Sparks, Batteries, Bulbs, and Wires

Grade Level or Special Area: Fourth Grade; Science
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Length of Unit: Nine lessons (approximately 12 days, one day=forty-five minutes)

I. ABSTRACT

This unit is intended to provide fourth graders with an overview of electricity and to provide teachers with lessons to cover the requirements in the *Core Knowledge Sequence* by E. D. Hirsch Jr. Through reading, class discussion, and hands-on experiments, students will learn about how electricity is created, static electricity, current electricity, simple circuits, the inventor Michael Faraday, and how to use electricity safely. This unit uses a variety of approaches to learning, including writing, hands-on activities, cooperative learning, and developing a science notebook.

II. OVERVIEW

A. Concept Objectives
   1. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations. *(Colorado Grade 4 Standard 1 for Science)*
   2. Students understand common properties, forms, and changes in matter and energy. *(Colorado Grade 4 Standard 2 for Science)*
   3. Students understand interrelationships among science, technology, and human activities and how they can affect the world. *(Colorado Grade 4 Standard 5 for Science)*

B. Content from the *Core Knowledge Sequence*
   1. Fourth Grade Science
      a. Electricity (p. 105)
         i. Electricity as the flow of electrons
         ii. Static electricity
         iii. Electric current
         iv. Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse)
            a) Closed circuit, open circuit, short circuit
         v. Conductors and insulators
         vi. Electromagnets: how they work and common uses
         vii. Using electricity safely
      b. Chemistry: Basic Terms and Concepts (p. 104)
         i. Atoms
      c. Science Biographies (p. 106)
         i. Michael Faraday

C. Skill Objectives
   1. [Students] organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram). *(Colorado Grade 4 Expectations for Science, 4.1.1D)*
   2. [Students] sort information as it relates to a specific topic or purpose. *(Colorado Grade 4 Expectations for Language Arts, 4.5E)*
   3. [Students] use listening skills to understand directions. *(Colorado Grade 4 Expectations for Language Art, 4.4F)*
   4. [Students] develop and evaluate explanations based upon experimental evidence and experience of others. *(Colorado Grade 4 Expectations for Science, 4.1.1G)*

5. [Students] read, respond to, and discuss a variety of literature as a way to explore such as…non-fiction and content area reading. *(Colorado Grade 4 Expectations for Language Arts, 4.6 A)*
6. [Students] plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations. *(Colorado Grade 4 Expectations for Science 4.1.1A)*
7. [Students] use knowledge and evidence obtained in experiments to support explanations. *(Colorado Grade 4 Expectations for Science, 4.1.3H)*
8. [Students] use …sketches…and stories to represent objects, events, and processes. *(Colorado Grade 4 Expectations for Science, 4.1.1M)*
9. [Students] compare a model with what it represents. *(Colorado Grade 4 Expectations for Science, 4.6E)*

III. BACKGROUND KNOWLEDGE

A. For Teachers
1. DiSpezio, Michael, *Awesome Experiments in Electricity and Magnetism*
2. VanCleave, Janice, *Janice VanCleave's Electricity: Mind-boggling Experiments You Can Turn Into Science Fair Projects*
3. Appendices provided in this unit also will give sufficient background on the topics.

B. For Students
1. Introduction to static electricity (1st Grade) *Core Knowledge Sequence*, p. 38
2. Basic Parts of simple electric circuits (for example, batteries, wire, bulb or buzzer, wire, switch) (1st Grade) *Core Knowledge Sequence*, p. 38
3. Conductive and Nonconductive Materials (1st Grade) *Core Knowledge Sequence*, p. 38
4. Safety rules for electricity (for example, never put your finger or anything metallic in an electrical outlet, never touch a switch or electrical appliance when your hands are wet or when you're in the bathtub, never put your finger in a lamp socket, etc.) (1st Grade), *Core Knowledge Sequence*, p. 38
5. Science Biography: Thomas Edison (1st Grade), *Core Knowledge Sequence*, p. 39
6. Introduction to Magnetism: (Kindergarten and 2nd Grade), *Core Knowledge Sequence*, p. 60 and 20
7. Introduction to Matter: Basic concept of atoms (1st Grade), *Core Knowledge Sequence*, p. 38
8. Chemistry: Basic terms and concepts of atoms (4th Grade), *Core Knowledge Sequence*, p. 104

IV. RESOURCES

A. Electricity KWL Chart done on a bulletin board or butcher paper (all lessons)

B. Student Science Folders (these should be put together before starting the unit and will be used for each lesson; the folders should contain Appendix A: Electricity KWL Chart, Appendix B: Electricity-A Household Word, Appendix C: Electricity Introduction, Appendix D: Atom Notes, Appendix E: Static Electricity Introduction, Appendix F: Static Electricity Notes, Appendix I: Journal Entry for Static Electricity Investigation, Appendix J: Electric Circuit Notes, Appendix K: Drawing Circuits, Appendix M: Switch Worksheet, Appendix P: Conductors and Insulators Data Chart, Appendix Q: Magnets from Electricity, Appendix S: Michael Faraday Biography, Appendix T: Michael Faraday Paragraph, Appendix V: Electrical Safety Rules, and Appendix X: Electricity Study Guide) (all lessons)

V. LESSONS

Lesson One: Electricity Introduction (one lesson, approximately forty-five minutes)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
   2. Lesson Content
      a. Electricity unit is introduced
   3. Skill Objective(s)
      a. [Students] organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram).
      b. [Students] sort information as it relates to a specific topic or purpose.
      c. [Students] use listening skills to understand directions.

B. *Materials*
   1. Appendix A: Electricity KWL Chart (one copy for each student in science folders)
   2. Appendix B: Electricity-Household Word, page one and two (one copy for each student in science folders)
   3. Overhead of Appendix B: Electricity-A Household Word, page two
   4. Bulletin Board or butcher paper that has been prepared for a KWL chart
   5. Prepared science folders with brads and appropriate appendices (one for each student)

C. *Key Vocabulary*
   1. KWL chart-this is a chart that prepares students for learning by getting them to think about what they already know about the subject, what they want to learn about this topic, and later organizes ideas and concepts they have been taught

D. *Procedures/Activities*
   1. Before starting this unit, you will need to prepare science folders for your students. This folder will contain the KWL chart, worksheets, note pages, and journal entry sheets which they will be completing throughout the unit. See the resources section for which appendices should go into the folders.
   2. Before this lesson, you will need to prepare a bulletin board or a large piece butcher paper with a KWL chart for electricity. A KWL chart is a chart that prepares students for learning by getting students to think about what they already know, what they want to know, and later organizes ideas and concepts that they have been taught. This chart should be large enough to be used over this entire unit. The chart will be divided into three sections with the third section being the largest. Each section should be labeled respectively: “What do we know about electricity?”, “What do we want to learn about electricity?” and “What have we learned about electricity?” For the lesson today, we will be completing the first two sections.
   3. To begin the lesson, tell the students that they will be starting a new unit about electricity. Tell them that you want to see how much they already know about electricity, so they will be creating a KWL chart as a class. Have the students brainstorm as many things as they can on what they already know about electricity. As students contribute ideas write them on the chart.
   4. After they have given as many ideas on what they already know, have them think about things that they don’t know or want to learn about electricity. Write these on the second section of the chart as students contribute ideas.
   5. Let the students know they will be completing the third section after each lesson in this unit. They will be adding main concepts from each lesson that have been

learned or discovered. Now give the students some time to complete the first two sections of the KWL chart in their science notebooks (Appendix A: Electricity KWL Chart).

6. When the students have finished their first two sections of their KWL charts give them their science homework. Ask them why they think learning about electricity is important? Accept and discuss all answers. Tell them that you want them to think about how important electricity is to us. In order to help them do this, they will be required to make a list of electrical appliances and other items that require electricity in their homes (Appendix B: Electricity-A Household Word). Go over the directions on this worksheet with the class. They need to categorize these items based on how often the items are used. They will use this information to complete the bar graph on Appendix B, page two. Model how you would create this bar graph with the class.

E. *Assessment/Evaluations*
   1. Students contributed ideas with the class discussion on what the already know and what they want to learn about electricity while completing the KWL chart.
   2. Students complete Appendix B: Electricity a Household Word Worksheets for homework. Note-you can either grade each individual assignment on a daily or weekly basis or collect and grade the science folders at the end of the unit.

Lesson Two: Electricity Begins with Atoms! (one lesson, approximately forty-five minutes)

A. *Daily Objectives*
   a. Concept Objective(s)
      a. Students understand common properties, forms, and changes in matter and energy.
      b. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
   b. Lesson Content
      a. Atoms
      b. Electricity as the flow of electrons
   c. Skill Objective(s)
      a. [Students] develop and evaluate explanations based upon experimental evidence and experience of others.
      b. [Students] sort information as it relates to a specific topic or purpose
      c. [Students] read, respond to, and discuss a variety of literature as a way to explore such as…non-fiction and content area reading.

B. *Materials*
   1. Appendix A: Electricity KWL Chart (one for each student in science folders)
   2. Appendix C: Electricity Introduction (one for each student in science folders)
   3. Appendix D: Atoms Notes, page one (one for each student in science folders)
   4. Overhead transparency of Appendix D: Atom Notes, page two

C. *Key Vocabulary*
   1. Atom-smallest part of an element that still retains properties of that element
   2. Electrons-negatively charged particles that orbit the nucleus of an atom
   3. Proton-positively charged particles in the nucleus of an atom
   4. Electricity-negatively charged particles (electrons) flowing from area to another

D. *Procedures/Activities*
   1. Do a quick check to see that students completed their homework assignments in their science folders. Let students share some of the appliances and items they came up with for each category. Discuss their bar graphs. Which type of

appliance was used the most? Which type was used the least? What did this activity help them realize about electricity? Accept and discuss student's answers. Make sure that the students realize that electricity is a part of our lives that we often take for granted. We often think nothing of flipping a light switch or hitting the power button on the television. Make sure students understand that there was a time when electricity was nonexistent. Talk briefly about what they think life was like without electricity.

2. Have students open their science folders to Appendix C: Electricity Introduction. Read this sheet with the class. Take notes from this sheet on Appendix D: Atom Notes. Encourage students come up with and share what they think good definitions would be for each term based on their reading and model taking notes on the overhead while the students write notes in their folders.
3. Finish up this lesson with having the students turn to their KWL chart and write the main thing they learned about electricity today. After you have given them a few minutes to think and write, have students share with a neighbor for a few seconds what they have written. Then, choose a few students to share what they wrote with the entire class. As a class, come up with a sentence to add to the KWL chart on the bulletin board. *Electricity is the flow of negatively charged particles (electrons) from one area to another.*

E. *Assessment/Evaluation*
1. Students read, discuss, and take notes on atoms and electricity.
2. Students come up with what they learned about electricity in the lesson today and write it in their KWL charts and discuss this with the class.

Lesson Three: Static Electricity-A Hair Raising Phenomenon (two lessons, approximately forty-five minutes each)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
   b. Students understand common properties, forms, and changes in matter and energy.
2. Lesson Content
   a. Static Electricity
3. Skill Objective(s)
   a. [Students] plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations.
   b. [Students] use listening skills to understand directions.
   c. [Students] develop and evaluate explanations based upon experimental evidence and experience of others.
   d. [Students] read, respond to, and discuss a variety of literature as a way to explore such as…non-fiction and content area reading.
   e. [Students] use knowledge and evidence obtained in experiments to support explanations.

B. *Materials*
1. Five latex balloons
2. Three pieces of wool or felt
3. Four pieces of string (about a foot long)
4. Tape
5. Appendix A: Electricity KWL Chart (one for each student in science folders)

6. Appendix E: Static Electricity Introduction (one for each student in science folders)
7. Appendix F: Static Electricity Notes, page one (one for each student in science folders)
8. Overhead transparence of Appendix F: Static Electricity Notes, page two-(for modeling note taking)
9. Overhead transparency of Appendix G: Group Responsibilities and Expectations
10. Appendix H: Directions for Static Electricity Investigations (a set of directions/data capture sheets for each student at corresponding stations)
11. Appendix I: Journal Entry for Static Electricity Investigation (one for each student in science folders)
12. One nylon pair of stockings
13. One plastic grocery bag
14. Three plastic combs
15. Aluminum foil
16. Plastic wrap
17. Sugar
18. Pepper
19. Small plate
20. Puffed grain cereal
21. One latex balloon (not blown up)
22. Wooden Ruler

C. *Key Vocabulary*
1. Static electricity-the build–up of electric charges on an object
2. Law of electric charges-unlike charges attract each other and like charges repel
3. Repel-push away from each other

D. *Procedures/Activities*

Day One

1. Review with the students that electricity begins with atoms and the electrons in the atoms. Review the different parts of atoms and that electricity occurs when electrons flow from one area to another. Ask the students what the two types of electricity are. *(Static and current)* Let them know that we will be focusing on static electricity first.
2. Tell the students that they are going to see an example of static electricity. Show them a latex balloon that has been blow up. Rub the balloon with a piece of wool or on a rug for about thirty seconds. Now ask a volunteer to come up to the front and hold the balloon over his/her head. Ask the students what they notice. *The hair rises to meet the balloon.* Tell the students that by rubbing the balloon, you electrically charged it. The hair rises toward the balloon because of that charge. Let the students know that the electrical charge is also strong enough to hold the balloon against the wall for a short time. Rub the balloon again and try it and see how long the balloon will stay. Tell them that they will be learning about why this happens today.
3. Have students open their science folders to Appendix E: Static Electricity Introduction. Read this page with the students and model taking notes on Appendix F: Static Electricity Notes with the students encouraging the students to come up with the definitions using what they just read.
4. When students have finished writing notes, finish this lesson by demonstrating this phenomenon you just introduced with balloons and wool. Inflate two balloons and attach a 1-foot length thread to each of the balloons. (To save time, you could do this before the lesson). Use tape to attach the thread of one balloon

to the bottom of a desk or table. Rub the balloon with a piece of wool or felt for at least thirty seconds. Release the balloon and let it hang. Now rub the second balloon with wool or felt for about thirty seconds. Hold it by the end of the thread and bring it near the first balloon. Ask the students what is happening to the balloons? *They repel each other.* Tape the second balloon close enough to the first so that they appear to be flying away from each other. Based on what we have read and discussed, why do they repel each other? *As each balloon was rubbed with wool, negative charges (electrons) flowed from the wool onto the balloon giving the balloon a negative charge. Since both balloons had a negative charge, they had like charges which caused them to repel each other.*

5. Now ask the students to predict what will happen to the balloons if one balloon is given a negative charge and the other remains neutral. Allow two or three students to give their predictions and tell why they are predicting this. Inflate two more balloons and tie a one-foot string to each. (This could be done ahead of time to save time.) Position the balloons and tape them from a desk or table so that they hang side-by-side, separated by several inches of space. Hold one of the balloons and stroke it with a piece of wool for about thirty seconds. Gently let the balloon fall back into place. As it moves into its original position, ask the students what happened to the nearby neutral balloon? *It was attracted to the negatively charged balloon.* Explain why this happened. *The balloon that was stroked with the wool, gained a negative charge from the wool that was rubbed across it. This charge repelled the negative charges in the neighboring balloon. As those charges moved to other regions of the neutral balloon, the nearby area became positive in charge. Based on the Law of Electric Charges we know that opposite charges attract, so the attraction between the negative balloon and the positive region of the neighboring balloon brought these charged objects together.*

4. Ask the students to open to their KWL charts and write a sentence about what they learned today. After a couple of minutes ask them to share what they wrote with a neighbor. Then, have a few students volunteer what they wrote and come up with a sentence to write on the KWL chart on the bulletin board. *Examples: Static electricity is the build–up of electric charges on an object. If the charges of two objects are opposite, they will attract each other and if the charges are the same they will repel each other.*

Day Two

5. Today students will be working in five separate groups at various stations that have been set up for exploring static electricity. Be sure you have decided on student groups before beginning today. Each group will be at a different station conducting a different experiment on static electricity. When they all have finished their experiments they will be required to present to the class what they did and discovered. The experiments they are conducting comes from the book *Awesome Experiments in Electricity and Magnetism* by Michael DiSpezio.

6. Prior to class, you will need to set up the stations for the static electricity investigations. Each station should include Appendix H: Directions for Static Electricity Investigations, all necessary materials, and data-capture sheets for recording and reporting data and findings. There are five different stations and each station should have five of the corresponding data-capture sheets.

7. Today you will need to go over the Appendix G: Group Responsibilities and Expectations with the class. After group work expectations are clear, go over directions for each investigation and make sure students are clear on what they

must do at each station. Then, assign each team to a station. Remind them that the first thing they must do as a group is decide on group responsibilities.

8. While students are working on investigations, circulate around the room to make sure students are on task and are accurately completing investigations. Each investigation will take 10-15 minutes.
9. When all groups have completed their activity, have students return to their seats and have each group present their findings to the class.
10. After all presentations have been given, have the students find and complete Appendix I: Journal Entry for Static Electricity Investigation in their science folders.

E. *Assessment/Evaluation*

1. Students read, discussed, and wrote about static electricity. Appendix F: Static Electricity Notes have been completed in science folders.
2. Students completed Appendix H: Static Electricity Investigation Sheets and discussed their group's findings with the class.
3. Students completed Appendix I: Journal Entry for Static Electricity Investigation in their science folders.

Lesson Four: Current Electricity and Simple Circuits (three lessons, approximately forty-five minutes each)

A. *Daily Objectives*

1. Concept Objective(s)
    a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
    b. Students understand common properties, forms, and changes in matter and energy.
    c. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
2. Lesson Content
    a. Electric current
    b. Electric circuits and experiments with simple circuits
3. Skill Objective(s)
    a. [Students] sort information as it relates to a specific topic or purpose.
    b. [Students] use listening skills to understand directions.
    c. [Students] develop and evaluate explanations based upon experimental evidence and experience of others.
    d. [Students] plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations.
    e. [Students] use knowledge and evidence obtained in experiments to support explanations.
    f. [Students] use …sketches…and stories to represent objects, events, and processes.
    g. [Students] compare a model with what it represents.

B. *Materials*

1. Ten brown lunch sacks
2. Twenty D cell batteries
3. Eighty pieces of insulated copper wire with ends striped 1 ½ inches bare
4. Ten battery holders
5. Twenty brass battery clips
6. Ten small flashlight bulbs and sockets
7. Ten bulb holders

8. Twenty small blocks of wood for switches
9. Forty thumbtacks
10. Twenty metal paper clips
11. Appendix A: KWL Chart for Electricity (one for each student in science folders)
12. Overhead transparency of Appendix J: Electric Circuit Notes, page two
13. Appendix J: Electric Circuit Notes, page one (one for each student in science folders)
14. Appendix K: Drawing Circuits (one for each student in science folders)
15. Overhead transparency of Appendix L: Creating Switches
16. Appendix M: Switch Worksheet (one for each student in science folders)
17. Overhead transparency of Appendix N: Short Circuit Assembly
18. Appendix O: Static and Current Electricity Quiz (one for each student)

C. *Key Vocabulary*

1. Electric current-the flow of electrons through a conductor
2. Conductor-a material through which electric current passes easily
3. Insulator-a material through which electric current does not pass easily
4. Circuit-the path electric current takes as it flows (circle)
5. Battery-also called "cells"/stores energy which pushes electrons into the wire to get the flow of electricity started
6. Filament-a very thin, coiled thread in a light bulb that glows from the resistance in the coiled wire as electricity passes through it
7. Switch-a device that can open and close a circuit; in the "on" position, the switch closes the circuit and completes the route for flowing current; in the "off" position, the switch places a gap in the path, which prevents any current from flowing
8. Fuse-a little wire made of metal that quickly melts and breaks at a fairly low temperature and cuts off the electricity supply

D. Procedures/Activities

Day One-Creating Simple Circuits

1. Before this lesson you will need to prepare kits for your students. All of these materials can be bought fairly inexpensively at Radio Shack. Prepare about ten kits, so students can be in groups of two or three. Each kit should include a brown lunch sack, one D cell battery, two insulated copper wires, one battery holder and two brass battery clips, and one small flashlight bulb and socket. All of these items need to be separated and in random order. Make sure the bags are closed before handing them out to the groups.
2. Give each group of students a bag and allow about 10 minutes for them to explore the material and figure out what to do with the contents in the bag. You should remain quiet unless you are asked a question. Do not give any clues as to how to use the contents in the bag.
3. Some students may create a simple circuit during this time. At the end of 10 minutes have the students stop for discussion and explain what they did, so others can follow. Have the students examine the parts of this circuit and discuss what they notice about these parts. You can know introduce the concept of current electricity. *Electric current is the flow of electrons through a conductor.* Discuss what conductors are and have students list some things they think would conduct electricity. *Conductors are materials through which electric current passes easily. Metals such as copper are good conductors. The wire is copper and is covered by plastic which is an insulator, a material that does not let electricity flow easily.* Explain why electrical wires would need insulators covering them. Discuss where the electricity comes from in the battery, and

where it goes. *Batteries store energy in the chemicals inside. They serve as a starter and push electrons into the wire to get the flow of electrons started. The electrons then pass through the wire to the bulb and back to the battery.* Explain how electricity makes the bulb light? *When a bulb is connected into a circuit it glows brightly. The part of the bulb which glows is called the filament. The filament is a coil of very thin wire made up of the metal tungsten. The coiled wire slows the flow of electricity and creates resistance for the electricity. When electricity flows through the wire it gets very hot-as hot as 2,700 degrees Celsius. It glows white and gives out heat.* How do we know that electrons are flowing? *The light comes on when the circuit is complete.*

4. Have the students draw a picture of the circuit they have created and list the main parts of the circuit and explain the jobs of these parts for this circuit on Appendix K: Drawing Simple Circuits.
5. After the students have been successful with creating simple circuits. Have students take notes with you modeling this process on the terms you just discussed on Appendix J: Electric Circuit Notes.
6. To end the lesson, ask the students to open to their KWL charts and write a sentence about what they learned today. After a couple of minutes ask them to share what they wrote with a neighbor. Then, have a few students volunteer what they wrote and come up with a sentence to write on the KWL chart on the bulletin board. *Examples: Current Electricity is the flow of electricity through a conductor. A circuit must be closed in order for electricity to flow.*

Day Two-Creating Switches

1. Today students will be making switches and learning about the purpose of switches in circuits. Ask the students to look around the room and look for switches. Most students will mention the wall switch, the switch for the overhead projector, or computer switches. Explain to them that although they can't see it, the wall switch is connected to electrical wires that lead to the light fixtures. Ask the students what they think the switch is doing when you flip it from on to off. Let students volunteer what they think is happening. Tell them they will be finding out today what really happens.
2. Have the students move into the same groups they were in for the previous lesson. Hand out the materials the students will need to create two switches to each group. Each group will need two small blocks of wood, four thumbtacks, two metal paper clips, and four connecting copper wires.
3. Go over the directions for creating the switches. Put Appendix L: Creating Switches on the overhead and go over each step. Give the students a few minutes to put together their switches.
4. Review that electricity can only flow in a closed circuit. Hand out the materials from the previous lesson to the groups and ask them to create a simple circuit. After all the groups have created their circuits ask them to find a way to connect the switch to their circuits. Ask the students why does electricity not cross over the switch when it is open? Does electricity jump? Does it matter where the switch was placed? What is the purpose of the switch?
5. To end the lesson, ask the students to open to their KWL charts and write a sentence about what they learned today. After a couple of minutes ask them to share what they wrote with a neighbor. Then, have a few students volunteer what they wrote and come up with a sentence to write on the KWL chart on the bulletin board. *A switch is a device that can open and close a circuit. In the "on" position, the switch closes the circuit and completes the route for flowing*

current. In the "off" position, the switch places a gap in the path, which prevents any current from flowing.

6. Have students open their folders to Appendix M: Switch Worksheet in their science folders. Read the top with the students and for homework have the students list at least 20 items that use switches.
7. Let the students know that there will be a short quiz over static and current electricity tomorrow. Encourage them to look over their notes to prepare for this.

<u>Day Three</u>-Short Circuits and Fuses/Quiz

1. Ask the students what they think would happen if you were to connect the positive and negative ends of a battery (cell) together without placing a bulb, motor, or some sort of resistance (a way to slow the flow) in the circuit. *If the circuit were left on for more than a few minutes, you would ruin the battery, and if the current source is large enough, you could burn yourself or start a fire. You have just created a short circuit.*
2. Have students move into groups of two or three and give each group a D cell batter, battery holder, one flashlight bulb in a lamp holder, two switches which they created in the previous lesson, and connecting wires with each end stripped bare of insulation. Show the students Appendix N: Short Circuit Assembly on the overhead and have them assemble the same circuit.
3. After everyone one has completed the circuit ask them to close only switch A. What happens to the bulb? *It is able to light up the bulb.* Is there a closed circuit? *Yes* Ask them to trace the complete circuit through which electricity flows with group members.
4. Now ask them to only close switch B. What happened to the bulb? *It did not light up.* Is there a closed circuit? *No* Have them open switch B.
5. Now tell the students to bend the clip in switch A so that this switch remains on. While the lamp is glowing, close switch B. What happened? *The light went out.* What path does the current follow when both switches are closed? *It takes the path through both switches.* Why? *It's shorter than the outside loop with only switch A.* Now have them release switch B. What happens now? *The bulb goes back on.* Why? *It follows the longer path, because this is the only path it can take now.*
6. Discuss with the students the science behind this activity. *Switch A controls the current flow in the outer loop. When switch A is closed, current flows along this outer path to light the bulb. Switch B is part of a separate path that offers no resistance. When switch B was closed, its path became complete. Since the path contained no resistors, it acted as a short circuit. The current flowed across switch B and bypassed the bulb. Without a current flow in the outer loop the lamp went out.* Why do we need to be concerned about short circuits? *Short circuits can cause fires. When a wire offers little or no resistance to current flow, excessive current flow can heat up the conductor. If the wire gets hot enough, it can cause burns and fires.*
7. Ask the students what is done in our homes to help prevent wires from over-heating and causing fires? *Fuses are put into electric circuits.* Explain what a fuse is. *A fuse is a little wire made of metal that quickly melts and breaks at a fairly low temperature and cuts off the electricity supply. It is kind of an automatic safety switch.* Ask the students if they have seen the fuse box or circuit breaker in their house and explain what happens when they "blow a fuse" at home. *Special wires called fuse wires are put into electric circuits inside buildings to prevent electrical fires from starting. The trouble with fuses is you have to replace them, and this takes time. A more convenient device is the*

electromagnetic circuit breaker. When a circuit breaker "blows", it is easily reset by a switch. We will be looking at electromagnets in the next lesson.

8. Give students Appendix O: Static and Current Electricity Quiz

E. *Assessment/Evaluation*

1. The students took notes on and discussed Appendix J: Current Electricity Notes.
2. Students wrote what they learned about current electricity in their KWL charts on Appendix A.
3. Students created switches and discussed the importance of switches.
4. Students created short circuits and discussed the dangers of these and understand that fuses are put in as safety switches.
5. Students completed Appendix O: Static and Current Electricity Quiz

Lesson Five: Testing Conductors and Insulators (one lesson, approximately forty-five minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
   b. Students understand common properties, forms, and changes in matter and energy.
2. Lesson Content
   a. Conductors and insulators
3. Skill Objective(s)
   a. [Students] organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram).
   b. [Students] use listening skills to understand directions.
   c. [Students] develop and evaluate explanations based upon experimental evidence and experience of others.
   d. [Students] plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations.
   e. [Students] use knowledge and evidence obtained in experiments to support explanations.

B. *Materials*

1. Appendix P: Conductors and Insulators Data Chart (one for each student in science folders)
2. Appendix A: Electricity KWL Chart (one for each student in science folders)
3. Ten D Cell Batteries
4. Ten D Cell Battery Holders
5. Ten Flashlight Bulbs with bulb holders
6. Twenty pieces of prepared copper wire
7. Ten pieces of aluminum foil
8. Ten pencils
9. Ten erasers
10. Ten plastic pen tops
11. Ten toothpicks
12. Ten corks
13. Ten paper clips
14. Ten rocks
15. Ten rubber bands
16. Ten marbles

C. *Key Vocabulary*
   1. Conductor-electrons flow easily through these materials
   2. Insulators-electrons do not easily pass through these materials

D. *Procedures/Activities*
   1. Review with the class what circuits are. Remind them that they have designed and built simple circuits with light bulbs in previous lessons. Ask them to tell you about designs that successfully lit up light bulbs. Tell them they can look back at Appendix K: Drawing Circuits. *They connected the bulb to the battery ends with wires so that the electric current made a loop.* What happened when there was a gap in the loop? *The bulb would not light.* Review with the class what conductors and insulators are. *Electrons can move easily through materials that are conductors. Electrons do not easily move through materials that are insulators.* Tell them that in the lesson today they will be testing objects to decide whether different materials are conductors or insulators.
   2. Ask the students to think of a way they could test different materials to see which materials conduct electricity and which ones do not. Encourage different ideas. Tell the students they will be creating circuits and using objects within the circuits to see if electricity will pass through them. How will you know electricity has passes through an object in a circuit? *The light bulb will light because the electric current will be able to move around the entire circuit with no interruptions.* Review with the students what you need to have a circuit. *A starter (battery), a conductor (copper wire), a device that uses electricity (a light bulb).* Have the student move into groups of two or three and hand out materials for building simple circuits. Give the groups a few minutes to create simple circuits and make sure their circuits are complete and bulbs can light.
   3. Now tell the students they will need to make a gap in the circuit, for example, where the wire touches the battery. Tell the students they will be connecting this gap in the circuit with several different materials. Ask them how they will be able to tell whether these materials are conductors or insulators. *If the material is a conductor the light bulb will light because the circuit is complete. If the material is an insulator, the bulb will not light because the circuit is incomplete.*
   4. Ask the students to open to Appendix P: Conductors and Insulators Data Chart. Hand out materials that the students will be testing to each group. As they test each object, have them record their data in their chart. As groups finish with the materials you have given them to test, encourage them to find other objects that they can test in the classroom and add the results of these tests to their data charts.
   5. When the students have finished their charts, chart the results on the board. What objects were conductors? *Aluminum foil, key, paper clip* What do these objects have in common? *They are made of metal.* Tell the students that metals make good conductors because the atoms of metal do not hold electrons tightly. Which objects were insulators? *Pencil, eraser, rock, plastic, glass, cork*
   6. To end the lesson, ask the students to open to their KWL charts and write a sentence about what they learned today. After a couple of minutes ask them to share what they wrote with a neighbor. Then, have a few students volunteer what they wrote and come up with a sentence to write on the KWL chart on the bulletin board. *Metals make good conductors because their atoms do not hold electrons tightly. Conductors allow electrons to pass through them easily, and insulators do not allow electrons to pass through them easily.*

E. *Assessment/Evaluation*

1. Students completed Appendix P: Conductors and Insulators Data Chart through experimenting and group work.
2. Students wrote about what they learned about conductors and insulators in their KWL charts on Appendix A in their science folders.

Lesson Six: Electromagnets (one lesson, approximately forty-five minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
   b. Students understand common properties, forms, and changes in matter and energy.
   c. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
2. Lesson Content
   a. Electromagnets: how they work and common uses
3. Skill Objective(s)
   a. [Students] organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram).
   b. [Students] use listening skills to understand directions.
   c. [Students] develop and evaluate explanations based upon experimental evidence and experience of others.
   d. [Students] read, respond to, and discuss a variety of literature as a way to explore such as…non-fiction and content area reading.
   e. [Students] plan, design, predict, and conduct an experiment, collect data, and communicate reasonable explanations.
   f. [Students] use knowledge and evidence obtained in experiments to support explanations.

B. *Materials*

1. Appendix Q: Magnets from Electricity (one for each student in science folders)
2. Appendix R: Electromagnet Experiment, page one and two (one for each student)
3. Overhead of Appendix R: Electromagnet Experiment (page three and four)
4. Appendix A: Electricity KWL Chart (one for each student in science folders)
5. 250 large paper clips
6. Ten metric rulers
7. Ten pieces of insulated wire with ends stripped
8. Ten large bolts
9. Ten D-cell batteries
10. Ten battery holders

C. *Key Vocabulary*

1. Electromagnets-a magnet that is created when an electric current flows through a coiled wire

D. *Procedures/Activities*

1. Have students open Appendix Q: Magnets from Electricity in their science folders. Read and discuss this page with the class. Explain to the students that they will be creating and experimenting with electromagnets today.
2. Have students break into groups of two or three making ten groups. Hand out Appendix R: Electromagnets Experiment to all of the students. Have group members come up and collect needed materials for the experiment.

3. Put Appendix R: Electromagnet Experiment (page three) on the overhead have them write the question and come up with a hypothesis based on what they have learned so far about electromagnets. Go over the procedure with the students. Once everyone is clear on directions and there are no questions give the groups time to work together on the experiment. Once they have finished all the steps in the procedure section, make sure they fill out their data charts and bar graphs and answer questions for results and conclusions. When all the groups have finished, discuss the results and conclusions as a class. Use the overhead of Appendix R: Electromagnet Experiment (page four) during your discussion.
4. To end the lesson, ask the students to open to their KWL charts and write a sentence about what they learned today. After a couple of minutes ask them to share what they wrote with a neighbor. Then, have a few students volunteer what they wrote and come up with a sentence to write on the KWL chart on the bulletin board. *An electromagnet is a magnet that is created when an electric current flows through a coiled wire.*

E. *Assessment/Evaluation*
1. Students work in groups to complete Appendix R: Electromagnet Experiment and discuss the experiment and conclusions they came up with when they have completed Appendix R.
2. Students write what they learned about electromagnets today in Appendix A: Electricity KWL Chart.

Lesson Seven: Michael Faraday and Electric Generators (one lesson, approximately forty-five minutes)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
   b. Students understand common properties, forms, and changes in matter and energy.
   c. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
2. Lesson Content
   a. Science Biographies: Michael Faraday
3. Skill Objective(s)
   a. [Students] organize data into an appropriate format (e.g. bar graph, pie chart, charts, Venn diagram).
   b. [Students] sort information as it relates to a specific topic or purpose.
   c. [Students] use listening skills to understand directions.
   d. [Students] develop and evaluate explanations based upon experimental evidence and experience of others.
   e. [Students] read, respond to, and discuss a variety of literature as a way to explore such as…non-fiction and content area reading.
   f. [Students] use knowledge and evidence obtained in experiments to support explanations.
   g. [Students] generate topics and develop ideas for a variety of writing and speaking purposes.
   h. [Students] organize their writing.

B. *Materials*
1. Appendix S: Michael Faraday Biography (one for each student in science folders)

2. Appendix T: Michael Faraday Paragraph (one for each student in science folders)
3. Appendix U: Paragraph Rubric (one for each student)
4. A strong bar magnet
5. Two separate pieces 24-gauge insulated copper wire with ends stripped (each piece should be 10 yards long)
6. A juice can
7. Packaging tape
8. Sewing needle
9. Thread
10. D cell battery

C. *Key Vocabulary*

1. Generator-a device that produces electric current by spinning a coil within a magnetic field

D. *Procedures/Activities*

1. Have the students open their science folders to Appendix S: Michael Faraday Biography and read and discuss this passage. When you have finished reading this ask them questions like "Who was Michael Faraday? What did he invent? What is a generator? Why was Faraday's discovery important?"
2. Tell the students that you will be demonstrating how Faraday came to this discovery of generating electricity.
3. Remind the students that most of the electricity experiments they have done so far have used batteries where electricity is produced by chemical reactions. Although this source of electricity is important, most of your homes and buildings are supplied by electricity that has been produced by generators. What are generators? *Large devices that change the energy of spinning magnetic fields into electric current.*
4. (The following activity comes from *Awesome Experiments in Electricity and Magnetism* by Michael DiSpezio.) Tell the students that you are first going to produce a current meter so we can see that electricity is flowing. Wrap one piece of the copper wire around a can into tight coils, leaving about a foot of wire at each end of the coil. Slip the coil off the can. Wrap several pieces of packaging tape around the coil to keep its shape. Use a larger piece of tape to tape the coil onto a flat surface so that is stands up.
5. Use a magnet to magnetize the sewing needle. Stroke the needle at least forty times in the same direction. Tie a small length of thread around the middle of the needle so that is balances. Tape the other end of the thread to the top of the wire coil. The magnetized needle should balance in the middle of the coil's open space.
6. Touch the free ends of the wires to the positive and negative ends of the battery. Ask the students what happened? *The needle spun and changed its direction.* Now switch the wires and touch the opposite sides of the battery with the wires. Ask the students what happened now? *The needle turned again and pointed in the opposite direction.*
7. Explain to the students that you just created a current meter that detects electric current. *When the wires were attached to the battery, electricity flowed through the coil. This movement of electric charge created a magnetic field which affected the magnetized needle and caused it to spin and change its pointing direction. When I switched the wires on the battery, the current flowed in the opposite direction, so the needle turned and pointed in the opposite direction.*

8. Tell the students now you are going to generate electricity using a magnet. Wrap the other piece of copper wire around a can into a tight coil leaving a foot of wire at each end again. Slip the coil off the can and secure its shape with several pieces of tape. Now attach the bare ends of this wire to the current meter's wires. A complete circuit containing both coils should now be formed.
9. Push the bar magnet in and out of the newly assembled coil. What happens to the needle that is suspended in the current meter? *The needle changed continually changed directions as you moved the magnet.* Why is this happening? *You've generated electricity. As the magnet moved in and out of the coil, it created a back-and-forth flow of charges within the coil. As this flow moved through the circuit, this back and forth current caused the meter (needle) to continually change directions because of the flip-flopping magnetic field.*
10. Have the students write a paragraph in their science folders stating three things they have learned about Michael Faraday and generators. Brainstorm some ideas as a class (chemist, physicist, helped make electricity useful to all people, invented generator, generators change the energy of spinning magnetic fields into electric current, inspired by Oersted's work with electromagnets, inspired Thomas Edison to study his work). Their paragraphs need to contain a topic sentence, three sentences stating a fact about Michael Faraday, one explanation or supporting sentence for each fact, and a concluding sentence. Depending on the ability of your students, you can work on these paragraphs independently, or this can be done as a class assignment. Remind students that these paragraphs will be graded on mechanics and content. Show them Appendix U: Paragraph Rubric.
11. To end the lesson, ask the students to open to their KWL charts and write a sentence about what they learned today. After a couple of minutes ask them to share what they wrote with a neighbor. Then, have a few students volunteer what they wrote and come up with a sentence to write on the KWL chart on the bulletin board. *Michael Faraday invented the generator which helped to make electricity available to all people.*

E. *Assessment/Evaluation*
1. Students will be evaluated on the completion of their paragraphs on Appendix T: Michael Faraday Paragraphs with Appendix U: Paragraph Rubric.
2. Students wrote what they learned about Michael Faraday today in Appendix A: Electricity KWL Chart.

Lesson Eight: Play It Safe Around Electricity (one lesson, approximately forty-five minutes)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
2. Lesson Content
   a. Using electricity safely
3. Skill Objective(s)
   a. [Students] use…sketches…and stories to represent objects, events, and processes.

B. *Materials*
1. Appendix V: Electrical Safety Rules (one for each student in science folders)
2. Appendix X: Electrical Safety Poster Rubric (one for each student)
3. Paper for posters

4. Appendix Y: Electricity Study Guide (one for each student in science folders)

C. *Key Vocabulary*

None

D. *Procedures/Activities*

1. Have students open their science folders to Appendix V: Electrical Safety Rules. Explain that experimenting with electricity can be lots of fun, but if it is used improperly or carelessly, electricity can be very dangerous. Tell them there are some important rules to remember when working around or with electricity. Read through and discuss these safety rules with the class. Then have the students brainstorm some other ways to use electricity safely and write them on their sheets. Possible ideas include: don't play on or near substations or transformers, keep paper away from heated electrical devices, don't put fingers or objects in electrical sockets, etc.
2. Explain to the students that they will be creating electricity safety posters that will be displayed in the classroom or hallway. Hand out large pieces of blank paper and have the students come up with an electrical safety slogan based on what they read about and discussed about electrical safety. Show students Appendix X: Electrical Safety Poster Rubric, so they know what they will be graded on with this poster. Give them time to create their posters. For the last ten minutes of class, allow students to share what they created with the class.
3. Have the students open their folders to Appendix Y: Electricity Study Guide. Tell the students all the information they need to study for the test is listed on the study guide and they can find all this information in their science folders. Note- you may want to direct them to and go over this study guide with them earlier in the unit if you want to give the students more time to study for the final test.

E. *Assessment/Evaluation*

1. Students created a poster showing what they have learned about electrical safety and use Appendix X: Electrical Safety Poster Rubric to grade posters.

Lesson Nine: Final Test (one lesson, approximately forty-five minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Students understand the processes of scientific investigation and design, conduct, communicate about, and evaluate such investigations.
   b. Students understand common properties, forms, and changes in matter and energy.
   c. Students understand interrelationships among science, technology, and human activities and how they can affect the world.
2. Lesson Content
   a. Electricity as the flow of electrons
   b. Static electricity
   c. Electric current
   d. Electric circuits, and experiments with simple circuits (battery, wire, light bulb, filament, switch, fuse)
   e. Conductors and insulators
   f. Electromagnets: how they work and common uses
   g. Using electricity safely
3. Skill Objective(s)
   a. [Students] use listening skills to understand directions.
   b. [Students] develop and evaluate explanations based upon experimental and experience of others.

c. [Students] use knowledge and evidence obtained in experiments to support explanations.

B. *Materials*
   1. Appendix Z: Electricity Test, pages one through four (one for each student)

C. *Key Vocabulary*
   1. None

D. *Procedures/Activities*
   1. Pass out the test to students (Appendix Z: Electricity Test).
   2. Review directions and answer any questions.
   3. Collect and grade the tests at the end of the class period.

E. *Assessment/Evaluation*
   1. Students will be graded by their correct responses on the test. (Use Appendix Z: Electricity Test, page five.)

VI. CULMINATING ACTIVITY

A. Final Electricity Test from Lesson Nine

B. Call your local power company and arrange a field trip to one of their local power plants.

VII. HANDOUTS/WORKSHEETS

A. Appendix A: Electricity KWL Chart (two pages)
B. Appendix B: Electricity-A Household Word (two pages)
C. Appendix C: Electricity Introduction
D. Appendix D: Atom Notes (two pages)
E. Appendix E: Static Electricity Introduction
F. Appendix F: Static Electricity Notes
G. Appendix G: Group Responsibilities and Expectations
H. Appendix H: Directions for Static Electricity Investigations (six pages)
I. Appendix I: Journal Entry for Static Electricity Investigation
J. Appendix J: Electric Circuit Notes (two pages)
K. Appendix K: Drawing Circuits
L. Appendix L: Creating Switches
M. Appendix M: Switch Worksheet
N. Appendix N: Short Circuit Assembly
O. Appendix O: Static and Current Electricity Quiz
P. Appendix P: Conductors and Insulators Data Chart (two pages)
Q. Appendix Q: Magnets from Electricity
R. Appendix R: Electromagnet Experiment (four pages)
S. Appendix S: Michael Faraday Biography
T. Appendix T: Michael Faraday Paragraph
U. Appendix U: Paragraph Rubric
V. Appendix V: Electrical Safety Rules
W. Appendix W: Electrical Safety Rules Poster Rubric
X. Appendix X: Electricity Study Guide
Y. Appendix Y: Electricity Test (five pages)

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Appendix A, page 1

Electricity: KWL Chart

What I already **know** about electricity…

What I **want to find out** about electricity…

Appendix A, page 2

Electricity: KWL Chart

What I've **learned** about electricity…

Appendix B, page 1

Electricity-A Household Word

Make a list of twenty electrical appliances and other items that require electricity in your home. In the spaces below list the items in the appropriate categories: Items used daily, Items used several times a week, Items used a few times a month, Items used a few times a year.

(20 points-You will receive one point for each electrical appliance or item you list. Make sure you list items in all four categories.)

Items used daily:	Items used several times a week:
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

Items used a few times a month:	Items used a few times a year:
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

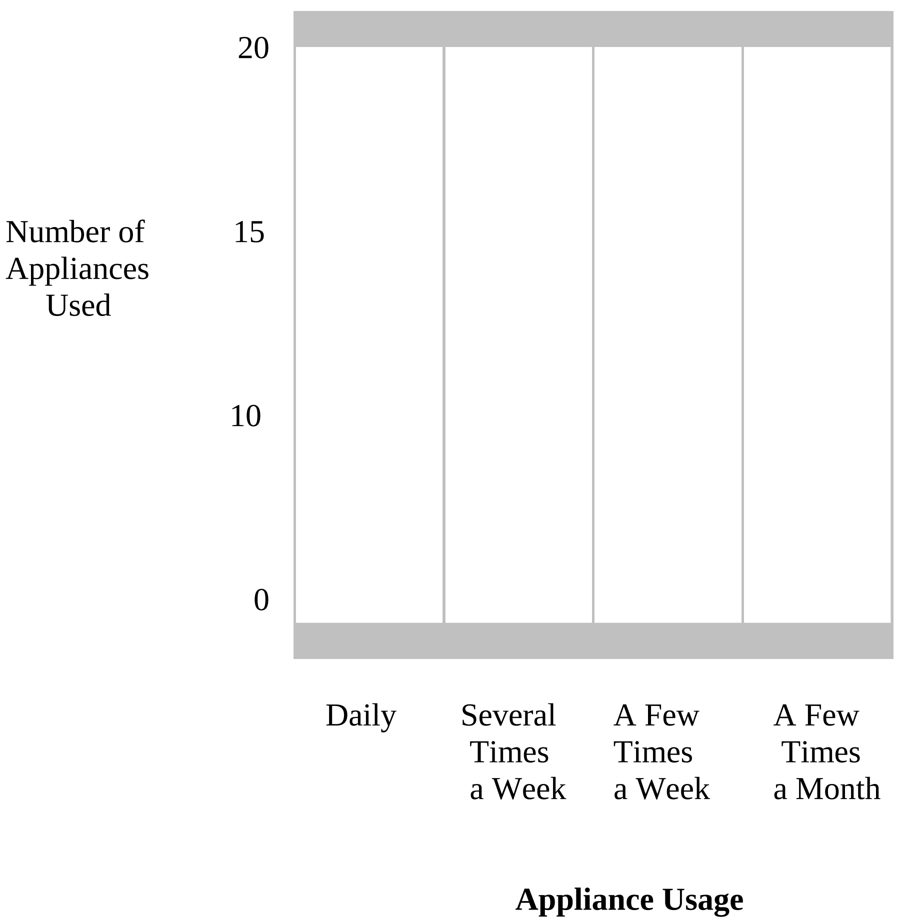
(**Source**: Gosnell, Kathy. *Electricity*. Westminster, CA: Teacher Created Materials, Inc., 2001. 1-55734-236-9)

Appendix B, page 2

Bar Graph of Electricity-A Household Word

Now that you have recorded the types of items that use electricity in your household and how often these items are used, create a bar graph with the data you've collected. Create a bar graph that shows the appliance usage on the X Axis (bottom of the graph) and the number of appliances used on the Y axis (0-20) (left side of the graph).

(5 points-you will receive one point for a title, and one point for accurately charting each bar)



(**Source**: Gosnell, Kathy. *Electricity*. Westminster, CA: Teacher Created Materials, Inc., 2001. 1-55734-236-9)

Appendix C
Electricity Introduction

Can you imagine a life without electricity? What would life be like without televisions, lights, and stereos? We take many of these things for granted and many of the appliances we use have only become widespread during the last eighty years. In some parts of the world today electricity from a power station is still not available. In these parts people still need to rely on animals for transport and fire for light and heat.

Electricity occurs naturally, but it also can be generated. For example, lightning is a natural form of electricity when there is a huge movement of an electric charge from cloud to cloud or cloud to ground. Large power stations are examples of how electricity can be generated. Power stations supply electricity to homes, schools, and industries. These power stations generate enough electricity to light hundreds of millions of bulbs and appliances.

In order to understand electricity, we first need to understand atoms. If we think back to chemistry, we know matter is anything that takes up space and has mass, such as gases, liquids, and solids. All matter is made up of **atoms**, which are the smallest part of an element that retains the properties of the element. Imagine a pure gold ring. Divide it in half and give one of the halves away. Keep dividing and dividing and dividing. Soon you will have a piece so small you will not be able to see it without a microscope. It may be very, very small, but it is still a piece of gold. If you could keep dividing it into smaller and smaller pieces, you would finally get to the smallest piece of gold possible. It is called an atom. If you divided it into smaller pieces, it would no longer be gold. Everything around us is made of atoms. Scientists so far have found only 115 different kinds of atoms. Everything you see is made of different combinations of these atoms.

Atoms have two types of charges, positive and negative. A **proton** has a positive charge of +1 and an **electron** has a negative charge of -1. Protons are found in the **nucleus** (center) of atoms, and electrons spin around the nucleus. Some atoms tend to lose electrons. The electrons in the outermost part of the atom are held more loosely, and sometimes these electrons are lost. Other types of atoms like to gain electrons and attract these lost electrons. **Electricity** occurs when these negatively charged particles (electrons) flow from one place to another. Electrons that manage to break away from atoms can "wander" around among the surrounding atoms with in the material. It is the movement of these "free" electrons that produces the flow of electric charges. As the number of "free" electrons increases in the material, it becomes more capable of creating an electric current. There are two forms of electricity-**static** (still) and **current** (flowing). We will be focusing on static electricity first.

(Source: Science Made Simple. *What is Static Electricity.* Available URL: http://www.proteacher.com/cgibin/outsidesite.cgi?external=http://www.sciencemadesimple.com/static.html&original=http://www.proteacher.com/110016.shtml&title=What%20is%20Static%20Electricity?, Date of access: 7/01/04 and VanCleave, Janice. *Electricity: Mind-Boggling Experiments You Can Turn Into Science Fair Projects.* Canada: John Wiley and Sons, Inc. 1994. 0-471-31010-7)

Appendix D, page 1

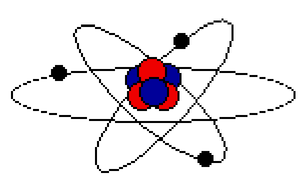
Atom Notes

Atom Notes (10 points-you will receive two points for each definition)

Atom	
Protons	
Electrons	
Electricity	
Draw a picture of an atom-label parts	

Atom Notes-Teacher's Copy

Atom Notes-(10 points-you will receive two points for each definition)

Atom	-the smallest part of an element that still has the properties of the element
Protons	-positively charged particles atoms -found in the nucleus (center) of the atom
Electrons	-negative charged particles in atoms -orbit (circle) the nucleus of an atom
Electricity	-negatively charged particles (electrons) flowing from one area to another
Draw a picture of an atom-label parts	

Appendix E

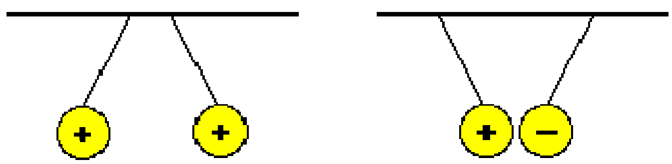
Static Electricity Introduction

What is Static Electricity?

Everything we see is made up of tiny little parts called atoms. The atoms are made of even smaller parts. These are called protons, electrons and neutrons. They are very different from each other in many ways. One way they are different is their "charge." Protons have a positive (+) charge. Electrons have a negative (-) charge. Neutrons have no charge.

Usually, atoms have the same number of electrons and protons. Then the atom has no charge, it is "neutral." If you rub things together, electrons can move from one atom to another. When this happens some atoms get extra electrons. When atoms gain extra electrons, a negative charge is created. Atoms could also lose electrons when objects are rubbed together. They would generate a positive charge because they have lost electrons (negative charges) and therefore have more protons (positive charges). S**tatic electricity** is the build-up of these electrical charges on an object. These charges are called **static charges** because they are stationary (not moving).

The **law of electric charges** states that like charges **repel** (push apart from) each other and unlike charges **attract** each other.



(Source: Science Made Simple. *What is Static Electricity.* Available URL:http://www.proteacher.com/cgibin/outsidesite.cgi?external=http://www.sciencemadesimple.com/static.html&original=http://www.proteacher.com/110016.shtml&title=What%20is%20Static%20Electricity?, Date of access: 7/01/04)

Appendix F, page 1

Static Electricity Notes

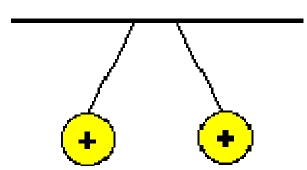
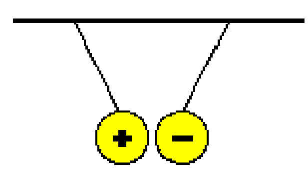
(10 points-you will receive two points for each definition)

Static Electricity	
Negative Charge (-)	
Positive Charge (+)	
Law of Electric Charges	
Draw a picture the Law of Electric Charges	

Appendix F, page 2

Static Electricity Notes

(10 points-you will receive two points for each definition)

Static Electricity	-A build up of charges on an object caused by rubbing
Negative Charge (-)	-An object gains a negative charge when electrons are added to the object
Positive Charge (+)	-An object gains a positive charge when electrons are removed from the object
Law of electric charges	-Like charges repel (push away from) each other and opposite charges attract each other
Draw a picture the Law of Electric Charges	 (materials with like charges repel each other)  (materials with opposite charges attract each other)

Appendix G

Group Responsibilities and Expectations

Group Responsibilities:

Project Leader: scientist in charge of reading directions and setting up equipment/materials needed to do the experiment

The Physicist: scientist in charge of carrying out the directions (more than one student)

The Stenographer: scientist in charge of recording all the information

The Transcriber: scientist who translates notes and communicates findings (describes experimental findings to the class)

(Primary Source: Feigen, Mel. *Magnetism and Electricity: Intermediate.* Westminster, CA: Teacher Created Materials, Inc. 2002. 1-55734-646-1)

Group Expectations:

- Be clear and focused on your purpose.
- **Listen** closely to **all** ideas. *All members should be considered equal. Of course, there will be individuals with more knowledge in certain areas than others, but no one person should be considered above the rest. Remember that sometimes answers to problems are found in unlikely places or people.*
- Be **courteous**.
- **Speak** so that all can hear, but remember that there are four other groups in the room who are also working and discussing. Keep your volume at a level that only your group members can hear.
- **Ask** questions.
- **Summarize** or paraphrase ideas.
- **Check** for agreement.
- Express **support** for one another ("That's right." "I never looked at it that way.")
- When opinions differ, **remember that you are criticizing ideas** and not people. *No backstabbing other students outside of class for ideas they hold that you may not agree with.*
- Before you begin your experiment decide what role each member will take and stick to your job for the entire experiment.

(Primary Source: *Speaking and Listening: Instructional Philosophy and Teaching Strategies.* [On-line]. Available URL: http://www.sasked.gov.sk.ca/docs/mla/speak.htm, Date of Access: 7/19/02)

Appendix H, page 1

Directions for Static Electricity Investigations

Before beginning your investigation, write your group member's names on the lines below.

Project Leader: ________________________ Stenographer: ________________________

Transcriber: __________________________ Physicists: _________________________

____

At **station #1** you will be creating "ghost legs" using your newfound knowledge of static electricity. (10 points possible)

Materials:

-nylon stocking -plastic grocery bag -smooth wall

Procedure:

1. With one hand, hold the top of the stocking against a flat wall. Use the other hand to stroke the stocking in one direction with the plastic grocery bag. As you stroke the nylon material, smooth it against the walls surface. After several strokes, release the stocking.

2. What happened to the material?(1 point) _____________________________

3. How is this similar to sticking a balloon on the wall? How is it different?(2 points)
   Similar? ____
   Different?____

4. Now gently grasp the top of the stocking and move it away from the wall. Make sure it does not touch anything (including yourself). Hold out the stocking.

5. What happened to the stocking's shape? (2 points)

____

6. Explain your observation based on what you know about static electricity? (5 points-two points for writing complete sentences, three points for explaining your observation)

____

____

____

Appendix H, page 2

Directions for Static Electricity Investigations

Before beginning your investigation, write your group member's names on the lines below.

Project Leader: ________________________ Stenographer: ________________________

Transcriber: ________________________ Physicists: ________________________

____

At **station #2** you will be completing the "charge the comb" activity using your newfound knowledge of static electricity. (10 points possible)

Materials:

-plastic comb -paper -aluminum foil -plastic wrap

Procedure:

1. Tear up a sheet of paper into small pieces. Place these pieces in a pile on a desk. Run a plastic comb through your hair several times (only one person may run the comb through their hair). Then, position the comb over the pile of paper.

2. What happens? (2 points)

____

3. Wait a minute. What has happened to the paper? (1 point)

____

4. Now try this activity with pieces of aluminum foil. What happens? (1 point)

____

5. Now try this activity with pieces of plastic wrap. What happens? (1 point)

____

6. Explain your observations with this activity based on what you know about static electricity. (5 points-two points for writing complete sentences, three points for explaining your observation)

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Directions for Static Electricity Investigations

Before beginning your investigation, write your group member's names on the lines below.

Project Leader: ___________________________ Stenographer: __________________________

Transcriber: _____________________________ Physicists: ____________________________

____

At **station #3** you will be completing the "static separator" activity using your newfound knowledge of static electricity. (10 points possible)

Materials:

-plastic comb -sugar -pepper -small plate

Procedure:

1. Place two pinches of sugar and pepper side-by-side. Charge a comb by running it through your hair. (Only one person may run the comb through their hair.) Hold the comb several inches above the sugar and pepper.

2. Now slowly bring the comb closer to the mixture. Stop the comb when particles begin to jump onto it.

3. Does the sugar or pepper jump onto the comb first? (2 points)

____

4. Bring the comb closer to the mixture. Which particles jump onto the comb now? (2 points)

____

5. Explain your observations with this activity based on what you know about static electricity. (5 points-two points for writing complete sentences, three points for explaining your observation)

____

____

____

6. Can a mixture of sugar and salt be separated by static charges? Why? (1 point)

____

____

Appendix H, page 4

Directions for Static Electricity Investigations

Before beginning your investigation, write your group member's names on the lines below.

Project Leader: ______________________ Stenographer: ______________________

Transcriber: ________________________ Physicists: ________________________

____

At **station #4** you will be completing the "static jumpers" activity using your newfound knowledge of static electricity. (10 points possible)

Materials:

-puffed cereal grains (like "Rice Crispies") -balloons -a piece of wool

Procedure:

1. Stuff about a dozen grains of puffed cereal into a balloon. Inflate the balloon and tie it. Then rub the balloon with a piece of wool. Hold the hanging balloon by its knot. Observe the grains within the balloon.

2. Explain what you observe. Are the grains stationary or moving? (2 points)

____

____

____

3. Now touch the balloon with the fingertips of your other hand. (If nothing happens, recharge the balloon by giving it twice as many strokes. Then, touch it again.) How do the grains behave? (3 points)

____

____

____

4. Explain your observations with this activity based on what you know about static electricity. (5 points-two points for writing complete sentences, three points for explaining your observation)

____

____

____

____

Appendix H, page 5

Directions for Static Electricity Investigations

Before beginning your investigation, write your group member's names on the lines below.

Project Leader: ________________________ Stenographer: ________________________

Transcriber: ___________________________ Physicists: ___________________________

____

At **station #5** you will be completing the "On the Edge" activity using your newfound knowledge of static electricity. (10 points possible)

Materials:

- wooden ruler - balloon -piece of wool

Procedure:

1. Position the wooden ruler so that it balances on the edge of the table. At this balance point, the ruler remains steady with one end slightly lifted from the tabletop.

2. Charge up the balloon by stroking it with the wool. Slowly approach the raised end of the ruler with the charged balloon. What happens? (3 points)

____

____

____

3. How does the electrostatic force work against the force of gravity? (2 points)

____

____

____

4. Explain your observations with this activity based on what you know about static electricity. (5 points-two points for writing complete sentences, three points for explaining your observation)

____

____

____

____

Appendix H, page 6

Directions for Static Electricity Investigations

"The science behind the activities for the teacher"

Station #1
The plastic bag picks up negative charges as it moves over the stocking. This produces a stocking with a net positive charge. This charged stocking induces an opposite charge in the nearby wall. The negative and positive charges attract and the stocking sticks to the wall. When the stocking is pulled from the wall, it still keeps its positive charge. The charges, which are distributed throughout the entire material, push away from each other. This causes the stocking to "expand" and take on the leg shape.

Station #2
As the comb rubs against the hair, negative charges are transferred from the hair onto the comb. The comb takes on a negative charge. When the comb is placed above the neutral paper, it exerts its negative field, which causes the negative charges in the paper to move away from the comb. These negative charges migrate through the paper and collect on the paper's far side. Through induction, the closer region becomes positive. The attraction between this positive region of the paper and the negative comb is strong enough to overcome gravity. The paper pieces jump from the tabletop to the comb. As the paper remains on the comb, the comb's negative charges migrate into the paper. This cancels the nearby charge and the paper falls to the tabletop.

Station #3
Both pepper and sugar are attracted to the negatively charged comb. However, because the pepper particles are lighter, they jump onto the comb first. As the comb is brought closer to the mixture, the force of attraction increases. Eventually, the force overcomes the greater weight of the sugar grains. Like the pepper, the sugar now jumps onto the comb.

Station #4
As the balloon was rubbed against the wool, the balloon became negatively charged. Its negative field induced a positive charge in the nearby side of the puffed grains. This positive region was attracted to the balloon, causing the grains to cling to the balloon's negative surface. When you touched the balloon with your fingertips the balloon's negative charges moved out through your fingers. This created a positive region in the balloon. The charges in the grains could not shift fast enough. Instead, the positive grain surface and the positive balloon surface repelled each other. The grains jumped to another location.

Station #5
When the ruler was balanced, it remained still. As the negatively charged balloon was brought over the end of the ruler, it upset the wood's balance of charges. The negatively-charged balloon induced a positive charge near the end of the ruler. This positive charge and the negative balloon attracted each other. The force of attraction was large enough to offset the balance of mass and cause the end of the ruler to rise up.

(Source: DiSpezio, Michael. *Awesome Experiments in Electricity and Magnetism.* New York, NY: Sterling Publishing Co., Inc. 1998. 0-8069-9819-9)

Appendix I

Journal Entry for Static Electricity Investigation

Directions: (10 points possible)
Illustrate what you observed during your investigation. Then write three sentences describing what happened during your investigation and three sentences describing what you learned from this activity for static electricity.

Illustration (4 points):

This is what happened (3 points-one point per sentence):

This is what I learned (3 points-one point per sentence):

Appendix J, page 1

Electric Circuit Notes

(12 points-two points for each definition)

Electric Current	
Conductor	
Insulator	
Battery	
Filament	
Circuit	

Appendix J, page 2

Electric Circuit Notes

(12 points-two points for each definition)

Electric Current	- the flow of negative charges through matter - can only flow if it has a closed path, or a closed circuit, to flow through
Conductor	-a material through which electric current passes easily -metals such as copper are good conductors
Insulators	- a material through which electric current does not pass easily -the insulation keeps the electric current in its path in case wires touch other metal objects -glass, plastic, and rubber make good insulators
Battery	-stores energy -serves as a starter-it pushes electrons into the wire to get the flow of electrons started -chemicals in the battery that store the energy -volts-the amount of pressure or force a battery has to push electrons
Filament	-a very thin, coiled wire in a light bulb -when electricity flows through it, the resistance of the coiled wire heats it up and causes it to glow
Circuit	-the path an electric current takes as it flows (circle)

Appendix K

Drawing Circuits

Draw a picture of the circuit you created and label the parts. After you drew your circuit, list the three main parts of the circuit and describe the jobs of these parts (10 points possible).

Draw the circuit (2 points) and label the parts of the circuit (2 points).

List a part of the circuit and describe its job: (2 points each)

1. ________________________

____

____

2. ________________________

____

____

3. ________________________

____

____

Appendix L

Creating Switches

1. Position two thumbtacks several inches apart on a small block of wood. Push them **partially** into the wood, leaving only a small space between the tacks head and the wood's surface.

2. Wrap the bare end of one of the wires around one of the thumbtacks. Push the tack into the wood to secure the wire.

3. Bend a paper clip into an "S" shape. Slip one end of the paper clip's hook under the other thumbtack. Wrap this same thumbtack with the bare end of the second wire. Push this tack into the wood to secure **both** the wire and the paperclip.

4. Make sure the paperclip extends over the other thumbtack. If not bend it out some more. When you press down on the clip, it should make contact with the head of the first thumbtack. When you release the clip is should spring back up to "open" the circuit.

5. Repeat these steps with the remaining materials to complete a second switch.

(Source: DiSpezio, Michael. *Awesome Experiments in Electricity and Magnetism.* New York, NY: Sterling Publishing Co., Inc. 1998. 0-8069-9819-9)

Appendix M

Switch Worksheet

The flow of electricity requires an uninterrupted path through which electric charges will move. The charges will stop flowing if there are any breaks in the path. It doesn't matter where the break is. As long as the path is not complete, no current will flow.

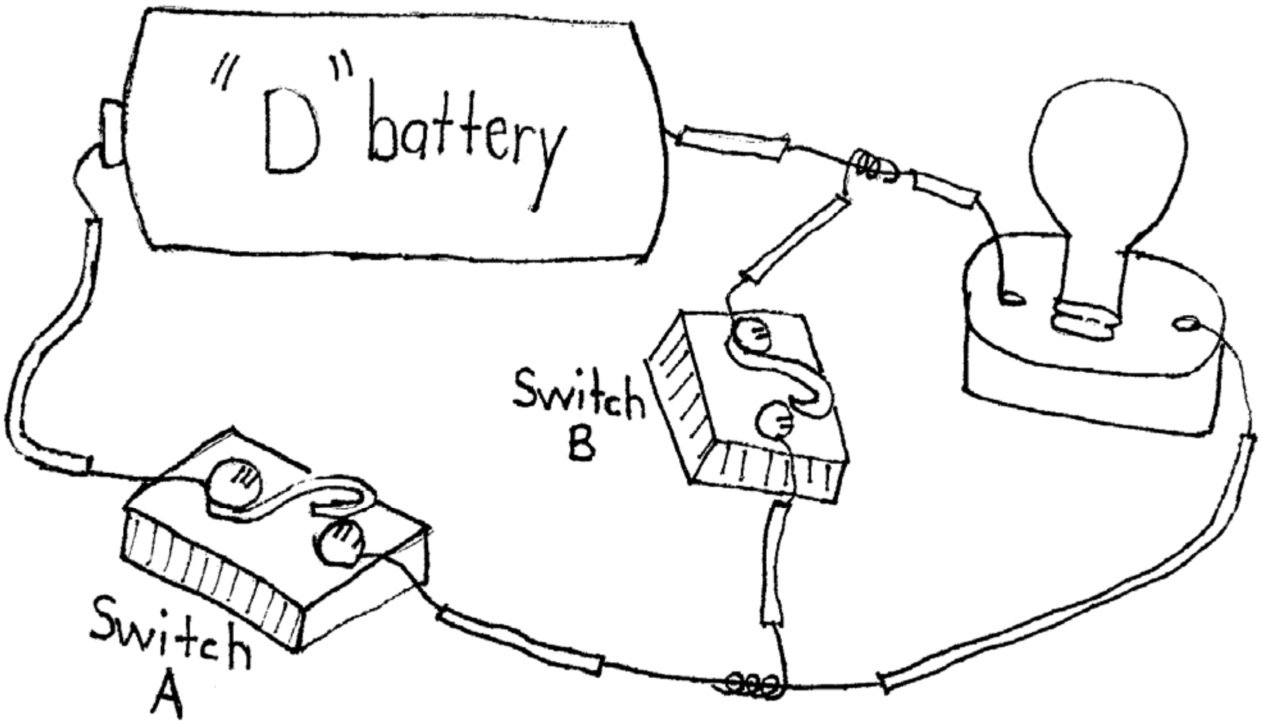
A switch is a device that can open and close a circuit. In the "on" position, the switch closes the circuit and completes the route for flowing current. In the "off" position, the switch places a gap in the path, which prevents any current from flowing.

Think of all the things that you do in a day. List the times that you turn on or off a switch (20 points-one point per item listed).

______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

Appendix N

Short Circuit Assembly



Appendix O

Static and Current Electricity Quiz

Name: ____________________________ Date: ____________________

True/False: Write T for true or F for false on the line before each sentence (30 points-3 points per question).

1. ______ All objects are made of tiny bits of material that have electric charges.

2. ______ When two objects have the same charge, they attract each other.

3. ______ An electric charge may be either positive or negative.

4. ______ An electric current is the flow of negative charges through a conductor.

5. ______ An electric current must have an opening for electricity to enter through.

6. ______ An insulator is a substance that electric current easily passes through.

7. ______ A light bulb gives off light because the material inside it is a filament.

8. ______ An object gains a negative charge when electrons are added to an object.

9. _____ Batteries store energy and start the flow of electrons in a circuit.

10. _____ If a circuit is closed, a light bulb cannot light.

Answers: 1. T, 2. F, 3. T, 4. T, 5. F, 6. F, 7. T, 8. T, 9. T, 10. F

Appendix P, page 1

Conductors and Insulators Data Chart

(40 points possible)

Object	Material it is made of	Conductor	Insulator

Appendix P, page 2

Conductors and Insulators Data Chart

(40 points possible-students get one point for each box they correctly fill in)

Object	Material it is made of	Conductor	Insulator
Aluminum foil	Metal	Yes	
Pencil	Wood		Yes
Eraser	Rubber		Yes
Plastic pen top	Plastic		Yes
Toothpick	Wood		Yes
Cork	Cork		Yes
Paper clip	Metal	Yes	
Rock	Rock		Yes
Rubber band	Rubber		Yes
Marble	Glass		Yes
Key	Metal	Yes	
Answers will vary			
Answers will vary			

Appendix Q

Magnets from Electricity

About 180 years ago, a scientist named Hans Christian Oersted was experimenting with electricity. Oersted connected some wire to a large battery so that electricity would flow through the wire. To his surprise, he noticed that when the electric current flowed through the wire something else happened. The needle on the nearby compass moved and pointed near the wire. Oersted then realized that electricity and magnetism are linked. He concluded that electric current causes wire to become magnetic.

All wires carrying a direct current are surrounded by a steady magnetic field. When the electric current flows through a coil of wire, the whole coil acts like a magnet. An **electromagnet** is a temporary magnet made when electric current flows through a coiled wire. Winding the wire into a coil increases the strength of the magnetic field around the electromagnet. When the electric current stops flowing, the wire loses its magnetism.

There are many uses for electromagnets because they can be turned on and off by closing and opening an electric circuit. Some examples of electromagnets include pushing a doorbell. When you push in a doorbell it closes the electric circuit, and the current flows through the electromagnet causing the doorbell to ring. Also, when a switch on a fan is turned on, electric current creates an electromagnet that runs the motor in the fan. Telephones also use electromagnets. When electricity flows through the electromagnet in a telephone, a thin disc called a diaphragm vibrates. This makes the telephone ring. Huge electromagnets are used in scrap yards to lift and move large metal objects. They are very powerful and can lift great weights. There are many advantages to having a magnet you can turn on and off.

(Source: Cooney, Timothy, and DiSpezio, Michael, et al. *Scott Foresman Science.* Glenview, IL: Addison-Wesley Educational Publishers Inc. 2000. 0-673-59307-X)

Electromagnet Experiment

Question (1 point):

____

____

Hypothesis (2 points):

____

____

Procedure:

Materials:

25 large paper clips, metric ruler, insulated wire with ends stripped, large bolt, D-cell battery, battery holder

Step by Step Directions:

1. Measure about 25 cm from one end of the wire. Start near the head of the bolt and wind the wire tightly around the bolt twenty times.

2. Bend a paper clip to form a hook.

3. Place the battery in the battery holder. Attach the ends of the wire to the clips on the battery holder. Electricity is now flowing through the wire.

4. Now you will measure the strength of the electromagnet. Pick up the hook-shaped clip with the head of the electromagnet using just magnetism. Place paperclips on the hook one at a time until the hook falls off. Record the number of paperclips the hook held before the paper clip fell off. Be sure to count the hook shaped magnet as well. Record your data in the chart.

5. Disconnect the battery and change the number of coils around the bolt to thirty times for Trial Two. Repeat steps 3 and 4.

6. Disconnect the battery and change the number of coils around the bolt to forty times for Trial Three. Repeat steps 3 and 4 again.

Collect your data (3 points):

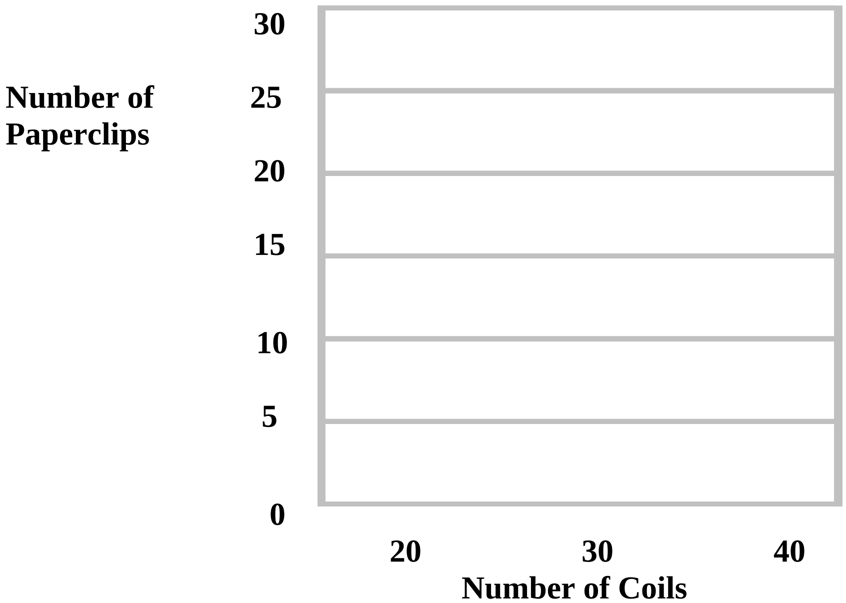
Trial	Coils of Wire on the Electromagnet	Number of Clips Held
1	20	
2	30	
3	40	

Appendix R, page 2

Electromagnets Experiment

7. Use the data from this chart to make a bar graph. (3 points)

Strength of an Electromagnet



Results:

8. Describe what happened as the number of coils of wire on the bolt increased (2 points).

____

____

____

Conclusion:

9. How do your results compare with your hypothesis (2 points)?

____

____

____

10. Explain how the number of coils affects the strength of the electromagnet (2 points).

____

____

____

Overhead for Electromagnet Experiment

Question (1 point):

How does the number of coils in electromagnets affect its strength?

Hypothesis (2 points):

If you increase the number of coils in an electromagnet, will its strength increase, decrease, or stay the same? Write your hypothesis.

Procedure:

Materials:
25 large paper clips, metric ruler, insulated wire with ends stripped, large bolt, D-cell battery, battery holder

Step by Step Directions:

1. Measure about 25 cm from one end of the wire. Start near the head of the bolt and wind the wire tightly around the bolt twenty times.

2. Bend a paper clip to form a hook.

3. Place the battery in the battery holder. Attach the ends of the wire to the clips on the battery holder. Electricity is now flowing through the wire.

4. Now you will measure the strength of the electromagnet. Pick up the hook-shaped clip with the head of the electromagnet using just magnetism. Place paperclips on the hook one at a time until the hook falls off. Record the number of paperclips the hook held before the paper clip fell off. Be sure to count the hook shaped magnet as well. Record your data in the chart.

5. Disconnect the battery and change the number of coils around the bolt to thirty times for Trial Two. Repeat steps 3 and 4.

6. Disconnect the battery and change the number of coils around the bolt to forty times for Trial Three. Repeat steps 3 and 4 again.

Collect your data (3 points-answers will Vary):

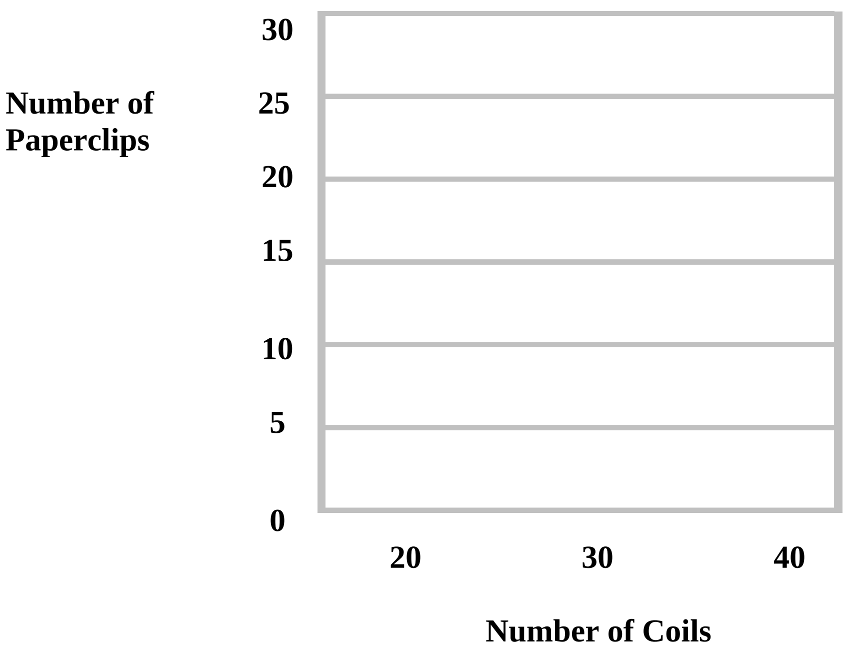
Trial	Coils of Wire on the Electromagnet	Number of Clips Held
1	20	
2	30	
3	40	

Appendix R, page 4

Overhead for Electromagnets Experiment

7. Use the data from this chart to make a bar graph. (3 points-answers will vary)

Strength of an Electromagnet



Results:

8. Describe what happened as the number of coils of wire on the bolt increased (2 points).
When the number of coils increased, the bolt was able to pick up more paper clips. This tells us that the electromagnet's magnetism increased as electricity increased.

Conclusion:

9. How do your results compare with your hypothesis (2 pts)?
Answers will vary

10. Explain how the number of coils affects the strength of the electromagnet (2 points)
As the number of coils of wire around the bolt increases, the strength of the electromagnet increases.

(Source: Cooney, Timothy, and DiSpezio, Michael, et al. *Scott Foresman Science.* Glenview, IL: Addison-Wesley Educational Publishers Inc. 2000. 0-673-59307-X)

Appendix S

Michael Faraday Biography

Michael Faraday was an English physicist. A physicist is someone who studies the science of matter and energy and how they are related. He was also a chemist. A chemist studies the composition, structure, properties and reactions of matter.

Faraday was born in Newington, England, on September 22, 1791. He died in Hampton Court, England, on August 25th, 1867. He was one of the greatest experimental scientists of all time, even though he had a poor education and no university training. He discovered that electricity and magnetism are related. This was an important step in making electricity useful to people.

After hearing about Oersted's work with electromagnets, Faraday showed that just as electricity could produce magnetism, magnetism could produce electricity. In 1831, he showed that when a copper plate was made to turn round and round near a magnet, an electric current was produced in the copper. Faraday produced or "generated" electricity in this way and had invented the "electric generator". A **generator** is a device that produces electric current by spinning a coil within a magnetic field.

This was an improvement on the electric battery. The battery produced electricity only while certain expensive metals like copper, tin, and zinc were being used up in chemical reactions. Beginning with Faraday's discovery, it was possible to have cheap electricity in as large amounts people could use.

The set of books that contained the works of Michael Faraday was bought by Thomas Edison. He was so fascinated by Faraday's work in electricity that he would read and read for hours. Thomas Edison would barely eat or sleep. Needless to say, Faraday had a great influence on the world as well as other great inventors.

(Sources: Gosnell, Kathy. *Electricity.* Westminster, CA: Teacher Created Materials, Inc. 2001. 1-55734-236-9 and Asimov, Isaac. *How Did We Find Out About Electricity?* New York, NY: Walker and Company. 1973. 0-8027-6123-2)

Appendix T

Michael Faraday Paragraph

Write a paragraph stating three things you have learned about Michael Faraday and generators and his work with generators. Your paragraphs need to contain a topic sentence, three sentences stating a fact about Michael Faraday, one explanation or supporting sentence for each fact, and a concluding sentence. (24 points possible- see Appendix U: Paragraph Rubric)

Appendix U

Paragraph Rubric

Michael Faraday Paragraph

Name: ________________________________
Date Submitted: __________________________

	4	3	2	1	Points
Topic Sentence	Topic sentence is clear and correctly placed.	Topic sentence is either unclear or incorrectly placed.	Topic sentence is unclear and incorrectly placed.	There is no topic sentence.	
Supporting Details Sentence	Paragraph has three or more supporting detail sentences that relate back to the main idea.	Paragraph has two supporting detail sentences that relates back to the main idea.	Paragraph has one supporting detail sentence relating back to the main idea.	Paragraph has no supporting detail sentence that relates back to the main idea.	
Explanation Sentences	Each supporting detail sentence has one explanation sentence.	Two supporting detail sentences has explanation sentences.	One supporting detail sentence has an explanation sentence.	None of the supporting detail sentences have an explanation sentence.	
Concluding Sentence	Concluding sentence is clear, correctly placed and restates the topic sentence.	Concluding sentence is either unclear or incorrectly placed, and restates the topic sentence.	Concluding sentence is unclear and incorrectly placed, and restates the topic sentence.	Concluding sentence is unclear, incorrectly placed, and does not restate the topic sentence.	
Legibility	Legible Handwriting	Marginally legible handwriting	Writing is not legible in places.	Writing is not legible.	
Mechanics and Grammar	Paragraph has no errors in punctuation, capitalization, and spelling.	Paragraph has one or two errors in punctuation, capitalization, and spelling.	Paragraph has three to five errors in punctuation, capitalization, and spelling.	Paragraph has six or more errors in punctuation, capitalization, and spelling.	
				Total	

Teacher Comments:

Appendix V

Electrical Safety Rules

Experimenting with electricity can be lots of fun, but if it is used improperly or carelessly, electricity can be very dangerous. Here are some important rules to remember when working around or with electricity.

1. Never touch an electrical appliance or switch with wet hands.
2. Never handle an electrical appliance, switch, telephone, or radio while in the bathtub.
3. Do not touch a bare wire.
4. Before plugging or unplugging an electrical appliance, make sure the power is turned off.
5. When connecting or disconnecting an electrical device make sure it is turned off.
6. If an electrical cord is worn or frayed, do not use it. Tell an adult that it needs to be replaced.
7. Do not overload a circuit by plugging in too many electrical appliances at one time.
8. Remove the batteries from toys and games when they are not being used for a long period of time. An old, corroded battery left in a toy or game can destroy it.

Brainstorm some of your own safety rules with electricity.

____

____

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(Source: Gosnell, Kathy. *Electricity*. Westminster, CA: Teacher Created Materials, Inc. 2001. 1-55734-236-9)

Appendix W

Electrical Safety Poster Rubric

Electrical Safety Poster

Name: ____

Date Submitted: ____

	5	3	1	Points
Slogan	The slogan discussed an important electrical safety rule and was clear to the reader.	The slogan was not clear or did not discuss an important electrical safety rule.	There was no slogan.	
Picture	The picture was neatly done and was colored.	The picture was neatly done but not colored.	The picture was not neatly done and was not colored.	
Neatness	The poster was written legibly and it was apparent time and effort was put into this poster.	The poster was written legibly, but it was apparent that not a lot of time was put into this poster.	The poster was not legible and it was apparent that not much time or effort was put into this project.	
			Total (15 points possible)	

Appendix X

Electricity Study Guide

Be able to define the following terms:

conductor
electromagnet
generator
insulator
filament
repel
attract
switch
static
current
battery
fuse

Be sure you understand:

Parts of atoms, how these parts interact, and that electricity is created by the movement of electrons

Static electricity concepts and terms

Simple electric circuits, parts of circuits, jobs of these parts, and what makes and open and closed circuit

Electrical safety rules and why understanding electricity's danger is important

How electricity affects our everyday lives

****All information is in your science folder!****

Appendix Y, page 1

Electricity Test

Name: ________________________________ Date: ______________

Circle the letter of the answer that best completes the statement. (Each question is worth 2 points.)

1. When two objects have different electric charges, they
   a. pull toward each other
   b. gain energy
   c. lose matter
   d. push away from each other

2. Electric current is the flow of
   a. positive charges through matter
   b. negative charges through matter
   c. magnetism through the matter
   d. energy and light through matter

3. Electric wire is coated with plastic or rubber because these materials
   a. melt very slow
   b. conduct the flow of electricity
   c. are expensive and easy to make
   d. slow or stop electricity

4. Electric current passes easily through a
   a. resistor
   b. conductor
   c. insulator
   d. switch

5. Every time you turn on a light, you
   a. open a closed circuit
   b. close an open circuit
   c. add a source of power to the circuit
   d. remove a source of power from a circuit

Appendix Y, page 2

Electricity Test

6. If you connect too many wires to one circuit, the wires can
    a. blow up
    b. generate more power than heat
    c. overheat and cause a fire
    d. create an electromagnet

7. The purpose of insulation on an electric wire is to
    a. make the electric current stay on its path
    b. heat the wire and generate energy
    c. resist the flow of electricity and light up
    d. close the circuit and make electricity flow

8. Which of these substances is the best conductor of electricity?
    a. air
    b. rubber
    c. plastic
    d. metal

9. Electric current will flow through a circuit as long as the
    a. switch is open
    b. charges are unequal
    c. path is unbroken
    d. wires are insulated

10. Frayed or broken insulation on wires can be dangerous because they
    a. prevent electricity from flowing
    b. cause the power to shut off
    c. cause a fire or electric shock
    d. will blow a fuse

Electricity Test

Matching:

Write the letter of the word or phrase that best completes each sentence. (Each question is worth 2 points.)

a. conductor	b. electromagnet	c. generator	d. insulator
f. filament	g. repel	h. attract	i. switch
j. static	k. current	l. battery	m. fuse

11. An electric current passes easily through a wire that is a _______.

12. An electric current does not pass through a(n) _______.

13. A magnet that is created when current flows through a coiled wire is a(n) ________.

14. The build up of charges on an object caused by rubbing is ______ electricity.

15. Opposite charges will ______ each other.

16. An object that is used to open and close circuits is a ______.

17. Like charges will ______ each other.

18. The flow of negative charges through matter is ______ electricity.

19. A device that produces electric current by spinning a coiled wire within a magnetic field is a ______.

20. A very thin, coiled wire in a light bulb that glows from the resistance in the coiled wire as electricity passes through it is a ______.

21. A little wire made of metal that quickly melts and breaks at a fairly low temperature and cuts off the electricity supply is a ______.

22. A device that stores energy which pushes electrons into a wire to get the flow of electricity started is a ______.

Electricity Test

Short Answers (5 pts each):

Answer the following questions completely and accurately (3 points) and use complete sentences (2 points).

23. Suppose you saw a bunch of balloons tied together, but none of them were touching one another. What might you infer about the electric charges on the balloons?

____

____

____

____

____

24. You construct a circuit, but electricity will not flow through it. Draw a conclusion about what kind of circuit you constructed. Explain your reasoning.

____

____

____

____

____

25. How does the use of electricity make your life different than it would be without electricity? Be sure to explain your answer by stating two specific examples.

____

____

____

____

____

Total out of 50 points: ____________

Percentage: ____________ Grade: ____________

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Electricity Test Answer Key

Multiple Choice and Matching Answers (2 points each):

1. A
2. B
3. D
4. B
5. B
6. C
7. A
8. D
9. C
10. C
11. A
12. D
13. B
14. J
15. H
16. I
17. G
18. K
19. C
20. F
21. M
22. L

Short Answers:

(5 points each) Check to see that they accurately and completely answered the questions (3 points) in complete sentences (2 points).

23. Answers will vary.
    Example: The balloons were rubbing together and became negatively charged because of static electricity. We know that like charges will repel each other, so they would not be touching each other.

24. Answers will vary.
    Example: If it was apparent that electricity was not flowing, that would tell me that I have created an open circuit. There is probably a spot where the circuit is broken or open.

25. Answers will vary,
    Check to see that they have stated two examples of how life would be different without electricity.