charged, and neutrons have no charge. The "charge" on a proton is equal in magnitude to the "charge" on an electron. The nucleus of an atom, in general, is composed of protons and neutrons. The nucleus is surrounded by clouds of electrons. Whenever most objects are left undisturbed for an unspecified length of time, their protons and electrons are equal in number and the objects are regarded as having balanced electrical "charge."

Some objects will pick up excess electrons from material rubbed on them while others transfer excess electrons to material rubbed against them. When a balloon is rubbed on a piece of wool, the balloon picks up excess electrons from the wool. Now the balloon is regarded as being negatively "charged." A wall may be regarded as a neutrally "charged" surface. Both positively and negatively "charged" objects are capable of being attracted to neutrally charged objects. Like "charges" repel, unlike "charges" attract. In both cases, static electricity is at work.

## INTRODUCTION:

Have you ever walked across a carpeted room and touched the door handle and received a little shock? Have you ever got out of a car and touched the door to close it and received a shock? These are examples of static electricity, which occurs thanks to the movement of electrons. Electrons behave in certain ways. We see the effect of electron movement by the electricity generated and the lights that are on. We can also see the effect of electron movement through some simple and fun activities:

## DO: Part I - ELECTRIC HAIR

- ✓ Have youth refer to the ELECTRON ACTION ACTIVITY PAGE.
- ✓ Distribute to youth a plastic comb and a handful of the ½ inch cut-out paper squares.
- ✓ Have youth, using the plastic comb, comb their hair for about 1 minute.
- ✓ Have youth put the teeth of the comb on the ½ inch cut-out square paper and lift carefully.



### OBJECTIVES

Youth will be able to:

- ✓ demonstrate static electricity.
- ✓ explain how static electricity "works" in the environment.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

15 minutes

### ADVANCE PREPARATION & MATERIALS

1. Copies of ELECTRON ACTION ACTIVITY PAGE
2. Cut out the ½ inch squares of paper
3. Plastic comb for each youth
4. 2 balloons for each youth
5. 3 feet of thread for each youth
6. Piece of nylon, wool, fur, or clothing



## DO: Part II - BALLOON MAGIC

- ✓ Have youth refer to the ELECTRON ACTION ACTIVITY PAGE.
- ✓ Distribute a balloon to each youth and have them inflate and knot the end of the balloon.
- ✓ Have youth rub the balloon in their hair for about 1 minute.
- ✓ Have youth place the “rubbed side” of the balloon against the wall.

## REFLECT:

- ✓ What happens to the balloon when placed against the wall? **It sticks; the positive charged balloon was attracted to the neutrally charged wall.**

## DO: Part III - BALLOON PAIRS

- ✓ Have youth “pair up” together so they have two balloons.
- ✓ Have them tie their balloons together with a long piece of thread.
- ✓ Have youth “charge” each balloon by rubbing them with nylon, wool or clothing for 1 minute.
- ✓ Have youth hold thread in the middle of their arm stretched out so that the balloons are equal distance from the middle of the thread, and let the balloons hang freely.

## REFLECT:

- ✓ What happens to the balloons? Why? **They repel each other; they have the same charge**
- ✓ Do you hear a crackling sound when you rub the balloon against the cloth? Do you see sparks? **Answers will vary**
- ✓ Where did the electrons come from? **The material**

## APPLY:

- ✓ How have you experienced static electricity before? **Answers will vary**
- ✓ Explain what causes static electricity. **Attraction of repulsion of charges**

### Example Application:

Ask youth to look for metal stripping in the middle of the road in front of a toll booth. Ask youth what purpose the metal strands have. (When vehicles travel on the highway, they build up static electricity. As vehicles rub on the strands of metal, the stored electricity is discharged into the ground. If the strips were not present, a spark would pass between the driver and the toll booth operator.)



## Electron Action

### Electric Hair

#### What You Need:

- ✓ Plastic comb
- ✓ ½ inch cut-out paper squares

#### What You Do:

- ✎ Using the plastic comb, comb through your hair for about 1 minute.
- ✎ Put the teeth of the comb on the pieces of paper and lift carefully.

### Balloon Magic

#### What You Need:

- ✓ Balloon

#### What You Do:

- ✎ Inflate and knot the end of the balloon.
- ✎ Rub the balloon in your hair for about 1 minute.
- ✎ Place the rubbed side of the balloon against the wall.

### Now, try this...

- ✓ Tie two balloons together with a long piece of thread.
- ✓ Charge each balloon by rubbing them with nylon, wool, or on your clothing for 1 minute.
- ✓ Hold the thread in the middle with your arm stretched out so that the balloons are equal distance from the middle of the thread.
- ✓ Let the balloons hang freely.
- ✓ Describe what you saw and explain why you think it happened:





# ACTIVITY 6 Nature's Electric Energy



**LIFE SKILLS:** Communicating and relating with others

## INTRODUCTION:

Have you ever been caught in a storm where lightning struck close by? Lightning is a phenomena of nature. What are other natural phenomena? (earthquakes, tornados, hurricanes, etc.). Let's learn more about lightning by doing a little "research."

## DO: NATURE'S ELECTRIC ENERGY

- ✓ As you pass out NATURE'S ELECTRICITY Activity Sheet, ask youth about how they might research the topic of lightning.
- ✓ Have youth work in pairs of small groups of "research teams" to develop a list of information on the natural phenomenon of lightning from the library of resource materials provided. Use the activity sheet as a guide for the research.
- ✓ Arrange for a guest to be available to interact with the research teams to answer interview questions. (You may want to provide each guest with the interview questions prior to their interaction with the youth if time and scheduling permit.)
- ✓ Have each team determine three interview questions to ask the guest about lightning and write them on the activity sheet.
- ✓ Have each team organize the information they've collected during the interview and their own research. Have them prepare a newspaper release, newsletter article, illustrated talk, or science exhibit featuring the data collected about lightning.

### OBJECTIVES

Youth will be able to:

- ✓ explain how lightning and thunder are formed.
- ✓ develop research skills.
- ✓ discover how electricity is formed in the environment.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

60 minutes

### ADVANCE PREPARATION & MATERIALS

1. Copies of NATURE'S ELECTRICITY ACTIVITY PAGES for each youth
2. Paper and pencils
3. Access to a library of resource materials
4. Copy of DO'S AND DON'TS OF A GUEST SPEAKER handout

## REFLECT:

- ✓ What was your best source of information about lightning? Why? **Answers will vary**
- ✓ Why does lightning and thunder occur? **Differences in the atmospheric charges**
- ✓ Does lightning occur only during thunderstorms? What of why not?
- ✓ Can lightning affect our use of electrical appliances? If so, how?

## APPLY:

- ✓ How can lightning affect the environment? **Starts fires, destroy trees, electrocute animals**
- ✓ What are some standards of safety precautions that people should utilize during an electrical storm when they're inside? Outside? **Answers will vary**





## Nature's Electricity

As you research, look for answers or explanations to the following questions:

- ✎ When does lightning occur?
- ✎ When does lightning form?
- ✎ What role do electrons have in making lightning?
- ✎ What is thunder and how is it formed?
- ✎ How long (time-wise) does lightning last?
- ✎ How far away is the lightning if you hear thunder?
- ✎ How often does lightning strike in Florida?
- ✎ What can we do to keep safe in a lightning storm?



## Interview Questions

As a result of your research on lightning, write three questions or things about lightning that you still would like to know:

1.

2.

3.





# ACTIVITY 7 Chemical Energy

**LIFE SKILLS:** Acquiring, analyzing, using information

## BACKGROUND:

### PLEASE READ BACKGROUND INFORMATION

Batteries are small energy storing devices that are either classified as wet cell or dry cell. Wet cell batteries use metals and chemicals to "move" atoms and electrons to produce charges, that when connected, allow for the electric current to flow. This flow is called a Direct Current (DC) because the flow is in one direction; from negative to positive. These types of batteries are used in automobiles, boats, etc. Dry cell batteries operate in very much the same way except the chemicals used are in the form of a paste not a liquid. These are a more common form of batteries and are used in many appliances, games, etc. (Note: The voltage in dry cell batteries is very low (1.5 volts maximum) providing no noticeable shock.)

## INTRODUCTION:

We've learned that electron flow is the key to electricity. We've also learned about the different forms of energy. What are they? How can we get a steady flow of electrons? How might we use the forms of energy to produce a steady flow of electrons? How might a battery help us? Batteries are little energy storing devices. Do we use "electricity" or electron flow with batteries? Let's learn more about batteries and electron flow.

## DO: Part I - DC-FROM BATTERIES

- ✓ Have youth work in groups and list on a sheet of paper how batteries are used everyday? (flashlights, radios, cars, etc.)
- ✓ Ask youth to be thinking of the following questions they will be asked to answer. Are all batteries the same size? Do they all last the same amount of time? How are they different?
- ✓ Distribute necessary materials to youth.
- ✓ Have the youth fill the glass within  $\frac{1}{2}$  inch of the top with the warm water. Add the salt and stir with a spoon, as shown in Figure 1.



Figure 1



### OBJECTIVES

Youth will be able to:

- ✓ demonstrate the movement of electrons in batteries in one direction.
- ✓ identify 2 types of batteries.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. Gather appropriate materials
2. Review information in Background Basics
3. Copies of CHEMICAL ENERGY ACTIVITY PAGE
4. 8 oz. glass
5. Plastic spoon
6. 4 tablespoons salt
7. 30"(inches) terminal wire
8. 6 inch strip of copper wire
9. 6 inch strip of zinc
10. 6 oz. warm distilled water
11. Compass
12. Low metal glue gun
13. Paper and Pencil for each youth
14. Copies of Wet Cell Battery Picture for each group
15. Copies of Dry Cell Battery Picture for each group



- ✎ Have the youth carefully add the copper and zinc strips to either side of the glass as shown in *Figure 2*.
- ✎ Have youth wrap the terminal wire around the compass, and note compass reading.
- ✎ Using the glue gun, connect one end of the terminal wire to the zinc strip and the other end to the copper strip, as shown in *Figure 3*.

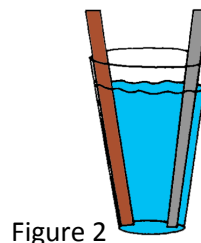


Figure 2



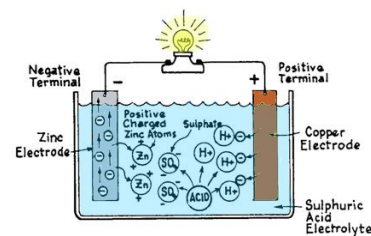
Figure 3

## REFLECT:

- ✎ Is an electric current present when the terminal wires are connected to the zinc and copper strips? How do we know? **Yes; the compass will show magnetic field that is generated from the zinc, copper, and salt water; electrons are flowing from (-) to (+)**
- ✎ What form of energy does this electrical current come from? Why? **Chemicals; because the battery is using the stored energy of the chemicals and the flow of atoms between the chemicals to generate the current**
- ✎ Using the zinc and copper with salt water we notice electrons movement by the movement of our compass. How might this process be used for electricity? **In batteries**

## DO: Part II - DC-FROM BATTERIES

- ✎ Using the WET CELL picture (page 36), ask youth to identify the materials used in the battery. How are they similar to the experiment? (Copper, Zinc used). Explain to youth how electrons flow in the wet cell battery (review the information in the Background Basics on batteries for this).
- ✎ Using the DRY CELL picture (page 37), ask youth to identify the materials used in the battery. How are they similar or different from the experiment and a wet cell battery? Explain to youth how electrons move in a dry cell battery (again, review the information in the Background Basics).
- ✎ Have youth trace the electron flow in both the wet and dry cell batteries.



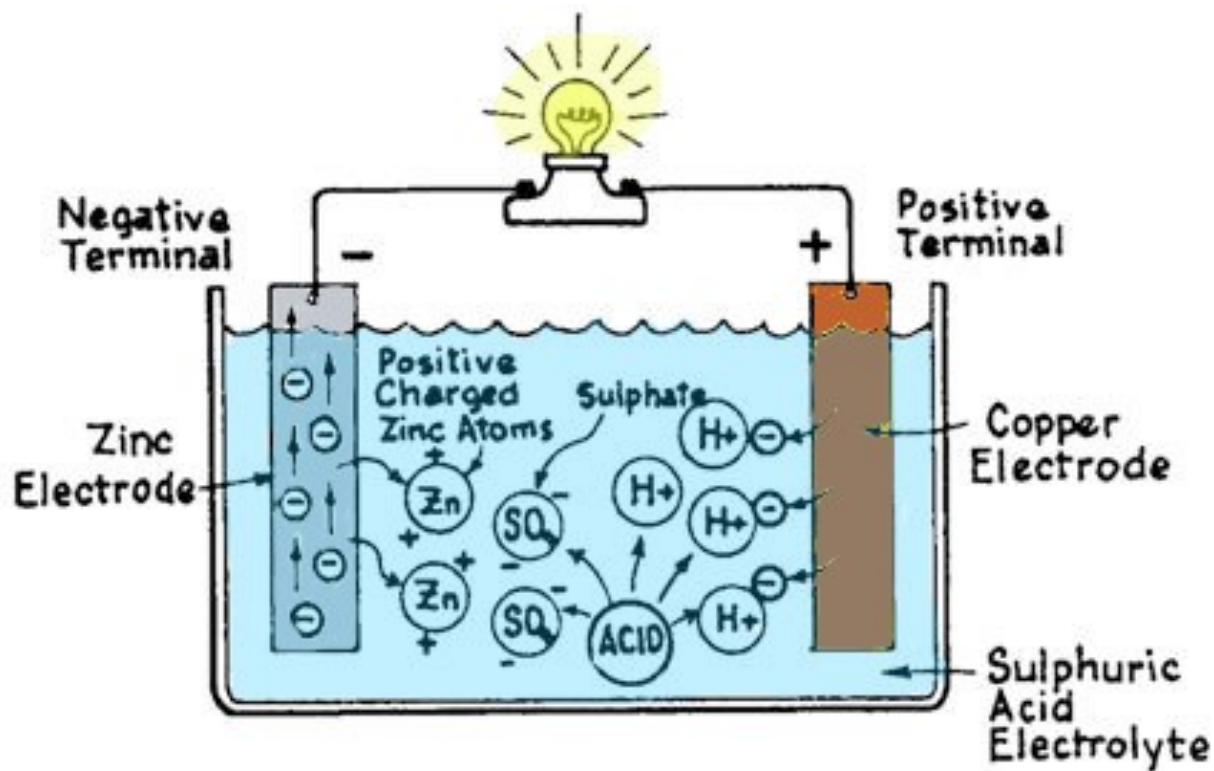
## REFLECT/APPLY:

- ✎ How do electrons flow in both the wet and dry cell batteries? **From Zinc to the Copper of Carbon and/or from (-) to (+)**
- ✎ What produce the electrons in a wet cell battery? **Zinc**
- ✎ What form of energy are we using in batteries? **Chemical**
- ✎ How can we use batteries and direct current to increase the amount of energy we want? **Batteries place (-) to (+)**



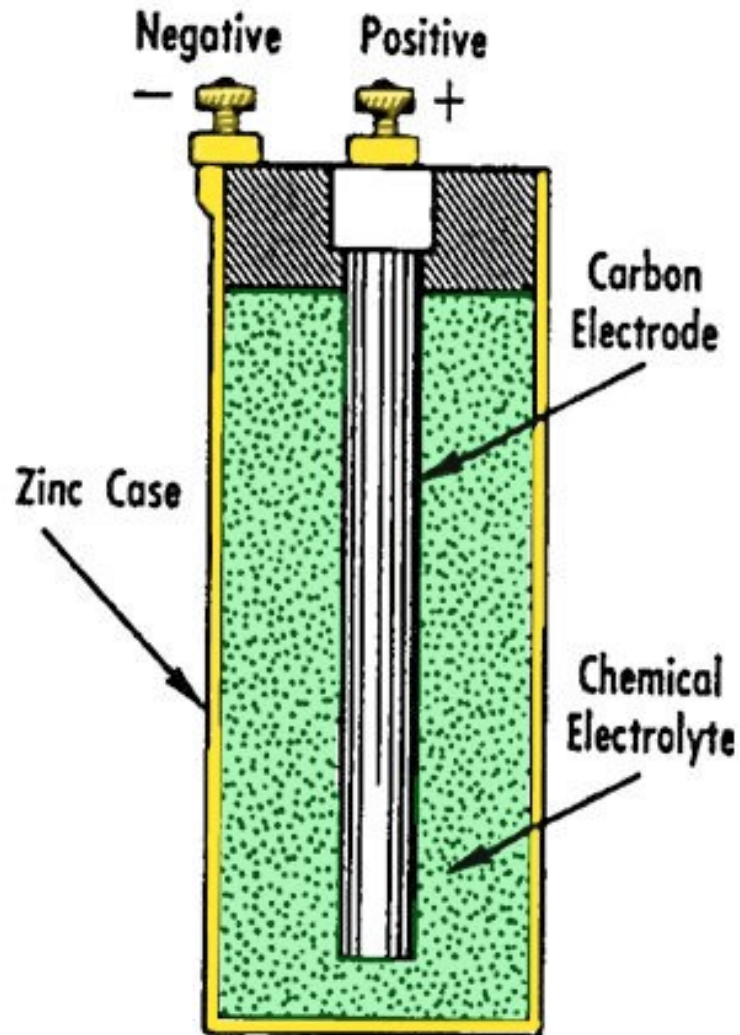
# The Power of Electricity

## Wet Cell Battery



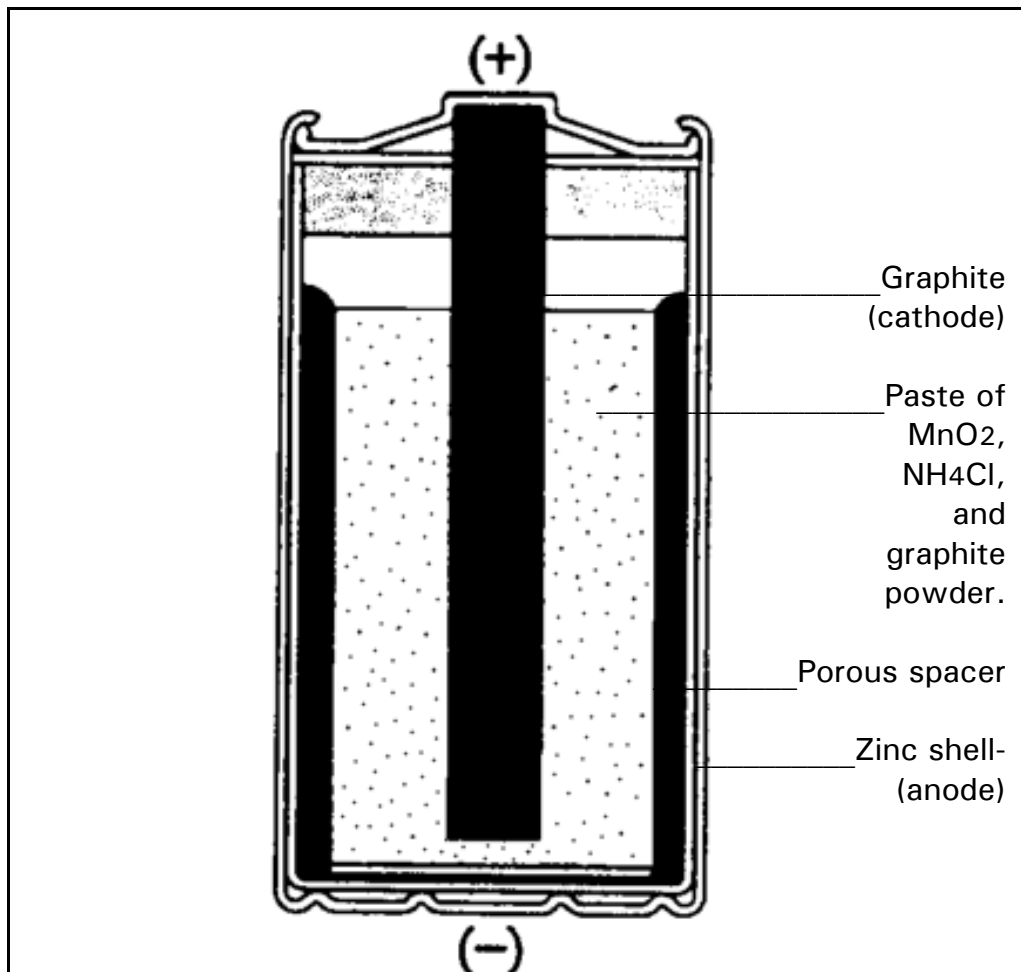
# The Power of Electricity

## Dry Cell Battery



# The Power of Electricity

## Zinc-Carbon Dry Cell





## Chemical Energy

### What You Need:

- ✓ 8 oz. glass
- ✓ Plastic spoon
- ✓ 4 Tablespoons of salt
- ✓ 30 inches terminal wire
- ✓ 6-inch strip of copper
- ✓ 6-inch strip of zinc
- ✓ 6 oz. warm distilled water
- ✓ Compass
- ✓ Low melt glue gun

### What You Do:

- ✓ Fill the glass within  $\frac{1}{2}$  inch of the top with the warm water. Add the salt and stir with a spoon, as shown in *Figure 1*.
- ✓ Have the youth carefully add the copper and zinc strips to either side of the glass as shown in *Figure 2*.
- ✓ Have youth wrap the terminal wire around the compass, and note compass reading.
- ✓ Using the glue gun, connect one end of the terminal wire to the zinc strip and the other end to the copper strip, as shown in *Figure 3*.

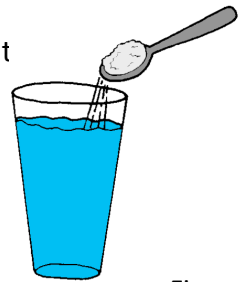


Figure 1

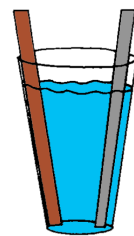


Figure 2



Figure 3

What direction does the compass point:

When the wire is wrapped around it? \_\_\_\_\_

When the wire is attached to the copper and zinc? \_\_\_\_\_

The copper has a \_\_\_\_\_ charge and the zinc has a \_\_\_\_\_ charge.



# ACTIVITY 8 Zapped!

**LIFE SKILLS:** Acquiring, analyzing, using information

## INTRODUCTION:

We've studied about our dependency on electrical energy, the forms of energy and the relationship of atomic particles to electrical energy. Let's see how much you really learned by playing "ZAPPED!"

## DO: Play "ZAPPED!" (this game is similar to OLD MAID)

- ✓ Have youth work in groups and list on a sheet of paper how batteries are used everyday? (flashlights, radios, cars, etc.)
- ✓ Divide the group into four teams of two to six players.
- ✓ A full deck is dealt among each team going clockwise in the group. Immediately after the deal, each team member checks their hand for matched pairs. A matched pair consists of the term and the meaning. The matched pairs are placed in front of each team member on the table.
- ✓ The first team member starting clockwise to the dealer can ask any other team member for a match to a card in its hand. If the team member does not have the matched pair but it does have the "ZAPPED!" card, it can pass the "ZAPPED!" card to the asking team member.
- ✓ If the giving member does not have a card to pass to the asking team member, the asking team member must draw a card from the team member on its left. Continue playing until all matches are made.
- ✓ "ZAPPED!" has no match. The team member holding this card cannot win the game.

## REFLECT/APPLY:

- ✓ Which of these concepts occur naturally? **Answers will vary**
- ✓ Which represent non-renewable and renewable energy sources? **Answers will vary**
- ✓ What did you learn about renewable and non-renewable resources? **Answers will vary**
- ✓ Did you learn anything new? What? **Answers will vary**
- ✓ Why is it important to know about renewable and non-renewable energy sources?
- ✓ How do these sources impact our lives?



### OBJECTIVES

Youth will be able to:

- ✓ define electric terms and associate their use in electrical energy.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. Prepare the deck of cards using the master provided. Each group/team receives 55 cards plus a ZAPPED! Card
2. Copies of ZAPPED! Playing Cards for each group/team



TERM	DEFINITION
<b>Atom</b>	the smallest particle of an element with the chemical properties of that element
<b>Proton</b>	a positively charged particle located in the atomic nucleus
<b>Electron</b>	a negatively charged particle located at some distance from the atomic nucleus
<b>Neutron</b>	a neutrally charged particle found in the atomic nucleus
<b>Motion Energy</b>	waves on the move
<b>Chemical Energy</b>	stored energy waiting to be moved
<b>Electrical Energy</b>	electrons on the move
<b>Thermal Energy</b>	molecules on the move
<b>Radiant Energy</b>	light rays on the move
<b>Mechanical Energy</b>	puts objects on the move
<b>Electricity</b>	secondary source of energy
<b>Lightning</b>	nature's electricity
<b>Non-renewable</b>	not able to be replaced
<b>Renewable</b>	able to be replaced or restored
<b>Coal</b>	one non-renewable resource
<b>Petroleum</b>	one non-renewable resource
<b>Oil</b>	one non-renewable resource
<b>Water</b>	one renewable resource
<b>Wind</b>	one renewable resource
<b>Solar</b>	one renewable resource
<b>Battery</b>	a group of 2 or more cells connected together to furnish electric current
<b>Direct Current</b>	electric current flowing in one direction only and substantially constant in value
<b>Nucleus</b>	the core of an atom which contains the protons and neutrons
<b>Current</b>	a flow of electricity similar to the flow of a river
<b>Conductor</b>	a substance or body capable of transmitting electricity
<b>Insulator</b>	a material that is poor for transmitting electricity



# ZAPPED! Cards

**ATOM**

**PROTON**

**ELECTRON**

**NEUTRON**

**MOTION  
ENERGY**

**CHEMICAL  
ENERGY**



# ZAPPED! Cards

<b>ELECTRICAL ENERGY</b>	<b>THERMAL ENERGY</b>
<b>RADIANT ENERGY</b>	<b>MECHANICAL ENERGY</b>
<b>ELECTRICITY</b>	<b>LIGHTNING</b>



# ZAPPED! Cards

<b>NON-RENEWABLE</b>	<b>RENEWABLE</b>
<b>COAL</b>	<b>PETROLEUM</b>
<b>OIL</b>	<b>WATER</b>



# ZAPPED! Cards

**WIND**

**SOLAR**

**BATTERY**

**DIRECT  
CURRENT**

**NUCLEUS**

**CURRENT**



# ZAPPED! Cards

<b>INSULATOR</b>	<b>CONDUCTOR</b>
the smallest particle of an element with the chemical properties of that element	a positively charged particle located in the atomic nucleus
a negatively charged particle located at some distance from the atomic nucleus	a neutrally charged particle found in the atomic nucleus





# ZAPPED! Cards

waves on the move	stored energy waiting to be moved
electrons on the move	molecules on the move
light rays on the move	puts objects on the move



# ZAPPED! Cards

secondary source of energy	nature's electricity
not able to be replaced	able to be replaced or restored
one non-renewable resource	one non-renewable resource



# ZAPPED! Cards

one non-renewable resource	one renewable resource
one renewable resource	one renewable resource
a group of 2 or more cells connected together to furnish electric current	electric current flowing in one direction only and substantially constant in value



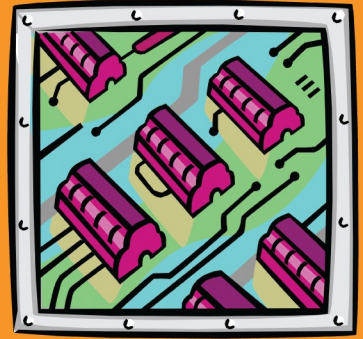
# ZAPPED! Cards

the core of an atom which contains the protons and neutrons	a flow of electricity similar to the flow of a river
a substance or body capable of transmitting electricity	a material that is poor for transmitting electricity





## How Electricity Travels



### KEY CONCEPT:

To explore how electrons move in electric energy.

### OBJECTIVES:

Youth will be able to:

- ✎ determine conductivity of various materials.
- ✎ identify electric currents.
- ✎ identify various forms of electricity (battery - chemical).
- ✎ define DC currents.
- ✎ identify use of electric currents.
- ✎ explain electric measurements. (kw, kwh, volts, amps, watt)
- ✎ demonstrate, explain, and build electric circuits.

### ADVANCED PREPARATIONS:

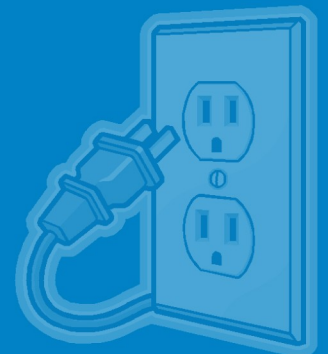
1. Read BACKGROUND BASICS for this lesson.
2. Review activities and choose appropriate one(s) to use.
3. Secure necessary materials as described.

**DO:** The following must be done in order using the activities in Lesson 2. Materials needed for each are listed within the activity.

- ✎ Discover what conducts electron movement in **TO CONDUCT OR NOT**.
- ✎ Investigate more about an electron movement through **A CURRENT DISCOVERY**.
- ✎ Complete **SIX BILLION BILLION** to learn how electron flow is measured.
- ✎ Discover how electrons flow through circuits in **ELECTRON RACETRACKS**.
- ✎ Make a lighted picture in **LIGHTS ALL AROUND** to use what you've learned about circuits.

### LESSON TIME:

Lesson time will vary upon learning activities selected. Lesson activities also vary depending upon numbers of youth. Most activities are approximately **45 minutes**.



## REFLECT on what was learned and why with these questions:

- ✓ Which materials conduct electricity? **Answers will vary but be mostly various metals**
- ✓ What are “open” and “closed” circuits? **Open– electrons do not flow completely through the circuit; Closed– electrons allowed to flow completely through circuit**
- ✓ In what direction do electrons flow? **Negative to positive**
- ✓ How is the force of electrons measured? The speed? **Voltage, ampere**
- ✓ What is a amp? **Number of electrons that flow by a given point**
- ✓ What is a direct current? **Direct flow of electrons**
- ✓ What form of energy does an electrical current come from? **Electrical**
- ✓ What is a parallel circuit/A series circuit?

**Series – electron flows flow energy source through the circuit**

**Parallel – electrons flow to each part of the circuit**

- ✓ What type of circuit did you use to make the lighted picture? **Answers will vary**

## APPLY these connections to everyday life:

- ✓ Why do we need to know about “conductors” and “insulators” of electricity?
- ✓ How do we open and close circuits?
- ✓ How can the amps and volts effect our use of electricity?
- ✓ How can we use batteries and direct circuit to increase the amount of energy we want?
- ✓ In what situations can you think of that would be a good use of a series circuit? A parallel circuit?
- ✓ How else can we use wiring?

## Background Basics:

### CURRENT AND VOLTAGE

If you look closely at a home appliance (usually in a spot that isn't easy to see), you'll find some numbers. These numbers may be on a small chart stamped directly onto the appliance or on a small plate or sticker (nameplate) attached to the appliance. Beside giving the model and serial numbers, you may also find terms like "Volts: 110," "Amperes:2.1," or "Watts: 1350." These numbers are important since they tell how much electricity is needed to make the appliance to work properly. Let's consider how we define a flow electrons so we can tell someone else just how large that flow is.

The word "flow" often suggests water. This is appropriate since there are many similarities between the flow of water and the flow of electricity. In fact, a water system is very much like an electrical system. The way of electricity flows through a wire is similar to the flow of water through a water pipe. The rate of flow in each case can be measured; water in gallons-per-minute and electric current in amperes, or **amps**, for short.



These terms are substituted for the billions of water droplets and electrons which move through pipes or wire. One "ampere" is 6,300,000,000,000,000,000 (more than six billion billion) electrons passing a point each second. As you can see, this number of electrons is pretty difficult to work with because it is so large! Obviously, it's a lot easier to use a unit of measure like the ampere or amp to measure the rate of flow of electricity.

Often the nameplate will say how many amps the appliance needs to do its work properly. Some appliances, like radios, only need a fraction of an amp, while some heating appliances or air conditioners may need as much as 10 amps or more. Generally, the more amps required, the larger the wire you will need to supply the electricity.

Just as water needs some pressure to force along in a pipe, electricity needs a force to make it flow. This force is known as "voltage." We measure water pressure with pounds-per-square-inch and electrical pressure in units called "**volts**." Therefore, volts are the measure of electrical pressure. Unless power is interrupted, a constant voltage is maintained in the wiring circuits of your home. When a switch is turned on, voltage moves the electrons along so they do their work.

Circuits in your home are supplied with 110 to 120 volts for lighting and small appliances. Appliances with nameplates indicating 110-120 volts can only be used for these circuits. You may find a piece of equipment labeled 120 volts,  $\frac{1}{4}$  amp. This means when that appliance is connected to a 120-volt circuit, an electric current of  $\frac{1}{4}$  amp will flow into it.

Your home probably also is supplied with 220-240 volt electricity for use in large appliances like electric ranges, clothes dryers, and large air conditioners. An appliance designed for 120 volts should never be plugged into a 240-volt outlet, nor should an appliance requiring 220-240 volts be plugged into a 120-volt circuit. These types of errors can result in extensive damage to the equipment. To help you avoid these costly mistakes, electrical outlets that supply high voltages are specially designed. The outlets will accept only special plugs. Ordinary two-pronged household electric cords will not fit into these outlets.

## TWO KINDS OF CURRENT

There are two ways in which electrons flow through a wire. One is called "direct current," because the electrons always travel in the same direction. We usually refer to direct current as "DC." DC current is the kind of electric current produced by batteries, as we learned in Lesson 1. Voltage in direct current always pushes the electrons in the same direction. That is, positive (+) is always in the same direction, as well as negative (-). In direct current, voltage has the same "polarity" at all times.

This type of current is important. It was the first kind of electric current put to use, and was for a long time the only current anyone knew anything about. DC is the kind of current used in your family car, and in any electrical system powered by a battery like flashlights, toy, or portable radios. However, DC is no longer the principle kind of electrical current since it loses most of its energy when carried over long distances, such as from a utility company to your home.

Another kind of electric current is called "alternating current" or "AC." Instead of always traveling in the same direction, AC causes electrons to travel first one way and then the opposite way. It changes direction many times a second. Therefore, the voltage in an AC system changes the direction in which it pushes the electrons--that is, its polarity--an equal number of times per second. Each change of polarity from plus to minus and back to plus is called one "cycle."





In the United States, the voltage in an AC current makes this complete cycle 60 times each second. So, it's called "60-cycle" AC. A 60-cycle AC is the kind of electricity used in your home as well as in business and industry. Because electric power suppliers maintain the 60-cycle value, your electric clock keeps accurate time.

The rate of alteration is so fast that we don't notice the flickering of our lights as the current stops very briefly between each cycle. AC is capable of doing almost all the things DC does, including the delivery of power to a circuit. AC, however, does some things that DC cannot do. For example, AC allows for easier transmission of electricity from one location to another. It also allows us to change voltage nearly anywhere along the circuit by using devices called "transformers."

AC is not produced from batteries. Instead, it is produced by large machines called "generators," which use magnetism. We will learn more about how generators and motors work in later Lessons. For now, it is enough to know the difference between AC and DC, and why the current in your house is not the same as the current that comes from a battery.

## CONDUCTORS AND NON-CONDUCTORS

Materials whose atoms hold their outermost electrons loosely, and allow them to jump from atom to atom and cause a flow of electrons, are rather important. If it were not for these materials, there would be no electricity. The wires that bring electricity to our homes, or from the wall outlet to the television or other appliance, are made of these materials. They permit electrons to flow with ease. These are called **conductors**. Materials like silver and gold are good conductors, but they cost far too much to be used for this purpose. Instead, copper, which is not quite so good, is widely used as a conductor because of its lower cost. In general, most metals are at least fair conductors of electricity, though some are better than others.

Some other materials do not let electrons flow easily through them. In these materials, atoms hold all their electrons so firmly that they cannot jump from atom to atom. They do not allow free electrons to pass either. Materials that hinder electricity from flowing are called **insulators**. Good insulators are materials like glass, plastic, rubber, and porcelain. Wood, paper, and even air tend to be insulators, but can break down and allow electricity to pass under certain conditions. Any insulator can let electricity pass if there is enough voltage.

People working with electricity know how to use conductors and insulators. Generally, the thicker the insulation, the higher the voltage it can hold. If a water pipe with thin walls is subjected to too much pressure, it may burst. This can also happen to insulation on a wire if it is forced to hold in too much voltage. When poor insulating material is used, a thicker layer is required.

Even with an insulator present, it is still important to be careful with electricity around water. Water can soak into or cover an insulating material and turn it into a conductor as quickly as you can say "ouch!" Even though insulators don't allow electricity to flow, they are just as important in the control of electricity as are conductors. Without them, the electrons would tend to "leak" out of the conductors into any metal object the conductor touches. Wrapping insulation around a conductor keeps the electron flow in the proper path. Insulators keep the electron flow from straying or getting out of control.



The electric cords to your lamps and appliances include conductors and insulators. Near the center are wires made of good conductor such as copper. Separating the wires and around the outside of the cord is a layer of insulation such as rubber or plastic. The cord keeps the electrons in the wires "in line" so they will all get to their destination and do the work for which they were intended.

Electricity, despite its power, is really pretty lazy. It tends to take the path of least resistance and it usually tries to get to ground. To get to ground, a current flowing in a conductor (such as a wire), will always seek out the easiest path. Given a choice between traveling through two materials, *most* of the current will flow through the better conductor.

Birds don't get a shock when they land on an electric wire. Electricity continues along the wire rather than entering the bird. However, if the bird were to put one foot on the wire and the other foot on another wire connected to the ground, it would be killed. This is because electricity finds it easier to get to ground by going through the bird than continuing on its way. As long as the bird perches only on the current-carrying wire, however, it is perfectly safe.

Obviously, the safe thing for you to do is not to take chances. Always assume you are the best conductor around! In fact, you are actually a better conductor than many other materials. Treated with care and respect, electricity can be your friend.

## CIRCUITS

For electricity to do its work, it must have somewhere to start, someplace to go, and then a way to flow back to where it started or to ground. This last point is important. If the electrons have no place to go after flowing through a wire, they tend to bunch up at the end of the wire and the flow stops. In your home, electron flow (electric current) must make a complete path, returning to the starting point. Such a path is called a "circuit." The word circuit comes from the word circle, since the electrons must travel in a circle, a complete path, to keep flowing.

The flow of current in a circuit is from negative to positive, or "-" to "+" This is most easily seen with a simple circuit attached to a battery. The battery causes electrons to flow through the light bulb, causing it to glow. This is a "closed circuit." If we were to cut one of the wires, then the electron path has been broken and no electrons can flow and the light bulb goes out. This is an "open circuit." Obviously, it is desirable to have a circuit open or closed at different times, just as you want light bulbs in your home on or off at different times. It would be silly and dangerous to cut the wires each time we wanted the lights off and repair the wires whenever we want them on. Therefore we use a switch.

A switch is a piece of conductor that can be moved between two contacts so that the circuit can be opened or closed. You turn the lights on or off in your home in the same way. When you flip a switch "on," you make a closed circuit and the light burns. When you turn the switch "off," you make an open circuit and the light goes out.

In a normal circuit, the electron path should be continuous and unbroken. A broken wire can cause an unwanted open circuit, as can a burned-out light bulb. When a bulb burns out, the tiny piece of wire inside is burned in two. Therefore, there is no longer a complete path for the electrons, causing the flow to stop.



If you have just one battery and one light bulb, it's pretty easy to see how to connect them together to make a circuit. But what if you have more than one light bulb (or appliance) or more than one battery? How should you connect them to make a circuit?

There are two basic ways to make a circuit. One way is hook the lights or other devices one after another in a line. The electricity must flow through the first device and then into the second. As long as each light bulb burns, and passes the electrons on to the next bulb, the circuit is continues and the flow continues. If one bulb burns out, it cannot pass on the electrons and the flow stops all along the line. This is called a "**series**" circuit. Remember during Christmas when you were trimming the tree? You may have had a string of lights in which if one bulb went out, they all did. In order to have them all light up again, you had to replace each bulb along the line with a new one until you found the bad one, then they all lit up. That string of lights was wired in series.

In a series circuit, the same amount of current flows through each device in the circuit and each device must share the voltage applied to the circuit. Such a circuit is not very practical for ordinary home uses. Imagine having to light up the whole house just to read the newspaper! You would, if it were wired in a series and only had one circuit.

There is another way we can hook up devise in a circuit. We can hook each device between the main wire from the battery and the main wire back to the battery. In this circuit, electricity can flow through any one device without having to flow through any others. Each one works on its own. For example, if one lamp burns out, this does not affect the other lamps. This is called a "**parallel**" circuit. Our homes are wired in parallel circuits. This allows us to use only the appliances we want to use at one time.

## SHORT CIRCUITS

If you accidentally connect a light bulb circuit so that there is a direct path through wires from the negative terminal to the positive terminal of a battery, the electricity will not flow through the light bulb. The path of electron flow has been "shortened" from the originally intended path. The condition has caused a "short circuit," or simply a short.

Shorts are definitely not good! They can drain a battery very quickly and can cause a wire to overheat. The short provides such a good path that the electrons start flowing faster in the wire. The rush of electrons can cause the wire to heat up, possibly enough to start the insulation burning or the wire to melt. In the case of higher voltages, such as in house wiring, shorts can be dangerous fire hazards, as well as become inconvenient. Shorts can usually be prevented by taking good care of electrical equipment and by making sure it is properly connected.

House wiring also is provided with special "electric watchdogs" to guard against shorts. Their job is to cause an open circuit automatically whenever the current goes above a certain pre-determined ampere value, such as in the event of a short. This pre-set current value is called the "rating." The current flow stops before the wires can get hot enough to cause damage whenever the current flow goes over this rating. One such watchdog is a fuse. All fuses have a short piece of special wire inside called an "element," or "fuse link." The element is the weakest link in the whole wiring system. If a short circuit develops, and the current goes over the rating of the fuse, the entire circuit heats up-including the fuse element. The fuse element melts, thus opening the circuit and stopping the flow of electricity.



Circuit breakers are another kind of electric watchdog and do the same job as fuses. Like fuses, they are available in many different ampere ratings. Circuit breakers have a metal strip that gets warm and bends when electricity flows through it. As the flow of the electricity increases, the strip gets hotter and bends more. If the strip bends enough, it causes a trigger to be released, which in turn opens the circuit, stopping the current flow. When the trigger is released, the circuit breaker is said to be "tripped." With the current stopped, the metal strip cools and straightens out again. When the metal strip straightens (which happens quickly), the trigger can be set back to its original position and current can flow again. This is called "resetting" the circuit breaker.

Circuit breaker triggers or levels usually have three positions: "on," "tripped" and "off." To reset a tripped breaker, you usually have to move the lever to the off position first, and then all the way back to the on position. Circuit breakers are more convenient than fuses, since you don't have to replace the whole unit each time the circuit is opened. All you have to do is reset it.

When a circuit is opened by an electric watchdog, you should ask: Why was the watchdog activated? Before a fuse is replaced or a breaker is reset, you should find out why it opened the circuit in the first place. Was there a short or an overload somewhere on the circuit? Replacing the fuse or resetting the breaker before the trouble is located will just cause the new fuse to blow or the breaker to trip again.

Sometimes it is easy to find the reason for a blown fuse or tripped circuit breaker. Check cords for broken wires or plugs for shorts. If there are none of these, the circuit may be "overloaded." A good rule of thumb is to turn the switch to off on the last appliance that was turned on just before the circuit was opened.

**Remember: Don't ignore your electric watchdog when it tells you something is wrong. That makes you an important electric watchdog, too!**

## ADDITIONAL BACKGROUND NOTES:



## How Electricity Travels

We know that everything is made up of atoms and that atoms are made up, in part, of electrons. Electrical energy comes from the movement of electrons. These moving or “traveling” electrons behave in certain ways. They travel through some substances much more easily than others. Substances that allow for electron flow are called **conductors**. Those that do not allow electrons to flow are called **insulators**. In order for electron flow to be beneficial for electricity, a circuit, or circle, of electron flow has to be complete.

A **closed circuit** allows the electrons to flow completely through the system, uninterrupted. An **open circuit** prevents electrons from flowing through the system.

Electrons travel at different speeds and can be controlled by the size of the conductor and the force behind the electron movement. Different size wiring is required to safely allow for different amounts of electrons to flow. **Circuits** are the paths that electrons are allowed to take and can be designed to do different things. An electron path that flows through all parts of a circuit is called a **series circuit**. An electron path that flows to each part of a circuit is called a **parallel circuit**.

In many ways, electricity can be compared to water. Both water and electricity need pressure to force them to flow. **Voltage** is a measure of the force behind the motion of electricity. Voltage is measured in units called **volts**. We constantly have voltage running through our electrical outlets unless there is a power outage. **Amperes (amps)** are a measure of the amount of flow of electric current. Volts and amperes together give us electricity. This electric power is measured in **watts**. We can determine the number of watts by multiplying the voltage and the amperes.



# ACTIVITY 1 To Conduct or Not?



**LIFE SKILLS:** Acquiring, analyzing, and using information

## LEADER INFORMATION:

This activity can be done as a demonstration of in small groups if materials and time are limited.

## INTRODUCTION:

We've learned in the previous lesson that when electrons jump from one atom to another it is called electrical energy and that a steady flow of these electrons is electricity. Materials whose atoms hold their electrons loosely (refer or look back at models built previously) allow for electrons to jump from atom to atom creating a steady flow of electrons, or electric current. Lightning, as we know, is an example of such a flow naturally.

What would stop this flow of electrons or allow us to control them in our use of electricity? (Materials that don't allow electrons to flow). Some materials allow electrons to flow with ease...these are called **CONDUCTORS**. Are our bodies a conductor of electricity? (Yes, think about lightening..it can flow through us). What are other materials you think would be conductors of electricity? (List for group to see). Animals, as well as the human body, will allow electrons to flow. Most metals are fair conductors of electricity. Wet wood will allow electrons to flow while dry wood will not. Some other materials do not let electrons flow easily. These materials are made up of atoms that hold all their electrons so firmly that they cannot jump from atom to atom or allow free "racing" electrons to pass either. These are called **INSULATORS**. What materials do you think would stop electron flow? (List these). The flow of electrons through various materials is referred to as conductivity of electricity. Let's test some items to find out their level of conductivity.

## DO: TO CONDUCT or NOT

- ✓ If this activity is being done in small groups, divide youth into groups of 2 to 3.
- ✓ Distribute materials and have youth refer to ELECTRON FLOW ACTIVITY PAGE.
- ✓ Review the INTRODUCTION so youth can define **CONDUCTORS** and **INSULATORS** on their Record Sheet.

### OBJECTIVES

Youth will be able to:

- ✓ determine conductivity of various material.

### SETTING:

A large comfortable room.

### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. (Optional) Prepare the 24 ball wire, by stripping (removing) the wire insulation by approximately 1/2" from each end of the wire, by using the stripper pliers.
2. D cell battery
3. Small light socket with 1.5 volt bulbs
4. Three 24" bell wire
5. Items to test for conductivity such as an iron nail, piece of rubber, a dime, jewelry, a small piece of wood, a glass or a plastic object (these items must be clean and dry to allow for maximum flow of electrons)
6. Wire strippers or electrician pliers
7. ELECTRON FLOW ACTIVITY PAGE
8. Pencils (one for each youth)
9. Flip chart/poster board/chalkboard (Optional)



- ✎ If you have not already removed  $\frac{1}{2}$ " of the insulation from the ends of the wire, instruct the group to do so with the stripper of pliers of all three 24" bell wires.
- ✎ Have youth connect 1 wire between one terminal of a dry cell battery and one terminal of a small light socket with 1.5 volt bulb as shown in *Figure 1*.
- ✎ Have youth attach one end of the other wire to the other dry-cell terminal as shown in *Figure 2*.
- ✎ Have youth attach a third wire to the other terminal of the light socket. The ends of the two wires should be free, as shown in *Figure 3*.
- ✎ Have youth touch the two free ends of the wires together and note what happens on their Record Sheet.
- ✎ Have youth then touch the two free wires to opposite ends of an iron nail, as shown in *Figure 4*, and note what happens on their Record Sheet.
- ✎ Have youth touch the two free ends of the wires to the other materials you have collected and note what happens on their Record Sheet.

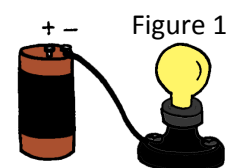


Figure 1

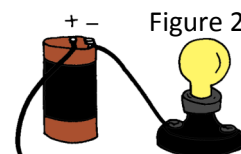


Figure 2

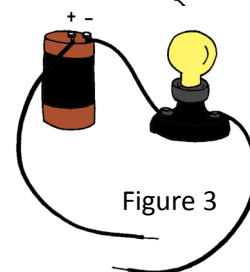


Figure 3

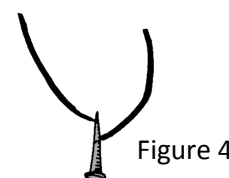


Figure 4

## REFLECT/APPLY:

- ✎ What happens when you touched the two free ends of the wire to each other? How brightly does the light bulb shine? **The light came "on"; light should be quite bright**
- ✎ What happens when you touch the two free ends of the wire to opposite ends of the iron nail? How brightly does the light bulb shine? **The light came "on"; brightness will be less**
- ✎ What happens when you touch the two free ends of the wire to the opposite ends of the piece of rubber? **The light does not come on**
- ✎ List the differences you observe when touching the wires to various objects. Do any of the conductors allow the light to burn more brightly, than other conductors tested? **Answers will vary**
- ✎ Which "conductors" produced the brightest light? **Copper wire of silver/gold jewelry would be the brightest**
- ✎ Is the brightness of light an indication of the strength of the electron flow of electrical current? **Yes**
- ✎ Do some materials not allow electrons to flow through them or do so less effectively? What materials are they? **Yes; answers will vary**
- ✎ Why did we have to remove the insulation from the wires in our experiment? **To allow for electron flow; copper is a good strong conductor of electrical current**
- ✎ Why is the covering of the copper wire called "insulation"? What kind of material is it? **Non conducting materials; plastic, rubber, and fiber**
- ✎ Why did we need to know "conductors" and "insulators" of electricity? **Safety**
- ✎ Do you know what element is used in the wiring in your home?



## Electron Flow

Using a D-cell battery, a small light socket, and three 24" pieces of bell wire, test various materials to see if they allow for electron flow.

Define the following:

CONDUCTORS:

INSULATORS:

WIRES CONNECTED TO:	DID THE LIGHT BULB WORK? (Yes or No)	CONDUCTOR OF ELECTRICITY? (✓ if Yes)	INSULATOR OF ELECTRICITY? (✓ if Yes)
Other Wire			
Nail			
Paper			
Rubber			
Pencil			
Plastic			
Other:			
Other:			

List materials that are:

CONDUCTORS

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INSULATORS

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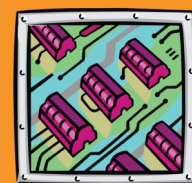
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# ACTIVITY 2 A Current Discovery!



**LIFE SKILLS:** problem solving and decisions making.

## LEADER INFORMATION:

The first part of this activity is a demonstration for you to do. The second part of this activity can be done by each individual youth in groups of 2-3.

## BACKGROUND

For electricity to do work, electrons must have some place to start, someplace to go, and a way to flow back to where it started or to the ground. If the electrons have no place to go after flowing through a wire, they tend to bunch up at the end of the wire and the flow stops.

In our homes, electrons flow (electric current) must make a complete path, returning to the starting point. This path is called a **CIRCUIT**. What does the word circuit mean? The word circuit comes from the word circle since the electrons must travel in a circle to keep flowing.

The electrical current's path of circuit is considered to be **CLOSED** if electron are allowed to flow completely through the cycle. An electric circuit is considered **OPEN** if the electrical path is broken and electrons are not allowed to flow to complete the cycle.

## INTRODUCTION:

We've learned insulators and conductors, now let's learn more about the traveling electron.

## DO Part I: A CURRENT DISCOVERY!

(Always keep your hand on the insulated part of the wire.)

- ✓ Show the youth the light socket, the bulb, 2 wires, scotch tape, and the battery and ask if they can create a current that will light the bulb? How? **Answers will vary**
- ✓ Allow the youth to help in giving you suggestions. Start by taping one end of one of the wires to the positive end of the battery, as shown in *Figures 1 and 2* (see next page).

### OBJECTIVES

Youth will be able to:

- ✓ create an electrical current.
- ✓ discover that electrons flow from (-) to (+) charge.
- ✓ identify open and closed circuits.

### SETTING:

A large comfortable room.

### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. Gather appropriate materials
2. Review background information on Circuits in Background Basics
3. D cell battery Light Socket (for each youth)
4. 1" by 5" strip of aluminum foil D cell Battery (for each youth)
5. Flashlight bulb (for each youth)
6. Scotch Tape
7. Two 12" Bell Wires
8. Pencils for each youth
9. Copies of A CURRENT DISCOVERY! ACTIVITY PAGE



- ✍ INSTRUCTORS NOTE: Don't strip ½" of the plastic covering on both ends of both wires until you are instructed by the youth.
- ✍ Ask the youth if this is an open or closed circuit. Why? **Open: electrons are not allowed to flow in a circle from (-) to (+)**
- ✍ How can we close the circuit? **Screw in the light bulb as shown in Figure 3**

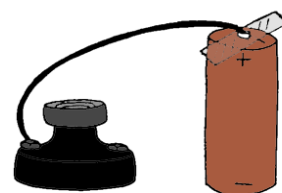


Figure 1

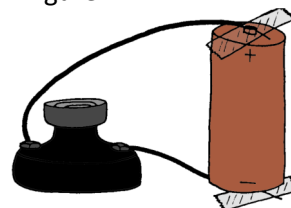


Figure 2

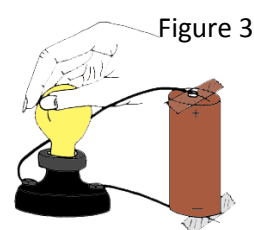


Figure 3

## REFLECT:

- ✍ What parts of the light bulb are conductors or insulators of the circuit? **Inner parts (metal) are conductors, the base is an insulator**
- ✍ What part of the bulb does the "light" come from? How does the light bulb affect the current? **The small wire at the top, when the wire is connected to a current, when burned out– no flow**
- ✍ Is the circuit "open" or "closed" when the light is on? What happens when the bulb "burns out?"
- ✍ How far do electrons move in our closed circuit that has no light bulb?
- ✍ How do electrons move from the battery when it is connected to a closed circuit? **From (-) to (+)**

## DO Part II: A CURRENT DISCOVERY!

- ✍ Distribute materials to each youth of group and have the youth refer to A CURRENT DISCOVERY workbook page 7.
- ✍ Instruct youth to try and "light" the light bulb using foil, battery, and bulb only.
- ✍ Have youth record each attempt to light the bulb on A CURRENT DISCOVERY workbook page 7. Ask them to check the foil for heat after each try.
- ✍ Have youth examine the bulb to see what the insides look like. Have them draw a picture of the light bulb and the "parts" inside the bulb.

### Instructors' Note

This activity is designed to be a discover exercise, letting youth experiment and figure it out on their own. You may want to give them a designated time period for their "discovery time."

## REFLECT/APPLY:

- ✍ Why were some of the attempts to get the bulb to light successful and others were not? **Answers will vary: the foil must contain the (-) and the (+) poles as well as the metal lip of the bulb.**
- ✍ Did the foil become warm when it touched the (-) and the (+) poles of the battery? Why? **Yes; the foil has no insulation**
- ✍ Why is it important for us to have open and closed circuits?
- ✍ How do we open and close circuits?



## A Current Discovery!

### What You Need:

- ✓ D-cell battery
- ✓ 1 inch x 5 inch strip of aluminum foil
- ✓ Flashlight bulb

### What You Do:



Using ONLY the materials listed above, make the light bulb “light up.” *Record each attempt by drawing and labeling a detailed picture below.*

1.	2.
3.	4.

Explain what had to take place for the light bulb to “light up.”





# ACTIVITY 3 Six Billion Billion

**LIFE SKILLS:** *Acquiring, analyzing, and using information*

## INTRODUCTION:

We know that electrons “flow” through conductors of electricity, and like the water that flows through the pipe or a hose, electrons flow at a certain force or speed. Let’s use water to demonstrate.

## DO: SIX BILLION BILLION

- ✎ Have the youth time how much water flows from a water faucet in 30 seconds.
- ✎ At the end of the 30 seconds, calculate the amount of water that flowed through the faucet in terms of gallons per minute. (ex:  $\frac{1}{2}$  gallon per minute,  $1\frac{1}{2}$  gallons, 1 gallon,  $1\frac{1}{4}$  gallons per minute)
- ✎ Explain to youth if they can see electrons move? If we can’t see electrons moving, how do we measure electron flow?
- ✎ Write the number 6,300,000,000,000,000 on a flip chart or chalkboard and let youth guess at what this number is.
- ✎ Explain to youth that the number is six billion billion and is the number of electrons that pass a given point (the flip of a light switch) each second. This represents one ampere or AMP. So the more the amps, the more electrons flowing.
- ✎ Ask youth how the water flows through the pipes? How does water flow out of a faucet on the 3rd floor of a building?
- ✎ Explain to youth that because of *pressure*, the force of the water through the pipes is greater.
- ✎ Ask youth if they know how “water pressure” on the force is measured. It’s called pounds-per-square-inch.
- ✎ Explain to youth that electricity also needs a force to move electrons through a wire, and that the force is called *VOLTS*.
- ✎ Explain to youth that a *WATT* is the amps x volts. What are amps? (electrons moving past a given point) What are volts? (force to move electrons)
- ✎ If 13 amps are moving past a point with force of 5 volts, what are the watts that will be produced?

### OBJECTIVES

Youth will be able to:

- ✎ distinguish how the force of electrons is measured.
- ✎ identifies how the speed of electrons is measured.

### SETTING:

A room with access to a sink or outside with access to water.

### LESSON TIME:

15 minutes

### ADVANCE PREPARATION & MATERIALS

1. Read background information prior to doing this activity
2. Access to a sink or hose (water flow)
3. Gallon size containers (milk jug, buckets)
4. Flip chart or poster board
5. Stop watch (optional)



## REFLECT:

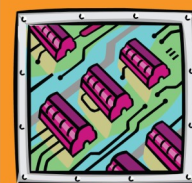
- ✍ Do electrons flow at the same speed? **No**
- ✍ How can electrons flow be increased? Decreased? **Increase force or volts**
- ✍ Do different appliances require different volts? Amps? Why? **Yes; varying energy requirements**

## APPLY:

- ✍ How can the amps and volts effect our use of electricity?
- ✍ What might happen if we supply an appliance with too little volts? Too many?



# ACTIVITY 4 Electron Racetracks



**LIFE SKILLS:** Acquiring, analyzing, and using information;  
Problem solving and decision making.

## LEADER INFORMATION:

This activity can be done as a demonstration or in small groups.

## INTRODUCTION:

We've learned that electrons flow from (-) to (+) and that electric circuits are the paths where electrons flow. What are "Closed" circuits? **When the electron flow is complete from that starting spot, and back to the starting spot.** What are "open circuits"? **Circuits that do not allow the electrons to flow completely back to the starting spot.** Let's learn even more about this electron flow that we call circuits.

## DO: ELECTRON RACETRACKS

- ✓ Have youth refer to ELECTRIC CIRCUITS ACTIVITY PAGES.
- ✓ Lay out the board with a pencil and ruler as shown in *Figure 1*.

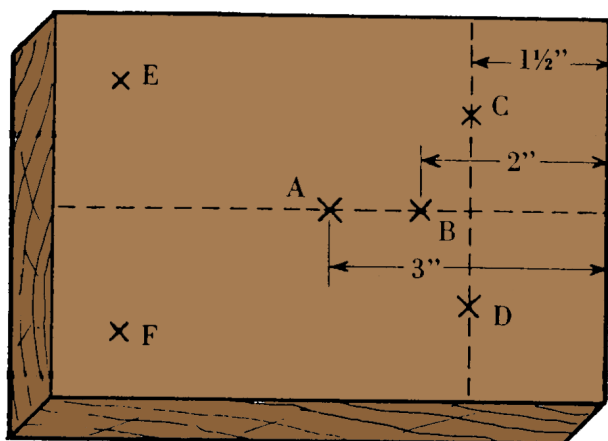


Figure 1

- ✓ Have youth measure points A, B, C, and D first. Point A needs to be 3" from the long end and approximately 2" from the short end. (Point A needs to be near the center of the board). Point B is measured 2" from the end in the same line as point A.
- ✓ Have youth measure 1 1/2" from one of the long ends of the board and draw a line across the board.
- ✓ Place points E and F in the corners at the opposite end of the board as the line just drawn.

### OBJECTIVES

Youth will be able to:

- ✓ identify different types of circuits.
- ✓ differentiate between closed and open circuits.
- ✓ differentiate between parallel and series circuits.

### SETTING:

A large comfortable room for role playing activity.

### LESSON TIME:

30 minutes to 1 hour (time for making circuit board will vary)

### ADVANCE PREPARATION & MATERIALS

1. Read through the entire activity and decide what parts of the activity need to be done in advance
2. 3/4" wide board about 4" x 6"
3. 6 volt dry cell battery
4. 1 piece of 24" black bell wire
5. pieces of 12" white bell wire
6. Two 10-penny box nails (3 in)
7. Three 3-penny box nails (1 in)
8. Two small screws or carpet tacks
9. Two 2" rubber bands
10. Two minute sockets with solder terminals
11. Two 1-1/2 volt flashlight bulbs
12. Tools – ruler, pencil, hammer, pliers or vise
13. Copies of ELECTRIC CIRCUIT ACTIVITY PAGES





- ✍ Bend the 3" nail as shown in *Figure 2* using pliers or vice and hammer. This is the crank nail or switch. (This may be too hard for some youth to do and may need to be done before hand.)

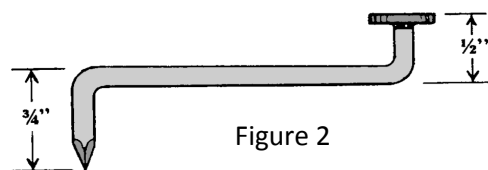


Figure 2

- ✍ Pound the 1" nails  $\frac{1}{2}$ " into the board at points A, C and D (*Figure 3*). Use the 3" nail to make a hole  $\frac{1}{2}$ " deep at point B. Put the crank nail in this hole and pound it in a little farther (*Figure 4*). Attach the lamp socket brackets at points E and F. Insert the 1.5 volt bulbs into the sockets. Stretch the rubber band as shown in the figure (*Figure 5*).

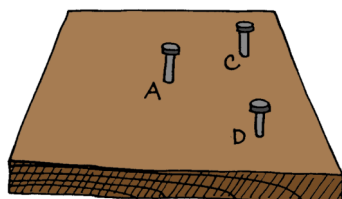


Figure 3

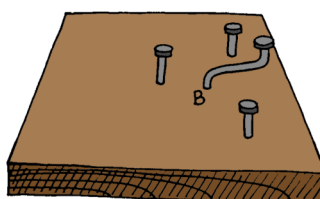


Figure 4

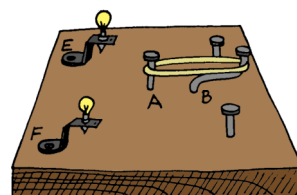


Figure 5

- ✍ Have youth lay out the electricity path and the circuit (as shown in *Figure 6*). Use the black wire for the positive side of the circuit (the center "POLE" of battery). Twist it around the switch crank at point B and the center pole of the battery. Run another piece to the outside terminal of bulb socket at E. Run the white wire to the negative pole of the battery from the other terminal at E.

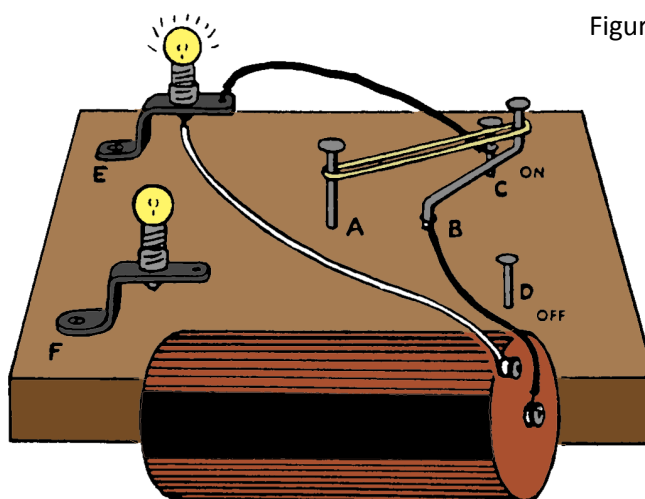


Figure 6

- ✍ Now your electric circuit is complete.
- ✍ Close the switch. The rubber band should hold the switch nail tightly against nail C.



## REFLECT:

- ✎ What happens when the switch is held tightly against C?
- ✎ What happens when the wire does not make a connection?
- ✎ When is the circuit “closed?” When is the circuit “open?”
- ✎ Which wire (black or white) are electrons flowing through first?
- ✎ Is this a D.C. or an A.C. current?

## DO: SERIES CIRCUITS *FIGURE 7*

- ✎ Before starting, have youth open the circuit by moving the switch nail to D, stopping the flow of electrons.
- ✎ Leave the black wire from the positive pole on the battery attached to the switch at B.
- ✎ Attach a negative wire to one of the terminals. (Which is the negative wire? (WHITE) Why? It starts at the negative pole of the battery.)
- ✎ Attach a wire (either) between the two bulbs.
- ✎ Attach bulb socket E to nail C.
- ✎ Close the circuit.

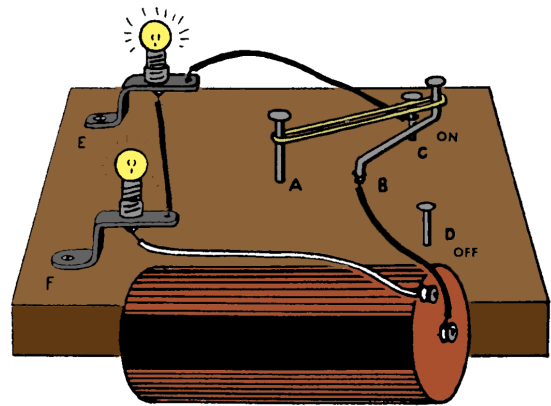


Figure 7

## REFLECT:

- ✎ What happens when everything is connected? **Lights burn**
- ✎ What happens in a series Circuit if you remove one of the bulbs? **None of the lights burn.**
- ✎ Will the same thing happen if the bulb burns out? **Yes**
- ✎ Why? Can you trace the electron flow from the (-) pole to the (+) pole of the battery? At what point is the electron flow stopped? **Because an open circuit— electron flow is broken when light bulb is removed or burned out**



## DO: PARALLEL CIRCUITS *FIGURE 8*

- ✍ Before starting, open the circuit by moving the switch lever to nail D, stopping the flow of electrons.
- ✍ Attach another white wire to the negative “POLE” of the battery and a terminal of the second flashlight bulb, Socket F.
- ✍ Run a black wire from the terminal of Socket F to the switch terminal at point C, as shown in *Figure 15*.
- ✍ Ask youth if they close the circuit (move the switch to touch nail C), what will happen?
- ✍ Close the circuit.

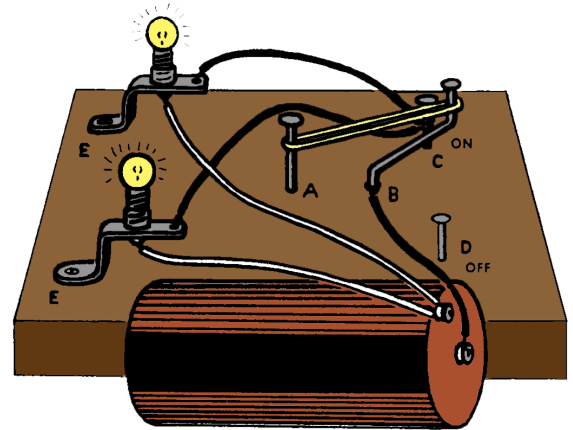


Figure 8

## REFLECT:

- ✍ What did we do different in creating this circuit than in the Series circuit? **Wire each bulb directly to energy source**
- ✍ Trace the electron flow. What's different in this circuit?
- ✍ With the circuit closed, unscrew one of the bulbs. What happens when one bulb burns out of is removed in this current? Why? **The other bulb remains burning because its circuit is not broken and the electron flow completes the cycle, or is closed since the bulbs are on separately wired circuits**
- ✍ What happens when the wires do not make a connection?
- ✍ When is the circuit “closed?” When is the circuit “open?”
- ✍ How long will the battery last? Will the life of the battery be the same for all three circuits? Why or why not? **The battery life will vary by the three circuit types**
- ✍ What form of energy is being used in these circuits to produce electricity? **Chemical energy from the battery**

## APPLY:

- ✍ In what situations can you think of that would be good uses of Series Circuits and Parallel Circuits? **SERIES: An example is Christmas tree lights (if one burns out none of the bulbs work). PARALLEL: Our houses are wired with parallel circuits (if the light burns out in one room it does not affect another).**



## Electric Circuits

### What You Need:

- ✓  $\frac{3}{4}$ " wide board about 4" x 6"
- ✓ One 6-volt dry-cell battery
- ✓ One piece of 24" black bell wire
- ✓ Two pieces of 12" white bell wire
- ✓ Two 10-penny box nails (3 in.)
- ✓ Three 3-penny box nails (1 in.)
- ✓ Two small screws or carpet tacks
- ✓ Two 2" rubber bands
- ✓ Two miniature sockets with solder terminals
- ✓ Two  $1\frac{1}{2}$ -volt flashlight bulbs
- ✓ Tools: ruler, pencil, hammer, pliers, or vise

### What You Do:

1. Lay out the board with a pencil and ruler as shown in *Figure 1*.
2. Measure points A, B, C, and D first. Point A needs to be 3" from the long end and approximately 2" from the short end. (Point A needs to be near the center of the board). Point B is measured 2" from the end in the same line as point A.

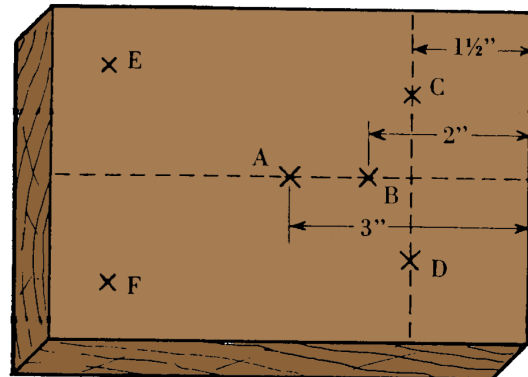


Figure 1

3. Measure  $1\frac{1}{2}$ " from one of the long ends of the board and draw a line across the board.
4. Place points E and F in the corners at the opposite end of the board as the line you've just drawn.
5. Bend the 3" nail as shown in *Figure 2* using pliers or vice and hammer. This is the crank nail or switch.

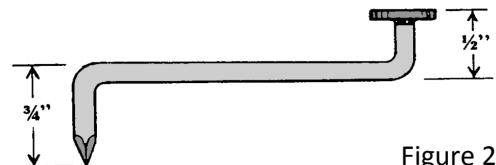


Figure 2



6. Pound the 1" nails  $\frac{1}{2}$ " into the board at points A, C and D (*Figure 3*). Use the 3" nail to make a hole  $\frac{1}{2}$ " deep at point B. Put the crank nail in this hole and pound it in a little farther (*Figure 4*). Attach the lamp socket brackets at points E and F. Insert the 1.5 volt bulbs into the sockets. Stretch the rubber band as shown in *Figure 5*.

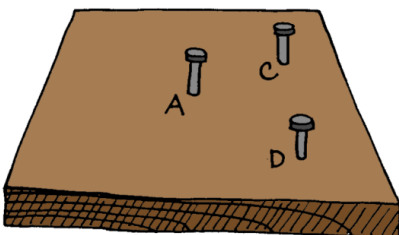


Figure 3

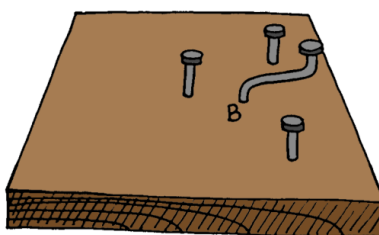


Figure 4

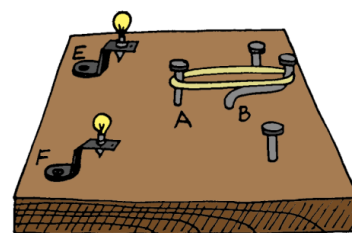


Figure 5

7. Lay out the electricity path and the circuit as shown in *Figure 6*. Use the black wire for the positive side of the circuit (the center "POLE" of battery). Twist it around the switch crank at point B and the center pole of the battery. Run another piece to the outside terminal of bulb socket at E. Run the white wire to the negative pole of the battery from the other terminal at E.

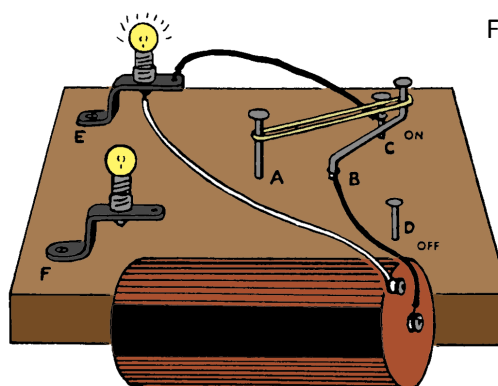


Figure 6

8. Now your electric circuit is complete. Close the switch (turn switch to On - point C). The rubber band should hold the switch nail tightly against nail C. Open the circuit (turn switch to OFF - point D).

## Now, try this...

- ✓ Remove the wire that goes from socket E to the negative pole and reattach to socket F.
- ✓ Run a wire from socket F to socket E and turn the circuit on.
- ✓ Wire each socket with a white wire directly to the negative pole of the battery and to Point C. Close the circuit.



# ACTIVITY 5 Lights all Around

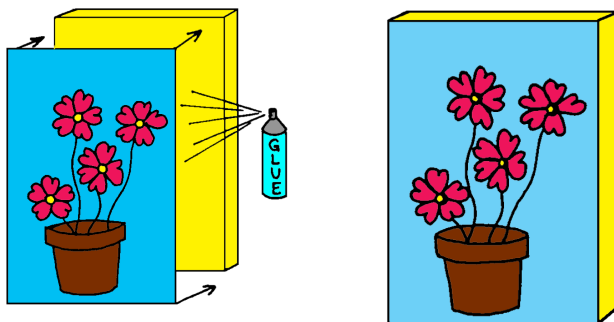
**LIFE SKILLS:** *Acquiring, analyzing, and using information*

## INTRODUCTION:

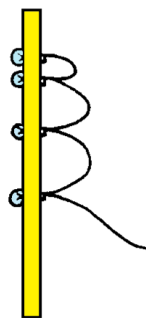
We know the difference between *series* and *parallel* circuits. Now, let's use this new knowledge to work for us.

## DO: LIGHTS ALL AROUND

- ✦ With spray glue, mount a poster on the foam board as shown below.



- ✦ Decide where to position the lights and punch holes through the poster and foam board with the nail punch.
- ✦ Position light in the holes.
- ✦ Decide the path your wiring will take and attach the two combined wires to a prong of the second light.
- ✦ Attach the second wire to the first wire, then attach the two combined wires to a prong of the second light.
- ✦ Repeat procedure until the last light.
- ✦ When you get to the last light, the wire should be left long enough to attach to the battery.
- ✦ Go back to the first light. Attach a single wire to the second prong of the light.
- ✦ Attach the next wire to the first wire, then attach both of those wires to the next light.



### OBJECTIVES

Youth will be able to:

- ✦ demonstrate how a circuit works.

### SETTING:

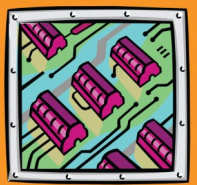
A large comfortable room.

### LESSON TIME:

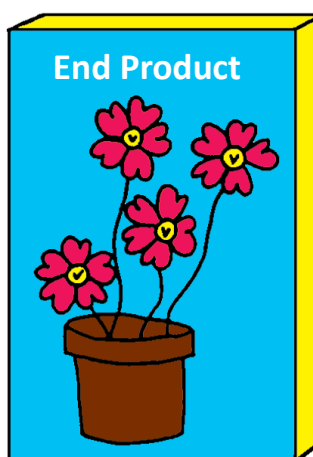
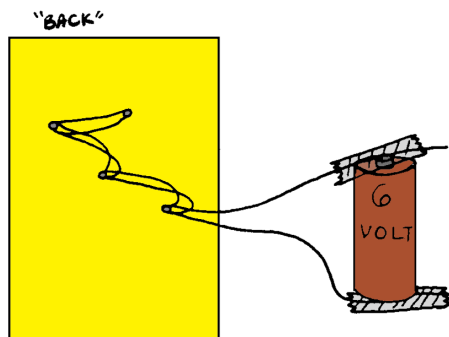
1–2 hours (time will vary greatly with the number of youth)

### ADVANCE PREPARATION & MATERIALS

1. Gather enough materials to do activity in group of individually
2. Poster of your choice
3. Foam board to fit size of poster
4. Lights (micro 12 volt lamp assemblies—maximum 8 lights)
5. Two color insulated copper wire
6. 6 volt battery
7. 4-D cell batteries with housing unit
8. Soldering iron and solder
9. Wire strippers
10. Black electrical tape
11. Spray glue
12. Nail bar punching tools



- ✍ Repeat the procedure until the last light.
- ✍ The last wire should be long enough to reach the battery. Attach the long wire to the last attached wire and attach the two to the last light prong leaving the other end free.
- ✍ Test the lights with the battery.
- ✍ When the lights are all working, solder the wires together and cover with the black electrical tape.



## REFLECT/APPLY:

- ✍ Was it difficult to make a light picture? Why? **Answers will vary**
- ✍ Does the more light that you use make this more difficult? **Answers will vary**
- ✍ What type of circuit are you using? **Answers will vary**
- ✍ How else can we use wiring?

## EXTENDED ACTIVITY:

- ✍ Have youth prepare an electric game board for their 4-H project. Examples could include a parts identification with a correct identification resulting in a light coming on.



## Electricity's Silent Partner

### KEY CONCEPT:

To become familiar with how magnets work with electron flow to produce electricity.

### OBJECTIVES:

Youth will be able to:

- ✓ identify objects that have magnetic attraction
- ✓ identify the poles of a magnetic field.
- ✓ describe how magnets work with electron flow to produce electricity.
- ✓ construct an electric motor.

### ADVANCED PREPARATIONS:

1. Read **BACKGROUND BASICS** for this lesson.
2. Review activities and choose appropriate one(s) to use.
3. Secure necessary materials as described.

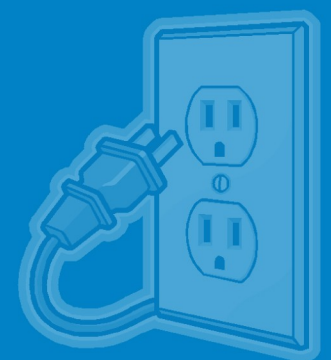
**DO:** The following must be done in order using the activities in Lesson 3.  
Materials needed for each are listed within the activity.

- ✓ Discover electricity's silent partner in the **SILENT PARTNER** activity.
- ✓ Discover how magnets work with electron flow in **MAKING AN ELECTROMAGNET**.
- ✓ Make an electromagnetic **"BUZZ"er**.
- ✓ **CONSTRUCT A SIMPLE MOTOR** to see how magnets and electrons work together.



### LESSON TIME:

Lesson time will vary upon learning activities selected. Lesson activities also vary depending upon numbers of youth. Most activities are approximately **45 minutes**.





## REFLECT on what was learned and why with these questions:

- ✍ How do magnets behave like electron flow? **The forces and results of attraction and repulsion**
- ✍ What is a magnetic field? **Force surrounding the pole of a magnet**
- ✍ How do electrons from a battery react with an electromagnet? **Flow of electrons causes the magnet to have north and south poles**
- ✍ How can an electromagnet do work? **Yes, the poles of electromagnet can be reversed**
- ✍ How does a motor work? **Answers will vary. Rotating electromagnet and the magnetic fields**
- ✍ What are the four main parts of our simple motor? **Armature, fields, brushes, commutator**

## APPLY these connections to everyday life:

- ✍ How do we use magnets, magnetic attraction and magnetic forces?
- ✍ Explain why you think electromagnets are important to the electricity used everyday.
- ✍ Trace the flow of electrons through a circuit.
- ✍ Prepare a science fair project on electromagnets.
- ✍ How do we use motors everyday?
- ✍ What forms of energy are used in various motors?

## Background Basics:

### MAGNETISM

In ancient times, people found certain rocks that stuck together. This was certainly mysterious, but not much use was found for these odd rocks until it was discovered that, when allowed to turn freely, one side would always turn to the north. The Chinese were the first to use these stones for a practical purpose about 5000 years ago. They found that, on journeys, if they carried one of the strange rocks suspended from a string, it would always point toward the North Star, thus helping guide them on their way. They called the rocks "lodestones," which means "leading stone." The early explorers and sailors used these lodestones to find their way on sea voyages.

Meanwhile, on the other side of the world about 2000 years ago, the Greeks found the same unusual kind of rock near a city called Magnesia. They named the rock "magnetite" for the city near which they found it. The strange power of this rock, which is the same as that of the lodestone, is called "magnetism." Rocks like this are called "natural" magnets. The planet earth is itself a large natural magnet. The reason the lodestones always turned north was due to the magnetism of the earth.



The area around a magnet is called a magnetic "field." This field cannot be seen, but we know it exists. Magnetic fields play an important role in the study and use of electricity. If it were not for magnetic fields, we would not have electric motors. Telephones, radios, television and many other things we use every day also depend on magnetic fields.

The ends of the magnets are called "poles." They are the points where the strength of the magnet is the greatest. To tell them apart, one end has come to be called the north pole, the other end the south pole (regardless of whether the magnet is in the shape of a bar or bent around into the shape of a "U"). The north pole is at the end of the magnet which points north when the magnet swings freely. We say that the lines of the magnetic field leave the magnet at the north pole, and re-enter it at the south pole.

Just as similar electric charges repel (drive away) each other and dissimilar electric charges attract, two north or two south magnetic poles will repel each other. However, a north pole and a south pole will attract one another.

Someone once found that when a natural magnet is stroked with a piece of iron, then the iron itself becomes a magnet. Why should this be? Modern scientists believe that magnets are made of millions of small particles, called molecules, which are in turn made of atoms. Each molecule is itself a tiny magnet. In an unmagnetized bar of iron, the molecules have no rectangular arrangement and produce no magnetic field outside the bar. Under the influence of a magnet, however, the molecules arrange themselves so that their magnetic fields are aligned in the same direction. The magnetic field is, therefore, strengthened and extends outside the bar itself.

Only certain kinds of metals can be made into magnets. These include iron, steel, nickel, cobalt and special combinations of metals (alloys) such as Alnico (made of aluminum, nickel and cobalt). Iron does not hold its magnetism very long. However, magnets made of steel hold their magnetism for a long time, as do those made of special metals. Magnets such as these are called "permanent" magnets. Some common materials that cannot be magnetized or attracted by a magnet are copper, brass, glass, paper, plastic and many others.

## ELECTROMAGNETS

Electromagnets are much more useful than permanent magnets. They can be made much stronger than permanent magnets and they can be controlled by changing the electric current.

One of the most simple uses of electromagnets comes from their ability to switch a magnetic field on and off at will, and do so very quickly. Electromagnets are often found in many devices and have many uses. They are most often seen in the form of doorbells, although many homes use ringing chimes instead of a simple bell. Alarms that use bells and buzzers can warn us when it's time to get up, or if the building is on fire or if a burglar is trying to break in. Buzzers and bells can be controlled by clocks, temperature control, automatic "trip" switches and other means. Most often, though, they are controlled by a simple push button.



## Electricity's Silent Partner

The flow of electrons is only one part of the story in the production of electricity. We already know that electricity is the flow of electrons from one atom to another atom. However, an important fact when studying electricity is that charges that are alike will repel one another, while unlike charges will attract one another. This principle is the same in magnets and the world of magnetism, which also contribute to the world of electricity.

The ends of magnets have charges - we call these ends "poles." This is where the strength of the magnet is the strongest. These poles, "north" and "south," have forces that surround them. We call these areas magnetic fields. Magnetic fields that have alike charges (N & N or S & S) will repel each other, while unlike charges (N & S) will be attracted to one another. In fact, the earth, itself, is a large natural magnet, having a north pole and south pole.

Modern scientists believe that magnets are made of millions of small particles, called molecules. These molecules are in turn made of atoms. Each molecule is itself a tiny magnet. In an unmagnified bar of iron, the molecules have no rectangular arrangement and produce no magnetic field outside the bar. However, under the influence of a magnet the molecules arrange themselves so that their magnetic fields are aligned in the same direction. Now the bar of iron has become a temporary magnet.

Only certain types of metal can be made into magnets. These include iron, steel, nickel, cobalt, and special combinations of metals (called alloys). Magnets made of steel or special metals hold their magnetism for a long time. These are called "permanent" magnets.

There are magnets that are much more useful than permanent magnets. These electromagnets can be made much stronger than permanent magnets and can be controlled by changing the current (or flow of electrons). One of the most simple uses of electromagnets comes from their ability to switch magnetic fields on and off very quickly, such as in doorbells or buzzers.



# ACTIVITY 1 Silent Partner

**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

We know electricity is a flow of electrons from atom to atom by substances called conductors. We know other materials do not allow electrons to flow and these are called insulators. Combinations of conductors and insulators make up devices we use to control electricity. Let's look at electricity's working partner-magnetism.

## DO: THE SILENT PARTNER

- ✓ Have youth refer to THE SILENT PARTNER ACTIVITY PAGE as you distribute the magnets and other small objects. Have youth distinguish and note which objects are attracted to the magnet and which are not.
- ✓ Distribute a string to each youth and have them tie the string to the middle of each magnet. Suspend the magnets and using the compass, note which end points to the north. This is the north pole of the magnet.
- ✓ Have youth move the north end of one magnet next to the north end of another. Note what happens.
- ✓ Have youth reverse ends. What happens?
- ✓ Place the magnet under the cardboard and sprinkle iron filings on the top as shown in *Figure 1*. Note what happens.
- ✓ Move the magnet around under the cardboard, and note what happens.

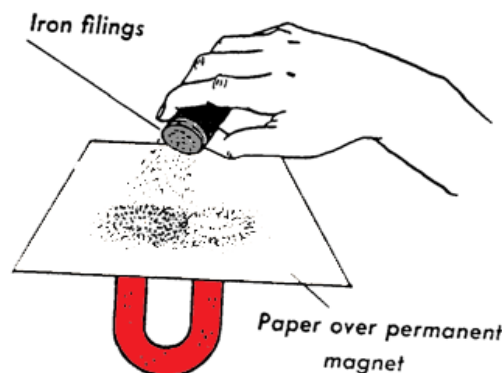


Figure 1



### OBJECTIVES

Youth will be able to:

- ✓ identify objects that have magnetic attractions.
- ✓ identify the poles of a magnet.
- ✓ determine the north and south poles of a magnet.
- ✓ discover what a magnetic "field" is.

### SETTING:

A large comfortable room.

### LESSON TIME:

30 minutes

### ADVANCE PREPARATION & MATERIALS

1. Gather appropriate materials
2. Copies of THE SILENT PARTNER ACTIVITY PAGE
3. 2 bar magnets
4. Objects containing iron, nickel, and/or cobalt (paper clips, washers, tacks, etc.)
5. Objects not containing iron, nickel, and/or cobalt (pennies, wood, plastic)
6. Piece of construction paper, cardboard, or shoe box top.
7. Iron filings (or rub steel wool pad together to produce small bits of metal)
8. String
9. Compass (one per youth)
10. Pencil per each youth



## REFLECT:

- ✓ What did the objects that were attracted to the magnet have in common? What materials are they made from? **Answers will vary. Most were metals (iron)**
- ✓ What happens to the attraction or repulsion of the magnet when moved toward each other? When reversed? **Like poles (north/north repel or push apart, unlike pole (south/north) attract.**
- ✓ What happens to the filings? When you move the magnet? What is the “area” around the magnet called? **Magnetic field.**
- ✓ Where were the filings attracted? Why? **Poles**

## APPLY:

- ✓ How do we use magnetic attraction and magnet forces? **In machines, motors, and compasses.**
- ✓ How might we use this in travel? **Direction**

### EXAMPLES IN NATURE:

Magnetism is mysterious and there is still much to learn about it. It is thought that animals and birds are aided in their sense of direction by magnetism. How do birds demonstrate this?  
(THROUGH ANIMAL MIGRATION NORTH AND SOUTH)



The Power Of

# ELECTRICITY

## The Silent Partner



What objects are attracted to a magnet?

### MAGNETIC ATTRACTION

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### NO MAGNETIC ATTRACTION

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Using magnets suspended by the middle, determine the north “poles” of the magnets. Use the magnets to determine if “like” poles attract or repel each other. What about opposite poles?

Do these **ATTRACT** or **REPEL**?

North and North \_\_\_\_\_

North and South \_\_\_\_\_

South and South \_\_\_\_\_

South and North \_\_\_\_\_





# ACTIVITY 2 Making an Electromagnet



**LIFE SKILLS:** Acquiring, analyzing, and using information; Problem solving

## LEADER INFORMATION:

This activity can be done as a demonstration or in small groups. The quantity of materials listed above are for the demonstration approach. Additional materials will be necessary for small group work.

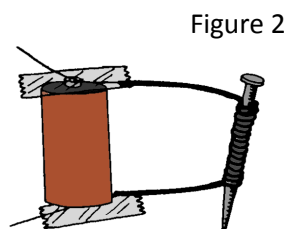
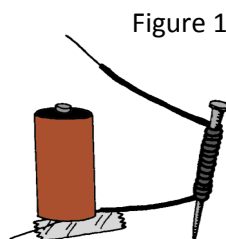
## INTRODUCTION:

We've learned that electricity is? (The movement of electrons). Each electron has a force of its own, called? (A charge). Magnets help align electrons making a magnetic force even stronger. In this activity we will build a magnet. Let's get started.

## DO PART I: MAKING AN ELECTROMAGNET

**Caution:** Do not touch "bare" wire while attached to the battery. Have youth refer to MAKING AN ELECTROMAGNET ACTIVITY PAGE.

- ✓ Show youth a magnet and tell them that the magnet is called a permanent magnet. Use this magnet to attract metal objects such as paper clip, staples, etc.
- ✓ Ask youth why the magnet is called a permanent magnet? (Permanent means forever. Permanent magnets retain their magnetism for a long time.)
- ✓ Tell youth that they are going to build "temporary" magnets by making an electromagnet.
- ✓ If you have not already done so, have youth use the wire strippers to remove  $\frac{1}{2}$ " of the plastic covering from both ends of a 24" piece of bell wire.
- ✓ Wind the wire tightly around a 3" or 4" nail or screw about 20 times and leave about 3" of wire free on each end of the nail.
- ✓ Use a piece of tape to hold the stripped ends of the wire against the two terminals of the battery, as shown in Figures 1 and 2.



## OBJECTIVES

Youth will be able to:

- ✓ make a magnet using direct current (DC).
- ✓ discover how electromagnets are used.
- ✓ explain how different types of magnets work.

## SETTING:

A large comfortable room.

## LESSON TIME:

30 to 45 minutes

## ADVANCE PREPARATION & MATERIALS

1. Gather appropriate materials and review Background Basics information on electromagnets
2. Copies of MAKING AN ELECTROMAGNET ACTIVITY PAGE
3. Magnet
4. D-cell battery
5. 24" piece of bell wire
6. Penknife
7. One iron 3" - 4" nail or screw.
8. Scotch tape
9. Steel paper clips, small nails, etc.
10. Wire Strippers





- ✍ Have youth try to pick up paper clips, small nails, or any tiny metal object that a magnet would normally pick up.
- ✍ Have youth “disconnect” one of the ends of the wire from the battery and note what happened when trying to attract items.

## PART II: MAKING AN ELECTROMAGNET

- ✍ Hook-up the temporary (electromagnet) again and place the compass near each end of the magnet to determine the North and South poles of the magnet.
- ✍ Place the north pole of the permanent magnet next to the south pole of the electromagnet.
  - Switch the ends of leads to the battery. What happens?
  - Switch the ends of leads a second time. What happens?

## REFLECT:

- ✍ What did we do in this activity? **Make an electromagnet**
- ✍ Can you pick up objects with your 3” - 4” electromagnetic nail? What? **Yes, metal objects**
- ✍ What has happened to the 3” -4” electromagnetic nail? **It became magnetized from the electrical current**
- ✍ How do the electrons from the battery react with the electromagnet? **From the negative to positive**
- ✍ If you remove one end of the wire from the battery, can you still continue to pick up metal objects? Why or why not? **No, no electron flow**
- ✍ Why is the electromagnet use direct current (DC)? **Electron flow goes directly from negative to positive**
- ✍ Which end of the electromagnet is the north pole? South pole? **Answers will vary depending on hook-up**
- ✍ How did we determine this? **compass**

## APPLY:

- ✍ How do we use electron movement?
- ✍ Prepare an illustrated talk for county event on electromagnets and their importance in our lives.
- ✍ Research electromagnets and how they work to supply power to our homes and schools.



## Making an Electromagnet

### What You Need:

- ✓ Magnet
- ✓ 6-volt lantern battery
- ✓ 24" piece of bell wire
- ✓ Penknife
- ✓ One 3" to 4" iron nail or screw
- ✓ Transparent tape
- ✓ Steel paper clips, small nails, etc.
- ✓ Wire strippers

### What You Do:

1. Using the wire strippers, remove  $\frac{1}{2}$ " of the plastic covering from both ends of a 24" piece of bell wire.
2. Wind the wire tightly around a 3" or 4" nail or screw about 20 times and leave about 3" of wire free on each end of the nail.
3. Use a piece of tape to hold the stripped ends of the wire against the two terminals of the battery, as shown in *Figures 1 and 2*.
4. Try to pick up paper clips, small nails, or any tiny metal objects that a magnet would normally pick up.
5. "Disconnect" one of the ends of the wire from the battery and record what happens:

Figure 1

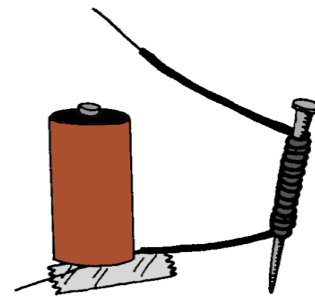
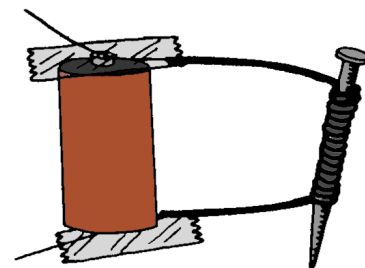


Figure 2



6. Place the north pole of the permanent magnet next to the south pole of the electromagnet.
  - Switch the ends or leads to the battery. What happens?
  - Now, switch the ends or leads a second time. What happens?





# ACTIVITY 3 "BUZZ"ers



**LIFE SKILLS:** Acquiring, analyzing, and using information; Problem solving

## LEADER INFORMATION:

This activity can be done as a demonstration or in small groups. The quantity of materials listed above are for the demonstration approach. Additional materials will be necessary for small group work.

## INTRODUCTION:

Do you remember what DC (direct current) is? Let's discover how we can "use" an electromagnetic and a DC current together to "work" for us.

## DO: MAKING AN ELECTROMAGNETIC "BUZZ"ER

- ✓ Distribute materials to each individual or group of youth.
- ✓ Wind 100 turns of No.18 wire around a 10-penny nail to make the electromagnetic nail. Leave about 6 inches of wire free at each end of the nail as shown in *Figure 1*.
- ✓ Drive the electromagnetic nail into the board as shown in *Figure 2*.
- ✓ Bend the piece of tin into shape as shown in *Figure 3*.

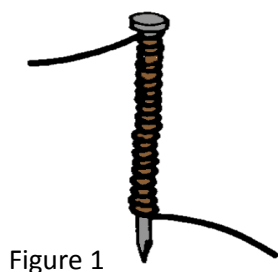


Figure 1

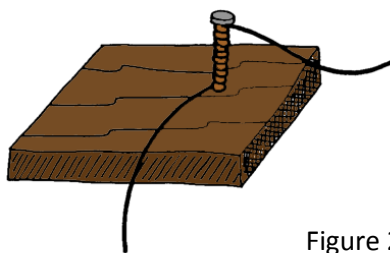


Figure 2

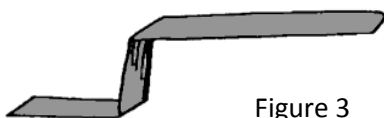


Figure 3

### OBJECTIVES

Youth will be able to:

- ✓ explain how the use of an electromagnet can do work.
- ✓ trace electron flow through a closed circuit.

### SETTING:

A large comfortable room.

### LESSON TIME:

45 minutes

### ADVANCE PREPARATION & MATERIALS

1. Gather appropriate materials
2. Eight feet of No. 18 insulated wire
3. One 1"x 3" x 6" block of soft wood (pine)
4. One strip of 1/2" wide x 10" long from a tin can (make sure the edges are not sharp)
5. Two 10-penny nails
6. Two carpet nails
7. One 6-Volt battery
8. Wire strippers



✎ Remove 1" of insulation from the end of the wire at the top of electromagnetic nail with the wire strippers.

✎ Place the end of the barbed wire completely under the tin strip. Use two carpet tracks to fasten the tin strip and wire to board as shown in *Figure 4*. Be sure tin strip is as close as it can be but **does not touch** the magnetic tail and extends past the electromagnetic nail ( $\frac{1}{2}$ " - 1").

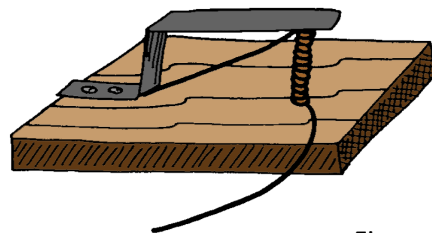


Figure 4

✎ Cut a piece of No. 18 insulated wire 18" long. Remove 1" of insulation from both ends of wire.

✎ Drive one end of the wire into the board with the second nail. Be sure to drive the nail at exactly the right place so that the tin strip is under the nail head, **BUT** not close enough so that the tin rubs that nail itself. (only the nail head and tin are in contact). As shown in *Figures 5 and 6*.

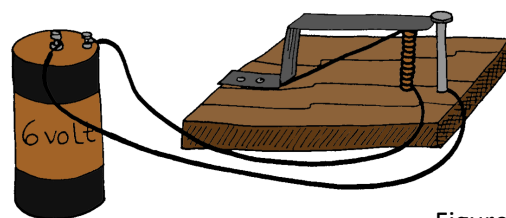


Figure 5

✎ Check two things before connecting the battery or batteries. The tin strip must be close to the head of the electromagnetic nail. But not touching it. The end of the tin strip must also be under the head of the second nail. See that the strip won't rub the second nail as it moves up and down.

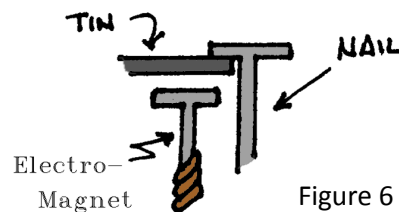


Figure 6

✎ Remove 1" of insulation from the end of wire coming from the bottom end of the electromagnetic nail.

✎ Connect the two wires to the 6-volt battery and note what happens.

## REFLECT/APPLY:

- ✎ What did we do in this activity? **Build a buzzer using an electromagnet and DC current**
- ✎ What did we learn? **How to connect all the pieces necessary to make the buzzer.**
- ✎ What does the electromagnet do to help make the buzzer work? **Make the nail as electromagnet**
- ✎ What does the tin strip do? **Vibrate**
- ✎ Why can't the tin strip touch the magnetic nail? **It would open the circuit**
- ✎ What does the battery do? **Provide the electron flow**
- ✎ Trace the electron flow through the buzzer.
- ✎ What did you like about this activity?
- ✎ Explain how an electromagnet can be used in a door buzzer?
- ✎ Prepare a science fair project on electromagnets.
- ✎ Explain to your family how your door buzzer works.



# Constructing A Simple Motor

**LIFE SKILLS:** Working with others



## LEADER INFORMATION:

This activity will take some time to complete. It can be done as a demonstration or by youth in small groups.

## INTRODUCTION:

Electric motors are very important in our everyday lives. If you were to guess how many electric motors you use a day, it is quite possible that you would guess too low. Electric motors are so quiet that many times you don't realize you're using one. We already know that like poles repel and unlike poles attract with magnets. This principle is applied to the operation of a magnet. Today we're going to demonstrate how an electromagnet works in an electric motor.

## DO: CONSTRUCTING A SIMPLE MOTOR

Have youth refer to CONSTRUCT A SIMPLE MOTOR ACTIVITY PAGE.

### STEP I: MAKING AN ARMATURE

- ✓ Ask youth if they know what an armature is. If they do not know, explain that an armature is a coil in which voltage is induced by motion through a magnetic field.
- ✓ To create your armature, wrap about 1 ½" of a 4 inch nail with two layers of electrical tape as shown in *Figure 1*. This will be the SHAFT of the motor.
- ✓ Using two pairs of 2 ½" nails with the heads and points in opposite directions, wrap tape around them as shown in *Figure 2*. Wrap tape around each pair with heads and points alternating. When complete, there will be 2 sets of 2 nails, taped head to end together.
- ✓ Center a set on each side of the shaft. Place the sets about 1" from the head of the shaft nail. Wrap them together with two layers of tape from tip to tip as shown in *Figure 3*.

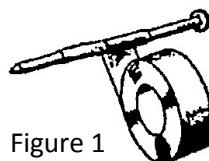


Figure 1

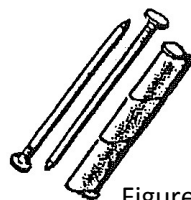


Figure 2

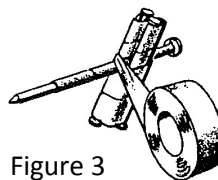


Figure 3

### OBJECTIVES

Youth will be able to:

- ✓ demonstrate how an electromagnet works in an electric motor.
- ✓ demonstrate how electromagnets are used in electricity everyday.

### SETTING:

A large comfortable room with table and chairs.

### LESSON TIME:

If doing in small groups 2–3 hours.  
As a demonstration: 60 minutes.

### ADVANCE PREPARATION & MATERIALS

1. Gather enough materials for the activity to be done as a demonstration or by youth in small groups
2. Copies of CONSTRUCT A SIMPLE MOTOR ACTIVITY PAGE
3. One roll of No. 24 enamel wire
4. One roll of electrition's tape
5. Three 4" (20 penny) nails
6. Four 2 ½" (8-penny) nails
7. Four 3" brads (10-penny)
8. Board for motor base, 4"x 6"x ¾"
9. Two staples or 4 small brads
10. Two tracks
11. Two 3-volt dry-cell batteries or a 6-volt transformer)
12. Pocket knife, vise (or 2 pairs of pliers)
13. Compass



- ✍ Start at the shaft and wind No. 24 enameled wire to one end and back. Then do the same on the other end. Always wind in the same direction. Leave 6" of spare wire at start and finish as shown in *Figure 4*.

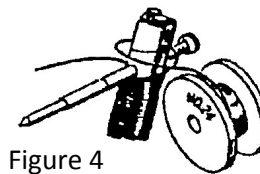


Figure 4

**STEP II: MAKING A COMMUTATOR** (A commutator reverses the current automatically and keeps the electromagnet spinning.)

- ✍ Ask youth if they know what a commutator is. Explain what a commutator is if they do not know.
- ✍ Scrape all insulation off the ends of the 6" wire coming from the Armature. Bend the bare ends back and forth like a "Z" as shown in *Figure 5*. Lay them flat over the taped shaft, one on each side of the shaft.
- ✍ Hold the commutator down with narrow strips of tape as shown in *Figure 6*. Wrap the tape tightly near the armature or core and at the opposite end.

Figure 5

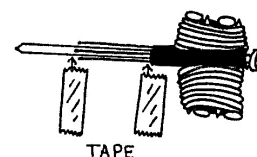
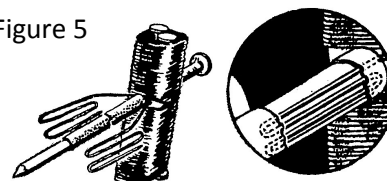


Figure 6

**STEP III: MAKING THE STATOR OR FIELD** (The stator is the magnet that stays in one position and whose poles do not change. This could be a U-shaped permanent magnet of electromagnet.)

- ✍ Make the core by bending two 4 inch nails in the middle at right angles. Space the heads about 3 inches apart to form a horseshoe. Wrap together with three two layers of electrical tape as shown in *Figure 7*.
- ✍ Wind about 400 turns of wire around the center. Leave 4 inches of spare wire at start and finish as shown in *Figure 8*. Remember to wind in the same direction.
- ✍ Attach the stator of "**FIELD**" to the wood base at each end of the wire with staples or small brads bent over as shown in *Figure 9*. The **FIELD** poles are now in place.

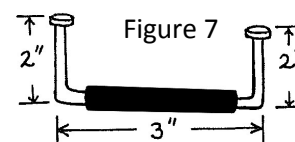


Figure 7

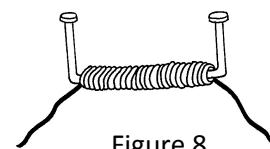


Figure 8

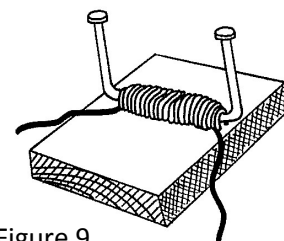


Figure 9



**STEP IV: MAKING THE ARMATURE SUPPORT AND BRUSHES** (These wires transmit electricity to the commutators. Since the commutators is spinning with the motor, it cannot be directly connected to a source of current. The current-carrying wires must “brush” against the commutators to transfer the current.)

- ✍ Scrape the insulation from the ends of two 6” pieces of wire. Tack them to the base and bend them as shown in *Figure 10* to make **BRUSHES**.
- ✍ Drive two pairs of 3-inch finishing nails side by side into the base about 3 ¼ inch apart from top to bottom and in a like midway between the field poles.
- ✍ Wrap wire around the supports to form armature bearings or supports, as shown in *Figure 11*.
- ✍ Scrape the insulation off the ends of the wire from the **FIELD** poles and connect one end to a **BRUSH**.

Figure 10

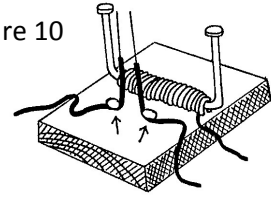
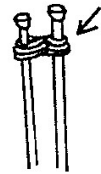


Figure 11

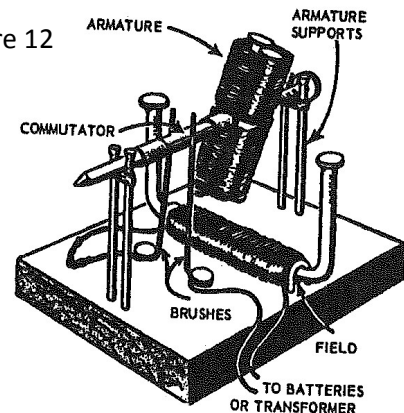


#### STEP V: CONNECT THE MOTOR

The following are parts of our assembled simple motor as shown assembled in *Figure 12*.

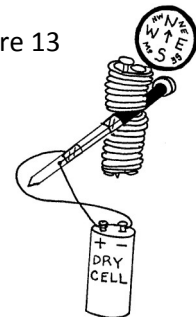
- Armature
- Armature Supports
- Commutator
- Brushes
- Field

Figure 12



- ✍ Place the commutators and armature in the armature supports as shown in the assembled motor. Adjust the positions of **COMMUTATOR** and tension of **BRUSHES** so that the brushes touch the commutators when it is turning for best operation.
- ✍ Take the armature off the motor and connect the commutators to wires from a dry-cell battery. To test the polarity of each end of the armature, place a compass at each end (*Figure 13*) and note the needle compass direction.
- ✍ Switch the connections on the commutators and test again. Note what happens.

Figure 13





- ✎ With the armature still off, connect the field coil directly to the dry cell as shown in *Figure 14*.
- ✎ Test the polarity of each end of the field with the compass. Reassemble the motor again and start it by attaching the field coil and the brush wire.
- ✎ Push **FIELD** poles slightly out of alignment with the turning **ARMATURE** (*Figure 15*) and observe.

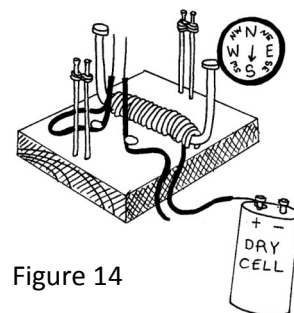


Figure 14

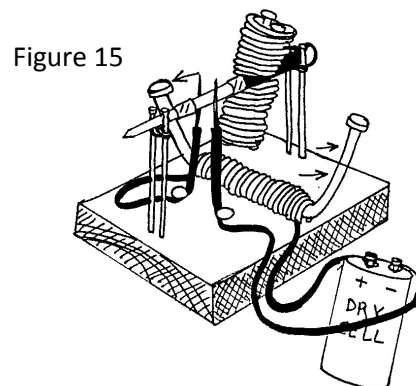


Figure 15

## REFLECT/APPLY:

- ✎ What happened to the electromagnet? Why did the permanent magnet behave in this manner? **It begins to spin by the force of magnetic attraction and electron flow**
- ✎ What happens when the leads are continually reversed? **The armature will change directions.**
- ✎ What happens to the compass needle? **It will show polarity**
- ✎ Can you reverse polarity? How? **Change leads**
- ✎ When the field poles are pushed slightly out of alignment with the turning armature, what happens to the motor's speed? **Decreases**
- ✎ What form of energy are being used in our simple motor? **Chemical, mechanical**
- ✎ What makes a motor work? **Magnetic forces and electron flow**
- ✎ What are four main parts of our motor? **Armature, commutators, field, brushes**
- ✎ Is this an example of a DC or an AC motor? How do you know?
- ✎ What forms of energy are used in motors?
- ✎ How much energy does it take to run motors?
- ✎ Do all motors require the same form of energy or amount of energy?
- ✎ Take a tour of a local power facility.



## Construct a Simple Motor

### What You Need:

- ✓ One roll of No. 24 enameled wire
- ✓ One roll of electric tape
- ✓ Three 4-inch (20-penny) nails
- ✓ Four 2 ½" (8-penny) nails
- ✓ Four 3" brads (10-penny)
- ✓ Board for motor base, 4" x 6" x ¾"
- ✓ Two staples or 4 small brads
- ✓ Two tracks
- ✓ Two 3-volt dry-cell batteries (or one 6-volt transformer)
- ✓ Pocket knife, vise (or 2 pairs of pliers)
- ✓ Compass

### What You Do:

#### Step 1: Making an armature (the spinning part of the motor)

- ✎ Wrap about 1 ½ inches of a 4-inch nail with two layers of electrical tape as shown in *Figure 1*. This will be the SHAFT of the motor.
- ✎ Using two pairs of 2 ½" nails with the heads and points in opposite directions, wrap tape around them as shown in *Figure 2*. Wrap tape around each pair with heads and points alternating. When complete, there will be 2 sets of 2 nails, taped head to end together.
- ✎ Center a set on each side of the shaft. Place the sets about 1" from the head of the shaft nail. Wrap them together with two layers of tape from tip to tip as shown in *Figure 3*.
- ✎ Start at the shaft and wind No. 24 enameled wire to one end and back. Then do the same on the other end. Always wind in the same direction. Leave 6" of spare wire at start and finish as shown in *Figure 4*.

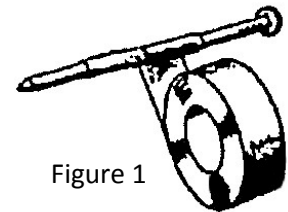


Figure 1

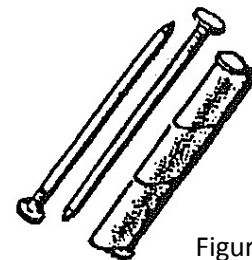


Figure 2

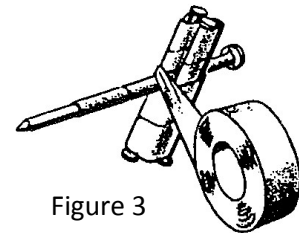


Figure 3

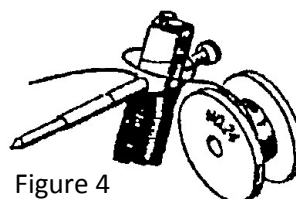


Figure 4

**CONTINUED** ➞



**Step 2: Making an commutator (this reverses the current automatically and keeps the electromagnet spinning)**

- ✎ Scrape all insulation off the ends of the 6" wire coming from the Armature. Bend the bare ends back and forth like a "Z" as shown in *Figure 5*. Lay them flat over the taped shaft, one on each side of the shaft.
- ✎ Hold the commutator down with narrow strips of tape as shown in *Figure 6*. Wrap the tape tightly near the armature or core and at the opposite end.

Figure 5

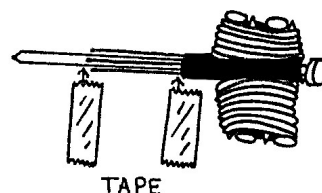
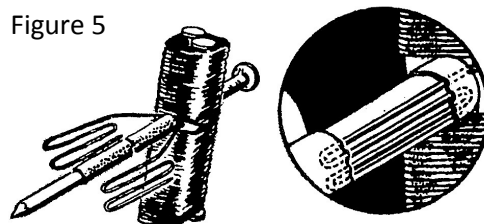


Figure 6

**Step 3: Making the stator or field (the magnet that stays in one position and whose poles do not change. This could be a U-shaped permanent magnet or electromagnet.)**

- ✎ Make the core by bending two 4 inch nails in the middle at right angles. Space the heads about 3 inches apart to form a horseshoe. Wrap together with three two layers of electrical tape as shown in *Figure 7*.
- ✎ Wind about 400 turns of wire around the center. Leave 4 inches of spare wire at a start and finish as shown in *Figure 8*. Remember to wind in the same direction.
- ✎ Attach the stator of "**FIELD**" to the wood base at each end of the wire with staples or small brads bent over as shown in *Figure 9*. The **FIELD** poles are now in place.

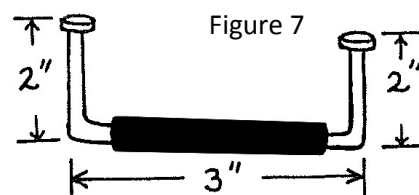


Figure 7

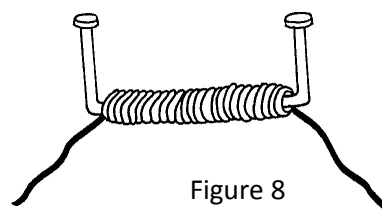


Figure 8

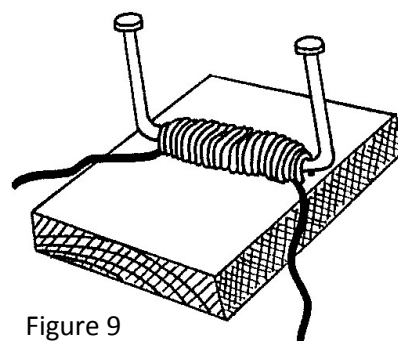


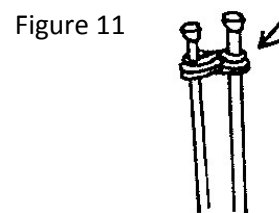
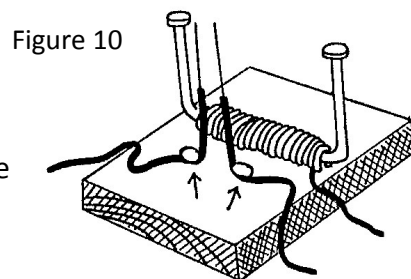
Figure 9

**Step 4: Making the armature support AND BRUSHES (These wires transmit electricity to the commutators. Since the commutators is spinning with the motor, it cannot be directly connected to a source of current. The current-carrying wires must "brush" against the commutators to transfer the current.)**

**CONTINUED** ➡



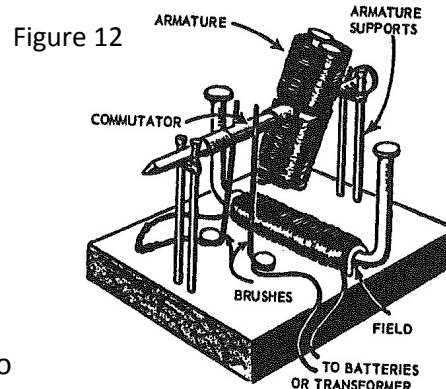
- ✓ Scrape the insulation from the ends of two 6" pieces of wire. Tack them to the base and bend them as shown in *Figure 10* to make **BRUSHES**.
- ✓ Drive two pairs of 3-inch finishing nails side by side into the base about 3 ¼ inch apart from top to bottom and in a like midway between the field poles.
- ✓ Wrap wire around the supports to form armature bearings or supports, as shown in *Figure 11*.
- ✓ Scrape the insulation off the ends of the wire from the **FIELD** poles and connect one end to a **BRUSH**.



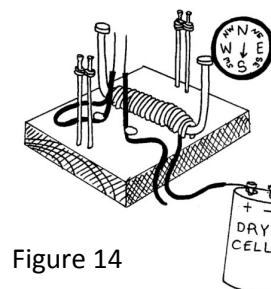
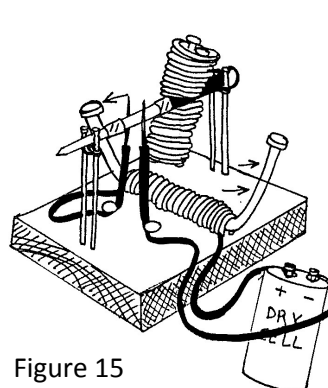
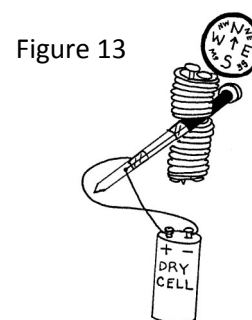
### Step 5: Connect the motor

The following are parts of our assembled simple motor as shown assembled in *Figure 12*.

- Armature
- Brushes
- Armature Supports
- Field
- Commutator



- ✓ Place the commutators and armature in the armature supports as shown in the assembled motor. Adjust the positions of **COMMUTATOR** and tension of **BRUSHES** so that the brushes touch the commutators when it is turning for best operation.
- ✓ Take the armature off the motor and connect the commutators to wires from a dry-cell battery. To test the polarity of each end of the armature, place a compass at each end (*Figure 13*) and note the needle compass direction.
- ✓ Switch the connections on the commutators and test again. Note what happens.
- ✓ With the armature still off, connect the field coil directly to the dry cell as shown in *Figure 14*.
- ✓ Test the polarity of each end of the field with the compass. Reassemble the motor again and start it by attaching the field coil and the brush wire.
- ✓ Push **FIELD** poles slightly out of alignment with the turning **ARMATURE** (*Figure 15*) and observe.





## Electricity: Energy in Action

### KEY CONCEPT:

To become familiar with how electric energy is safely used and the costs associated with the consumption of electricity.

### OBJECTIVES:

Youth will be able to:

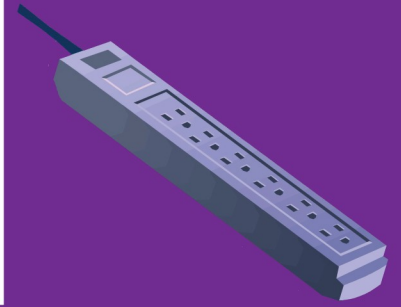
- ✓ identify how electric energy is used.
- ✓ calculate electricity cost.
- ✓ identify ways to more efficiently use electricity.
- ✓ describe how electricity is generated at an electrical power plant.

### ADVANCED PREPARATIONS:

1. Read BACKGROUND BASICS for this lesson.
2. Review activities and choose appropriate one(s) to use.
3. Secure necessary materials as described.

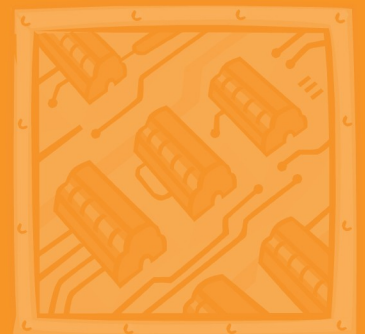
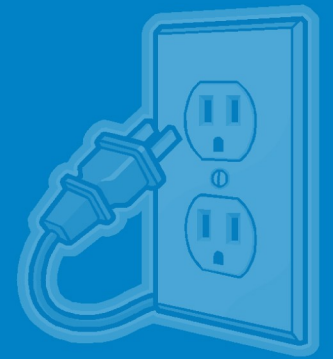
**DO:** The following must be done in order using the activities in Lesson 4.  
Materials needed for each are listed within the activity.

- ✓ Complete **RULES TO REMEMBER** activity to discover how to be safe around electricity.
- ✓ Find **WHERE'S THE MARK** activity to discover about electricity and appliances.
- ✓ Find out **WATTS THE BIG DEAL**.
- ✓ Discover **IS IT WORTH IT?**



### LESSON TIME:

Lesson time will vary upon learning activities selected. Lesson activities also vary depending upon numbers of youth. Most activities are approximately **45 minutes**.



## REFLECT on what was learned and why with these questions:

- ✍ Are we always safe from electrical hazards? How can we be sure? **No, think safety**
- ✍ Do all appliances use the same amount of electricity? What appliances use more? **No, answers will vary**
- ✍ What does the UL symbol mean? **The UL symbol means that an electrical appliance has been tested for any possible electrical problems**
- ✍ Does it cost a lot to run electrical appliance? Which are more costly, least costly? **It depends on the appliance, answers will vary**

## APPLY these connections to everyday life:

- ✍ Can we save electricity? How?
- ✍ When buying something that uses electricity, what can we do to be sure we can save electricity?
- ✍ If we save electricity how does that effect our environment?

## Background Basics:

### ELECTRICITY: ENERGY IN ACTION

In homes, electric appliances save hours of labor. Meals can be prepared quickly and easily with electric appliances, microwave ovens, and grills. Electric air conditioners and fans cool homes in summer. Electric heaters and blankets provide warmth during the winter. Modern industry could not exist without electricity. Electric motors run drills and other tools. Electricity runs elevators and escalators. Calculators, typewriters, computers, and photocopying machines enable office workers to save time and effort.

Radio, telegraph, telephones, and televisions link people in almost every part of the world. Much of this communication is relayed by electrically powered satellites that circle Earth. Subway trains carry millions of people to and from work. Motor vehicles equipped with spark plugs use electric sparks to ignite the gasoline that runs their engines. From airplanes and ships to space vehicles, many modes of transportation electronic devices are used to navigate or to operate many of the controls.

In science, nearly all research equipment depends on electricity. Astronomers use giant radio telescopes to study the sky, while electron microscopes help researchers unlock the secrets of individual cells. Electrically operated scanners locate tumors deep in the human body.

In many ways, electricity can be compared to water. Both water and electricity need pressure to force them to flow. Remember, **voltage** is a measure of the force behind the motion of electricity. Voltage is measured in units called volts. We constantly have voltage running through our electrical outlets unless there is a power outage. **Amperes** (amps) are a measure of the amount of flow of electric current. Volts and amperes together give us electricity. This electric power is measured in watts. A **watt** is a measure of the electric power an appliance uses. Appliances require different amounts of watts to operate (100 watt light bulb).





Watts are determined by multiplying voltage and amperes. For example: an electric range that has 10 amperes of current flowing when it is connected to 240 volts is using 2400 watts of electricity. Electric energy is the work done or the energy expended in a circuit or part of a circuit in a given time. A unit of energy is the **watt-hour** that can be determined by multiplying watts by the hours, or the length of time the energy is used. A kilowatt is simply 1000 watts.

Each month when the power company reads our meter, they read in kilowatt-hours. Kilowatt-hours are figured by multiplying watts by 1000. Kilowatt-hours measure the amount of electricity we use in our homes and businesses.

## THE UNDERWRITERS' LABORATORY

The Underwriters' Laboratory sets minimum safety standards (codes) for electrical items. The UL seal does not necessarily mean that the item is the best that can be bought. However, it does mean the item, when new, is safe to use under the conditions for which it was designed. It indicates that samples of the design of the product on which it appears have been tested to UL

Standards and found to be reasonably free from fire, electric shock, and related accident hazards. The familiar label UL is the registered trademark of Underwriters Laboratories, Inc., a nationwide, independent, not-for-profit organization. UL has been testing products for safety since 1894.



The engineers at Underwriters Laboratories test samples of products voluntarily submitted by manufacturers to see if the products meet UL requirements for safety. A listed product is tested and analyzed for all reasonably foreseeable hazards. If samples of the product pass Underwriters Laboratories' initial investigation, a manufacturer agrees to use the label only on products which have been determined to comply with UL requirements. The manufacturer also agrees that UL personnel will make periodic unannounced follow-up visits at the factory to countercheck the manufacturing program for continuing compliance with UL requirements.

UL Standards for Safety are developed under procedures that provide for participation, review, and comment from industry, government, insurance groups, consumers, other interested parties, and the general public. These procedures take into consideration the needs and opinions of a wide variety of interests concerned with the subject of the standard and afford due process to all those who will be affected by the standard.

## ADDITIONAL BACKGROUND NOTES:







# ACTIVITY 1 Rules to Remember

**LIFE SKILLS:** Communicating and relating to others.

## INTRODUCTION:

Electricity has many uses and we depend on it for numerous things, but it demands that we treat it with great respect and caution.

## DO PART I: RULES TO REMEMBER

- ✓ Divide youth into groups of 3-4.
- ✓ In small groups, have youth list what they think are good “rules to remember” to remain safe around electricity.
- ✓ Have each small group participate until all the “rules” are presented. Have youth refer to ENERGY IN ACTION ACTIVITY PAGE and list the rules they identified.
- ✓ Using the “rules to remember” presented by the youth, come up with a list of 15 rules of what they identify as most important to remember. Write these on a sheet of flip chart paper or on the chalkboard.

## REFLECT:

- ✓ What did you do in this activity? **List the safety precautions of electricity**
- ✓ Which “rules to remember” about electricity had you not thought of before? **Answers will vary**
- ✓ What did you learn about working in small groups that will help you the next time you do it? **Answers will vary**

## DO PART II: RULES TO REMEMBER

- ✓ On a sheet of paper, have each youth write something they remember about an electrical experience (such as getting zapped or shocked by electricity).
- ✓ Ask one participant to read aloud the electrical energy experience. Collect all participants’ papers who have had a similar experience. Have someone else share a different experience. Continue grouping the papers until all experience paper are collected.
- ✓ Now create groups. Each participant joins a group according to their experience to discuss their individual experiences and discuss safety factors that could have been implemented.
- ✓ Each group should appoint a recorder to list safety suggestions. Record additional safety precautions on the ENERGY IN ACTION ACTIVITY PAGE.

### OBJECTIVES

Youth will be able to:

- ✓ identify safety precautions.

### SETTING:

A large comfortable room with table and chairs.

### LESSON TIME:

45 minutes

### ADVANCED PREPARATION & MATERIALS

1. Copies of ENERGY IN ACTION ACTIVITY PAGE
2. Paper
3. Pencils
4. Flip chart paper and markers (or access to blackboard and chalk)



## REFLECT:

- ✍ Were there any positive effects from these electrical experiences? **Learn what not to do**
- ✍ What safety measures could be taken to avoid some of the negative electrical experiences?  
**Answers will vary**
- ✍ Why did individuals who said they had been shocked receive a shock of electricity? **Answers will vary**
- ✍ Are there currently things that you or your family do that are electric precautions? What are they? How do you and your family decide what to do? **Answers will vary**
- ✍ What things do you do that could be electric hazards? How can you correct this?  
**Answers will vary**

## APPLY:

- ✍ How can you safeguard your home against negative electrical experiences? Give specific examples.
- ✍ Complete the CAN YOU FIND... Section of the ENERGY IN ACTION ACTIVITY PAGE.
- ✍ In what other circumstances in our lives do we follow safety precautions?
- ✍ Why is it important that we have these safety rules? Why?



# Energy in Action

Electric energy is the work done or the energy expended in a circuit or part of a circuit in a given time. Remember that electricity is measured in watts.

- A **watt** is equal to volts (force of energy) times amperes (flow of electricity).  
*watt = volt x ampere*
- A unit of energy, the **watt-hour**, can be determined by multiplying the number of watts by the number of hours the electricity was used (*watt-hour = watts x hours of use*)
- A **kilowatt** is also a common measurement for energy. A kilowatt is 1000 watts (*kilowatt = watts x 1000*)

The Underwriters' Laboratory sets minimum safety standards (codes) for electrical items. The UL seal does not mean that the item is the best that can be bought. However, it does mean the item, when new, is safe to use under the conditions for which it was designed. The familiar label UL is the registered trademark of Underwriters Laboratories, Inc., a nationwide, independent, not-for-profit organization. UL has been testing products for safety since 1894.



## Rules to Remember

List "Rules to Remember" to remain safe when around electricity.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

## Can you find...

where the fuse box or breaker switch is in your home? \_\_\_\_\_

where the electrical lines come into your home? \_\_\_\_\_

where your family keeps "USE AND CARE" information  
for appliances in your home? \_\_\_\_\_





# ACTIVITY 2 Where's The Mark?

**LIFE SKILLS:** Acquiring, analyzing and using information

## INTRODUCTION:

We use countless electrical appliances every day. How do we know if each appliance is safe?

## DO: WHERE'S THE MARK?

- ✓ Hand out copies of WHERE'S THE MARK ACTIVITY PAGE to youth.
- ✓ Have youth look at the UL symbol and ask them if they have seen it before. If so, where?
- ✓ Ask youth what they think it means?
- ✓ Explain to youth that the symbol stands for Underwriters' Laboratories and that the appliance has been tested by electrical engineers to be sure that appliance is safe from fire, electrical shock, and related accidents.
- ✓ Have youth identify and locate the UL mark on as many appliances at home as they can. Use the WHERE'S THE MARK ACTIVITY PAGE to record their answers.



### OBJECTIVES

Youth will be able to:

- ✓ identify appliances that are safe to use.

### SETTING:

A large comfortable room with table and chairs.

### LESSON TIME:

15 minutes

### ADVANCED PREPARATION & MATERIALS

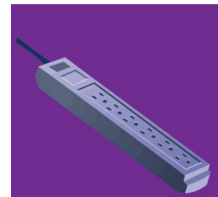
1. Copies of WHERE'S THE MARK ACTIVITY PAGE for each youth
2. An electric appliance that have a visible UL symbol. (Computer, electric pencil sharpener, radio, etc.)
3. Pencils (on for each youth)

## REFLECT:

- ✓ Had you heard of Underwriters' Laboratories before? How? **Answers will vary**
- ✓ Does every appliance have a UL symbol? Why or why not? **Answer should be yes, but not always**
- ✓ Does the fact that an appliance has a UL symbol mean that the appliance is safe forever? Why or why not? **No; wear and tear**
- ✓ Now that you know what UL means, how can it help you remain safe around electrical appliances? **Answers will vary**

## APPLY:

- ✓ In addition to being sure that an appliance has been determined "safe" by Underwriters' Laboratories, what can we do to ensure our safety?
- ✓ Write to Underwriters' Laboratories and ask about their procedures for those appliances that do not pass inspection.





- ◆ What would an electrical engineer be testing for?

- | Appliance | Is a UL Symbol Present? (✓) |    | Where Located |
|-----------|-----------------------------|----|---------------|
|           | YES                         | NO |               |
|           |                             |    |               |
|           |                             |    |               |
|           |                             |    |               |
|           |                             |    |               |
|           |                             |    |               |

# ACTIVITY 3 Watts the Big Deal!

**LIFE SKILLS:** Acquiring, analyzing, and using information.

## INTRODUCTION:

All appliances require a specific wattage in order to run, like a 40 watt light bulb needs how many watts? 40.

## DO: WATTS THE BIG DEAL!

- ✓ Have each youth look at an electric bill to determine the cost of electricity per kilowatt-hour. (Instructor should note that the cost of electricity may increase by specified amounts of usage.)
- ✓ Have the youth refer to WATTS THE BIG DEAL ACTIVITY PAGE.
- ✓ Work through the Watt-hour question on the activity page.
  - Watt-hours of a 100-watt lamp turned on for one hour and for thirty minutes:

$$100 \text{ watts} \times 1 \text{ hour} = 100 \text{ Watt/hr}$$

$$100 \text{ watts} \times \frac{1}{2} \text{ hour} = 50 \text{ Watt/hr}$$

- ✓ Distribute APPLIANCE AND WATTAGE Resource Sheets.
- ✓ Demonstrate how to determine watt usage for appliances from several electrical appliances.
- ✓ Assign the youth the task of surveying their appliances usage at home, school, etc. Have them check the wattage label on each application and estimate the amount of time that the appliance is used on a monthly basis on the WATTS THE BIG DEAL! ACTIVITY PAGE.
- ✓ Have youth calculate the watt-hours for each appliance by multiplying the:

$$\frac{(\text{Watts required}) \times (\text{Hours operated}) \times \text{days per week used}}{7 \text{ (days in a week)}}$$

- ✓ Calculate total watt-hours used.
- ✓ Have youth calculate the electricity cost for each day. Given a KWH cost 8¢ (reminder: 1KWH= 1000 watts)

### OBJECTIVES

Youth will be able to:

- ✓ determine wattage requirements on various electrical appliances.
- ✓ calculate watt hour usage of electrical appliances.
- ✓ identify ways to conserve the use of electricity.

### SETTING:

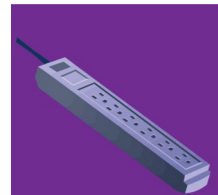
A large comfortable room with table and chairs.

### LESSON TIME:

45 minutes

### ADVANCED PREPARATION & MATERIALS

1. Gather "example" electrical appliance
2. Copies of WATTS THE BIG DEAL! ACTIVITY PAGE
3. Copies of APPLIANCES AND WATTAGES resource sheet
4. Small electrical appliances to demonstrate reading the wattage label
5. Pens and pencils
6. Sample electric bills





## REFLECT:

- ✎ What appliances are used most frequently in the home? **Answers will vary**
- ✎ What is the most energy consuming appliance? **Answers will vary.**

## APPLY:

- ✎ What substitutions can be made to conserve electric energy used by appliances?
- ✎ Is survival dependent upon electric appliances? Why or why not?
- ✎ What can you do to decrease your use of electric appliances?



# Watts the Big Deal!

A unit of energy is measured in WATT-HOURS and can be calculated by multiplying the number of watts by the time (in hours) that electrical energy was used for the appliance.

If a 100-watt lamp is left on for one hour,  
what would the number of watt-hours be? \_\_\_\_\_

What would the number of watt-hours be for 30 minutes? \_\_\_\_\_

List below electrical appliances you and your family use. Then, estimate the hours per day it is used, the number of days per week, and the daily watt-hours.

To calculate watt-hours:

Watts x hours x days per week  
divided by 7 (days in a week).

*This gives you watt-hours  
per day consumption.*

For example:  $\frac{8 \text{ watts} \times 10 \text{ hours per day} \times 4 \text{ days per week}}{7 \text{ days per week}} = \frac{320 \text{ watt-hours per week}}{7 \text{ days per week}} = \frac{45.7 \text{ watt-hours}}{\text{day}}$

Appliance	Watts Required	Hours per Days Used	Days per Week Used	Daily Watt-hours
Example: Portable radio	8	10	4	45.7

What is the TOTAL per day watt-hours you and your family consume?

How might that number increase or decrease?



# Appliances and Wattage

- ✎ There are many appliances on the market today. The following list is just a few of the appliances that can help make each of our lives a little easier. A watt is the standard unit of electrical power. Wattage requirements are listed with each appliance. Not all appliances will have the same watt usage. Use the list below if you are unable to locate the wattage on your own appliances.

APPLIANCE	WATTAGE
Microwave	600
Percolator - 12 cups	800
Coffee pot - 4 cups	725
Toaster - 4 slice	1650
Toaster - 2 slice	900
Bread Maker	430
Toaster Oven	1400
Fry Daddy	1200
Crock Pot (small)	75-100
Iron	1000
Popcorn popper	1000
Hot plate	1100
Electric griddle	1500
Waffle iron	1000
Curling iron	38
Hair dryer	1600
Blender	350
Hand mixer	170
Sewing machine	90

- ✎ Light bulbs are used by everyone everyday. An incandescent light bulb uses more wattage than the new compact fluorescent light bulbs (CFLs). The size and shape of the CFL affects the wattage usage. Here is a comparison of light bulb wattage averages:

INCANDESCENT	FLUORESCENT
40 watts	9-13 watts
60 watts	13-15 watts
75 watts	18-25 watts
100 watts	23-30 watts
150 watts	30-52 watts



# ACTIVITY 4 Is It Worth It?

**LIFE SKILLS:** Problem Solving; Decision Making;  
Acquiring, analyzing, and using information

## BACKGROUND:

The cost of operating appliances are calculated by multiplying kilowatt-hours by cost per kilowatt-hour. A kilowatt-hour is 1,000 watt-hours. A watt can be defined as the practical unit of electric power and is measured by multiplying volts by amps. The cost per kilowatt-hour can be determined using your electric bill. The wattage information for electrical appliances can be found on each appliance.

## INTRODUCTION:

Electricity is not free. Someone has to pay for it. Today we're going to figure out how that price is determined. Can you guess?

## DO: IS IT WORTH IT?

- ✓ On a flip chart or chalkboard, work through the following example problem with the youth:

We are charged for electricity by the kilowatt-hour which is 1,000 watt-hours. So, if the cost for 1 kilowatt-hour of electricity is 8 cents, the cost of operating a 100-watt lamp for one hour is: (kw x hr. x kWh cost= cost per hour)  $0.1 \text{ kw} \times 1 \text{ hr} \times .08 \text{ cents} = 0.8 \text{ cents}$  or \$0.008 (less than a penny).

**Remember that 1 Kw = 1000 watts so that 100 watts = .1 Kw.**

For two hours the cost would be:  $0.1 \text{ kw} \times 2 \text{ hrs} \times .08 \text{ cents} = \$0.016$  or:

$$\begin{array}{r} 1 \text{ hr} \\ \times 0.1 \text{ kw} \\ \hline .1 \\ \times .08 \\ \hline .008 \end{array}$$

$$\begin{array}{r} 2 \text{ hr} \\ \times 0.1 \text{ kw} \\ \hline .2 \\ \times .08 \\ \hline .016 \end{array}$$

- ✓ Using IS IT WORTH IT? ACTIVITY PAGE, work through the following calculations.

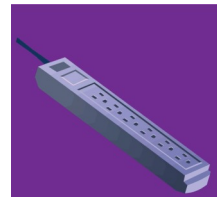
- What is the cost of a 1,000-watt toaster operating for five minutes?

Given 1,000 watts = 1kw:  $1 \text{ kw} \times 5/60 \text{ hrs} \times .08 \text{ cents} = .006$

- What is the electric cost of a 5,000-watt appliance that runs 24 hours a day?

$5 \text{ kw} \times 24 \text{ hrs} \times .08 \text{ cents} = \$9.60$

- ✓ Have youth go home and record the watt usages of various household appliances and complete the IS IT WORTH IT? ACTIVITY PAGE.



### OBJECTIVES

Youth will be able to:

- ✓ determine the cost of using electricity.
- ✓ identify ways to conserve electricity.

### SETTING:

A large comfortable room with table and chairs.

### LESSON TIME:

30 minutes

### ADVANCED PREPARATION & MATERIALS

1. Copies of IS IT WORTH IT? ACTIVITY PAGE
2. Paper and pencils
3. Flip chart and markers (or blackboard and chalk)



## REFLECT:

- ✎ Do appliances cost as much as you thought they would? **Answers will vary**
- ✎ What appliances used the most watts to run? The least? **Answers will vary**
- ✎ Did the appliances have the watt usage you expected? Why? Why not? **Answers will vary**
- ✎ What appliances cost the most to operate? The least? **Answers will vary**

## APPLY:

- ✎ How might the use of those appliances that cost the most be reduced?
- ✎ Would a decrease in the cost of a kwh change the amount of use certain appliances would get?  
What effect might an increase in the cost of a kwh have on electricity use?
- ✎ Ask your parents/guardians to review the electrical bill and determine how many kwh are used in your household and how much those kwh cost.
- ✎ To decrease your electric bill, how might you decrease kwh?



The Power Of

# ELECTRICITY

## Is It Worth It?



**Given: 1 Kilowatt = 1,000 Watts**

**Formula: kW x hr x kWh cost**

- What is the electric cost of a 1,000 watt toaster operated for 5 minutes with a kilowatt-hour costing 0.08 cents?
- What is the electric cost of a 5,000 watt appliance that runs 24 hours a day?

List some appliances and the watt use required for them to “run.”

APPLIANCE	WATTS NEEDED
_____	_____
_____	_____
_____	_____
_____	_____

If a kilowatt-hour costs 0.08 cents, how much does it cost to run each of the appliances above for 3 hours?

APPLIANCE	COST TO RUN 3 HOURS
_____	_____
_____	_____
_____	_____
_____	_____





## Electric Environment

### KEY CONCEPT:

To become familiar with how electric energy is safely used and the costs associated with the consumption of electricity.

### OBJECTIVES:

Youth will be able to:

- ✎ identify how electric energy is used.
- ✎ calculate electricity cost.
- ✎ identify ways to more efficiently use electricity.
- ✎ describe how electricity is generated at an electrical power plant.

### ADVANCED PREPARATIONS:

1. Read BACKGROUND BASICS for this lesson.
2. Review activities and choose appropriate one(s) to use.
3. Secure necessary materials as described.

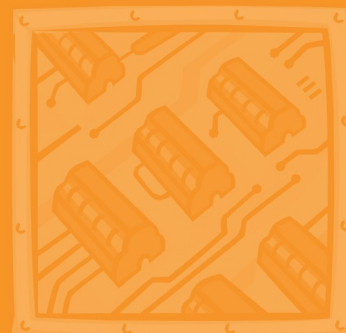
**DO:** The following must be done in order using the activities in Lesson 5. Materials needed for each are listed within the activity.

- ✎ Discover how electricity travels from the **POWER HIGHWAY**.
- ✎ Play **THE ELECTRIC POWER PLANT** to learn more about how electricity is generated.
- ✎ Have youth design **PLEASANTVILLE, USA**.
- ✎ Complete role play **EATUMUP CITY**.
- ✎ Discover if **RECHARGE=RECYCLE**.
- ✎ Play the **ENVIRONMENTAL ROLE** to discover the effects of generating electricity.
- ✎ Discover **CAN YOU LIVE WITH IT?**



### LESSON TIME:

Lesson time will vary upon learning activities selected. Lesson activities also vary depending upon numbers of youth. Most activities are approximately **45 minutes**.





## REFLECT on what was learned and why with these questions:

- ✍ How does our use of electricity effect our environment? **Answers will vary**
- ✍ What natural resources, do you think, should be used for generating electricity? Why?  
**Answers will vary**
- ✍ What are the barriers to using natural resources in generating electricity? **Answers will vary**

## APPLY these connections to everyday life:

- ✍ What can you do to effect the environmental impact of using electricity?
- ✍ What could be done to maintain the amount of electricity that is used yet decrease the environmental impacts of generating electricity?

## BACKGROUND BASICS: Electric Environment

### SOURCES OF ENERGY IN GENERATING ELECTRICITY

Electricity is a main source of energy in our daily lives. Without electricity our world would be different. We wouldn't have all the modern conveniences that we have today. Progress and technology would not be possible.

Electricity is generally produced at a power plants by converting one of the sources of energy into electricity. In the United States, the source is usually a fossil fuel (coal, oil, or natural gas), uranium, or water. The sun is the ultimate source of Earth's energy. The energy produced by the sun is called solar energy. Solar energy can be used to produce electricity. Fossil fuels, moving water, geothermal, wind, and nuclear energy are other sources of electricity. A power plant uses many *different forms of energy* to produce electricity for us to use every day at home, school or in our workplaces.

Most power plants are very similar in several important ways. Most are designed to *generate* spins inside a magnet. This causes electrons to flow in the coil, and the flow of electrons is electricity. The electricity produced in the generator is sent out over wires to homes, schools, hospital, farms, and factories. Getting it there is not a simple job.

The generating plants and wires are owned and operated by about 1,000 different electric power companies all across the nation. These companies must build power plants, string wires, or bury wires, buy fuel for the power plants, and hire workers to do all the jobs that must be done. As you can imagine, all this takes a lot of money. That is why the users of electricity must pay to use it.

Meters keep track of how much electricity travels from a power company's wires into homes, businesses, schools, and factories. The company sends a worker to read the meter to determine how much electricity each user has used over a period of time. The user is then sent a bill for the amount used.



Electricity is a little different from the other sources of energy that we talk about. Unlike coal, petroleum, or solar energy, electricity is a secondary, not a primary, source of energy. That means we must use other (primary) sources of energy to make electricity. It also means we can't classify electricity as a renewable or non-renewable form of energy. The energy source we use to make electricity may be renewable or nonrenewable, but the electricity is neither.

## ENVIRONMENTAL IMPACT

Coal, petroleum, natural gas and uranium (nonrenewable energy resources) come from the earth. To provide them for human use, we must dig for, transport and refine them. The potential for negative environmental impacts exists in each of the processes used to prepare and use these energy resources, from strip mines to radioactive wastes.

For example, almost 68% of the electricity used in Florida comes from burning coal, petroleum and natural gas. To a great extent, air pollutants are direct and indirect by-products of burning these fossil fuels. These air pollutants include particulates, hydrocarbon emissions (unburned or fragmented fuel molecules), carbon monoxide, nitrogen oxides, sulfur dioxide and ozone. These pollutants mix with the air we breathe. During periods when pollution reaches high levels, many people complain of headaches, eye, nose and throat irritations and nausea. Ozone seems to be the biggest cause of mucus membrane problems; asthma attack frequency increases with higher levels of sulfuric acid (formed from sulfur dioxide); exposure to high levels of particulates for a long period of time correlates with an increased frequency of respiratory disease and lung cancer. In reality, however, impacts on plants and animals, including people, are the combined effects of the entire air pollutant mixture acting over the total life span.



## Energy and the Environment

We have become very dependent on electricity. Just imagine what it would be like not to have the POWER of electricity! When your “power” goes off at home, it can be rather annoying. The cost for electricity varies from place to place, but we really pay very little for each kWh of electricity we use. It’s not free, but it’s a necessity that we are willing to pay for. However, there are additional costs of using energy and natural resources for the production of electricity.

Electricity is generated at power plants and can be produced from a number of different resources. Power plants typically use coal, natural gas, or nuclear fission to generate electricity. Other resources such as solar panels, wind mills, and biomass sources can also be used, but at a higher cost.

There are effects of using these resources on the natural environment. How do you think the following effect the environment when used to generate electricity?

Coal:

Natural Gas:

Nuclear Fission:

Water (hydropower):

Regardless of the resources used to generate electricity, there are effects to the environment as a result. How we discard used energy resources also impacts the environment.



# ACTIVITY 1 Power Highway

**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

We've learned many new things. We've learned about forms of energy, electric energy, electrons and electron flow, open and closed circuits, electricity, and sources of energy. Electricity comes to us by racing up and down "super highways" that are the power lines. To get to our homes, schools and businesses it must be generated and transported. Electricity must then follow the "speed" limit and "slow down" at transformers to get off the exit ramps to us. But how does this process begin? Let's see!

## DO: SIMULATE "THE POWER PLANT"

- ✓ Distribute ACTION CARDS to youth. Let them gather their materials needed.
- ✓ Explain to youth that once each part gets going, it must continue or there will be a loss of power. This means that as each participant in this process joins in one at a time, it must continue while all are going to generate electricity.
- ✓ Have Youth 1 "start-up" and pretend to run a mining machine and explain why this part is necessary.
- ✓ Youth 2 will be the train that takes the coal to the power plant and explain why that is important.
- ✓ Youth 3 will crush a piece of coal and explain why that is necessary.
- ✓ Youth 4 is the fire that burns the baby fine coal and explain why that is important.
- ✓ Youth 5 is the steam caused by burning coal which heats the water in nearby pipes and explain why this is necessary.
- ✓ Have Youth 6 turn a pinwheel which simulates the turbine which turns by the steam and explain why this is necessary.
- ✓ Youth 7 will be the generator which is turned by the turbine and generates electricity when the magnets inside spin inside the coils of wire and explain why this is necessary.
- ✓ Youth 8 and 9 hold the yarn that simulates the transmission lines that delivers the electricity and explain its importance.
- ✓ Youth 10 is a transfer which receives electricity and should explain why this is necessary.

### OBJECTIVES

Youth will be able to:

- ✓ identify the process of generating electricity through a power plant.
- ✓ explain the necessity of each component of the electricity generation process.

### SETTING:

A large comfortable room for role playing activity.

### LESSON TIME:

45 minutes

### ADVANCE PREPARATION & MATERIALS

1. Copies of ACTION CARDS (one per youth)
2. Black construction paper
3. Tea kettle
4. Pinwheel
5. Magnet
6. Yarn
7. Picture of light bulb



- ✎ Have Youth 11, 12, and 13 pretend to be poles holding up a power line that bring electricity to our homes, businesses, and schools and explain why this is necessary.
- ✎ Youth 14 will be the light bulb which “Lights up” with electricity and explain the importance of this.
- ✎ Have youth trace the electron movement from it’s beginning to it’s use.

## REFLECT:

- ✎ What did we do in this activity? **Show how electricity is generated and transported**
- ✎ What are the necessary step in the process of generating electricity through a power plant? **coal-heat-steam-turbine-generator-transmission lines-transformer-power lines-buildings**
- ✎ What is the significance of each component to the process? **Answers will vary**
- ✎ How did electron movement get started and how did it travel to our homes? **Started in generator and moved through transmission and power lines**
- ✎ What form of energy were used in our power plant? **Electrical, thermal, mechanical**
- ✎ What was our energy source or fuel for out electrical power plant? Renewable or nonrenewable. **Coal– non renewable.**
- ✎ What other energy sources are used or could be used by an electric power plant to generate electricity? **Nuclear, wind, solar, gas**
- ✎ What did you like about this activity? **Answers will vary**

## APPLY:

- ✎ Why is it important for us to understand this process?
- ✎ What did you like about this activity? Dislike?
- ✎ Prepare a science project on the process of generating electricity through a power plant. Visit a power plant.



# ACTION CARDS

## YOUTH 1:

You are the coal miner running the mining machine. Pretend that you are shoveling coal. (Use crumpled black construction paper). You are necessary to extract the natural resource coal from the ground so that it can be burned to make steam.

## YOUTH 2:

You are the train that takes the coal to the power plant. Pretend by either saying "Toot, toot," or making arm motions to "Chugga, chugga, choo, choo." You are necessary to transport the natural resource to the power plant.

## YOUTH 3:

You are the machine at the power plant that crushes the coal that is used to fuel the fire. Pretend by flattening pieces of crumpled black construction paper. You are the fuel necessary to allow the coal to become heated.

## YOUTH 4:

You are the fire that burns the coal which generates the heat for the next step. Pretend by crinkling a plastic shopping bag that causes the sounds of a fire. You are necessary to heat the coal to heat the water.

## YOUTH 5:

You are the steam that is produced by the fire heating the water in nearby pipes. Pretend by holding a tea kettle and making a "hissing" sound. You are necessary to turn the turbine.

## YOUTH 6:

You are the turbine that is turned by the steam. Pretend by blowing on a pinwheel to make it turn. You are necessary to spin the generator.



### YOUTH 7:

You are the generator which is turned by the turbine and generates electricity when the magnets inside spin inside the coils of wire. Pretend by turning around and around while holding a magnet. You are necessary to generate electricity.

### YOUTH 8:

You are the transmission line that delivers the electricity from the power plant to the transformer. Pretend by holding yarn between the two youth who are transmission lines. You are necessary to transmit electricity. You are quite powerful.

### YOUTH 9:

You are the transmission line that delivers the electricity from the power plant to the transformer. Pretend by holding yarn between the two youth who are transmission lines. You are necessary to transmit electricity. You are quite powerful.

### YOUTH 10:

You are a transformer. You receive electricity through the transmission lines and redistribute the electricity through power lines to homes and businesses. You are necessary to regulate the electric current.

### YOUTH 11:

You are the power line that delivers the electricity to everyone. Pretend by holding yarn between the four youth who are power lines. You are necessary to transmit electricity.

### YOUTH 12:

You are the power line that delivers the electricity to everyone. Pretend by holding yarn between the four youth who are power lines. You are necessary to transmit electricity.



### YOUTH 13:

You are the power line that delivers the electricity to everyone. Pretend by holding yarn between the four youth who are power lines. You are necessary to transmit electricity.

### YOUTH 14:

You are the product of everyone's work. You are the power that fuels appliances. Pretend by holding up a picture of a light bulb. You are necessary to enjoy everyday life!







# ACTIVITY 2 The Electrical Power Plant



**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

Electricity is generated at power plants. Where is the power plant that you get your electricity located? Exactly what all is involved in generating electricity? Let's see if we can figure out what we know about the power plant.

## DO: THE ELECTRICAL POWER PLANT

- ✓ Pick a youth to be the “electric power plant.” Have “electrical power plant” stand up in front of other youth.
- ✓ Distribute cards with terms to remainder of youth (add tape to the card to allow the youth to be able to place the card on the “power plant” .)
- ✓ Have youth place their electrical term on the “power plant” and define their term **AND** explain how or why it is related to an electrical power plant.

## REFLECT:

- ✓ Are all these terms necessary to generate electricity from a power plant? **Yes**
- ✓ What terms can be associated with portable electricity? (i.e. Flashlights, MP3 Player, remote control toy)? **DC currents, volts**
- ✓ Using these terms, pace them in the order it would take to generate electricity.

## APPLY:

- ✓ Take a tour of your local power facility. Note how these concepts are in use to bring electricity into your home.

### OBJECTIVES

Youth will be able to:

- ✓ define electric terms.
- ✓ identify how electrical energy reaches their home, school, recreation center, etc.

### SETTING:

A large comfortable room.

### LESSON TIME:

30-60 minutes

### ADVANCE PREPARATION & MATERIALS

1. Duplicate and “cut-out” the terms provided.
2. If desired, each term can be written on a 3” x 5” card.
3. Tape



# Power Plant Cards

<b>HEAT</b>	<b>CONDUCTIVITY</b>
<b>STEAM</b>	<b>TURBINE</b>
<b>GENERATOR</b>	<b>CONDUCTOR</b>
<b>TRANSMISSION LINES</b>	<b>DIRECT CURRENT</b>



<b>TRANSFORMER</b>	<b>WATT</b>
<b>URANIUM</b>	<b>HEAT</b>
<b>MOTOR</b>	<b>NON CONDUCTOR</b>
<b>VOLTAGE</b>	<b>ELECTRIC PLANT WASTE</b>



<b>ELECTRICITY</b>	<b>ATOM</b>
<b>GAS</b>	<b>OIL</b>
<b>EXHAUST</b>	<b>COOL WATER</b>
<b>NUCLEAR ENERGY</b>	<b>COAL</b>



<b>ELECTRO- MAGNETIC</b>	
<b>WATER</b>	
<b>METER</b>	
<b>WIND</b>	





# ACTIVITY 3 Pleasantville, USA

**LIFE SKILLS:** Problem solving and decision making.

## INTRODUCTION:

What would the perfect community look like? What would there be in the community? How would the people of this community "get" electricity, waste collection, water? Who would help govern this community? We are going to design what you consider to be Pleasantville, USA.

## DO: PLEASANTVILLE, USA

- ✦ From the group, hold an election for five *County Commissioners*, a *Planning Supervisor*, a *Zoning Supervisor*, and a *Waste Management Supervisor*.
- ✦ Divide the remaining group into four smaller groups and distribute copies of the lake and town blocks. Each of these smaller groups will develop their own community using any or all of the town blocks. Youth can create additional things for their ideal community. Cut the town blocks apart and paste in the desired location on the poster board.
- ✦ After the communities are developed, each group appoints a spokesperson to appear before the county commissioners, the planning and zoning supervisors and the waste management supervisor to present the community for approval.
- ✦ After the presentations are made, have the commissioners hear recommendations from the Planning Supervisor, Zoning Supervisor, and the Waste Management Supervisor.
- ✦ Have the County Commissioners vote on the recommendations.

## REFLECT/APPLY:

- ✦ Have groups discuss the positive and negative impacts of each community.
- ✦ Can any community be 100% acceptable? Why or why not? **Answers will vary**
- ✦ How can the power facility impact the community positively? **Answers will vary**
- ✦ How can a power facility impact the community negatively? **Answers will vary**
- ✦ What decisions did you make with regard to the environment? **Answers will vary**
- ✦ What energy source could be the most environmentally sound for this community?
- ✦ What do you like about your community? Dislike?

### OBJECTIVES

Youth will be able to:

- ✦ identify the impacts of an energy facility to the environment.

### SETTING:

A large comfortable room.

### LESSON TIME:

30-45 minutes

### ADVANCE PREPARATION & MATERIALS

1. Poster board
2. Scissors
3. Paste
4. Optional: crayons, coloring marking pens and pencils





# Town Blocks

Grocery	Gas Station	Dry Cleaners	Restaurant
---------	-------------	--------------	------------

Farm Feed Lot	House	House	House
	House	House	House

Farm Cornfield	Church
----------------	--------

Factory
---------

Park	Landfill
------	----------

Fire House
------------

Condominium
-------------

School	Electrical Power Plant
--------	------------------------

Highway
Highway

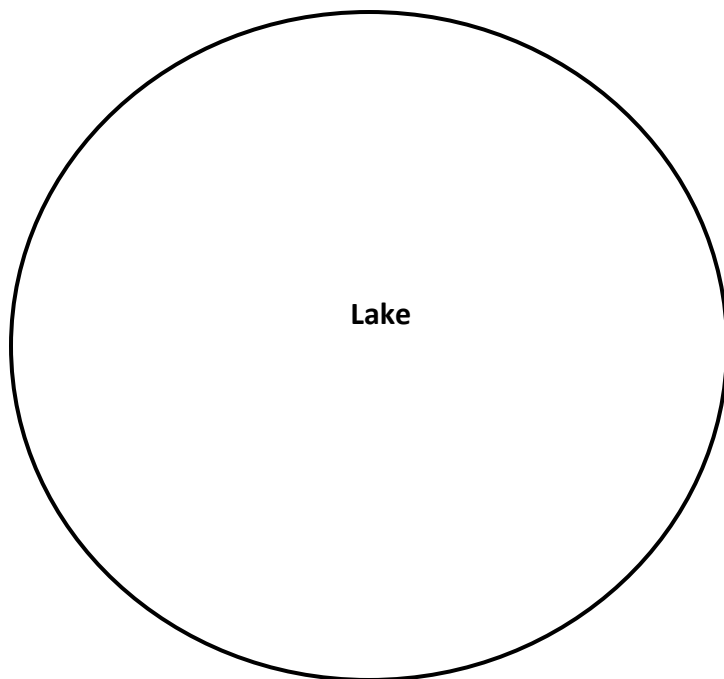
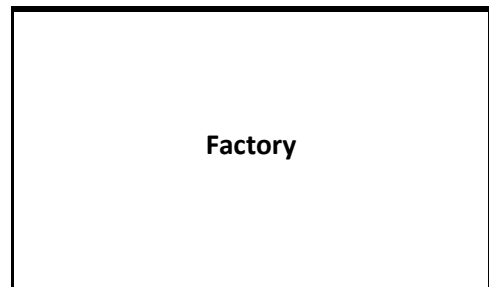


# Lake Diagram

Grocery	Gas Station	Dry Cleaners	Restaurant
---------	-------------	--------------	------------

Farm Feed Lot	House	House	House
	House	House	House

Farm Cornfield	Church
----------------	--------



Highway
Highway





# ACTIVITY 4 Eatumup City

**LIFE SKILLS:** Working with others; Communicating and relating to others; Problem Solving and decision making

## INTRODUCTION:

Where is the electricity that we use come from? What if an electrical power company wanted to build a power plant outside the city limits? Would it matter? Let's see if it matter's to the people of Eatumup City.

## Do:

- ✎ Distribute EATUMUP CITY SCENARIO and the CHARACTERS involved, to each youth. Read or have the youth read through the scenario and characters involved.
- ✎ Have the group determine and list the issues.
- ✎ Cut-out each CHARACTER and have youth “draw” from a hat who that will role play. Be sure to have enough for each youth. Youth who draw the same character will work together.
- ✎ Have youth think about the “issues” as they relate to their character.
- ✎ If time permits, allow youth time to gather information, to support their “side” of the issue.
- ✎ When ready, setup for a panel discussion. Hold discussions for youth to address the issues and how they (character) view the issue for EATUMUP City.
- ✎ Have the panel vote on the issue or come up with an alternative solution.

## REFLECT/APPLY:

- ✎ What are some of the issues in Eatumup City? **Answers will vary**
- ✎ Who agreed or disagreed on the issues in Eatumup City? Why? **Answers will vary**
- ✎ Who do you think had the most valid points? Why? **Answers will vary**
- ✎ What should happen next? **Answers will vary**
- ✎ Are there other alternatives to solving the issue? **Answers will vary**
- ✎ Where might Eatumup City be located in your area?
- ✎ If this scenario of one similar became an issue in your community who would the “people involved” be and how might they view the issue?

### OBJECTIVES

Youth will be able to:

- ✎ explore the “sides” of an energy issue.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

Time will vary depending on the amount of time you have to “research” their characters.

### ADVANCE PREPARATION & MATERIALS

1. Hat or bag
2. Paper
3. Pens/Pencils
4. Copies of EATUMUP CITY SCENARIO and MAP for each youth
5. Copies of EATUMUP CITY CHARACTERS



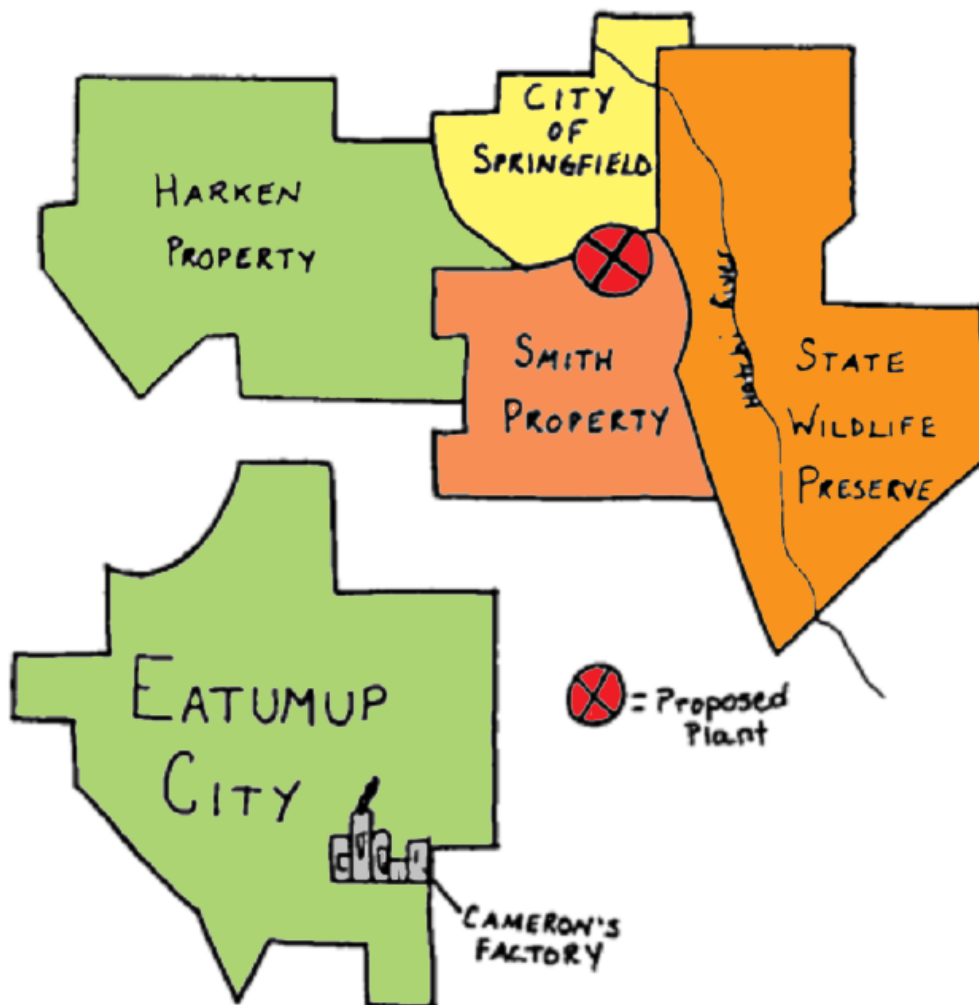
# Eatumup City

## Does Electric Energy Have an Impact on Your Community?

### SCENARIO:

The local power company wants to build a new power plant in the community of Springfield. This power plant would supply energy for over two million people who live about 70 miles away, in **EATUMUP CITY**. This city is growing and energy is needed. This proposal will help both the large city and the small community. The small community is very rural, the recession has hit the area very hard, many people, both white collar and blue collar, are out of jobs and are considering moving. Also, in the community is an 11,000 acre state wildlife preserve.

### MAP:



# Eatumup City Characters

**MR. JOHN BYRD** - Mr. Byrd is an environmental activist. He feels that as a community, everyone should look for alternative energy sources. He argues that solar and wind can create enough energy for the community's use and that **EATUMUP CITY** can supply their own energy. He moved away from **EATUMUP CITY** last year to enjoy the rural life.

**MS. MARIA DELAGO** - She is the mayor of the little town of Springfield. She has been working very hard for the past several years to encourage businesses to build in her community. She feels this is a way the town can survive economically. She also feels this will help bring other industry into the county.

**MR. TOMMY SMITH** - He and his wife own the land the power company wants to build the new power plant on. Mr. Smith, who was a county employee with the road department, lost his job last year with the county cutbacks. Mr. Smith is unable to pay the taxes on his property next month and may lose his 200 acres that have been in the family for three generations. The power company is ready to pay him \$5,000.00 an acre. They are both environmentally conscious and want their two children to grow up with an appreciation for the land and nature.

**MRS. TOMMY SMITH** - She and her husband own the land the power company wants to build the new power plant on. She is a local school science teacher. They are both environmentally conscious and want their children to grow up with an appreciation for the land and nature.

**MS. MARY HARKEN** - She owns 3,000 acres adjacent to the Smith's. Her ranch has been in the family for the past 200 years. She and her family raise livestock and are willing to rent the Smith's property so they can have more grazing area for their animals. This will take care of the Smith's tax problem and she sees no need to allow the power company to build the plant.

**JACK SASWACHEN** - Native American whose ancestors have been on this land for centuries. He feels there is no need to allow the power company to ruin his ancestors' land.



**MR. CHARLES CAMERON** - The Camerons own a large factory in Eatumup City. This factory has made millions for the Cameron family. One of their highest costs is energy. Charles Cameron feels this proposed power plant will keep his cost down thus allowing for raises and extra benefits for his employees. His business is considered one of the best places to work. The Camerons have a summer home here in Springfield and their oldest son, Charlie Jr., is considering a career in the State Forestry Department.

**MS. CAMILLE YEAGER** - She is an executive for the power company. She has guaranteed the company will hire 40% from within the immediate community. She has also promised that the Land Utilization Office within her company will utilize the land properly. She also feels as many as 200 of their employees will move into the community when the plant is finished.

**LINDA MELLER** - Linda works with the State Wildlife Preserve. She is a biologist and is aware there are several species of plants, one animal species and one fish species that are almost on the endangered species list. The proposed power plant will utilize the local river that flows through the State Wildlife Preserve. She knows of other instances when an industry came in, fragile wildlife such as these died out.

**JOHN MORGAN** - John is a building contractor in the Springfield community. A slow economy has forced many layoffs of his constructions crew. His business generally employs of one hundred, but he has had to layoff 80 of his crew over the last two years. New construction would enable him to rehire many of his crew who are presently unemployed in the community.

**PANEL MEMBER**

**PANEL MEMBER**

**PANEL MEMBER**



# ACTIVITY 5 Recharge = Recycle

**LIFE SKILLS:** Managing resources; Acquiring, analyzing, and using information

## INTRODUCTION:

As we know, batteries provide direct current. They are storage tanks for electrons. We also know there are two types of batteries. What are they? (**wet cell and dry cell**). What is an example of a wet cell battery? (**car battery**). What is the type of battery used in flashlights? (**Dry cell batteries**) Batteries are made from potentially toxic chemicals including zinc, copper, sulfuric acid and mercury. These batteries, if disposed of improperly, can leak chemicals into groundwater supplies and can be a major cause of pollution. Technology for making batteries is advancing, so that less potentially toxic chemicals are used.

Rechargeable batteries are special batteries that can have electrons added to them. These electrons can come from either electricity produced at a power plant with conventional energy resources, for example, coal, oil, natural gas or uranium, or electricity produced from solar energy with a photovoltaic cell by an electric source or a solar source. Rechargeable batteries can be more energy efficient than disposable batteries.

## DO: demonstration problems

- ✓ On a flip chart or blackboard, work through the following example problems with the youth:

A MP3 player over a three year period used 876 disposable batteries and each one of these batteries costs \$0.75. What is the total cost of operating the cassette player?

$$\begin{array}{r} 876 \text{ (disposable batteries)} \\ \times \quad .75 \text{ (cost of each battery)} \\ \hline = \quad \$675 \text{ (total cost used for disposable batteries)} \end{array}$$

- ✓ The same MP3 player uses the same rechargeable batteries at the cost of \$11.00. The cost of the recharger and recharging is an additional \$15.00. What is the total cost to use rechargeable batteries?

$$\begin{array}{r} \$ 11.00 \text{ (rechargeable batteries)} \\ + \quad 15.00 \text{ (recharger and recharging cost)} \\ \hline = \quad 26.00 \text{ (cost for use of rechargeable batteries)} \end{array}$$

### OBJECTIVES

Youth will be able to:

- ✓ demonstrate the savings incurred when using rechargeable batteries.
- ✓ identify the environmental impacts of battery usage.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

20 Minutes

### ADVANCE PREPARATION & MATERIALS

1. Flip chart or blackboard.
2. Rechargeable battery and battery charger (optional)
3. Weight scale
4. D cell battery
5. Copies of RECHARGEABLE RECYCLABLE ACTIVITY PAGE





- ✍ If each of the 876 batteries was a D cell battery, and each battery weighs 28 grams, how much (by weight) solid waste did we have?

$$\begin{array}{r} 876 \text{ (batteries)} \\ \times \quad 28 \text{ (grams per battery)} \\ \hline 24,528 \text{ (grams)} \end{array}$$

- ✍ If each of the 876 batteries has 10 grams of potential toxic waste, what would be the total potential toxic waste?

$$\begin{array}{r} 876 \text{ (batteries)} \\ \times \quad 10 \text{ (grams toxic)} \\ \hline 87.6 \text{ (grams)} \end{array}$$

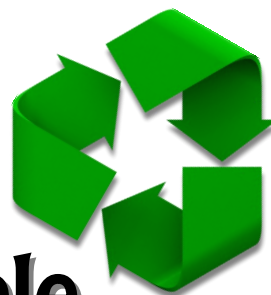
The 876 disposable add up to 24,100 grams of solid waste including 105 grams of toxic chemicals (mercury).

- ✍ Have youth weigh a D cell battery and record weight (in grams) on activity sheet.
- ✍ Have youth refer to Rechargeable = Recyclable! Workbook page 20.
- ✍ Have youth take home and complete. Examine and record the number of each battery found in appliances, machines, toys, games, etc.

## REFLECT/APPLY:

- ✍ Can you save money by using rechargeable batteries? **Yes**
- ✍ How are batteries disposed of? **Thrown away, some are now being recycled**
- ✍ What are batteries made of? Which materials are considered potentially toxic? **Chemicals, zinc, copper; all of them if they are not handled properly**
- ✍ How many batteries are used worldwide? What can the impact be of that many batteries?  
**Answers will vary**
- ✍ Explain the advantages of using rechargeable batteries. Are there any disadvantages to using rechargeable batteries?





# Rechargeable = Recyclable

- How much does a D-cell battery weigh? Weigh several batteries.
- Below, identify the batteries used in your everyday life and complete the chart.

1 Measurements: 1 gram = 0.035 ounces

2 1 ounce = 28.4 grams

Battery type	Weight	# used daily	Where it was found	Total weight	Total weight of toxic substances

1. Assume that we are using only D-cell batteries. Calculate the total weight of solid waste generated by the total number of disposable batteries you use on a daily basis if each battery weighs \_\_\_\_\_ grams (insert the amount your D-cell batteries weighed).
2. Now, calculate the toxic chemicals that are disposed of if each D-cell battery produced 0.12 grams of toxic chemicals.
3. Now, estimate how often batteries “die-out” and new ones are needed for each item they are used in. Calculate the waste of solid and toxic waste disposed of.





# ACTIVITY 6 Can You Live With It?



**LIFE SKILLS:** Using information; Communicating and relating to others; Decision making

## INTRODUCTION:

How much of our everyday world is dependant on energy? Everything. Without the sun's energy, our world as we know it, would not exist. What are the issues of energy and energy consumption? Are we affected by what happens around the world? Let's "research" what the issues are concerning "energy".

## DO: CAN YOU LIVE WITH IT?

- ✦ During the first thirty minutes time period, distribute newspaper and magazine articles about environmental energy topics for youth to familiarize themselves with local, national and international energy topics. Each youth can do some investigative research on their own between the learning sessions.
- ✦ During the second thirty minute time period, each youth will need a piece of paper and a pencil. Allow five minutes for each youth to write their environmental concern(s). When this is complete, have each youth "wad up" their sheet of paper. The youth then throws the wadded paper into the group. The receiver opens and reads the contents of the papers.
- ✦ Ask the group, "Can you live with it?", and solicit their responses. Take a few minutes to discuss each. You may want to record and read back all responses when completed, if time allows.

### OBJECTIVES

Youth will be able to:

- ✦ explore environmental energy issues.
- ✦ identify environmental energy concerns.
- ✦ compare and prioritize energy environmental concerns of their community.

### SETTING:

A large comfortable room with tables and chairs.

### LESSON TIME:

Two 30 minute periods

### ADVANCE PREPARATION & MATERIALS

1. Collect newspaper and magazine articles specific to energy and environmental topics or issues.
2. Paper
3. Pencils
4. Newspaper and magazine articles

## REFLECT/APPLY:

- ✦ What are the environmental concerns that the group feels that can live with? Why? **Answers will vary**
- ✦ What concerns can the absolutely not live with? Why not? **Answers will vary**
- ✦ Can you alter your current lifestyle to address some of these concerns? How?
- ✦ How can you make your community, state, nations, and the world more aware of energy related environmental problems?
- ✦ How can you act upon the concerns to make a positive impact on your community, state, nations, and the world?





# ACTIVITY 7 Environmental Role

**LIFE SKILLS:** Acquiring, analyzing, and using information

## INTRODUCTION:

Electricity is generated using natural resources. The use of these natural resources to generate electricity effects the natural environment in many ways - from extracting the resource to utilization of the resource. Let's explore how generating electricity that we use everyday effects our environment?

## DO: ENVIRONMENTAL ROLE

- ✓ Review with youth the source of energy used to generate electricity: coal, solar, wind, nuclear, geothermal, petroleum, biomass, hydropower.
- ✓ From the group of youth into two groups and line them up facing each other.
- ✓ Group one rolls the die to the opposite person in group two. The person in group two must give a negative or a positive characteristic of the energy source show on the die. The free space allows the participant to pick a power source for the answer. The group two person rolls the die back to group one to the second person in line.
- ✓ That person must then give a negative or a positive characteristic of the energy source rolled on the die. The back and forth roll continues until the entire line has had an opportunity to answer without repetition of answers.
- ✓ The time keeper allows a ten-second limit for answers.
- ✓ The recorder keeps track of the responses for each group on the blackboard or large sheet of paper.
- ✓ When complete have the youth determine whether the responses are appropriate. One point can be allowed for each response.

## REFLECT/APPLY:

- ✓ Which energy source had the most positive environmental characteristics? Why? **Answers will vary**
- ✓ Which energy source has the most negative environmental characteristics? Why? **Answers will vary**
- ✓ What energy would you want in your neighborhood?
- ✓ What source do you have in your neighborhood?

### OBJECTIVES

Youth will be able to:

- ✓ give positive environmental impacts of different resources in electrical energy.
- ✓ give negative environmental impacts of different resources in electrical energy.

### SETTING:

A large comfortable room for role playing activity.

### LESSON TIME:

10–30 minutes

### ADVANCED PREPARATION & MATERIALS

1. Make die and gather appropriate materials
2. One box, about 12 inches on a side. (The box will be used to create a die for the environmental roll game)
3. A picture of word depiction: coal, solar, wind, water, uranium for each of five sides of the die. The sixth side of the die will say "free space"
4. Blackboard, flip chart or large sheet of paper and marking pen to record the positive and negative characteristics.
5. Bell, whistle, buzzer or some sound maker



# URANIUM



# SOLAR





# WIND



# WATER



# COAL



# FREE SPACE



# Glossary

**Atom:** the building block of the universe. Atoms bond together to form chemical elements and molecules, which make up all matter. Atoms have smaller or subatomic particles within them, but they cannot be broken apart without great effort, and that splitting releases tremendous energy.

**Biomass:** plant and animal materials used as fuel.

**Chemical Bonds:** links between atoms in a molecule that are created by sharing subatomic particles called electrons. These bonds are a form of energy and as such can be disrupted by other forms of energy, such as light or heat.

**Compost:** fertilizer made with nonmeat food scraps, leaves, grass clippings, soil, and water.

**Electron:** subatomic particle with a negative electrical charge that orbits the atom's nucleus. Chemical bonds are formed by atoms sharing electrons.

**Electromagnetism:** electrical and magnetic force fields created by the many cables, appliances, wires, and light fixtures that are part of modern life. Exposure to electromagnetic radiation may possibly be a health hazard.

**Energy:** the ability to move or do work. Energy comes in different forms and can change from one form to another. Common sources of energy: sunlight, heat, wind, fossil fuels, food. Renewable energy sources are those that replace themselves naturally (like wood) or that are always around (like sunlight).

**Environment:** the world and everything on and around it-sky, Earth, mankind and other living things, as well as everything man has created. In recent years, the word has come to mean primarily the natural world separate from man and his works.

**Fission:** splitting the nucleus of an atom to release energy.

**Fossil Fuels:** fuels formed millions of years ago from the remains of prehistoric plants and animals compressed in rock. Oil, natural gas, and coal are fossil fuels.

**Fusion:** the process by which atomic nuclei are joined together to make energy.

**Molecule:** combination of atoms held together by sharing electrons.

**Neutron:** subatomic particle with no charge that is part of the nucleus of an atom.

**Photosynthesis:** process by which plants take in sunlight, water, and carbon dioxide and make food for themselves, in the process releasing oxygen into the air.

**Proton:** subatomic particle with a positive charge that is part of the nucleus of an atom.

**Radioactive wastes:** by-products of the nuclear power and defense industries which emit radiation.

**Radon:** radioactive gas that occurs naturally in soil.







The Power Of

**ELECTRICITY**

## CERTIFICATE OF ACHIEVEMENT

I certify that \_\_\_\_\_

has successfully completed the requirements for the

**4-H Power of Electricity Project!**

Leader: \_\_\_\_\_

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



### **The 4-H Motto**

To make the best better.

### **The 4-H Pledge**

I pledge

my head to clearer thinking,  
my heart to greater loyalty,  
my hands to larger service, and  
my health to better living,  
for my club, my community,  
my country and my world.



*Visit the 4-H web site for more information: <http://www.florida4h.org>*

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