Entering Electronics

Project Activity Guide
Acknowledgments

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For more on Electricity, look for these other guides in this set.
Entering Electronics

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Note to the Electric Project Helper

This guide is the fourth in the 4-H Electric Excitement series developed to involve youth in the exciting world of electricity, and to improve their life skills and leadership in a science area. The first two guides should be completed by the youth in preparation for advancing to the Electronics I Guide. Electronics I introduces the basics of solid-state electronics. It also provides hands-on activities that give youth practical experience in understanding modern day electronic equipment, and provides them with career skills and opportunities. These activities can be used in a variety of settings such as in the classroom, with special interest clubs, after school groups or community clubs, or one-on-one.

Your Role

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

The Electric Excitement Series

This is the fourth activity guide in the Electric Excitement Series.

Activity Guide Level 1 Age Grade
Magic of Electricity 1 9–11 4–5
Investigating Electricity 2 11-13 6–7
Wired for Power 3 13–15 8–9
Entering Electronics 4 16–18 10–12

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

Electronics I Guide

This activity guide is designed for intermediate to advanced learners in the electric series. An understanding of DC circuits, voltage, amperage, current flow, polarity and some soldering is essential to properly undertake the activities. This guide can be used by an individual in a self-study mode or with a small group. The activities are especially designed to help youth develop skills in planning, organizing, making decisions, analyzing and communicating their experiences to others. Resources listed can provide further information and help on understanding and explaining these activities.

The Experiential Learning Model

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

1. Experience
   - The activity
   - Perform, do it
   - Youth share how they will use the project and life skill practiced in other parts of their lives.

2. Share
   - The results, reactions, observations
   - Youth describe the experience and their reactions.

3. Generalize
   - The project and the skill practiced to their own everyday experiences.
   - Youth relate the project and the skill practiced to their own everyday experiences.

4. Process
   - The process of planning and doing
   - Youth reflect on the experience, analysis, actions.

5. Apply
   - What was shared to a similar or different situation
   - Youth describe any similar or different situations.
   - Youth apply what was shared to a new situation

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

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

Evaluating the Experience

1. By asking the questions under Making Connections you can evaluate your youth’s understanding of the key concepts and life skills practiced in each activity. Listening to and encouraging consideration of each question results in conclusions and opportunities for further application. The Making Connections questions are found at the end of each chapter. In addition, the Success Indicator shown in the introduction of each activity will also help you evaluate the experience.

2. At the end of Book 5, Electric Group Activity Guide, you will find an assessment sheet, Evaluating the Impact. Use this sheet to help you evaluate your youth’s understanding of electronics as he or she completes the activities.

3. Youth and volunteer helper assessments of the Electric Excitement series can be found on page 35, Electric Group Activity Guide.
How This Book Works

Are you ready to learn about electronics? Through the activities in this guide you will have many exciting experiences and challenges. You will learn about diodes, transistors, LEDs, photocells, SCR’s, IC’s and amplifiers! These items are components in the family of solid-state electronics. Solid-state refers to the “solid” materials from which the electrical components are fabricated, such as silicon, gallium, boron, phosphorous, germanium, etc. The delicately prepared solid-state devices are usually enclosed in plastic or metal cases for physical protection and heat dissipation. They are also referred to as semi-conductors because they can either conduct or not conduct the flow of electric current. In this manner, they can act as switches and amplifiers. These components are an essential part of all modern day electronics products found in the home, office and business.

**The Activities**

Each activity in the Electric Excitement series is designed to help you learn something about electricity and electronics as you practice a life skill you can use everyday. Don’t forget to invite a family member or a friend to work with you on the activities. These projects can even be done with your classmates or in a special interest club, after school group or community club. Sometimes it is more fun and interesting to explore new things together. Here is a quick look at the various sections found in each activity.

**Skills**

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

**Success Indicators**

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

**Tools**

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

**Power Up**

This is the “do” part of the activity. You will usually get to share part of what you do with others.

**Closing the Circuit**

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

**Making Connections**

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

**Light Bulb Icon**

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

**Brain Boosters**

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

**Safety Icon**

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

**Kite Icon**

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

**Glossary Words**

All definitions for the words listed here are found in the glossary on page 38.

**Journal**

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

**Your Project Helper**

Your electric project helper is an important part of your overall experience in the electric project. The choice of a helper is yours. This person may be your project leader or advisor, troop leader, teacher, family member, neighbor, friend, or anyone who has the interest to work with you on these activities. Involve your helper as you set your goals, discuss the questions following each activity and sometimes work together on an activity.
**My Plans**
- Select an electric project helper
- Complete all four steps of the *Entering Electronics* Planning Guide
- Do at least seven activities each year
- Take part in at least two leadership experiences each year

My Name

My Project Helper

Helper’s Phone Number  E-mail Address

1. **My Electric Project Goals**
   I plan to complete my *Entering Electronics* activity book by ____________.

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

<table>
<thead>
<tr>
<th>Experience</th>
<th>Plan To Do</th>
<th>Date Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give an electric demonstration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teach someone something about electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encourage a friend to be a part of the electric project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attend an electronics assembly business</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tour an electric generating plant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Search the Internet for electric topics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhibit an electric project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My own activities:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. **Electric Project Highlights**
   List and record the date every time you do and learn something exciting in *Entering Electronics*.

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

(Use additional paper as needed.)
# Entering Electronics Achievement Program

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

## Required Activities

<table>
<thead>
<tr>
<th>Activity Name</th>
<th>Date Completed</th>
<th>Helper's Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is This and That?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunting for Electronic Wizards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How Many and How Much?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot Wire Hook-Ups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Capacity to Resist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diodes—One Way Only!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dim Your Bright Lights!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does Your LED Glow?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How Fast Do I Blink?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gotcha!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>My! How Bright is the Light?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surprise! Surprise!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More Volume, Please!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Optional Activities (Brain Boosters)
Select and do any of the Brain Boosters in Entering Electronics or make up your own. Record the page number of each one you complete.

---

## Entering Electronics Achievement Program Certificate

I certify that _____________ has successfully completed the requirements of Electric Excitement: Entering Electronics

Helper’s Signature: ____________________________________________

Date: ___________
What is This and That?

Do you know the difference between a resistor and a capacitor? Or, between a diode and a transistor? In this activity you will check your knowledge of electrical and electronic parts. Search through the references listed at the end of this book and other materials to help you identify the parts.

You may not be able to identify all of the parts right away. If you do not know all the parts now, continue working through the activities to learn about these parts, then come back and identify additional parts until you complete the list.

Power Up

Electrical and electronic parts symbols and images are defined and shown in many publications. Put the letter for each part shown in the picture in the blank beside the proper part name. Then describe to your electronics helper what each part is and how it is used. Check the High Voltage Glossary (pg. 38) for descriptions of many of the terms.

<table>
<thead>
<tr>
<th>Picture</th>
<th>Part</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Battery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Battery Holder</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bulb</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Switch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terminal strip</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transistor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resistor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potentiometer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Light Emitting Diode (LED)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacitor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Photocell</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Buzzer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Motor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Silicon Controlled Rectifier (SCR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Integrated Circuit (IC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speaker</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plug, miniature</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solar Cell</td>
<td></td>
</tr>
</tbody>
</table>

Symbols

1. Battery
2. Battery Holder
3. Bulb
4. Switch
5. Terminal strip
6. Diode
7. Transistor
8. Resistor
9. Potentiometer
10. Light Emitting Diode (LED)
11. Capacitor
12. Photocell
13. Buzzer
14. Motor
15. Silicon Controlled Rectifier (SCR)
16. Integrated Circuit (IC)
17. Speaker
18. Plug, miniature
19. Solar Cell
Closing the Circuit

People use many methods to describe something without saying or writing the entire word or phrase. One of these methods is by using the first letter of the words in the phrase to make up a word (acronym), for example, SCUBA stands for S(self) C(ontained) U(nderwater) B(breathing) A(apparatus). See if you can use a dictionary or an encyclopedia to find out the meaning of these words:

MODEM ______________________
____________________________

RADAR ______________________
____________________________

LASER ______________________
____________________________

NASA _______________________
____________________________

Can you think of other words we use that are actually made up of the first letters of many words? How does this make it easier to communicate? What are other “shorthand” methods that people use to communicate?

Electronics developed from experiments made in the 1800’s with electric currents flowing through glass tubes. Among the first men to develop such experiments was Heinrich Geissler (1814–1879), a German manufacturer of scientific instruments. He removed most of the air from a glass tube, and found that the tube would glow with colors when different gases were placed in the tube and an electric current was sent through it.

Glossary Words

- Terminal Strip
- Transistor
- Potentiometer
- Capacitor
- Buzzer
- Silicon Controlled Rectifier (SCR)
- Diode
- Resistor
- Light Emitting Diode (LED)
- Photocell
- Meter
- Integrated circuit (IC)

Brain Boosters

Sketch some other symbols you see daily and describe their important meaning and use.
Hunting for Electronic Wizards

Electronics is a branch of the science of electricity. “Electronics” takes its name from electrons, which are the tiny, negatively charged particles of atoms. Electronics deals chiefly with the flow of electrons (or electrical current) passing through vacuum tubes, gas-filled tubes, transistors and other similar devices. Electrical fans, generators and motors are not considered electronics because they depend only on electrons flowing through wires.

Electronic systems composed of semi-conductors are used as an essential part of all modern day electronics products found in the home, office and business. They do such things as operate the remote control for your TV or stereo, or dictate the power-level and timing in your microwave. In this activity you will discover the many items that we use every day that depend on electronics to operate.

Power Up

Prepare for a hunting expedition around your home, school, or other place for ‘wizards’ of the electronics world. Do this with a friend for more fun! Prepare a form as outlined below and see how many items you can “target.”

<table>
<thead>
<tr>
<th>Individual Item</th>
<th>Contained In</th>
<th>Action Performed (light, motion, sound, switch, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Glossary Words

- Electronics
- Semi-conductor
The World of Electronics

Electronic components are used in many of the devices that we use in the home, school, or workplace. Electronics make possible radio, television, CD players, tape recorders and telephones. Electronic thermostats control the temperature in some houses, and photoelectric cells turn on security lights when darkness comes.

In industry, electronic devices operate many powerful machines. They regulate the current used in spot welding, control the speed of lathes and other machines driven by electric motors, adjust temperatures in ovens, or measure and control the thickness of manufactured items. Photoelectric cells or “electric eyes” sort fruit and other products according to size and color. Electronic facsimile machines, computers, scanners and printers assist in operating most businesses.

Electronic devices are used in medicine, astronomy, business, physics, navigation, national defense, music and many other fields. What electronic devices do you use?

Making Connections

Share With Your Helper
- What electronic parts did you already know?
- Where or how did you find information about the other parts?
- How could you best recognize electronic devices around the house?

Process What's Important
- What appliances or devices around your home, school, or other places use electronic components?
- Why is knowledge of electronic parts important to the success of an electronic project?

Generalize To Your Life
- Where can you find electronics information when you need to know something about electronics?

Apply What You Learned
- How will you prepare yourself to do the activities in this guide?
- How do we use symbols in communication?

Sir William Crookes, a British scientist, invented the Crookes vacuum tube. He observed that when obstacles were placed in these vacuum tubes, they cast shadows on the sides of the tubes when a current flowed through them. This indicated that the current consisted of particles.

Vacuum tubes ushered in the age of electronics, but these devices were cumbersome, inefficient and expensive to make. Today we use smaller and less expensive transistors to perform the same electrical tasks as vacuum tubes once did. Giving credit to where it is due, discoveries with vacuum tubes led the way to the marvels of electronics that we know today.

Brain Boosters

1. Describe to your helper what our lives would be like if we did not have electronics. How have electronics improved our way of life?

2. Visualize how electronic parts and devices could be used for new devices and equipment for the home, school or work place. Make notes about some of these ideas and discuss with your helper, parent, teacher or electronic leader.
Chapter 2
What Do I Need?

Activity

How Many and How Much?

Several parts are needed to do the activities in Entering Electronics. In this activity you will obtain parts for the activities you plan to do. Electrical parts can be purchased from electrical supply catalogs, stores or internet sites.

Power Up

Listed are the parts you will need for each activity. Indicate in the chart which parts you have, which ones you'll need and price for each. Some of the parts have to be prepared for easy electrical connections. Wire leads are necessary to extend the short pins or tabs of some parts and enable them to connect together for circuit fabrication.

### PARTS NEEDED FOR ACTIVITIES IN ELECTRONICS 1

<table>
<thead>
<tr>
<th>Parts Required</th>
<th>Activity Number, Quantity and Price of Parts Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Battery, 1.5 Volt, &quot;C&quot; Size</td>
<td>1</td>
</tr>
<tr>
<td>Battery Holder, &quot;C&quot; Size, for 1 Battery</td>
<td>1</td>
</tr>
<tr>
<td>Battery Holder, &quot;C&quot; Size, for 2 Batteries</td>
<td>1</td>
</tr>
<tr>
<td>Bulb, 1.5 Volt, Screw Base</td>
<td>1</td>
</tr>
<tr>
<td>Bulb, 6 Volt, Screw Base</td>
<td>1</td>
</tr>
<tr>
<td>Bulb Base, Screw Type for above</td>
<td>1</td>
</tr>
<tr>
<td>Switch, On-Off, knife-blade or equal</td>
<td>1</td>
</tr>
<tr>
<td>Terminal Strip, 6 position</td>
<td>1</td>
</tr>
<tr>
<td>Terminal Strip, 8 position</td>
<td>1</td>
</tr>
<tr>
<td>Diode, 3 amp, 25 Volt or greater</td>
<td>1</td>
</tr>
<tr>
<td>Transistor, NPN, 2N4401, GE20 or SK3854</td>
<td>1</td>
</tr>
<tr>
<td>Resistor, 1000 Ohm, 1/2 Watt</td>
<td>1</td>
</tr>
<tr>
<td>Resistor, 120 Ohm, 1/4 Watt</td>
<td>1</td>
</tr>
<tr>
<td>Resistor, 220 Ohm, 1/4 Watt</td>
<td>1</td>
</tr>
<tr>
<td>Resistor, 2.2 Ohm, 1/2 Watt</td>
<td>1</td>
</tr>
<tr>
<td>Potentiometer, 5000 Ohm, linear</td>
<td>1</td>
</tr>
<tr>
<td>Transistor, Unijunction, 2N4691, SK9122</td>
<td>1</td>
</tr>
<tr>
<td>Light Emitting Diode (LED) 1.5 to 2.0 Volt</td>
<td>1</td>
</tr>
<tr>
<td>Capacitor, 22 mfd, 25 Volt</td>
<td>1</td>
</tr>
<tr>
<td>Capacitor, 0.2 mfd, 15 Volt or greater</td>
<td>2</td>
</tr>
<tr>
<td>Capacitor, 10 mfd, 15 Volt or greater</td>
<td>1</td>
</tr>
<tr>
<td>Capacitor, 200 mfd, 15 Volt or greater</td>
<td>1</td>
</tr>
<tr>
<td>Capacitor, 1000 mfd, 15 Volt or greater</td>
<td>1</td>
</tr>
<tr>
<td>Photocell, resistive COS type</td>
<td>1</td>
</tr>
<tr>
<td>Buzzer, 4-24 Volt DC, under 50 ma current</td>
<td>1</td>
</tr>
<tr>
<td>Solar Cell, 0.5 Volt, 100-300 ma output</td>
<td>1</td>
</tr>
<tr>
<td>Meter, 0-50 ma</td>
<td>1</td>
</tr>
<tr>
<td>Silicon Controlled Rectifier, SK3770 or equal</td>
<td>1</td>
</tr>
<tr>
<td>Integrated Circuit, LM393, SK3853 or equal</td>
<td>1</td>
</tr>
<tr>
<td>Speaker, 3 to 6 inch, 4 Ohm (or 6 Ohm)</td>
<td>1</td>
</tr>
<tr>
<td>Plug, Miniature</td>
<td>1</td>
</tr>
<tr>
<td>2 to 3 inch pieces of #18 or #20 insulated solid wire</td>
<td>*</td>
</tr>
<tr>
<td>Soldering iron</td>
<td>1</td>
</tr>
<tr>
<td>Solder</td>
<td>1</td>
</tr>
<tr>
<td>Wire cutting tool</td>
<td>1</td>
</tr>
<tr>
<td>Wire stripping tool</td>
<td>1</td>
</tr>
</tbody>
</table>

* Number of wires as required to connect to the parts being used.
** Other values can be used for tests.
There are many transistors and other electronic parts today that have similar characteristics. Cross-referenced lists show parts that can be substituted for one another. Did you find substitute parts when you were looking for those needed for these projects?

Do you use a computer? If so, try preparing a spreadsheet of the above parts lists so you can make changes or additions as needed and print a list for your records or to share with another person. Include a list of the substitute parts that you found in your search.

Marquis Guglielmo Marconi (1874–1937), an Italian inventor and electrical engineer, is recognized for his work in developing wireless telegraphy, or radio. Modern day electronics began in 1896 when Guglielmo Marconi transmitted and received radio signals over a distance of two miles. On Dec. 12, 1901 he produced the first transatlantic wireless signal in history!

Brain Boosters

Improve your record keeping skills by expanding the parts resource list above to include a column for the source of the parts. Use this information to determine your cost of each activity and where the parts can be obtained.

The Barrier Terminal Block

Many of the parts are used in several different activities. Entering Electronics projects use a quick and easy way to connect different parts in various circuits. A barrier terminal block is the means used in these activities to conveniently connect parts. The terminal block has screw terminals where wires can be clamped tightly under the screw head. The screw terminals are made in pairs. Each pair of screws is electrically connected by a short metal conductor, but are insulated from other pairs. With this feature you can quickly make connections of selected wire leads under one pair of screws but keep them electrically isolated from other connections. A small flat tip screwdriver is used to build and disassemble the test circuits. The terminal blocks are available in different sizes and number of screw pairs. Shown is a six position terminal size.

Glossary Words

- Solder
- Terminal Block