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**Literature Resources**  
These literature resources have been purchased to supplement the kit and are housed in each elementary school library.  

**Materials List**  
This list identifies the list of materials found in the kit. In many cases, the original kit material list has been modified from the manufacturers list.  

**Magnetism Inquiry Investigation:**  
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UNIT SUMMARY

In this unit, students will be invited to discover that electricity in circuits can generate energy in the form of light, heat and magnetism through the inquiry process.

Through a series of investigations, students learn that electric circuits require a complete circuit (circle) through which an electrical current passes, and that different types of circuits show different types of characteristics. They will also discover which materials are conductors and insulators of electricity. As a culminating activity, students will apply their new knowledge by researching testable questions and/or wiring flashlights and houses.

STAGE 1- STANDARDS/GOALS

What should students understand, know, and be able to do? Stage one identifies the desired results of the unit including the related state science content standards and expected performances, enduring understandings, essential questions, knowledge and skills.

<table>
<thead>
<tr>
<th>Enduring Understandings</th>
<th>Essential Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insights earned from exploring generalizations via the essential questions (Students will understand THAT…)</strong></td>
<td><strong>Inquiry used to explore generalizations</strong></td>
</tr>
<tr>
<td><strong>K-12 enduring understandings are those understandings that should be developed over time, they are not expected to be mastered over one unit or one year.</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Overarching Enduring Understandings:**
- Science is the method of observation and investigation used to understand our world. (K-12)
- Inquiry is the integration of process skills, the application of scientific content, and critical thinking to solve problems. (K-12)

**Unit Specific Enduring Understandings:**
- Electrical circuits require a complete loop through which an electrical current passes.
- Electricity is used to generate energy that can be transformed into other forms of energy (sound, light, heat and motion).
- Some materials conduct electricity and some materials do not.
- Electricity is essential to living in today’s modern, technologically advanced world.
- Magnets produce a force that can move certain objects without direct contact.
- Magnets produce a force that can vary in

- How is inquiry used to investigate the answers to questions we pose?
- How is electricity used to create heat, sound, light, and motion?
- How is electricity used in our world?
- How do batteries and wires conduct electricity to a light a bulb?
- What types of materials are conductors of electricity and what materials are not conductors (insulators)?
- How do magnets interact with each other and other objects?
- What are properties of magnets?
- How does the size and strength of a magnet affect its ability to push and pull?
- Can magnetic forces work through different materials?
strength and this force can move certain objects and not other objects.

**Knowledge and Skills**

*What students are expected to know and be able to do*

The knowledge and skills in this section have been extracted from Wallingford’s K-5 Science Scope and Sequence.

**Knowledge**

K1. Describe how batteries and wires can transfer energy to light (a light bulb) and/or heat.
K2. Explain the path of electricity in a circuit (open, closed, parallel, series circuit)
K3. Wire a simple electrical circuit to light a light bulb.
K4. Construct a circuit in more than one way using the same materials.
K5. Use symbols to represent the different parts of an electric circuit schematic.
K6. Classify materials as conductors of electricity and others materials as insulators based on tests using simple electrical circuits.
K7. Explain how electricity is essential to our modern world.
K8. Apply troubleshooting strategies (knowledge of electrical circuits) to complete an incomplete circuit.
K9. Investigate the properties of magnets including:
   - Magnets have north and south poles
   - Magnetic fields weaken as distance increases.
   - Magnets produce a force that some things respond to and some things do not.
   - Magnets exert a force at a distance/they can push or pull without touching.
   - A magnetic force can hold a limited amount of weight.
   - Magnets possess various degrees of strength.
   - Magnets can exert a force through materials.
K10. Explore how electricity and magnetism are related (electromagnet)

**Skills**

S1. Generate investigable and non-investigable questions.
S2. Observe objects and describe commonalities and differences.
S3. Classify, based on observations of properties.
S4. Predict what might happen.
S5. Design an investigation to help answer an investigable question.
S6. Conduct simple investigations.
S7. Employ simple equipment and measuring tools.
S8. Organize appropriate and accurate measurements and observations, using:
   - Graphic organizers
   - Charts and graphs
   - Illustrations or diagrams
   - Journaling
   - Etc.
S9. Draw conclusions based on data, observations, or findings.
S10. Communicate results or information in an appropriate manner, using:
*CSDE Embedded Task – Go With the Flow is integrated into the kit lessons and inquiries in this curriculum guide*

### Content Standard(s)

**Generalizations about what students should know and be able to do.**

<table>
<thead>
<tr>
<th>CSDE Content Standards</th>
<th>CSDE Primary Expected Performances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Transfer and Transformations – What is the role of energy in our world?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>4.4 - Electrical and magnetic energy can be transferred and transformed.</strong></td>
<td></td>
</tr>
<tr>
<td>- Electricity in circuits can be transformed into light, heat, sound and magnetic effects.</td>
<td>B14. Describe how batteries and wires can transfer energy to light a light bulb.</td>
</tr>
<tr>
<td>- Magnets can make objects move without direct contact between the object and the magnet.</td>
<td>B15. Explain how simple electrical circuits can be used to determine which materials conduct electricity.</td>
</tr>
<tr>
<td><strong>Forces and Motion – What makes objects move the way they do?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>4.1 - The position and motion of objects can be changed by pushing or pulling.</strong></td>
<td></td>
</tr>
<tr>
<td>- The size of the change in an object’s motion is related to the strength of the push or pull.</td>
<td>B8. Describe the effects of the strengths of pushes and pulls on the motion of objects.</td>
</tr>
<tr>
<td>- The more massive an object is, the less effect a given force will have on its motion.</td>
<td>B9. Describe the effect of the mass of an object on its motion.</td>
</tr>
<tr>
<td><strong>Scientific Inquiry</strong></td>
<td></td>
</tr>
<tr>
<td>B INQ.1 Make observations and ask questions about objects in the environment.</td>
<td></td>
</tr>
<tr>
<td>B INQ.2 Seek relevant information in books, magazines and electronic media.</td>
<td></td>
</tr>
<tr>
<td>B INQ.3 Design and conduct simple investigations.</td>
<td></td>
</tr>
<tr>
<td>B INQ.4 Employ simple equipment and measuring tools to gather data and extend the senses.</td>
<td></td>
</tr>
<tr>
<td>Scientific Literacy</td>
<td>B INQ.5 Use data to construct reasonable explanations.</td>
</tr>
<tr>
<td></td>
<td>B INQ.6 Analyze, critique and communicate investigations using words, graphs and drawings.</td>
</tr>
<tr>
<td></td>
<td>B INQ.7 Read and write a variety of science-related fiction and nonfiction texts.</td>
</tr>
</tbody>
</table>

| Scientific Numeracy                                 | B INQ.8 Search the Web and locate relevant science information. |
|                                                  | B INQ.9 Use measurement tools and standard units (e.g., cm, m, g, kg) to describe objects and materials. |
|                                                  | B INQ.10 Use mathematics to analyze, interpret and present data. |

| Common Misconceptions Children Have                  | By identifying misconceptions early, teachers can design appropriate lessons to address and change student misconceptions. |

Energy is lost, rather than conserved.
Variables do not affect the outcome.
Energy exists only when it’s visible.
Batteries store a certain amount of current. This current is consumed by any appliances or lights connected to it.
If wires are connected to a battery and bulb, no matter where, a complete circuit is made.
If a bulb is farther away from the battery, it will be dimmer.
**STAGE 2 – DETERMINE ACCEPTABLE EVIDENCE**

How will we know if students have achieved the desired results and met the content standards? How will we know that students really understand? Stage two identifies the acceptable evidence that students have acquired the understandings, knowledge, and skills identified in stage one.

<table>
<thead>
<tr>
<th>Performance Task(s)</th>
<th>Other Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authentic application in new context to evaluate student achievement of desired results designed according to GRASPS. (Goal, Role, Audience, Setting Performance, Standards)</strong></td>
<td><strong>Other methods to evaluate student achievement of desired results.</strong></td>
</tr>
<tr>
<td><strong>ELECTRICITY</strong></td>
<td><strong>Science notebooks</strong></td>
</tr>
</tbody>
</table>
| Lesson 10 in STC Teacher Manual – Constructing a Flashlight and/or Lesson 15 in STC Teacher Manual Wiring a House | - Observations-sketches, notes  
- Planning- investigations, steps, materials  
- Questioning- student’s questions  
- Data Collections- charts, graphs, logs, tables, thought processes  
- Analysis/Interpretation- make meaning/connections  
- Reflection/journal entries- responses to open-ended questioning – **SEE BELOW**  
- Use essential questions as pre-writes  
- Tests/Quizzes |
| You may elect to use this lesson as an assessment piece, as it requires students to use what they learned in previous lessons to build a flashlight. | 1. See page 11 for sample questions  
2. Show diagram and brainstorm why bulb will not light.  
3. Show diagram and ask.. What do you think will happen…? What is an advantage of having lights in a parallel circuit?  
4. Label parts of a light bulb.  
5. Label diagrams on and off.  
6. Open-ended questions to apply and show understanding of magnets (For example: Why is a magnet a good conductor? Why do magnets attract? Which materials allow magnets to attract to one another and why? What happens when two magnets get close to one another? Between two magnets, which is stronger, the push or the pull?) |
| **MAGNETS** | * graphics that can be used for assessments can be |
| After completing the observing and questioning phase of the magnet inquiry, you will choose an investigable question to further explore. Create a plan, list materials, investigate, and be prepared to communicate your results with the class. This brief “share” should include your question, your plan, and what you found as your results. | |
| **ELECTRICITY AND MAGNETS** | |
| Invention Convention (Challenging) | |
| Enter the invention convention by designing an invention that has a circuit or magnet in it. | |
| Some possible inventions may include:  
- A game or challenge with a circuit and/or magnets  
- Complicated switch in a device  
- Simple model with a circuit in, such as a house, car, home or robot. | |
| You will need to:  
- Title your project and provide a list of materials used  
- Draw a schematic diagram of your invention  
- Describe how your invention works using relevant science concepts and |
vocabulary
(modified from LHS Gems Electric Circuits
Electrical Inventions)

Play Station (Challenging)
Play Station has created a new series of educational board games. You are their top designer. It is your job to use your knowledge of electric circuits to create an electronic, educational trivia game. You will have to present and explain your product to a teacher and a test group of students. Your presentation must include a demonstration of your product (including 5 complete circuits), an explanation of how it works and should persuade your audience to buy your game. You will also be submitting a diagram labeling the paths of electricity.

Writing prompts

- Families and friends will be coming to Science Night. You want them to build a switch in a series circuit. Write the steps involved in completing this task. List materials needed. Remember to include signal words: first, next, then, and finally. Draw and label the finished project.

- You will be sharing your flashlights with the third graders. Explain the steps involved in making a flashlight so the third grader you are sharing with will clearly understand how to make a flashlight. Remember to include signal words: first, next, then and finally, in your explanation. Label any drawings or illustrations you include.

Quick Writes in Science Notebook

- Tell me what you know about electricity. List any questions you have about electricity.
- Describe one way you got the light bulb to light.
- Using pictures on the activity sheet select one picture and describe clearly why the bulb did or did not light.
- BEFORE LESSON: Predict how many batteries it will take to light the bulb. Explain why you think so. AFTER THE LESSON: Explain what actually happened.
- Draw and label the parts of a complete circuit. Explain your drawing.
- Tell me what you’ve learned about troubleshooting.
- Tell me what you’ve learned about conductors and insulators.
- Describe the strategy you used to find the hidden circuits in the mystery box.
• After learning about the secret language for diagramming circuits, tell why you think electricians use this method in their work.
• Predict what will happen to the light bulbs when you build circuits in a series and bulbs in parallel. After connecting the final wire, describe what actually happened and why you think this happened.
• Tell me what you have learned about switches.
• Today we are going to come up with a plan for making a flashlight. Describe what you think are the most important parts of a flashlight. Draw a diagram of the flashlight.
• When making a plan to wire a house for electricity, what things will you need to decide? Explain at least three.
• Write about an interesting or amusing example of a problem you had when wiring your house/flashlight and explain how you solved it.
Electricity & Magnet Assessment Questions

1. There are a group of 3rd graders that heard about our class investigations. They wanted to try a variety of objects to see which items would allow electricity to travel through them and which items would not allow electricity to flow through them. The objects they want to test are:

   - math books
   - pencil
   - erasers
   - crayons
   - metal
   - chairs
   - windows
   - plastic
   - pencil holders
   - door handle
   - teacher’s desk
   - carpet
   - coat hooks
   - file cabinets

   A. Design a plan that the group can follow to answer their question. Remember to include all of the important details of a plan, so that the group can conduct this investigation. You may include a drawing with labels to help them follow your plan.

   B. Explain what results you think they will get and why?

   C. Explain what conclusion they should come up with and why? Make sure you use science vocabulary.

2. Draw a carefully labeled picture that shows 2 or more bulbs lit, using wires, batteries, battery holders, bulb sockets, and bulbs. Explain why the bulbs are lit. Remember to use appropriate science vocabulary words.

3. A. Predict at least 3 things your magnet will be attracted to. Why will they attract?
   B. Predict at least 3 things your magnet will repel? Why will they repel?

4. Susie wanted to know how many small paper clips different sized magnets could pick up. Design a fair test for Susie to follow. On your paper be sure to write your prediction and then the steps Susie will take to carry out the experiment. Also, include a list of materials Susie will need.
STAGE 3 – LESSON ACTIVITIES

What will need to be taught and coached, and how should it best be taught, in light of the performance goals in stage one? How will we make learning both engaging and effective, given the goals (stage 1) and needed evidence (stage 2)? Stage 3 helps teachers plan learning experiences that align with stage one and enables students to be successful in stage two. Lesson activities are suggested, however, teachers are encouraged to customize these activities, maintaining alignment with stages one and two.

The suggested lesson activities are not sequenced in any particular order. Teachers may select which lesson activities will best meet the needs of their students and the unit objectives. Each lesson activity is coded with the corresponding knowledge (K) and/or skill (S) objectives that are found in stage one.

UNDERSTANDING MAGNETS INQUIRY

See directions for Magnet Inquiry on pp. 18

This 3 to 4 day inquiry will introduce students to the process of inquiry as well as introduce the students to magnetic concepts.

Time: 4-5 hours (4 to 5 sessions for planning, designing, and presenting)

Knowledge and Skills: K9, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10

Note: If you feel you need additional lessons to address some of the objectives, the Mostly Magnets (AIMS Activities) Book can be helpful for further investigation. Suggested lessons are:
- What will a Magnet Attract? pp. 7, 8, 11.
- Will a Magnet Attract Through These? pp. 32-34.
- Face to Face pp. 53-55.
- Tug of War pp. 67-69.

ELICIT PRIOR KNOWLEDGE OF ELECTRICITY

See Lesson 1 in STC Teacher Manual

Materials needed: science notebook

1. This is a pre-assessment activity to gain insight into the students’ prior knowledge of electricity. Write the word, Electricity, on the board. Instruct the students to “Brain Drain” everything they know about electricity in their science notebook. A “Brain Drain” is when students write for 10 minutes listing all the facts they think they know about electricity, then take 5 minutes to write questions they might have. Students can informally share their facts and questions with the class. Teacher may write student responses on chart paper. A KWL chart can be used if preferred; emphasizing that it is what the students think they know.

2. Refer to general safety contract in STC Teacher Resource Book,

Time: 35 Minutes

Knowledge and Skills: K1, K7, S2, S3, S4.
DIFFERENT WAYS TO LIGHT A LIGHTBULB
See page 33 for directions
This lesson is similar to Lesson 2 and Lesson 4 in STC Teacher’s Manual (This lesson is more inquiry based than teacher guide lesson.)
** modified from CSDE embedded task, “Go with the Flow.”
Time: 45-60 minutes
Knowledge and Skills: K1, K2, K3, K4, K7, K8, S4, S6, S7, S8, S9.

WHICH MATERIALS CONDUCT ELECTRICITY
See page 37 for directions
This lesson is similar to Lesson 7 in STC Teacher’s Manual (This lesson is more inquiry based than teacher lesson guide.)
** modified from CSDE embedded task, “Go with the Flow.”
Time: 45-60 minutes
Knowledge and Skills: K1, K2, K6, K8, S2, S3, S4, S5, S6, S7, S8, S9.

INVESTIGATING YOUR OWN QUESTIONS – INQUIRY INVESTIGATION
See page 41
** modified from CSDE embedded task, “Go with the Flow.”
Time: 2-4 hours
Knowledge and Skills: K1, K2, K3, K4, K6, K7, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10.

A CLOSER LOOK AT CIRCUITS
Follow Lesson 3 and 6 in the STC Teacher Manual
Note: You can combine these two lessons for students if the inquiry did not produce desired results.
After completing these lessons, students should have a better understanding of how circuits work.
Time: 45 minutes
Knowledge and Skills: K1, K2, K3, K4, K7, K8, S4, S6, S7, S8, S9.

MAKING A FILAMENT
Follow Lesson 8 in STC Teacher Manual
Note: This lesson is optional, time permitting.
Time: 45-60 minutes
Knowledge and Skills: K1, K2, K3, K8, S2, S4, S6, S7, S8, S9.

HIDDEN CIRCUITS
Follow Lesson 9 in STC Teacher Manual
Note: This lesson is optional, time permitting.
Time: 45-60 minutes
Knowledge and Skills: K1, K2, K3, K8, S2, S4, S6, S7, S8, S9.
EXPLORING SERIES AND PARALLEL CIRCUITS
Follow Lesson 11 and then integrate Lesson 10 near end of lesson in STC Teacher Manual
Time: 45-60 minutes
Knowledge and Skills: K1, K2, K3, K4, K5, K7, K8, S1, S2, S3, S4, S6, S7, S8, S9.

LEARNING ABOUT SWITCHES
Follow Lesson 12 in STC Teacher Manual
Time: 45-60 minutes
Knowledge and Skills: K1, K2, K3, K7, K8, S2, S4, S6, S7, S8, S9.

CONSTRUCTING A FLASHLIGHT/PLANNING TO WIRE A HOUSE
Follow Lesson 13 or 15 in STC Teacher Manual
Note: You may elect to use this lesson as an assessment piece, as it requires students to use what they learned in previous lessons to build a flashlight or wire a house.
Time: 60-90 minutes (Since it is an assessment, it would be advisable to complete in one session)
Knowledge and Skills: K1, K2, K3, K4, K5, K6, K7, K8, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10.

LITERATURE INQUIRY – Exploring the Different Roles Electricity Plays in Our World.
See page 44 for directions for inquiry
This integrates literature and science as well as research.
Time: approximately 2 hours (2 to 3 sessions for planning, designing, and presenting)
Knowledge and Skills: K1, K2, K3, K4, K5, K6, K7, K8, S1, S2, S3, S4, S5, S6, S8, S9, S10.
* also integrates reading and writing objectives

MAKE A COMPASS
Follow lesson on page 79 in Mostly Magnets
Time: 45 minutes
Knowledge and Skills: K10, S2, S4, S6, S7

MAKE AN ELECTROMAGNET
Follow lesson on page 80 in Mostly Magnets
Time: 45 minutes
Knowledge and Skills: K10, S2, S4, S6, S7

Contact Eli Whitney Museum in Hamden for related programs.

* Electrical circuit graphics (batteries, bulbs and wires) that can be used for lessons and assessments can be found on Wallingford’s W drive
**LITERATURE RESOURCES**

*These literature resources have been purchased to supplement the kit and are housed in each elementary school library.*

**Guided Reading Sets (6 copies in each school)**
*The Wizard of Sound: A Story About Thomas Alva Edison*, Barbara Mitchell  
*Science Alive - Switched On*, Wright Group  
*Magic School Bus and Electric Field Trip*, Joanna Cole  
*Batteries, Bulbs, and Wires*, David Glover  
*Discovering Electricity*, Newbridge  
*How We Use Electricity*, Newbridge  
*Understanding Electricity*, National Geographic  
*Global Warming*, National Geographic  
*Magnetism and Electricity*, FOSS Science Stories

**Related Materials that May Be Found in Your Library**
*Electricity*, Eyewitness Science  
*Solar Power*, Steck-Vaughn

**Additional Teacher Resources That Are Suggested**
*GEMS Electric Circuits Teacher’s Guide Grades 3-6*

**Websites for Students**
- [http://www.schoolscience.co.uk/content/3/physics/circuits/chal1.html](http://www.schoolscience.co.uk/content/3/physics/circuits/chal1.html) - build circuits with or without switches, add up to four batteries…all with the click of the mouse!  
- [http://fly.hiwaay.net/~palmer/motor.html](http://fly.hiwaay.net/~palmer/motor.html) - using ordinary materials, build a simple electric motor.  
- [http://www.energyquest.ca.gov/index.html](http://www.energyquest.ca.gov/index.html) - information and activities all about energy: everything from electricity to fossil fuels to nuclear energy in a child-friendly format.

**Websites for Teachers:**
- [http://www.eskimo.com/%7Ebillb/ele-edu.html](http://www.eskimo.com/%7Ebillb/ele-edu.html) - Everything you ever wanted to know about electricity, plus common student misconceptions, textbook errors and suggested activities. Written in a user-friendly format by an electrical engineer at the University of Washington.  
**Electricity Unit Plan**
- [http://www.parks.ca.gov/pages/501/files/unit.pdf](http://www.parks.ca.gov/pages/501/files/unit.pdf) - a 14-lesson teaching unit developed around a field trip to a hydroelectric generating station. Includes explorations of series and parallel circuits, switches, electromagnets, and several open-ended student investigations. Includes a teacher’s guide.
## Materials List

**Kit Electrical Circuits and Magnets – Grade 4**

Revised October 2006
(Based on the STC Electrical Circuit Kit)

### Expendable Materials

- 4 masking tape
- 2 boxes of #1 paper clips
- 100 – 3 x 5” index cards
- 30 labels
- 6 of each AAA, AA, 9 volt, C batteries
- 60 D cell batteries

### Reusable Materials

- 1 AIMS *Mostly Magnets* – teacher guide
- 1 teacher’s guide – *Electrical Circuits STC*
- 15 student activity books
- 60 - #48 bulbs (microlamp)
- 2 – 60 watt clear glass bulbs (1 with glass removed)
- 1 roll #22 coated hook-up wire – wire may be cut and stripped
- 1 roll #32 nichrome wire
- 30 battery holders
- 30 bulb sockets
- 15 diodes
- 1 wire cutter
- 1 pair needle nose pliers
- 2 screwdrivers
- 45 small boxes 2 x 4 x 7 1/2”
- 2 boxes #3 brass paper fasteners
- 1 pound modeling clay
- 1 faulty bulb #48
- 200 brass washers
- 200 Fahnstock clips
- 1 wire stripper tool
- 30 compasses

### Materials Teacher will Provide:

- Rulers
- Post-it notes
- Scissors
- 15 pkgs. assorted objects each containing: golf tee, 1 inch straw, brass screw, paper clip, aluminum screening 1 inch sq., plastic screening 1 inch sq., 1 inch chalk, wooden pencil stub, no eraser, brass paper fastener, wire nail, aluminum nail, marble, 1 in. pipe cleaner, 1 in. bare copper wire, 1 in. bare aluminum wire

### Safety Considerations:

- Some batteries may start peeling when they are taken in and out of the battery holders.
  - If you see any batteries that do not look safe, please discard them.
• Do not experiment with the electricity in wall plugs, either in school or at home. This current can give a deadly shock and should not be used for experiments.

• The batteries used in this unit will not give a noticeable shock until more than two dozen are connected in series, making their combined voltage about 36 volts.

• When holding wires to the end of batteries, some batteries may produce enough heat to cause a minor burn. If the battery gets warm, remove your fingers.

• Remember that electrical appliances that operate on household electricity can deliver shocks.

• Avoid downed power lines and electrical substations. They can give deadly shocks.

• Students should not be touching live wires. When a circuit is created with a battery you have created a live wire. Even though you have a weak circuit you should still model safety procedures. Students should only be touching the insulation on the wire, not the metal end of the wire. You may have to cut some longer wires for this purpose. Some lessons will require that students work in partners to help each other to hold the batteries and wires. This will prevent students from burning their fingers.

• The batteries should not give you a harmful electrical shock, but the batteries do contain acid that could hurt your skin or damage clothing. A leaky battery must be discarded.

• Do not leave a wire connected from one end of a battery to another. This short circuit will create a lot of heat and will run down the battery.

• The thin, nichrome wire that you use for making a filament could cut your finger if you pull it tightly. Also, the filament will be very hot. Do not touch it or let something that could catch fire touch it.

• If your teacher lets you prepare wires, be careful with the wire-cutting and stripping tool.

• Be careful with the bulbs. If they break, they can cut you.
INQUIRY INVESTIGATION FOR MAGNETISM
Magnetism Inquiry
Wallingford Public Schools
Grade 4

Modified from the work of the Exploratorium and Norwich Public Schools

This guide is a tool for helping you plan an inquiry activity. The prime factor is that your students get the opportunity to practice choosing their own question and planning and carrying out an investigation to find out what they can learn from investigating that question.

Approx. Time: 4 hours

Note: If you feel you need additional resources, the Mostly Magnets (AIMS Activities) Book can be helpful for further investigation. Suggested lessons are:
- What will a Magnet Attract? pp. 7,8,11.
- Will a Magnet Attract Through These? pp. 32-34.
- Face to Face pp. 53-55.
- Tug of War pp. 67-69.

* See page 31 for sample rubric

<table>
<thead>
<tr>
<th>Related State Content Standard(s):</th>
<th>Related State Expected Performance(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Transfer and Transformations – What is the role of energy in our world? 4.4 Electrical and magnetic energy can be transferred and transformed.</td>
<td>B16. Describe the properties of magnets, and how they can be used to identify and separate mixtures of solid materials.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Related Enduring Understanding(s):</th>
<th>Related Essential Question(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Science is the method of observation and investigation used to understand our world. (K-12) • Magnets produce a force that can vary in strength and this force can move certain objects and not other objects.</td>
<td>• How does science use inquiry to further understanding? • What are properties of magnets? • How does the size and strength of a magnet affect its ability to push and pull? • Can magnetic forces work through different materials?</td>
</tr>
</tbody>
</table>

What simple content objectives/goals do you want to accomplish with this investigation? (see district curriculum documents) What simple process skills do you want to improve with this investigation?
Students will understand that

- Magnets produce a force that some things respond to and some things do not.
- Magnets exert a force at a distance/they can push or pull without touching.
- Magnet pull is greatest when the magnet pull is closest to the magnet.
- A magnetic force can hold a limited amount of weight.
- Magnets possess various degrees of strength.
- Magnets can exert a force through materials.

Raising Questions
Observation
Planning
Data collection, organization, and display
Presentation/Sharing

### Materials/Resources:

**Magnet kit includes:**
- 100 Magnets 1” round
- 30 Plastic cups 5 oz. clear
- 30 Bags of stuff – electric circuits
- 100 Small washers
- 100 Medium washers
- 50 Large washers
- 24 Foam sheets
- 100 Small paper clips
- 100 Large paper clips

**Materials Teacher will Provide:**
- Approximately 10 rulers
- Post-it notes or scrap paper and tape
- science notebook

### What kinds of investigations do you anticipate students designing?

**Strength of magnets**
- How much does one magnet hold?
- Does more than one magnet hold more things?
- Does a bigger magnet pull more than the small one?

**Pushing and pulling**
- When do magnets flip over when they touch?
- How close can I get to a magnet before it moves?

**Materials magnets work through**
- What materials does a magnet pull through?
- Does a magnet work in water?
- Does a magnet pull through really thick things?

**Size of magnets**
- Do bigger magnets hold more than smaller magnets?
### PHASE 1 – Observing and Questioning

<table>
<thead>
<tr>
<th>INQUIRY STARTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>• What is the launching activity or <strong>inquiry starter</strong> for the investigation?</td>
</tr>
<tr>
<td>• What will be your <strong>inquiry starter prompt</strong>? How will you &quot;invite&quot; your audience to work with the materials?</td>
</tr>
<tr>
<td>• What <strong>materials</strong> will you use for the inquiry starters?</td>
</tr>
<tr>
<td>• How will you <strong>elicit and collect or display student’s questions</strong>? Will they share questions orally? In writing?</td>
</tr>
<tr>
<td>• <strong>Choosing investigation questions</strong>: How will you help your students determine which questions they can choose from to investigate? How will you or the students form investigation groups?</td>
</tr>
</tbody>
</table>

### Task | Hints
---|---
Introduce the activity. Tell the class that they are starting a 2 or 3 day investigation on magnets. They’re going to do two short explorations with magnets. Between each exploration, you are going to ask them to put down the magnets and share with the class some of the things they noticed and some of the things they wonder about magnets. By the end of the day, you want the class to have a lot of questions about magnets. They're not going to answer them today, just ask them. Then, during the next session, they’ll do an investigation to try to answer a question. | Have students sit in groups of two. Safety Note – no magnets on computer
Start by tapping into prior knowledge - Have each student write in their notebook “What do you already know about magnets?” Teacher will chart sample responses. Chart sample group responses after a few minutes. | If your students are proficient in designing data tables, allow them to design their own way of organizing their data. Remind students to make predictions before the magnets are passed out. Encourage students to record additional observations or questions they may have in their notebook. Teacher models how to set up science notebook, “I notice, I wonder” charts. Teacher should walk around and visit pairs of students.

**Inquiry starter 1 – Exploring with one magnet**

Pass out a bag of “stuff” to each group of two students. Explain to students that they will be investigating whether the magnet sticks to each of the objects. Have students create a 3 column chart in their notebook. On column for item tested one column for their prediction, and one column for the actual observation. (see page 27 for sample template) Pass out one magnet to each student in a plastic cup.
and have them explore the following question.

- “Predict if the magnets stick to the object”  “What materials are magnetic?”

Tell students that they have about 5 minutes to work with their partner at their desks to see what the magnet does with the materials in the bag.

After five minutes tell the class that you want them to put the magnet in the cup while they talk about what they observed.

<table>
<thead>
<tr>
<th>Inquiry starter 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Give each student group an additional magnet</td>
</tr>
<tr>
<td>Have students continue to write I notice… I wonder.... in their notebook. (2 column chart) (see page 28 for sample template)</td>
</tr>
<tr>
<td>Model how to continue to write additional observations (I notice) and questions (I wonder) while “messing about” with 2 magnets and the bag of stuff.</td>
</tr>
</tbody>
</table>

Sometimes it helps to model a question you have about magnets, something you may have noticed and wondered about as you visited groups and chart it. This helps students to get an idea of the process and get the list started. Or mention that you heard group X wondering about…..

Ask students to put both of their magnets inside the plastic cup at their desk. Have student’s share their “noticings” and “wonderings” with the class and chart these with the initial observations and questions.

| In particular, listen for questions regarding content objectives that didn’t get raised in the first charting period. |

For now, their magnets should be in the cup. Ask what they noticed and have students share. You can chart what they share on large pieces of chart paper or on the board. You may want to write “I Notice…” in large letters on the top of this paper.

Then say, “some of you may have questions or things you wonder about magnets. I want to hear some things you wonder.” Write “I Wonder ….” In large letters on top of chart paper. We aren’t going to try to answer them today; I just want to hear your questions. Record as many questions as you can during this time.

| Students may need to be encouraged to write in their notebooks observations and/or questions. It may be helpful to remove students from the materials to provide time for them to write in their notebooks. |

Again walk around and visit with pairs of students exploring the materials. While they explore, listen for new questions they ask. If you see students testing something repeatedly, you may ask them about what questions they might have.

Encourage the following type of questions to be raised:

- Strength of magnets
- Pushing and pulling
- Materials magnets work through
- Size of magnets
Introduce the concept of two main types of questions – testable (investigable) and research questions (non-investigable) – define

Testable questions can be investigated in the “hear and now” with reasonable materials that are available. Research questions are the type of questions that need to be answered through reading print resources.

As a class identify which questions are testable and which are research questions. Some questions may need to be clarified and some questions may be modified to make them testable questions.

Example of testable question:
- Does a bigger magnet hold more than a smaller one?

Example of a research question
- How are magnets made?

The non-fiction books housed in each school library can be used to research the answers to some of the non-investigable questions.

Teacher instructs students to write two more of their testable questions on sentence strips or scrap paper.

Teacher places sentence strips where whole class can view them. (Use tape on walls)

Introduce how to change a non-investigable question into an investigable question – using the T chart variable scan.

Non Investigable Questions – Examples
- How are magnets made?
- Would magnets be as strong if they were frozen?
- What type of magnet is the strongest?
- Do magnets attract all metal items?

PHASE 2 – Planning and Investigating

INVESTIGATION

- What additional materials will you introduce? How will you introduce additional materials participants can use to study the phenomena?
- How will you manage/organize materials, set up and clean up?
- How will you support the groups in planning their investigation? Will you provide criteria or planning sheets?
- How will you facilitate during the investigation?

Task

<table>
<thead>
<tr>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruct students to take a “gallery walk” and peruse the questions. Then have the students write on a post-it note 2 questions they would be interested in investigating</td>
<td>Teacher displays investigable questions for students to see. This is a good time to end the lesson. This gives the teacher time to review the questions and to form investigation groups. Prior to the beginning of the next lesson the teacher should divide students into pairs based on the question they wrote on their post-it note. Have students work on questions that are related to the content objectives of this unit. (see page 6-7 for content objectives)</td>
</tr>
</tbody>
</table>

Have students work on questions that are related to the content objectives of this unit. (see page 6-7 for content objectives)
<table>
<thead>
<tr>
<th>Hand out planning template and have students glue or tape this into their notebook. <em>(see page 29)</em></th>
<th>If your students are proficient in planning investigations, you may not need to use the planning template.</th>
</tr>
</thead>
<tbody>
<tr>
<td>You may need to select a question that students are not investigating to model how to develop a detailed plan.</td>
<td>Remind students of materials available. Students may choose to bring additional materials from home for the investigation.</td>
</tr>
<tr>
<td>Provide students time to plan.</td>
<td>Remind students to be specific in planning</td>
</tr>
<tr>
<td><strong>Students conduct investigations.</strong></td>
<td><strong>Remind students to record data in their notebook.</strong></td>
</tr>
</tbody>
</table>
| Teacher circulates as investigations begin, reminding students that:  
*“A good plan may still need revisions after you start conducting the investigation. These adjustments should be noted in your notebook.”*  
*“You will have approx. 30 minutes to: carry out your investigation, make observations, ask further questions, talk to each other about your observations and ideas, propose explanations, and record your observations and explanations using charts, diagrams, and through writing.”*  
Remind students that if they get stuck, they can:  
• walk around the room to see what other groups are doing  
• ask another group for advice  
• ask the teacher for advice  
• reflect in your notebook | Visit students to see what they are doing and what they are finding out. Watch them a bit before asking them questions – this helps you to get a sense of what’s going on. Really let them figure things out, as opposed to answering their question and designing their investigation for them. If they are struggling then offer some suggestions, how they might think about or use a material. Replicating what they found out, in particular if you think they may have come to a misleading conclusion.  
See open ended questions below to help you guide students through their investigations.  
Some students answer their questions early on, in this case, suggest an extension of their original question, or allow them to select an additional question. |
| Teacher gives 5 minute warning for the end of the investigation | Allow time for clean-up. |
### Open Ended Questions and Comments to Help Guide Students during the Investigation

<table>
<thead>
<tr>
<th>Question</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you know about…?</td>
<td>Tell me about it.</td>
</tr>
<tr>
<td>What will you need?</td>
<td>What’s your plan for that?</td>
</tr>
<tr>
<td>What will you add?</td>
<td>What does this remind you of?</td>
</tr>
<tr>
<td>I wonder what will happen when…?</td>
<td>Tell me more about…</td>
</tr>
<tr>
<td>Why is that happening?</td>
<td>How are you going to use…?</td>
</tr>
<tr>
<td>Show me how that…</td>
<td>How will you use this today?</td>
</tr>
<tr>
<td>How do you know that?</td>
<td>What does it need?</td>
</tr>
<tr>
<td>What do you see, notice, hear about…?</td>
<td>What else can you do about…?</td>
</tr>
<tr>
<td>What does this do?</td>
<td>What will happen if…?</td>
</tr>
<tr>
<td>Where have you seen…?</td>
<td>How can we change that?</td>
</tr>
<tr>
<td>What’s happening with this?</td>
<td>What happened when you did that?</td>
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<tr>
<td>What would you say about…?</td>
<td>What is different about that?</td>
</tr>
<tr>
<td>How can we find out about…?</td>
<td>What will you do to change that?</td>
</tr>
<tr>
<td>What other way can you try?</td>
<td>Show me…</td>
</tr>
<tr>
<td>What else can you do about…?</td>
<td>I’m noticing that…. how did that happen?</td>
</tr>
<tr>
<td>What can you use this for?</td>
<td></td>
</tr>
</tbody>
</table>

### PHASE 3 – Interpreting Results and Communicating

#### SHARING RESULTS AND PROCESSING FOR MEANING

- How will investigation groups present what they have learned from their investigations? (visual, oral presentation, combination, etc.) How will you decide the order of the presentations? (by similar questions, content goals, random, etc.)
- How will the facilitator synthesize the knowledge and findings of the participants for the groups?

<table>
<thead>
<tr>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher explains to students that they will be using the data they</td>
<td>Discuss various ways to display data (charts, graphs, diagrams, etc.)</td>
</tr>
<tr>
<td>collected yesterday to create a presentation on chart paper.</td>
<td>If your students are proficient in preparing for sharing, you will</td>
</tr>
<tr>
<td>Teacher passes out “sharing template,” and discusses what is expected</td>
<td>not need to use the template provided.</td>
</tr>
<tr>
<td>in their presentation. (see page 30)</td>
<td>Give each group one piece of chart paper (or large construction paper)</td>
</tr>
<tr>
<td>Students complete “sharing template” and create their poster</td>
<td>when they are done with their sharing template.</td>
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<tr>
<td>presentation on chart paper.</td>
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<tr>
<td>Students are given 3 minutes to present their findings to the class.</td>
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<tr>
<td>Encourage students to write their classmates’ findings in their own</td>
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</tr>
<tr>
<td>science notebook.</td>
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</tr>
<tr>
<td>Assist students in summarizing the class findings or</td>
<td>Design additional lessons to address any content</td>
</tr>
</tbody>
</table>

DRAFT June 2006
new leanings from the investigations.

These may include:

**Magnet Concepts**

- Magnets produce a force that some things respond to and some things do not.
- Magnets exert a force at a distance/they can push or pull without touching.
- Magnet pull is greatest when the magnet pull is closest to the magnet.
- A magnetic force can hold a limited amount of weight.
- Magnets possess various degrees of strength.
- Magnets can exert a force through materials.

*As each bullet above is discussed – mention the names of the students and relate the bullet above back to their experiments*

Provide additional lessons to allow students to further process their new learning related to magnets.

**Synthesis:** Have students reflect the inquiry investigations in their notebooks.

Suggest prompts:

- What did you learn about magnetism?
- What did you learn about the nature of science or inquiry?
- How did you work with your partner?
- What further questions do you still have?

Teacher may choose to have students share their thoughts.

See page 31 for a sample inquiry rubric.
## What Objects are Magnetic?

<table>
<thead>
<tr>
<th>Object</th>
<th>Prediction</th>
<th>Actual Observation</th>
</tr>
</thead>
<tbody>
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</table>

Other observations or questions:
### Magnets

<table>
<thead>
<tr>
<th>I notice….</th>
<th>I wonder….</th>
</tr>
</thead>
<tbody>
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</table>
Investigation Plan Template

Team member names:

Our question is: ________________________________________________________________
______________________________________________________________________________

Our prediction is: ________________________________________________________________
______________________________________________________________________________
We think this because __________________________________________________________________
______________________________________________________________________________

Materials we will use: ___________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

PLAN
First, we will___________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Then we will___________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Next we will___________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Finally we will_________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

What changes/revisions did you make to your original plan?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Preparing To Share Results

Question: _______________________________________________________

Prediction: _______________________________________________________

Summary of what you did (plan) _______________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

____________________________________________________________________

We found out that (data or results) _____________________________________

____________________________________________________________________

Conclusion (WHY?) ___________________________________________________

____________________________________________________________________

____________________________________________________________________

Space for illustration/diagram of investigation plan and/or results.
## Science Rubric

<table>
<thead>
<tr>
<th>Expected Performance</th>
<th>Limited evidence of skills</th>
<th>Progressing in skills</th>
<th>Mastery of Inquiry Skills</th>
<th>Exceed Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asks relevant questions about objects and events.</strong></td>
<td>Either seldom asks questions, or asks questions that are not at all related to the class investigation.</td>
<td>Occasionally asks questions, but those questions are not related to or are only vaguely related to the class investigation.</td>
<td>Regularly asks relevant questions about the observed event or phenomenon being discussed.</td>
<td>The student asks relevant questions and can identify whether the question is a testable question or a research question.</td>
</tr>
<tr>
<td><strong>Designs plan</strong></td>
<td>No written plan or diagram that will attempt to answer a question</td>
<td>Reasonable plan and/or diagram that attempts to answer a question.</td>
<td>Consistently designs a plan to answer a question and makes modifications and additions to the plan as needed. The plan is a “fair test”.</td>
<td>Consistently designs a plan with specific details to answer a question and makes modifications and additions to the plan as needed. The plan is a “fair test”.</td>
</tr>
<tr>
<td><strong>Designs an investigation</strong> including the steps to be done, observations to be made and recorded, and relationships to be explored.</td>
<td>Does not recognize the need for planning steps for an investigation, or identifies unrelated steps for an activity that does not lead to constructive observation of phenomena.</td>
<td>Identifies some steps to do an investigation, and when asked can identify observations to be made and recorded</td>
<td>The design identifies the steps to be done and the observations to be made and recorded. The plan is a “fair test”. Makes modifications and additions to the plan as needed.</td>
<td>The detailed design identifies the steps to be done, and the observations to be made and recorded. The plan is a “fair test”. Makes modifications and additions to the plan as needed.</td>
</tr>
<tr>
<td><strong>The student conducts investigations, records observations</strong></td>
<td>Easily distracted from the task, does not complete the task, and does not follow the steps in the task and records some of the data, but</td>
<td>Consistently follows the steps in the design, records their observations, and</td>
<td>Follows the steps to complete the entire task and records their</td>
<td></td>
</tr>
</tbody>
</table>

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*DRAFT June 2006*
<table>
<thead>
<tr>
<th>and completes the tasks.</th>
<th>record any observations.</th>
<th>seldom completes the task.</th>
<th>completes the entire task.</th>
<th>observations in appropriate organized formats.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The student analyzes the investigations, connects the observations to <strong>conclusions</strong> and <strong>communicates</strong> their findings.</td>
<td>The student does not identify any connections between the steps of the investigation and the observed phenomena, and does not communicate any findings from the tasks.</td>
<td>The student makes observations about some of the factors in the investigation, and communicates those observations verbally.</td>
<td>The student makes reasonable connections between their observations and the relationships within the event, and shares the findings in both verbal and written form.</td>
<td>The student not only makes reasonable written connections in the investigation, but also extends the connections to propose further investigations.</td>
</tr>
</tbody>
</table>
DIFFERENT WAYS
TO LIGHT A LIGHT BULB
Different Ways to Light a Bulb

(More inquiry based than lessons 2 AND 4 in the STC teacher guide – Electrical Circuits)

ENGAGE
During a thunderstorm you may have seen a bright flash of lightening streak across the sky. Lightening is electricity that is easy to see. Right now there is electricity around you that can’t be seen. Even though you can’t see it, you know it is there because it’s making things work. How many things can you find?

Teacher notes: Lead a class discussion to identify different uses of electricity. Students may note things such as the room lights, the clock, the computers, the calculators (batteries provide electricity), etc.

EXPLORE
In this activity, you and your partners will explore how electricity works to light a bulb.

To Get Ready:
Gather the following materials:

- Batteries
- Wires
- Battery holders
- Flashlight bulbs
- Bulb holders
- Assorted objects such as paper clips, erasers, rulers, etc
- Scissors/wire cutters

1. OBSERVE the wire, the battery and the bulb. In your science notebook, DRAW a detailed diagram of the wire, the battery and the bulb, and label the parts you have observed.

   Teacher notes: Have students set up an observation table in their science notebook, with 2 columns labeled “I Notice” and “I Wonder”. Students should observe properties of the battery, such as the different appearance of the terminal ends and the different materials used in the wires, the bulb and the battery.

2. Work with your partners to make the bulb light. See how many ways you can arrange the wire, battery and bulb to make the bulb light. In your science notebook, DRAW a diagram of each arrangement of battery, wire and bulb you try. Record next to each diagram whether or not the bulb lit.
Teacher notes: Encourage students to try several different arrangements to get the bulb to light. If students need prompting, suggest that they try touching different parts of the wire to different parts of the battery and the bulb. Groups that are “stuck” should be encouraged to visit other groups to get ideas. Groups that light the bulb quickly should be challenged to find a variety of other arrangements that also work.

3. Make a break in your circuit so you can easily “switch” the light on and off.
Teacher notes: A simple switch can be made by cutting the wire and twisting the bare wire ends together. Students can use their scissor/wire cutters to cut and strip wire. Ask the children, “How were you able to make the light turn on and off?” and “What happened to the electricity coming from the battery when you disconnected the wires?”

4. TALK with your partners about what you have discovered about how to light a bulb. Look at all your “bulb lit” diagrams. In what ways were they similar? Look at all your “bulb not lit” diagrams. In what ways were they similar?

EXPLAIN

5. SHARE your ideas with the class. Using 2 pieces of chart paper, draw 1 diagram that shows a way you got the bulb to light, and another diagram that shows a way the bulb did NOT light. Show the exact position of the battery, the wire, and the bulb. Then use arrows to label the path you think the electricity is moving.
Teacher notes: Once all groups have completed their “lit” and “not lit” diagrams, collect all the “bulb lit” charts and hang them together in the front of the room. Ask each group to describe their “complete circuit”. Casually begin to use the terms “complete circuit” (or “closed circuit”) and “incomplete circuit” (or “open circuit”) as you ask the students to talk about their diagrams. The terms can be used interchangeably. As students describe their diagrams, they will find the terminology useful and will begin to use the science words quite naturally.

The teacher lists on the board all the “things that were the same.” Some examples that children may come up with are: “You always had to touch one wire to the bottom of the battery.” Or “You always had to touch one wire to the top of the battery.” or “You always had to touch both ends of the battery with the wires.” or “You couldn’t get it to light by touching the bulb to the curvy part of the battery.” etc. As a result of sharing diagrams, students should recognize that there are several ways to construct a complete circuit; in all of them, the electricity leaves the battery at the “positive” terminal, travels through the wire inside the bulb, and returns to the battery at the “negative” terminal.
Once all groups have described their circuit diagrams, ask the class to identify “what was always the same” when the light bulbs lit. Then ask each group to describe their “not lit” diagram, and lead a class discussion about what was always the same when the bulbs did not light. Note students’ ideas about the direction of the electricity’s flow. You may want to have students come to the front of the room and support their ideas with evidence using a light bulb and battery.

Students will be able to observe the complete circuit path if they can see where the electricity goes when it is inside the bulb. If you prefer not to remove the base of the bulb, you can use a diagram similar to the one below:

![Diagram of a light bulb showing components]

6. What have you discovered about electric circuits? Write your conclusions in your science notebook.

Teacher notes: A language arts connection would be completing a comparison organizer (matrix, venn diagram, T-Chart, etc.) to show the similarities and differences between the two types of circuits. Some possible writing prompts are as follows:

- Explain how the two types of circuits are similar and/or different
- Write the procedure explaining how to build each type of circuit
- Explain how electricity flows through a circuit

Students should use the appropriate scientific vocabulary in their written responses.

7. Taking it further (optional Lighting a Household Bulb)
WHICH MATERIALS CONDUCT ELECTRICITY?
Which Materials Conduct Electricity?

INTRODUCTION: In Experiment #1, you made electricity pass through wires. In this experiment, you will test different materials to find out which ones let electricity pass through them.

1. OBSERVE the wires. In your science notebook, LIST some properties of the wire materials.
   Teacher notes: Ask students to theorize about which part of the wire the electricity moves through and which part it does not move through.

2. USE objects from kit (or you may choose to collect objects from home, the classroom or your backpack that are made of different materials). You will test these objects to see if they allow electricity to flow through your circuit.
   Teacher notes: Encourage students to gather objects that they think will and will not complete the circuit. The classroom usually provides many materials that students can test: chalk, paper clips, wooden rulers, plastic rulers, coins, pens, pencils, etc. Pencils can be especially interesting if students test the different components (e.g., eraser, metal band, lead).

3. Place the objects you will test on your work table. THINK about the materials from which they are made. PREDICT which ones you think will let electricity pass through them and which ones will not. SORT them into separate piles.
   Teacher notes: Depending on the materials your students choose to test, some of them may be better conductors than others. This may mean that some will light the bulb brightly, while others will light the bulb dimly or not at all. Students may want to sort their materials into 3 piles to reflect these options.

4. THINK of an organized way to keep track of your test objects, your predictions and your findings in your science notebook. This is called a “data table”. You will “record” the results of your experiment in your data table.
   Teacher notes: Have students record their observations in an organized table, similar to the one shown here. If your students are experienced at using observation tables, they may want to design their own table. If so, delete the table shown here and encourage students to design their own data table.
5. **DESIGN** and build an electric circuit that you can use to **TEST** your predictions. **DRAW** a diagram of your tester circuit in your science notebook. **WRITE** a description of how you will use it to find out which materials let electricity pass through them and which do not.

*Teacher notes:* Review the closed circuit diagrams from Experiment #1. Remind students how they made a break in their circuits to switch the light on and off. Encourage students to figure out how to insert test materials within the circuit so their conductivity can be tested. If some students are having difficult building their tester circuit, the teacher may have other groups share their designs or model how to build the tester circuit.

6. **TEST** the objects you’ve collected and record your findings in the data table in your science notebook.

*Teacher notes:* Students will probably become interested in testing additional objects. The more objects they test, the better the opportunity for them to see a pattern in their evidence.

7. **ANALYZE YOUR RESULTS.** Look for a **pattern** in the data. Is there anything similar about all the materials that lit the bulb? Is there anything similar about all the materials that did not light the bulb? **WRITE** your conclusion in your science notebook.

*Teacher notes:* Encourage students to look at the properties of the materials that lit the bulb. They may note that these materials were all shiny, solids, or opaque. They may also say that these materials are “made of metal”.

8. **SHARE** and compare your findings with the rest of your class.

*Teacher notes:* Call on several groups to describe the results of their conductivity tests. First, ask students to note how others’ experiments were similar to or different from their own. Then ask students to compare their predictions to their findings. Were they surprised by any results? Introduce the term “conductor” as you ask them to tell about materials that lit the bulb. As students describe their observations, they will also begin to use the term “conductor”. Ask questions such as: “Were all the conductors similar in any ways?” “Were the insulators similar in any ways?” After students share, teacher should synthesize the class’ discoveries by recording and displaying them along with any further questions the students may have.

9. **WRITE** in your science notebook what you have discovered about materials in electric circuits.

### Table: Material Prediction vs. Actual

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>PREDICTION</th>
<th>ACTUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(bright, dim, no light)</td>
</tr>
</tbody>
</table>

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*DRAFT June 2006*
Teacher notes: Students may describe their findings using the science terminology (e.g., conductors, insulators, complete circuits, incomplete circuits), but it is more important that they be able to describe what they understand about these materials and their arrangement to light a bulb.
INVESTIGATING YOUR OWN QUESTION
ELECTRICITY INQUIRY

You have worked with batteries, wires and bulbs to learn some things about the movement of electricity in circuits. What were you curious about as you worked with your circuits?

Teacher notes: As a result of their circuit explorations, students probably have become curious about other questions. This is a good opportunity to encourage them to design an investigation to answer their own questions. Remind students about the “Noticings” and “Wonderings” they generated in the first observation activity. These, as well as other things they have noticed during Experiments #1 and #2, can stimulate questions to investigate further.

1. TALK with your partners about things you were curious about during your circuit experiences. Decide on an electric circuit question that you can investigate.

Teacher notes: You may ask students to share their questions with the class and have the group discuss which ones are investigable vs those that are better answered through print research. For example, “Does a larger battery make the bulb light brighter?” is an investigable question. However, “How do they get the plastic insulation around a copper wire?” is a question that is better suited for research in books or the internet.

▲ If some students need help with ideas, you might suggest the following:
   (a) how do circuits with one battery compare to circuits with two or more batteries;
   (b) the effect of different battery sizes (“AA”, “AAA”, “C” and “D” size);
   (c) how does changing the wire length affect the brightness of the bulb;
   (d) how does adding more bulbs to the circuit affect the brightness of the bulbs?

As a classroom management suggestion, you may want students to individually choose a question they are interested in and find other students who are interested in the same question to form a group (groups of 2 or 3 are recommended).

2. THINK about how you can use your circuit experiences to test your idea. Then decide what results you will record.

3. PLAN the steps you will follow in your experiment, and use your science notebook to record the question you are investigating and the steps you will follow. (You can use planning organizer attached.)

DRAFT June 2006
4. DO your experiment and record your findings in an organized way in your science notebook.

5. THINK about your results. What new ideas do you have as a result of your experiment? What are you still wondering about? (You can use the share out organizer attached).

Communicate Your Learning
The school newspaper is doing an article about science projects going on around the school. Write an article for the newspaper describing your electric circuit investigations. In your article, tell about:

- The main ideas your class was studying;
- Why you think these ideas are important to know;
- What experiments you did and how you did them;
- What you learned from your experiments about electricity and about how scientists work; and
- What was difficult for you and what was fun for you.

Teacher notes: ▲ Before asking students to write about their learning, you may want to give students an opportunity to deepen their understanding of electric circuits by conducting further research. A variety of nonfiction reading materials can be used (e.g., leveled readers, internet sites, biographies of Edison or Morse, or textbooks) to enhance literacy skills and deepen science understanding.
Investigation Plan Template

Team member names:

Our question is: ________________________________________________________________
______________________________________________________________________________

Our prediction is: ______________________________________________________________
______________________________________________________________________________

We think this because __________________________________________________________
______________________________________________________________________________

Materials we will use: __________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

PLAN
First, we will___________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Then we will___________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Next we will___________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Finally we will_________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

What changes/revisions did you make to your original plan?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Preparing To Share Results
“Go with the Flow”

Question: ______________________________________________________________

Prediction: ______________________________________________________________

________________________________________________________________________

Summary of what you did (plan) ____________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

We found out that (data or results) __________________________________________

________________________________________________________________________

Conclusion (WHY?) _______________________________________________________

________________________________________________________________________

________________________________________________________________________

Space for illustration/diagram of investigation plan and/or results.
LITERATURE
INQUIRY

Exploring the Different Roles Electricity Plays in Our World
## Literature Inquiry:
**Exploring the Different Roles Electricity Plays in Our World**

This material, developed by the CT Center for Science Inquiry Teaching and Learning, is based upon work supported by the Connecticut State Department of Higher Education through the U.S. State Department of Education Teacher Quality State Grant Program, under PL 107-110, Title II, Part A, Subpart 3, CDHE# 12060; Agency # DHE66500-20107; Identification # 05DHE1028GR.

Modified from Norwich Public Schools

This guide is a tool for helping you plan an inquiry activity. The prime factor is that your students get the opportunity to practice choosing their own question and planning and carrying out an investigation to find out what they can learn from investigating that question.

**Approx. Time:** 3 hours

<table>
<thead>
<tr>
<th>Related State Content Standard(s):</th>
<th>Related State Expected Performance(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Transfer and Transformations – What is the role of energy in our world?</strong></td>
<td>B14. Describe how batteries and wires can transfer energy to light a light bulb.</td>
</tr>
<tr>
<td><strong>4.4 - Electrical and magnetic energy can be transferred and transformed.</strong></td>
<td>B15. Explain how simple electrical circuits can be used to determine which materials conduct electricity.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Related Enduring Understanding(s):</th>
<th>Related Essential Question(s):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity is essential to living in today’s modern, technologically advanced world.</td>
<td>How is electricity used to in our world?</td>
</tr>
<tr>
<td>Electricity is used to generate energy that can be transformed into other forms of energy (sound, light, heat and motion).</td>
<td>How is electricity used to create light, heat, sound, and motion?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What simple <strong>content objectives/goals</strong> do you want to accomplish with this investigation? (see district curriculum documents)</th>
<th>What simple <strong>process skills</strong> do you want to improve with this investigation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will understand that:</td>
<td>• Draw conclusions about topics in electricity by reading a variety of reference materials.</td>
</tr>
<tr>
<td>• electricity can generate energy to produce light and heat.</td>
<td>• Read to learn more about electricity and its real world applications.</td>
</tr>
<tr>
<td>• electricity is essential to our modern world.</td>
<td>• Communicate results and ideas through writing, drawing, and discussion.</td>
</tr>
<tr>
<td>• electricity has many important roles in our society.</td>
<td></td>
</tr>
</tbody>
</table>
- people use electricity everyday.
  Some people have careers directly related to electricity.

<table>
<thead>
<tr>
<th>What phase of this investigation will you provide the most modeling/templates/mini-lessons/scaffolding for better skill development?</th>
</tr>
</thead>
</table>

**Phase 1- Raising questions from observing engaging materials.**

**Materials/Resources:**
- See Literature List in this Curriculum Guide.
- Gather reference sources at varying reading levels. See Media Specialist for assistance.

<table>
<thead>
<tr>
<th>What kinds of investigations do you anticipate students designing?</th>
</tr>
</thead>
</table>

Sample student investigation questions:
- What do electricians do?
- How do power plants give us energy?
- What causes lightning?
- How does electricity work in our body?
- How are eels electric?
- How do electricians make sure they are safe?
- How did Ben Franklin and Thomas Edison help us learn about electricity?
- How does electricity work in my house?
- Why is the meter checked?
- How do things and people get electrocuted?
- Where does electricity come from?
## PHASE 1 – Observing and Questioning

### INQUIRY STARTERS

- What is the launching activity or **inquiry starter** for the investigation?
- What will be your **inquiry starter prompt**? How will you "invite" your audience to work with the materials?
- What **materials** will you use for the inquiry starters?
- How will you **elicit and collect or display student’s questions**? Will they share questions orally? In writing?
- **Choosing investigation questions**: How will you help your students determine which questions they can choose from to investigate? How will you or the students form investigation groups?

### Time Task Hints

<table>
<thead>
<tr>
<th>Time</th>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
</table>
| 15 minutes | Introduce Fact, Question and Reaction (FQR) graphic organizer. Create a FQR chart on the board. This will be used during the teacher model and later to chart student observations. Model/ Think Aloud the FQR by reading a related passage. Write facts, questions and reactions on board or chart paper. After modeling this explain to the students that during this unit you will be focusing on your investigation on what role electricity plays in our world. | • Each fact or question does not have to have a corresponding comment in each column.  
• FQR Chart see page 53 |
| 1 minute | Explain to students that they will be using resources to list facts, questions and reactions as they read/skim through the resources. | • Select text that address content goals and are at various reading levels. You may want to flag certain chapters of books ahead time that address different roles of electricity. |
| 35 minutes | Have students create a three column FQR in their science notebooks or use FQR template. Give students a small amount of time to peruse the available reference materials to familiarize | Students should be divided into groups to preview materials. Students should be able to preview many of the available reference materials. There are several options in doing this including: |
themselves with resources. Then tell students they will be given 15 minutes to add to the FQR in their notebook using self-selected materials.

Students will now be given post it notes and asked to write 2 facts, 2 questions and 2 reactions uncovered during their reading. They will then post their FQRs on the teacher created chart in the room.

Teacher will briefly allow the students to share and discuss what they put up on the board. The teacher will then ask the students to choose one question that interests them the most to further investigate.

- Teacher may choose the most appropriate questions for investigation based on the content objectives of this lesson.

- Book pass- Students preview a book for a short time and pass it on (prior to FQR to “see” the materials).
- Station rotation- books at different places and students rotate through (computers can be used as well)
- Having a variety of materials at each group that the students will look through and then choose one to focus on.
- Student investigation could be either individual or in groups based on interest. Use your own discretion.

This is a suggested end to Day 1 of literature inquiry.

---

**PHASE 2 – Planning and Investigating**

**INVESTIGATION**

- What additional materials will you introduce? How will you introduce additional materials participants can use to study the phenomena?
- How will you manage/organize materials, set up and clean up?
- How will you support the groups in planning their investigation? Will you provide criteria or planning sheets?
- How will you facilitate during the investigation?

<table>
<thead>
<tr>
<th>Time</th>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 minutes</td>
<td>Teacher will review reference materials available for the groups to use to make</td>
<td>Sorting the questions and finding additional resources may be helpful</td>
</tr>
</tbody>
</table>
sure they are appropriate for investigating their questions.

| 20 minutes | Class can brainstorm the elements of an effective plan while the teacher records on chart paper. Items discussed may include:
|            | o Question
|            | o Directions of plan of research – numbered/sequenced steps
|            | o Other references to use to further investigation-glossary, table of contents, indexes
|            | o Revise plans when changes are made
|            | o List of resources
|            | o Jobs – if assigned
|            | o Presentation- display research results (poster, role play, power point, demonstration, report, etc)
|            | This can remain as a guide for students to refer to as they plan, or can be utilized to formulate a rubric.
|            | Teacher directs each group to develop a plan to use to investigate their question.

| Students should revisit their plans at this time, making the necessary revisions. | Teacher should be adding key elements of an effective plan to the original list recorded on chart paper.
|                                                                                | Teacher should reinforce the fact that most/all of the important plan elements were included in students’ shared plans.
|                                                                                | Note: This is the suggested end to Day 2.

- This can be done with minimal teacher input; in order for students to develop their own plans (mistakes are expected).
- **Assessment Note:** This is an opportunity to formatively assess student planning.
- Part of planning is asking students “Where will you look first?” and identifying key terms to help their research.
- Teachers may choose to use the Investigation Plan Template on page 54. This template can be taped into students’ journals for future reference.
- Teacher may choose to model a plan using a question that students are not investigating.
- This could be recorded by each group to share with the class in words or pictures.
Using their investigation plans and materials, students can conduct their research investigations. Students will record their observations during the research investigation in their student journals.

Teacher will facilitate with reminders to record observations and information. Removing students from their materials for a few minutes will help them concentrate on recording observations and noting revisions they made to their plan.

If students finish their investigation early they can continue to investigate a related question or start preparing for their presentation/sharing with the larger group.

**Guided Lesson/Thinking Tools:**
Teacher may need to provide a mini-lesson on data collection and organization of this data. Some groups may need a template/chart to help with data collection.

**Note:** This is the suggested end to Day 3 of the lesson.

---

### Open Ended Questions and Comments to Help Guide Students during the Investigation

<table>
<thead>
<tr>
<th>Question</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do you know about…?</td>
<td>Tell me about it.</td>
</tr>
<tr>
<td>What will you need?</td>
<td>What’s your plan for that?</td>
</tr>
<tr>
<td>What will you add?</td>
<td>What does this remind you of?</td>
</tr>
<tr>
<td>I wonder what will happen when…?</td>
<td>Tell me more about…</td>
</tr>
<tr>
<td>Why is that happening?</td>
<td>How are you going to use…?</td>
</tr>
<tr>
<td>Show me how that…</td>
<td>How will you use this today?</td>
</tr>
<tr>
<td>How do you know that?</td>
<td>What does it need?</td>
</tr>
<tr>
<td>What do you see, notice, hear about…?</td>
<td>What else can you do about…?</td>
</tr>
<tr>
<td>What does this do?</td>
<td>What will happen if…?</td>
</tr>
<tr>
<td>Where have you seen…?</td>
<td>How can we change that?</td>
</tr>
<tr>
<td>What’s happening with this?</td>
<td>What happened when you did that?</td>
</tr>
<tr>
<td>What would you say about…?</td>
<td>What is different about that?</td>
</tr>
<tr>
<td>How can we find out about…?</td>
<td>What will you do to change that?</td>
</tr>
<tr>
<td>What other way can you try?</td>
<td>Show me…</td>
</tr>
<tr>
<td>What else can you do about…?</td>
<td>I’m noticing that…. how did that happen?</td>
</tr>
<tr>
<td>What can you use this for?</td>
<td></td>
</tr>
</tbody>
</table>
PHASE 3 – Interpreting Results and Communicating

SHARING RESULTS AND PROCESSING FOR MEANING

- How will investigation groups present what they have learned from their investigations? (visual, oral presentation, combination, etc.) How will you decide the order of the presentations? (by similar questions, content goals, random, etc.)
- How will the facilitator synthesize the knowledge and findings of the participants for the group?

<table>
<thead>
<tr>
<th>Time</th>
<th>Task</th>
<th>Hints</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 minutes</td>
<td>Prepare to share results.</td>
<td>• Guided Lesson/Thinking Tool: Discuss with students what would be in an “effective presentation” (question, hypothesis/prediction, overview of procedure, results, and conclusion).</td>
</tr>
<tr>
<td></td>
<td>Things to consider: How will students visually share their results? (power point, overheads, chart paper, poster, report, etc.)</td>
<td>• Teachers may find it helpful to take notes as students present; documenting which groups had evidence of each big idea.</td>
</tr>
<tr>
<td>30 minutes</td>
<td>Teacher will allow an allotted time for each group to share their results (approximately 3 minutes).</td>
<td>• Teachers may choose to use the template, called “Preparing to Share Results,” (see page 55) to prepare for sharing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Consider charting “findings/conclusions” after each group presentation.  This will be helpful later during the synthesis.</td>
</tr>
</tbody>
</table>

Sample Student Visual for Presentation:

Question: How does electricity work in my house?
Plan: First we will choose different books and websites. Next we will use the index and table of contents to find keywords. Then we will skim and scan the books looking for information. Last, we will create a picture/poster of what we learned.

Results (data): Electricity travels through wires from room to room to outlets to where you plug in lamps, toasters, televisions, etc.

Conclusion: Circuits in our house make electricity travel to several different rooms.

Synthesis – What have we learned about the role electricity plays in our world? Use specific examples from the class to support new learning/findings. 

Use the big ideas (see below) to question students to guide them toward the content goals of the inquiry investigation.
Provide a copy (or have students copy into their journal) of the big ideas/summary of investigation findings.

Sample – Big Ideas/Summary of Investigation Findings:

- Electricity comes into our homes through power lines, and then goes through the meter, which tells how much electricity a home is using.
- Electricians install, connect and test electrical systems.
- Electricians make sure they are safe by turning off the power before they begin working, and wear big rubber protective gloves and boots.
- People are good conductors of electricity because they contain water and sweat.

<table>
<thead>
<tr>
<th>5 minutes</th>
<th>Follow up activity after synthesis. Students will be prompted to write in their science journals about how electricity plays a role in your own life.</th>
<th>You may have students Pair Share their journal entry or share as a class.</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 minutes</td>
<td>Whole class discussion regarding student journal entries and Pair Share discussions.</td>
<td>You might ask, “How was this different than how you have done science before?”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment Note: Teacher will collect the student science notebooks for summative assessment.</td>
</tr>
</tbody>
</table>
FOR CHART

Name ____________________________

<table>
<thead>
<tr>
<th>FACT</th>
<th>QUESTION</th>
<th>REACTION</th>
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</thead>
<tbody>
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</table>
Planning Your Investigation

Literature Inquiry

Question:
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Key Words:
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

Books to Use:
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

My Findings:
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Preparing To Share Results

Question: ____________________________________________________________

Prediction: __________________________________________________________

Summary of what you did (plan) ____________________________________________

_______________________________________________________________________

_______________________________________________________________________

_______________________________________________________________________

_______________________________________________________________________

_______________________________________________________________________

We found out that (data or results) _________________________________________

_______________________________________________________________________

Conclusion (WHY?) _____________________________________________________

_______________________________________________________________________

_______________________________________________________________________

Space for illustration/diagram of investigation plan and/or results.
1. What is Electricity?

Electricity is the flow of very small units called electrons. Electrons are so small that is impossible to see them in even the most powerful of microscopes. Electrons are one of the building blocks of matter. The others are called protons and neutrons.

![Picture of electrons orbiting around the center or “nucleus” of an atom](image)

The electron has a negative charge and orbits around the protons and neutrons in an atom in a way similar to the way the planets orbit around the sun. In some atoms the electrons are in very stable paths but in other atoms they are not. In these atoms, the electrons can be “stripped” off the atoms with relatively little force. Examples of some of these atoms are gold, silver and copper. Gold, silver and copper are formed into conductors which take the shape of wires. Theses wires can be found in almost every single piece of electronic equipment on the planet. It is in these wires where the electrons flow and thus we have electricity.

For more information on electricity and atoms please see the following:

*DRAFT June 2006*
2. How is electricity created?

One of the most common ways of producing electricity occurs in electrical power plants. Power plants use a variety of fuel sources such as coal, nuclear power, wind and water to create electricity. In a Hydroelectric power plant such as the one pictured below, water is used to turn a machine called a turbine which turns another machine called a generator. The generator actually creates the electricity which is then made usable by the transformer and then sent to your home.

![Inside a Hydropower Plant](http://www.howstuffworks.com/hydropower-plant.htm)

The sun can also be used to create electricity in a variety of methods. One common way is in the use of solar cells. Chemical reactions can also produce electricity with the most common method being the battery.

For more information on Power Plants please see the following:
- [http://www.howstuffworks.com/nuclear-power.htm](http://www.howstuffworks.com/nuclear-power.htm)
- [http://science.howstuffworks.com/hydropower-plant.htm](http://science.howstuffworks.com/hydropower-plant.htm)
- [http://science.howstuffworks.com/power.htm](http://science.howstuffworks.com/power.htm)
- [http://www.eere.energy.gov/consumerinfo/factsheets/ad2.html](http://www.eere.energy.gov/consumerinfo/factsheets/ad2.html)
- [http://www.howstuffworks.com/solar-cell.htm](http://www.howstuffworks.com/solar-cell.htm)

3. How is electricity used?
Electricity is used in just about everything you see or touch. Electricity is used in the microwave or toaster to make your breakfast, in the car or bus that you took to work and in the washer and dryer used to clean the clothes you are wearing. Electricity is so integrated into modern society that it is hard to imagine life without it.

For more information on how electricity is used please see the following:
http://www.teachnet.ie/pcoakley/consumers.htm

4. What is a Circuit?

A circuit is a collection of conductors and components which electricity flows through and is designed to do something useful. An example of an electric circuit is the circuit in your house that turns on the lamp in your living room. The electricity comes from outside into the home through a circuit box. From there it travels through wires to the outlet. It then goes out of the outlet through the wires of the lamp up into the light bulb and across the filament, thus producing light. In this circuit the component is the light bulb and the wires are the conductors. There are many different types of circuits but the two that are most common is the series circuit and the parallel circuit. The main difference between these two circuits is the way current flows in each circuit. In a series circuit, the current can flow in one direction only because there is only one path for it to flow. Below is a picture of a series circuit.

In the circuit above, the current starts from the negative side of the battery and flows through each of the resistors and finally back into the positive side of the battery.

In a parallel circuit, current can have many paths to flow into.
In this circuit, the electricity starts from the battery and then part of the current flows into the resistor labeled $R_1$, some flows into $R_2$ and the rest flows into $R_3$.

This leads us to the major difference between series and parallel circuits. We have previously defined current as the flow of electrons in a circuit and said that the measurement of current was made in units of amperes. When measuring current in a series circuit, it does not matter where in the circuit you measure it, it will always be the same. In a parallel circuit, the current is not the same in all areas of the circuit. The reason for this is that current will always flow in the direction of least resistance. In a series circuit, since there is only one path, all of the current will flow in that one path only; therefore the measurement of current will be the same. In a parallel circuit, some of the current will flow into one path and some of the current will flow into another path. Now you may be asking yourself why, in the above circuit, does not all of the current flow into the path with the one ohm resistor. While the path with the one ohm resistor is the path with the least resistance, current will still flow through the other paths because there is a path back to the beginning of the circuit. Think of a waterfall sprinkler.

When water is run through this sprinkler it will come out of every hole, even though one of the holes may be slightly bigger than the others.

For more information on circuits please see the following:
http://www.allaboutcircuits.com/vol_1/chpt_5/1.html

5. What is Current?

Current is a measure of how much electricity is flowing in an electric circuit.
6. What is Voltage?

Voltage can be thought of as electrical pressure. In any electrical circuit there will be some type of resistance to the flow of electricity. This resistance can be compared to a clogged pipe. When a pipe is clean it takes very little water pressure to get the water flowing, but if the pipe were much clogged one would have to increase the water pressure in order for the water to flow. This is how electricity behaves, the more “clogged” up the circuit the more pressure or “voltage” it will take to make the electricity to flow.

For more information on voltage please see the following:
http://hyperphysics.phy-astr.gsu.edu/hbase/electric/elevol.html

7. What is a Battery made of?

The first battery was created by Alessandro Volta in 1800. To create his battery, he made a stack by alternating layers of zinc, blotting paper soaked in salt water, and silver, like this:
This arrangement was known as a **voltaic pile**. The top and bottom layers of the pile must be different metals, as shown. If you attach a wire to the top and bottom of the pile, you can measure a voltage and a current from the pile. The pile can be stacked as high as you like, and each layer will increase the voltage by a fixed amount.

http://science.howstuffworks.com/battery2.htm

8. Conductors and Insulators.

Conductor is the term used to describe things that conduct electricity while insulators are the term used to describe things that do no conduct electricity. There is no way to look at an object and tell if it is a good conductor or good insulator but in general most metals make good conductors and plastic or rubber material makes good insulators. The most common types of metal conductors are made from gold, silver and copper. A good insulating material is glass. One thing to keep in mind however is that if the voltage is high enough, anything can conduct electricity. You never want to stand under a tree or in a pool of water during a lightning storm because wood and water will conduct electricity under the right conditions.

For more information on conductors and insulators please see the following:
http://hyperphysics.phy-astr.gsu.edu/hbase/electric/conins.html
http://www.glenbrook.k12.il.us/gbssci/phys/Class/estatics/u8l1d.html
At the Exploratorium Institute for Inquiry our work in science education is deeply rooted in the belief that human beings are natural inquirers and that inquiry is at the heart of all learning. The work that we do with educators is designed to give them an opportunity to personally experience the process of learning science through inquiry. Our hope is that this experience will stimulate their thinking about how to create classrooms that are supportive environments for children's inquiry.

Inquiry is an approach to learning that involves a process of exploring the natural or material world, that leads to asking questions and making discoveries in the search for new understandings. Inquiry, as it relates to science education, should mirror as closely as possible the enterprise of doing real science.

The inquiry process is driven by one's own curiosity, wonder, interest or passion to understand an observation or solve a problem.

The process begins when the learner notices something that intrigues, surprises, or stimulates a question—something that is new, or something that may not make sense in relationship to the learner's previous experience or current understanding.

The next step is to take action—through continued observing, raising questions, making predictions, testing hypotheses and creating theories and conceptual models.

The learner must find her or his own pathway through this process. It is rarely a linear progression, but rather more of a back and forth, or cyclical, series of events.

As the process unfolds, more observations and questions emerge, giving occasion for deeper interaction and relationship with the phenomena—and greater potential for further development of understanding.

Along the way, the inquirer collects and records data, makes representations of results and explanations, and draws upon other resources such as books, videos and the expertise or insights of others.

Making meaning from the experience requires reflection, conversations and comparison of findings with others, interpretation of data and observations, and the application of new conceptions to other contexts. All of this serves to help the learner construct new mental frameworks of the world.

Teaching science using the inquiry process requires a fundamental reexamination of the relationship between the teacher and the learner whereby the teacher becomes a facilitator or guide for the learner's own process of discovery and creating understanding of the world.
Map of IFI Inquiry Structure
(3 Phases of Inquiry Diagram)

INQUIRY STARTER
raising questions from observing engaging materials

FOCUSED INVESTIGATION
planning and investigating questions

PROCESS FOR MEANING
thinking about and communicating what you learned

content goal