

# ELECTRIFYING SCIENCE

**Grade Level or Special Area:** 4<sup>th</sup> Grade

**Written by:** Adina Felten, Crown Pointe Academy, Westminster, CO

**Length of Unit:** Seven lessons (approximately three weeks (14 days), one day=45 minutes)

## I. ABSTRACT

Since electricity can be evidenced and experienced all around us at any given time, it is easy to notice its relevance in our daily lives. Throughout the course of this engaging, hands-on unit, students will receive a solid background on electricity and gain appreciation and enthusiasm to learn more. Basic components of electricity explored include types of electricity, circuits (and components thereof), conductors, insulators, electromagnets, and key historical contributors such as Michael Faraday and Thomas Edison. Students will also learn several crucial safety precautions to follow when working with or playing around electricity.

## II. OVERVIEW

### A. Concept Objectives

1. Students will understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
2. Students will understand common properties, forms, and changes in matter and energy.
3. Students will understand interrelationships among science, technology, and human activity and how they can affect the world.
4. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.

### B. Content from the *Core Knowledge Sequence* (p. 105)

1. Electricity as the flow of electrons
2. Static Electricity
3. Electric Current
4. Electric Circuits
5. Conductors and Insulators
6. Electromagnets
7. Safety with electricity
8. Key historical contributors including Thomas Edison and Michael Faraday (Edison listed in the *Core Knowledge Sequence* for Grade 1 on p. 39, Faraday listed under “Science Biographies” on p. 106)

### C. Skill Objectives

1. Students will recognize that electricity can occur in several forms and is an integral part of their everyday lives.
2. Students will define electricity as a form of energy produced when electrons move from one atom to another and depict where on an atom electrons may be found.
3. Students will experiment with both static and current electricity to identify properties of the different electricity types.
4. Students will become familiar with materials necessary to design a circuit, labeling parts of a battery wire, and bulb.
5. Through several simple experiments, students will learn the difference between a closed, open, and short circuit.

6. Students will learn how conductors and insulators affect an electric current, and will compose a list of conductors and insulators, which will complete a basic circuit through experimentation.
7. Students will discover the relationship between electricity and magnets by creating an electromagnet.
8. Students will practice following steps of experimentation following the scientific process including questioning, hypothesizing, following a procedure, determining results, and forming a conclusion.
9. Students will realize that our technology has made immense advances over time since the invention of electricity due to several key historical figures including Thomas Edison and Michael Faraday.
10. Students will review several milestone technological advances and predict how their lives will be altered ten years from now due to continuing advances.
11. Students will know how to use both current and static electricity safely and learn precautionary methods when working or playing around both types.

### III. BACKGROUND KNOWLEDGE

#### A. For Teachers

1. Kerrod, Robin. *Let's Investigate Science: Electricity and Magnetism*. New York: Marshall Cavendish Corporation, 1994. 1-85435-626-7.
2. Lafferty, Peter. *More Science Projects: Electricity & Magnetism*. New York: Marshall Cavendish Corporation, 1989. 1-85435-175-3.
3. "Matter and Energy." *Macmillan Encyclopedia of Science: Volume 1*. 1991ed. 0- 02-941141-6.

#### B. For Students

1. Kindergarten and Grade 2: Introduction to Magnetism
2. Grade 1: Matter, Introduction of Electricity, and Science Biography: Thomas Edison
3. Grade 4: Chemistry: Basic Terms and Concepts

### IV. RESOURCES

- A. Appendices A-K
- B. *Electricity*, by Mark Bailey (Lesson One)
- C. *More Science Projects: Electricity and Magnetism*, by Peter Lafferty pp. 18-23, 26-27,33 (Lesson Five; pp. 34-35, 40-41 are optional)
- D. *Eyewitness Books: Electricity*, by Steve Parker (Lesson Six)
- E. *The Electricity Story*, by George D. Leon (Lesson Six)

### V. LESSONS

#### Lesson One: Introducing Electricity (two days)

##### A. Daily Objectives

1. Concept Objective(s)
  - a. Students will understand common properties, forms, and changes in matter and energy.
  - b. Students will understand interrelationships among science, technology, and human activity and how they can affect the world.
  - c. Students understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
2. Lesson Content
  - a. Electricity as the flow of electrons

3. Skill Objective(s)
    - a. Students will recognize that electricity can occur in several forms and is an integral part of their everyday lives.
    - b. Students will define electricity as a form of energy produced when electrons move from one atom to another and depict where on an atom electrons may be found.
- B. *Materials*
1. *Electricity*, by Mark Bailey
  2. Appendix A: Lights Out! (one copy per student)
  3. Appendix B: Electricity Notes (teacher copy for reference)
- C. *Key Vocabulary*
1. Atom - smallest parts in all material
  2. Nucleus - a cluster of protons and neutrons in the center of an atom
  3. Proton - a positively charged particle that is found in the nucleus of every atom
  4. Neutron - a particle in the nucleus of an atom that has no charge
  5. Electron - a negatively charged particle present in all atoms
  6. Attract - the power or force that pulls two unlike charges together
  7. Repel - to push away from
- D. *Procedures/Activities*
1. Have lights and any other electrical appliances turned off in the classroom. Have students close their eyes and imagine that they have traveled back in time to where there is no electricity. Ask them to picture their environment and the differences they notice compared to their present surroundings. Have them think about all the ways their lives will be impacted due to the lack of electricity and technology.
  2. Students may then open their eyes. Brainstorm together some of the changes thought about.
  3. Hand out "Lights Out!" (Appendix A). Read directions at the top of the page together and have students write a one-page story about a day without electricity. They may either have the story take place during a time period prior to the invention of electricity or in the present where the electricity goes out for the day.
  4. After 15-20 minutes, have several students share their stories, stressing with the class how much we depend upon electricity and the technology produced because of it on a daily basis.
  5. Display on the board the following questions:
    - a. What is electricity?
    - b. Where does it come from?
    - c. Is there more than one kind?
    - d. Can it be dangerous?
    - e. What experiences have you had with electricity?
 Discuss answers to these questions briefly, writing several responses on the board.
  6. Tell students that they will discover many of the answers to these questions from listening to a story.
  7. Read aloud *Electricity* and have students focus on finding some of the answers while listening. When finished, add more information on the board from what they learned in the book.
  8. Tell students that to truly understand electricity, they need to understand atoms. Refer back to previously studied Chemistry Unit reviewing what they remember about atoms and mentioning that Electricity builds upon many of the concepts they already learned in Chemistry. Have students take several notes about

protons, neutrons, electrons, and how the transfer of charges works (use Appendix B for reference).

- E. *Assessment/Evaluation*
1. Students will realize their dependence upon electricity in their everyday lives by writing a one-page story to support the story title "Lights Out!"
  2. Students will illustrate one example where electricity occurs (Ex: clouds touching, static cling, radio, etc.) and present their chosen form of electricity to the rest of the class.
  3. Students will take notes about basic components of electricity including definitions for electricity, atoms, protons, neutrons, and electrons and a diagram of a simple model of an atom.

### **Lesson Two: Static vs. Current Electricity (two days)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand common properties, forms, and changes in matter and energy.
    - b. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
  2. Lesson Content
    - a. Static Electricity
    - b. Electric Current
  3. Skill Objective(s)
    - a. Students will experiment with both static and current electricity to identify properties of the different electricity types.
- B. *Materials*
1. Appendix C: Making Static Electricity (one copy per student)
  2. Appendix D: Making Current Electricity (one copy per student)
  3. Static Electricity experiment materials:
    - a. Piece of wool or nylon, table salt
    - b. Small pieces of paper
    - c. Two balloons
    - d. Comb
    - e. One piece of puffed corn cereal
    - f. Thread
  4. Current Electricity experiment materials:
    - a. One piece insulated wire with stripped ends or aluminum foil (about 12" long)
    - b. Two C or D volt batteries
    - c. One small flashlight bulb
- C. *Key Vocabulary*
1. Static electricity - the electricity associated with electric charges, which tends to stay where it is ("static") rather than flowing away; electricity at rest
  2. Current electricity - a flow of electrons through a conductor; moving electricity
  3. Negative charge - the charge held by an object that has a lot of extra electrons
  4. Positive charge - the charge held by an object that has lost electrons and is left with extra protons
  5. Neutral charge - the charge held by an object that has an equal number of protons and electrons (it is neutral and basically holds no charge)

D. *Procedures/Activities*

1. **Static Electricity:** Define static electricity. Tell students that they are going to have some chances to make the type of electricity known as static electricity. Hand students Appendix C: Making Static Electricity. Do each of the experiments together as a group, reading directions from Appendix C along the way. Illustrate results of each demonstration in the boxes labeled “What Happened.” After completing all static electricity experiments, ask students to write one or two sentences under “Conclusion” to summarize rules they learned applicable to static electricity (just have them make an educated guess for now if they do not know.)
2. Review what happened in each experiment. For the balloon/salt activity, the balloon gained extra electrons from the cloth receiving a negative charge. Thus, it tended to be attracted to items without built up electrons such as the cloth, salt, or small pieces of paper. For activity 2, if hair was completely dry and combed through vigorously it should have raised toward the comb. Here the hairs gained extra electrons from the comb, however individual hairs received the same charge as the hairs next to them, causing them to repel and separate from one another. Along those same lines, when the second balloon was rubbed against the dry hair and placed next to the first balloon, they repelled each other due to having the same charge. Activity 3 also demonstrated this. Since a charged object attracts an uncharged object or a neutral object (having equal negative and positive charges), the cereal, having a neutral charge, was attracted to the comb which gained a negative charge after picking up extra electrons after rubbing against the cloth. However, while the cereal was touching the comb, some of the extra negative charges moved from the comb to the cereal. Soon the cereal also built up a negative charge. Since the comb and cereal both became negatively charged, they began repelling each other. After touching the cereal, it lost its negative charge since the electrons jumped onto the finger, and was once again attracted to the comb.
3. Once the rationale behind these experiments has been explained to students, ask them what general rule applies to positive and negative charges as demonstrated by the various experiments. They should generalize that objects with similar charges repelled each other and objects with opposite charges were attracted to each other. Have them adjust their conclusions to state that similar charges repel and opposite charges attract. If desired results were not met, brainstorm ideas of why this may be. Tell students that these experiments won’t work well on humid days and will work best with dry weather. Explain that experiments often have variables that will alter the results, in this case it was weather. Also discuss that experiments often have to be repeated several times to obtain a reliable general rule. In this case, several different experiments were performed and all showed similar reactions, crediting our conclusion, however let them know that for more accuracy each individual activity should be performed again.
4. **Current Electricity:** Ask students how else electricity is produced. Remind them of the book read earlier in the unit. (Many responses may include: plug-ins, batteries, power plants, etc.) Tell students that any electricity that runs from a source to an object through a wire (ex: from outlet through cord to TV) is called current electricity. Tell them that current flowing through a wire works similar to water flowing through a pipe. For each, there must be something pushing the flow. Whereas a pump pushes along the water through the pipe, a battery or other power source is needed to push electrons along a wire. The amount of pressure used to push the electrons can vary depending on the power source and

amount and is measured in volts. Higher voltages sent through the wire will produce stronger electrical pressures.

5. Give students Appendix D. Let them know they will see an example of current electricity. Remind them of the definition and tell them that they will see an example of what current electricity can do when the electricity flows in a complete circle. For both demonstrations students need to illustrate what they see happening.
  6. For the teacher demonstration only simple materials are needed. Using a C or D voltage battery, connect a piece of insulated copper wire with stripped ends or a piece of aluminum foil coiled into a wire to the bottom of the battery. Place a low wattage bulb on top of the battery (a flashlight bulb works best) and connect the wire to the side of the bulb. The bulb should easily light up. Now repeat the experiment by following all of the same steps, except add another battery on top of the first one. Results should be the same, but the bulb should shine brighter. Explain that this is because more voltage is sent through the wire to the bulb, similar to turning on a faucet higher to receive a more powerful flow of water. Make sure students filled out Appendix D and wrote a concluding sentence such as the stronger the power source, the more energy is created (or the brighter the bulb shined).
  7. Review properties of each type of electricity and have students complete evaluation on their own paper.
- E. *Assessment/Evaluation*
1. Students will design and complete a two-column chart in which they list at least two attributes for both static and current electricity and draw a picture of an experiment that displayed each type of electricity.

### **Lesson Three: Circuits (one day)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will understand common properties, forms, and changes in matter and energy.
2. Lesson Content
  - a. Electric Circuits
3. Skill Objective(s)
  - a. Students will become familiar with materials necessary to design a circuit, labeling parts of a battery, wire, and bulb.
  - b. Through several simple experiments students will learn the difference between a closed, open, and short circuit.

B. *Materials*

1. Appendix E: Batteries, Bulbs, and Wires (one copy per student)
2. Appendix F: Batteries, Bulbs, and Wires Answer Key (teacher copy for reference)
3. Circuit materials per group of four students:
  - a. One piece insulated wire with stripped ends (or aluminum foil strips) at least 12" long
  - b. One C or D battery
  - c. One small flashlight bulb
  - d. One sheet of typing paper divided into four quadrants

C. *Key Vocabulary*

1. Battery - a storage source of electricity
2. Bulb - storage container for incandescent light

3. Wire - anything metal
4. Circuit - a complete circle of electricity
5. Closed circuit - a complete circle of electricity (or circuit)
6. Open circuit - there is a gap or opening in the circle of electricity (or circuit)
7. Short circuit - a connection that occurs when the electricity accidentally takes a path other than the desired path (usually trying to take a short cut)
8. Circuit breaker - a safety switch installed in a circuit that will automatically shut off the power if the current is too strong

D. *Procedures/Activities*

1. Ask students if they remember which materials were needed to make a complete circle of electricity shown in the previous lesson. They should mention a battery, bulb, and wire. Let them know that we will often refer to these items and their components, therefore it is important to be familiar with terms regarding these items.
2. Hand out Appendix E to students. Have students brainstorm ideas for labeled parts and fill out accordingly. Make sure they have included for the battery: battery casing, positive electrode, negative electrode, for the bulb: electrodes, wire, filament, spacer, glass, base, and for the wire: copper strands, plastic insulation, stripped ends (use Appendix F answer key if necessary).
3. Review with students the two types of electricity and how each one is formed. Inform students that when they watched the demonstration for current electricity they watched a complete circle of electricity, which is also known as a closed circuit. Have students define a closed circuit on notepaper. Demonstrate for them again a closed circuit as performed in Lesson Two (with only one battery). Have students guess what an open circuit may be. Tell students the definition and have them add this to their notes. This time place one stripped end of wire under the C or D battery (touching the negative electrode), set the flashlight bulb on top of the battery, but leave an opening between the other end of the wire and the side of the bulb. Tell student that there is a gap or opening in the circle of electricity. Ask what happened to the bulb. They should respond that nothing happened or that it did not light up. Inform them that when there is an open circuit, the electricity cannot complete its path. Now add the term short circuit to their definitions. Explain that this happens when electricity gets confused about which way to go and tries to take a short cut. This often happens when too much current is sent through a wire or if a wire is damaged or connected incorrectly. Give an example that at home if too many appliances are plugged into a single outlet sending too much power through the wires, they can often short circuit and blow a fuse, causing the power to go off. Introduce the term circuit breaker and have students add the definition to their notes. Let them know that due to the circuit breaker, in the given scenario the power went off because of this built in device that shut off the power when too much electricity was sent through the wires. Tell students that this is a good thing to have, since too much current can cause wires to overheat and perhaps start a fire. Reinforce that it is important not to overload circuits to avoid accidents. This is even the case with experiments. If too many batteries are stacked up to create a closed circuit, the wire will get extremely hot and perhaps burn their fingers or burn out the battery or bulb.
4. Divide students into groups of four. They will each need a set of materials including a bulb, battery, wire, and a sheet of typing paper divided into four quadrants. Have each group designate a team captain who will model the sample teacher-led circuits. Show students the same closed circuit as modeled earlier, and ask captains to make the same closed circuit with their own materials. Next,

make another closed circuit, however this time connect one end of the wire to the negative electrode on the bottom of the battery, place the bulb on top of the battery, and place the other end of the wire on top of the bulb. Students will notice that the second example did not light up the bulb. Explain to students that they will need to come up with at least four more circuit arrangements to test whether they will or will not light up the bulb. Each team member should receive a turn at designing a circuit arrangement. After each one, students need to draw a diagram of their arrangement in one of the quadrants on their paper. They will continue this until they have tested four circuits and drawn four diagrams. When finished, the captain may appoint a spokesperson to share one of their circuit arrangements with the rest of the class. Discuss briefly what did and did not work.

- E. *Assessment/Evaluation*
1. Students will illustrate each part of a circuit including the battery, bulb, and wire and label each part of their diagrams.
  2. Students will define each type of circuit and construct an example of an open and closed circuit.
  3. Students will work in cooperative groups to experiment with a given set of materials to determine which arrangements produce complete circuits.

#### **Lesson Four: Conductors and Insulators (one day)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand common properties, forms, and changes in matter and energy.
  2. Lesson Content
    - a. Conductors and Insulators
  3. Skill Objective(s)
    - a. Students will learn how conductors and insulators affect an electric current, and will compose a list of conductors and insulators, which will complete a basic circuit through experimentation.
- B. *Materials*
1. Appendix G: Conductors and Insulators (one copy per student)
  2. Activity materials per pair of students:
    - a. One piece insulated wire with stripped ends
    - b. One C or D battery
    - c. One small flashlight bulb
    - d. Paper clip
    - e. Eraser
- C. *Key Vocabulary*
1. Conductor - a material that electricity can flow through easily
  2. Insulator - a material that electricity cannot flow through easily
- D. *Procedures/Activities*
1. Ask students why they think the copper wire they have been using has a plastic coating on it. Let them know that the electricity cannot flow through it easily and burn their fingers; it is there for a protective covering. Ask them if the aluminum foil burned their fingers. It did so slightly because there is no protective covering and the current can easily travel through the aluminum foil. Define conductors and insulators on the board.
  2. Distribute Appendix G and have students transfer the two definitions onto their papers, informing them that they will soon experiment to find examples of both

conductors and insulators. Model again for students a closed circuit. Now leave a gap creating an open circuit. Let them know that a conductor would still let electricity flow through to light the bulb. Place a paper clip in the gap, showing the complete circuit. Since the electricity flowed through, lighting the bulb, the paper clip is a conductor. Students need to list this item beside number one under the conductor column. Now test an object that will not conduct electricity such as an eraser. Students will see that this time the bulb will not light up. They are to list the eraser beside number one under the insulator column. Read through activity directions together and have students work in pairs to discover at least 10 classroom items to list under each of the columns.

3. Meet together as a class to share results. While exchanging information, students are to add five extra items under each of their columns from class findings.
4. Summarize again what conductors and insulators are. Generalize basic materials that are insulators such as plastic, rubber, porcelain, glass, cloth, wood, and dry air. Mention the importance of insulators when working with electricity.

E. *Assessment/Evaluation*

1. Given a set of materials, students will design an open circuit and test several items to determine which complete the circuit, therefore distinguishing between conductors and insulators, and will compile their findings into a list of five items under each category.

**Lesson Five: Electromagnets (three days)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will understand the process of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
  - b. Students will understand common properties, forms, and changes in matter and energy.
2. Lesson Content
  - a. Electromagnets
3. Skill Objective(s)
  - a. Students will discover the relationship between electricity and magnets by creating an electromagnet.
  - b. Students will practice following steps of experimentation following the scientific process including questioning, hypothesizing, following a procedure, determining results, and forming a conclusion.

B. *Materials*

1. *More Science Projects: Electricity and Magnetism*, by Peter Lafferty pp. 18-23, 26-27, 33, (optional: pp. 34-35, 40-41)
2. Appendix H: Scientific Process Experiment Form (one copy per student)
3. Electromagnet experiment materials per student:
  - a. One C or D battery
  - b. A large iron nail
  - c. Electric tape
  - d. A 20" piece of thin insulated copper wire with stripped ends
  - e. Paper clips
  - f. A pencil

C. *Key Vocabulary*

1. Magnet - any piece of certain kinds of material, such as iron, that has the property of attracting like materials

2. Magnetism - a natural, invisible force that makes certain metals attract or repel one another
3. Magnetic field - the region around a magnet in which the magnetic forces act
4. Electromagnet - a temporary magnet consisting of a set of coils wound on an iron core; the device becomes magnetic when electricity is passed through the coils
5. Motor - a machine for converting electric energy into mechanical energy

D. *Procedures/Activities*

1. Ask students if they have ever experimented with magnets. Have them share their background knowledge of magnets and magnetism. Ask them if they think magnets are magic and inform them that people thought they were during the Middle Ages and would use them as a form of entertainment. Read aloud together about magnets, magnetism, force fields, electromagnets, and motors from *More Science Projects: Electricity and Magnetism* pp. 18-23, 26-27, 33 discussing vocabulary words/definitions along the way. Be sure to discuss earth's magnetic fields, the Northern and Southern Lights, how magnets demonstrate static electricity, the relationship between electricity and magnetism, and what everyday items use electromagnets.
2. Hand out Appendix H: Scientific Process Experiment Form to students. Explain to students that when scientists are trying to discover new things or figure things out they follow a given procedure such as the one on their form. Go through each of the steps together. Students will write their name for the scientist and title the activity "Electromagnetic Exploration." The question they are finding out will be "How do I make an electromagnet?" Next, list materials on the board students will be using for the procedure. Students will need to copy these down under the Procedure section. Now have them go back to the hypothesis. Ask them to think back to the background information read aloud together about magnetism and early electromagnets. Have them think about the list of materials they will be using and state a hypothesis about how they plan to design their electromagnet. Next, students will need to list the steps they plan to follow during their experiment. Students are now ready to test their hypotheses.
3. Give each student a set of materials consisting of one C or D battery, a large iron nail, electric tape, a 20" piece of thin insulated copper wire with stripped ends, paper clips, and a pencil. Only give students a few clues. Let them know that they received all necessary items to test their hypothesis. They will also need to know that the tape is to hold the wire to the battery if they want to use it instead of holding it there by hand. Finally, tell them that if they perform the experiment correctly, they should be able to pick up at least one or two paper clips with their electromagnet. Give the class about 20 minutes to explore how to make their electromagnet. After that time, have them set aside supplies.
4. Ask students to refer back to their experiment form (Appendix H). They now need to record their results about what actually happened in their experiment. After they have noted these, they need to fill out the conclusion (what they learned from their experiment). Discuss findings together as a class and let several students who formed successful electromagnets share them with the rest of the class.
5. (Optional Activity: Select several student volunteers who would like to perform several experiments at home for extra credit. Distribute copies of "Make an electric Motor," and "Electrifying Changes" from *More Science Projects: Electricity and Magnetism* pp. 34-35, 40-41 to those volunteers. Inform them that they can share their experiments with the rest of the class in a few days.)

- E. *Assessment/Evaluation*
1. Given a set of materials and referring to information learned about early electromagnets, students will create an electromagnet and complete an experiment form (a template following the scientific process) to show their question, hypothesis, procedure, results, and conclusion of how to make an electromagnet.

**Lesson Six: Key Contributors of Electricity (two days)**

A. *Daily Objectives*

1. Concept Objective(s)
  - a. Students will understand interrelationships among science, technology, and human activity and how they can affect the world.
  - b. Students will understand that science involves a particular way of knowing and understand common connections among scientific disciplines.
2. Lesson Content
  - a. Key historical contributors including Thomas Edison and Michael Faraday
3. Skill Objective(s)
  - a. Students will realize that our technology has made immense advances over time since the invention of electricity due to several key historical figures including Thomas Edison and Michael Faraday.
  - b. Students will review several milestone technological advances and predict how their lives will be altered ten years from now due to continuing advances.

B. *Materials*

1. *Eyewitness Books: Electricity*, by Steve Parker
2. *The Electricity Story*, by George D. Leon

C. *Key Vocabulary*

1. Invention - making or thinking up something new for the first time

D. *Procedures/Activities*

1. Have students think back to their “Lights Out!” stories. Ask them what some of the major differences are in everyday life now due to having electricity. Ask students what people in past years used for light or for the machines we use now. Impress the notion that technology has come such a long way due to electricity by listing all the items students can think about in and around their house/neighborhood that use electricity.
2. Tell students that these inventions gradually came about over time as more and more knowledge was discovered about electrons, magnets, and various ways of generating/storing electricity. List 10 key contributors to the advances of electricity. Let students select one scientist they will research (two-three students may have the same topic). Students need to find out how this person ties in with electricity and how their findings have affected our present lives. They should also include a short description of how their inventions worked. This research could either take place at home or during one-two Science class periods. After researching, they need to write their findings in a one-page report, which they will orally present, to the rest of the class. After presentations, hold a class discussion as to who is the greatest key contributor to the field of Electricity. Again reiterate that our lives have drastically changed due to work they have done.

3. (Suggestions for key contributors include Benjamin Franklin, Chester Carlson, Luigi Galvani, Alessandro Volta, Georg Ohm, William Sturgeon, Joseph Henry, Humphrey Davy, Michael Faraday, Thomas Edison, Samuel Morse, Alexander Graham Bell, Guglielmo Marconi, and Vladamir Zworykin. Short excerpts and contributions for each can be found in *Eyewitness Books: Electricity* and/or *The Electricity Story*.)
  4. (If students were given extra credit opportunities to make experiments from Lesson Five including “Make an Electric Motor” or “Electrifying Changes,” have them share these with the class at this time. These will tie in well with several of the inventions of key contributors researched by students including Faraday’s Electric Motor.)
  5. Refer back to compiled list of electrical inventions over the past several centuries. Now ask students to think how these advances will impact the future. Brainstorm predictions of new inventions we will see ten years from now. Have students draw a model and include a simple description of an invention they would like to see developed in their lifetime. Share these in a classroom display.
- E. *Assessment/Evaluation*
1. Students will research a scientist whose work contributed greatly to advances with Electricity and present findings to the rest of the class through a one-page written report and oral presentation.
  2. After discussing the huge progress made in technology due to the invention of electricity, students will predict future inventions, choosing one to illustrate and describe.

### **Lesson Seven: Safety with Electricity (one day)**

- A. *Daily Objectives*
1. Concept Objective(s)
    - a. Students will understand interrelationships among science, technology, and human activity and how they can affect the world.
  2. Lesson Content
    - a. Safety with electricity
  3. Skill Objective(s)
    - a. Students will know how to use both current and static electricity safely and learn precautionary methods when working or playing around both types.
- B. *Materials*
1. Poster showing unsafe actions during lightning storm (assign to a group of students to make beforehand)
  2. Poster showing unsafe actions around current electricity (assign to a group of students to make beforehand)
  3. One piece typing paper per pair of students
- C. *Key Vocabulary*
1. Safety - freedom from harm or danger
  2. Precaution - care taken beforehand to secure good results
- D. *Procedures/Activities*
1. Beforehand assign two small groups to draw posters as visual aids for this lesson. One group is to create a scene where people are performing unsafe actions during a lightning storm (showing static electricity). List several examples for them to include such as showing lightning in the background, a person standing outside with an umbrella, someone playing in a puddle, etc. Have them brainstorm several ideas on their own as well for their picture. The other group is to design a

poster showing unsafe actions around current electricity such as someone playing with a power outlet, using electrical appliances near water, playing or working around power lines, etc. Again, this group will need to brainstorm other ideas to include in their picture.

2. Show the poster for static electricity to the class. Have them identify all the unsafe things happening in the picture. Discuss how these things could be dangerous and list on the board other safety precautions to take during a thunderstorm.
  3. Next, display the current electricity poster. Have students point out what is “wrong” in this picture and discuss why these actions are dangerous. Add to the board list safety measures to follow when working/playing around current electricity.
  4. Have students pair up and create a smaller poster of their own on typing paper showing unsafe scenes around current or static electricity. They also need to attach a short list of unsafe things in each picture.
- E. *Assessment/Evaluation*
1. Students will create an illustration showing dangerous situations with static and current electricity attaching a list of all the unsafe things in the pictures.

## **VI. CULMINATING ACTIVITY (two days)**

- A. One week prior to completing this unit, give students a study guide (Appendix I) summarizing Electricity Unit material to begin studying from a little each night. A few days before the unit test have students take out their study guides to use for this activity. Divide students into groups of five. Assign each group a topic covered on the study guide (one group would be assigned static/current electricity, the second group- conductors/insulators, the third- circuits, the fourth- safety, and the fifth group would cover the rest of the miscellaneous information on the study guide). Each person in the group needs to write one question/answer over their topic. All together the group should have five different questions/answers for their topic. When finished, the group needs to transfer questions and answers on a piece of poster board, writing all questions in the left hand column and answers in random order on the right hand column. Give each group one copy of quiz board directions (Appendix J.) Group members will work together to finish assembling the electric quiz board according to their direction sheet. When boards are complete, set group boards around the room. Have groups rotate to stations and test each other on the boards. Make sure each group gets to each station for a complete review of study guide information.
- B. Have students complete Electricity Quiz (Appendix K.)

## **VII. HANDOUTS/WORKSHEETS**

- A. Appendix A: Lights Out!
- B. Appendix B: Electricity Notes
- C. Appendix C: Making Static Electricity
- D. Appendix D: Making Current Electricity
- E. Appendix E: Batteries, Bulbs, and Wires
- F. Appendix F: Batteries, Bulbs, and Wires Answer Key
- G. Appendix G: Conductors and Insulators
- H. Appendix H: Scientific Process Experiment Form
- I. Appendix I: Electricity Study Guide
- J. Appendix J: Electric Quiz Board
- K. Appendix K: Electricity Quiz

## VIII. BIBLIOGRAPHY

- A. Bailey, Mark. *Electricity*. Milwaukee: Macdonald-Raintree, Inc., 1978. 0-8393-0085-9.
- B. Catherall, Ed. *Exploring Electricity*. Austin, Texas: Steck-Vaughn Co., 1990. 0-8114-2594-0.
- C. Challand, Helen J. *Experiments with Electricity*. Children's Press, 1986. 0-516-01276-2.
- D. Gosnell, Kathee. *Thematic Unit: Electricity*. Huntington Beach, CA: Teacher Created Materials, Inc., 1994. 1-55734-236-9.
- E. Kerrod, Robin. *Let's Investigate Science: Electricity and Magnetism*. New York: Marshall Cavendish Corporation, 1994. 1-85435-626-7.
- F. Lafferty, Peter. *More Science Projects: Electricity & Magnetism*. New York: Marshall Cavendish Corporation, 1989. 1-85435-175-3.
- G. Leon, George D. *The Electricity Story*. New York, New York: Arco Publishing, Inc., 1983. 0-668-05546-4.
- H. "Matter and Energy." *Macmillan Encyclopedia of Science: Volume 1. 1991 ed.* 0-02-941141-6.
- I. Parker, Steve. *Eyewitness Books: Electricity*. New York: Dorling Kindersley, 1992. 0-7894-6711-9.
- J. Spero, Daniel J. *Electricity: Current & Static*. Monterey, CA: Evan-Moor Corp., 1994. 1-55799-293-2.
- K. Wood, Robert W. *Electricity & Magnetism Fundamentals*. New York: The McGraw-Hill Companies, Inc., 1997. 0-07-071805-9.



## Appendix B

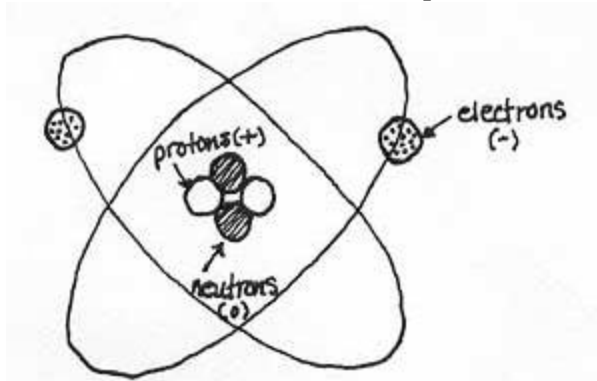
Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### ELECTRICITY NOTES

Electricity: a form of energy produced when electrons move from one atom to another

Atom - smallest parts in all material; every living thing is made up of atoms

- need to be made million times larger to see by naked eye
- there are 106 different kinds of atoms
- are made up of three kinds of particles: protons, neutrons, and electrons
  - center of atom is nucleus and holds two types of particles: protons and neutrons
  - electrons circle in the space outside the nucleus
- usually atoms are neutral: same number electrons and protons



Electrons- hold the secret to electricity

- have - charge
  - (protons have + charge)
  - (neutrons have 0 charge- neutral)
  - can go from one atom to another
  - this movement causes a charge (not neutral anymore)
  - material that picks up extra electrons = negatively charged
  - material that loses electrons = positively charged
- materials with same charge repel (move away) from each other
- materials that have different charges attract (move closer) to each other
- object that has + or - attract neutral material
- opposites attract!

+	+	repel
-	-	repel
-	+	attract
+	0	attract
-	0	attract

## Appendix C

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### MAKING STATIC ELECTRICITY

#### What To Do?

1. Rub a balloon with a wool or nylon cloth. Now hold the rubbed side of the balloon above some salt grains on the table. Try this same process again, holding the balloon above some small pieces of paper. Draw your picture of what you observed happening.
2. Comb through your hair several times (make sure it is dry hair). Now hold the comb slightly above the ends of the combed hair. What does it do? Repeat using a balloon instead of a comb. Now take a second balloon, also rubbing it against dry hair and place it next to the first balloon. How do the balloons react toward each other? Draw the results.
3. Tie one end of thread around a piece of puffed corn cereal and tie the other end to a support so that it can swing freely. Rub the comb quickly with a wool or nylon cloth and slowly bring one end of the comb near the puffed corn cereal. What happens? Now, allow the cereal to touch the comb for a few seconds before moving the comb. Bring the comb near the cereal again. What happens now? Finally, touch the puffed corn with your finger, and bring the comb near the cereal once more. Draw your observations in the box.

#### What Happened?


**Conclusion:** \_\_\_\_\_

---

---

## Appendix D

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### MAKING CURRENT ELECTRICITY

What is current electricity? \_\_\_\_\_

---

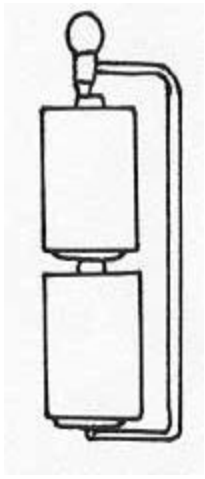
#### Demonstrations:

#### What Happened?

##### Demonstration #1:



##### Demonstration #2:



**Conclusion:** \_\_\_\_\_

---

---

## Appendix E

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

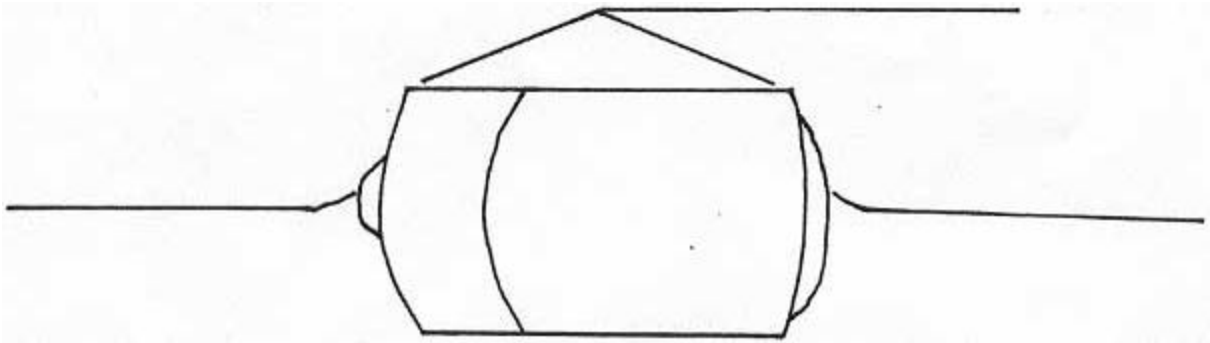
### BATTERIES, BULBS, AND WIRES

What is a battery? \_\_\_\_\_

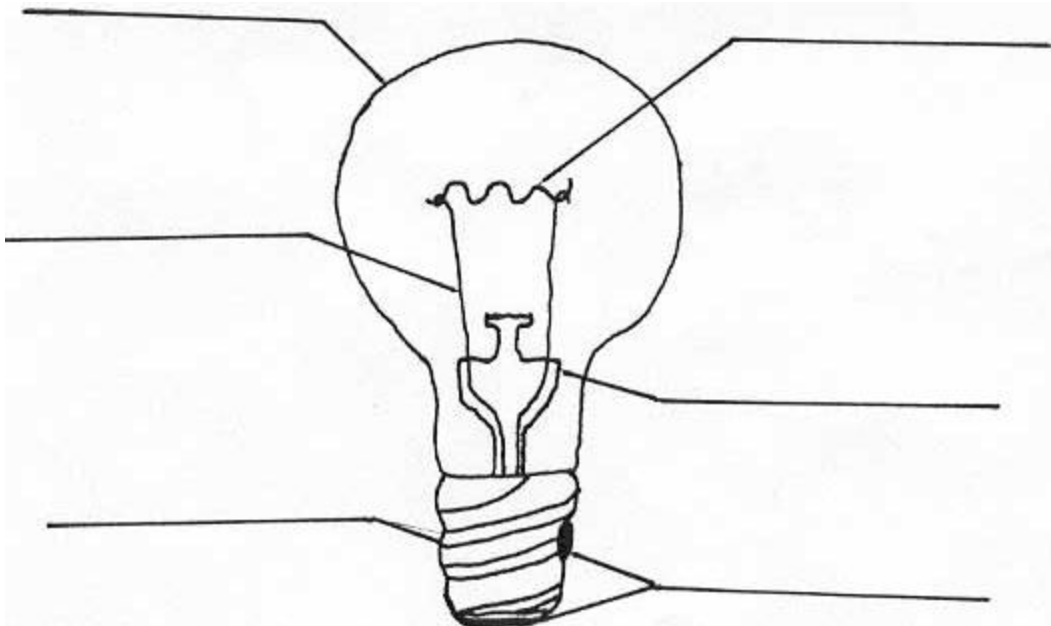
What is a bulb? \_\_\_\_\_

What is a wire? \_\_\_\_\_

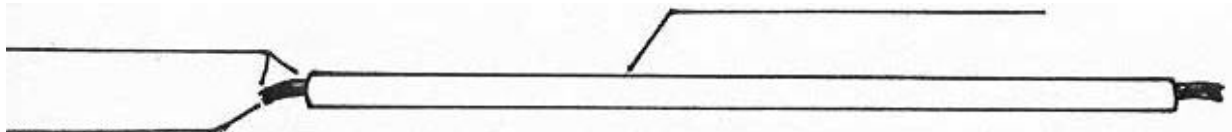
#### Battery



#### Bulb:



#### Wire:



## Appendix F

Name \_\_\_\_\_ # \_\_\_\_\_

Date \_\_\_\_\_

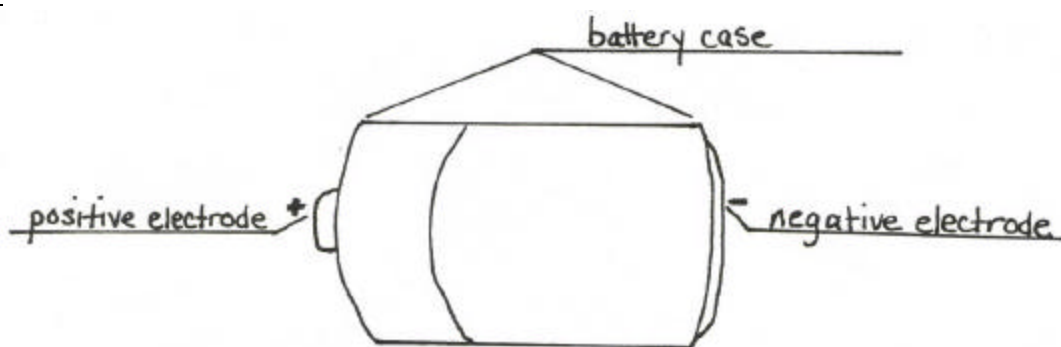
### BATTERIES, BULBS, AND WIRES ANSWER KEY

What is a battery? \_\_\_\_\_

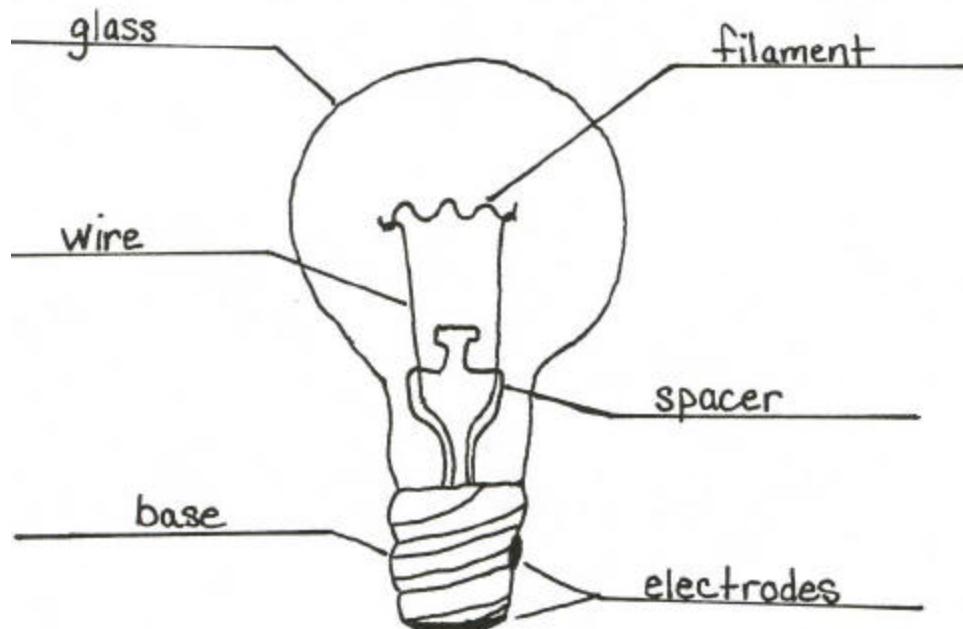
What is a bulb? \_\_\_\_\_

What is a wire? \_\_\_\_\_

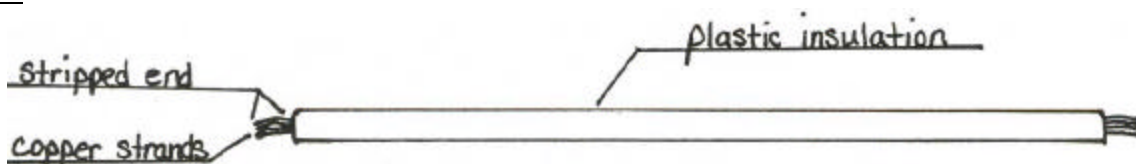
#### Battery



#### Bulb:



#### Wire:



## Appendix G

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### CONDUCTORS AND INSULATORS

What is a conductor? \_\_\_\_\_

What is an insulator? \_\_\_\_\_

**Directions:** Observe teacher demonstration showing how to find out if items are conductors or insulators. After each demonstration, list the item under the “Conductors” column if the bulb lights up, showing that it conducts electricity, or list it under “Insulators” if the bulb does not light up, showing that it does not conduct electricity. Now find other items of your own around the classroom you wish to test. Examples may include a coin, eraser, pencil, glue stick, shoelace, etc. After testing each item, be sure to list it under the proper column next to numbers 1-10. When you meet back as whole class and exchange results, add additional items tested by other students in columns next to numbers 11-15.

CONDUCTORS	INSULATORS
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.
11.	11.
12.	12.
13.	13.
14.	14.
15.	15.

## Appendix H

Scientist \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### SCIENTIFIC PROCESS EXPERIMENT FORM

**Activity Title:** \_\_\_\_\_

**Question:** (What do you want to find out?) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Hypothesis:** (Predict what you will find out) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Materials:** (List items you will need for this experiment) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Procedure:** (List steps you will take to test your hypothesis)

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

**Results:** (What actually happened?) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Conclusion:** (What did you learn from this experiment?) \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Appendix I-1

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### ELECTRICITY STUDY GUIDE

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

#### GENERAL INFORMATION:

**Electricity** is a form of energy produced when electrons move from one atom to another.

**Electrons** are tiny particles, which are negatively charged. They move around atoms like planets move around the sun. They can jump from one atom to another while traveling through conductors to an object such as a radio or TV.

**Battery** - storage source of electricity

**Bulb** - storage container for incandescent light

**Wire** - anything metal

#### TWO TYPES OF ELECTRICITY:

1. Static Electricity
2. Current Electricity

**Static Electricity** – Static electricity is the rubbing together of materials that causes one material to gain electrons while the other loses them. If an object gets filled with a lot of extra electrons, it can neutralize its charge by releasing the electrons as a blast of energy such as lightning or an electric shock that can hurt you.

Clouds are either negative or positively charged. The air around clouds acts as an insulator. When clouds of different charges get close enough, they can zap or hit the ground as lightning.

--for static electricity to occur, the two objects must have opposite charges  
--is also known as electricity at rest

**Current Electricity** – Current electricity is electricity that flows through wires to objects like radios, clocks, and TVs. Current electricity flows from place to place (from a source to an object).

--also known as moving electricity

#### CIRCUITS:

**Circuit** - A circuit is a circle of electricity. When lighting a bulb, you must have a circuit.

#### **Three Types of Circuits are:**

1. Closed Circuit
2. Open Circuit
3. Short Circuit

## Appendix I-2

A **closed circuit** is when current flows from the source (battery) through a conductor and back to the source. A closed circuit creates a full circle of electricity.

An **open circuit** is when there is a gap or opening in the circle of electricity (or circuit). When this happens, electricity cannot complete its path.

A **short circuit** is a connection that occurs when the electricity accidentally takes a path other than the desired path. This often happens when too much current is sent through a wire or if a wire is damaged or connected incorrectly. Here the electrons get confused about which way to go and try to take a “short cut.”

A **circuit breaker** is a safety switch installed in a circuit that will automatically shut off the power if the current is too strong. This is a good safety precaution because too much current can cause wires to overheat and perhaps start as fire. It is important not to overload circuits to avoid accidents.

### CONDUCTORS AND INSULATORS:

A **conductor** is a material that electricity can flow through easily. Several examples of good conductors include metal, water, and your body.

An **insulator** is a material that electricity cannot flow through easily. Plastic, rubber, wood, glass, porcelain, and dry air are examples of insulators.

### ELECTROMAGNETS:

An **electromagnet** is a temporary magnet formed when electricity flows through a coil of wire wrapped around an iron core.

**Michael Faraday** – He discovered that electricity and magnetism are related and used this principle to invent the electric motor, transformer, and electric generator.

**Thomas Edison** – He was inspired by Michael Faraday’s works and discoveries, which greatly influenced Edison’s experiments and electrical inventions. He is best known for bringing electricity to the people through his most famous invention, the lightbulb.

### SAFETY WITH ELECTRICITY

**Safety with Current Electricity** - It is extremely dangerous to have electrical appliances near water. Avoid climbing power poles or cutting branches near wires. Do not fly a kite near power lines. Never poke something into an electrical outlet.

**Safety with Static Electricity**- During a lightning storm, remember the following: If you are outside, scrunch down to make yourself short, carry an umbrella with a wooden handle (however the umbrella makes you a taller object which is dangerous), and don’t play in puddles. Remember that lightning will go after tall objects and conductors. When inside during a lightning storm, stay away from windows and walls, don’t talk on the phone, or take a shower/bath. Be careful and be safe.

## Appendix J

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### ELECTRIC QUIZ BOARD

#### Materials (per group):

One sheet poster board  
Ten metal paper fasteners (brads)  
Eight pieces insulated copper wire (12" ea.) with stripped ends  
One 6-volt battery  
Small flashlight bulb  
Bulb holder

**Directions:** Before you begin, make sure you have all of the above listed items and your list of five questions and answers based on the study guide. Be sure to read all of the steps before you start. Good Luck!

1. Write the title "Electric Quiz Board" at the top of your poster board.
2. In pencil, write your five questions in a column on the left side of your board. Then, write the answers to these questions on the right side of your board in random order so that the questions are not opposite their answers. Now check your neatness and spelling, correcting any mistakes you see. After proofreading, trace over the pencil with a black felt tip pen, so that your questions and answers stand out.
3. Use a sharp pencil to make a hole through the poster board next to each question and answer. Poke holes directly to the right of each question and directly to the left of each answer. Push a metal paper fastener through each hole and bend their legs back against the back of the board.
4. Turn over your poster board so that you are looking at the back. Attach a piece of wire to one of the metal fasteners next to a question by wrapping it around the leg and securing it in place with electrical tape. Now glance at the front to find the answer that matches up to that question and find its metal fastener on the back. Attach the other end of the wire to this paper fastener. Repeat these steps until all answer paper fasteners are matched up with all the question paper fasteners. When finished, double check that wires are secured with pieces of electrical tape. Also make sure none of the wire ends are touching each other.
5. Now that the board is complete, you need to make your circuit tester. Wind one of the wire ends around one of the battery electrodes and leave the other end dangling loose. Wind another wire around the other battery electrode, connecting its other end to the bulb holder. Take the final piece of wire and attach it to the other bulb holder end leaving the other wire end dangling loose. You should now have two wire arms to test your circuit board with.
6. Test your board by holding one circuit tester arm against one of the paper fasteners next to a question. Read the question and select the correct answer from the right hand column of answers. Hold the other arm against that answer. The bulb should light up if the answer is correct. If it does not, turn your board over and make sure all connections are correct. Make adjustments as needed.

## Appendix K-1

Name \_\_\_\_\_ # \_\_\_\_\_  
Date \_\_\_\_\_

### ELECTRICITY QUIZ

#### **Fill in the blanks:**

1. What are two types of electricity?
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
2. Name the three types of circuits:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
3. Name two examples of insulators:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
4. List two kinds of conductors:
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_

#### **Short Answer: Please use complete sentences to answer to following questions in the space provided.**

1. What is electricity?
2. Tell me what electrons are and why did we compare them to the sun/planets?
3. What is current electricity? Provide an example of how you use it.
4. What is static electricity? Provide an example.
5. Write a definition of a circuit.

## Appendix K-2

6. Why is Michael Faraday an important figure in Electricity?
  
7. Tell me why Thomas Edison is well remembered for work with Electricity.
  
8. Who do you think is more important, Michael Faraday or Thomas Edison? Explain your reasons.

**Matching:** Write the correct letter in the number blank that it matches.

- |                             |  |
|-----------------------------|--|
| ____ 1. insulator           | A. anything metal  |
| ____ 2. closed circuit      | B. safety switch that shuts off power if current is too strong               |
| ____ 3. wire                | C. material that electricity can flow through easily                         |
| ____ 4. circuit breaker     | D. electricity takes a short cut, blowing a fuse                             |
| ____ 5. open circuit        | E. magnet formed when electricity flows through wire coiled around iron core |
| ____ 6. conductor           | F. electricity at rest   |
| ____ 7. short circuit       | G. material that electricity cannot flow through easily                      |
| ____ 8. electromagnet       | H. current flows in a complete circle of electricity                         |
| ____ 9. battery             | I. a gap or opening in the circle of electricity                             |
| ____ 10. static electricity | J. storage source of electricity   |

**Essay Question:** Please read both options listed below and choose one. Write one paragraph, including an introductory sentence, at least three supporting sentences, and a concluding sentence for your option. Write your paragraph on a lined sheet of paper, then glue or staple it on. You may choose to do both paragraphs for extra credit!

**Option #1:** Write a paragraph on safety procedures during a lightning storm (static electricity).

**Option #2:** Write a paragraph on safety measures to take when working or playing near current electricity.