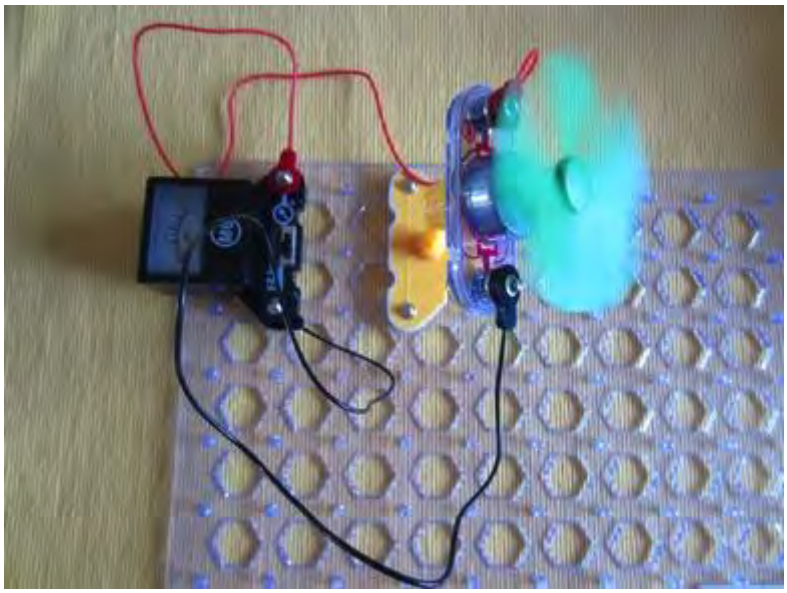
Generating Fun with Alternative Energy



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For information concerning IMPACT II opportunities, such as interschool visits, staff development, workshops, and Adapter and Disseminator grants, please contact:

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600 SE Third Avenue, 1st Floor
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www.BrowardEdFoundation.net

IMPACT II is a program of the Broward Education Foundation

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Goals and Objectives

Goals-

(1) Increase student knowledge and understanding of electricity (including how it is produced), energy, energy transformations, alternative energy and conservation of energy.

(2) Create more environmentally conscious students.

Objectives-

- Students will be able to make a light bulb light up with only 1 battery, 1 wire and 1 light bulb.
- Students will identify materials that electricity can flow through easily (conductors) and materials that electricity cannot flow through easily (insulators).
- The student will be able to distinguish between an open- and closed-circuit.
- The student will explain how a switch works to open and close a circuit.
- The student will understand that electricity can flow through a closed circuit, but not an open circuit.
- The student will be able to explain how energy is transformed from one form (such as mechanical energy) to another form (such as electrical energy).
- The student will be able to explain the difference between a motor and a generator.

For advanced or secondary students-

- The student will be able to explain how electricity is generated with a coil of wire and a magnet.

Standards

Next Generation Sunshine State Science Standards

SC.3.P.10.1
Identify some basic forms of energy such as light, heat, sound, electrical and mechanical.
SC.3.P.10.2
Recognize that energy has the ability to cause motion or create change.
SC.3.P.11.1
Investigate, observe, and explain that things that give off light often also give off heat.
SC.4.P.10.1
Observe and describe some basic forms of energy, including light, heat, sound, electrical and the energy of motion.
SC.4.P.10.2
Investigate and describe that energy has the ability to cause motion or create change.
SC.4.P.10.4
Describe how moving water and air are sources of energy and can be used to move things.
SC.5.P.11.1
Investigate and illustrate the fact that the flow of electricity requires a closed circuit (a complete loop).
SC.5.P.10.1
Investigate and describe some basic forms of energy, including light, heat, sound, electrical, chemical and mechanical.
SC.5.P.10.2
Investigate and explain that energy has the ability to cause motion or create change.
SC.5.P.10.4
Investigate and explain that electrical energy can be transformed into heat, light and sound energy, as well as the energy of motion.
SC.5.P.11.2
Identify and classify materials that conduct electricity and materials that do not.

Course Outline

For this project, students will be exploring alternative energy sources by designing and testing wind generators. Prior to the final lesson where students create wind turbines, a series of lessons will be implemented to give students the background knowledge needed to understand how the generators work. Generators can be created using easily found materials, such as corks, cardboard, Styrofoam trays, etc. At the end of the unit, students will take what they have learned and create a matching game (simple circuit board) for others to test their knowledge about energy. The matching game will illuminate a light bulb, when the correct matching pairs are selected. This project can be used when energy is being taught during the school year (according to the science instructional focus calendar for the district).

Lesson Plans

- **Lesson 1: Light Bulb Challenge**
- **Lesson 2: Conductors and Insulators**
- **Lesson 3: Circuits & Switches**
- **Lesson 4: Simple Motor**
- **Lesson 5: Simple Generator**
- **Lesson 6: Wind Turbine Generator**

Evaluation:

- Rubric
- Matching Game

Sample Worksheets

- **Conductors & Insulators Worksheet**
- **Projected Budget**
- **Purchase Order Form**
- **Company Balance Sheet**
- **Job Badges**
- **Play Checks**

Conductors & Insulators Worksheet

Projected Budget

Purchase Order Form

Company Balance Sheet

Job Badges

Play Checks

Lesson Plans

Lesson 1: Light Bulb Challenge

Grade Level: 3rd – 5th grade

Objective: Students will be able to make a light bulb light up with only 1 battery, 1 wire and 1 light bulb.

Time: Two 30-minute sessions

It will take all of Session 1 for at least one pair of students to figure out how to make the light bulb light. For Session 2, students will explore additional ways to make the light bulb light and share with the other groups the successful configurations they have discovered.

Materials:

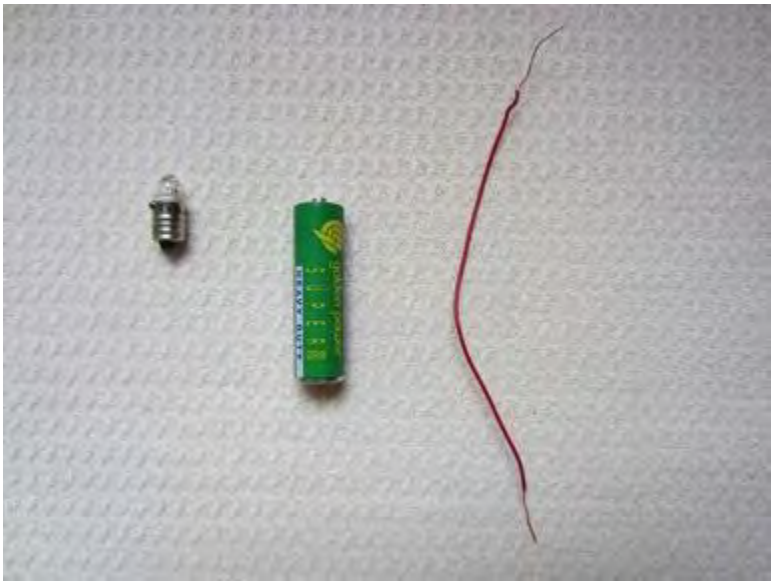
- For teacher preparation
  - Wire cutters/strippers*
  - Spool of copper wire*
- Per team of 2 students
  - One small incandescent light bulb* (1.5 volts)
  - One 6-inch piece of insulated copper wire (1/2 inch of each end of wire should be stripped)
  - 1 AA battery
  - Science Journal (one for each student)

- 2 sheets white printer paper

*Can be found in 4th and 5th grade Delta Hands-On Kits

- **Wire cutters/strippers**: 5th and 4th grade Delta Hands-On Kits (Bin # 6)
- **Spool of insulated copper wire**: 5th and 4th grade Delta Hands-On Kits (Bin # 6)
- **Light bulbs**: can be taken out of small penlights in 5th grade Delta Hands-On Kits (Bin # 3)
- **AA Battery:** 5th grade Delta Hands-On Kits (Bin # 3)

wire cutters, spool of insulated copper wire, pieces of insulated wire with stripped ends



Procedure:

1. Explain the following scenario to the students- *"You were on a small cruise that was shipwrecked. Everyone on the ship was able to swim safely to a nearby deserted island, but you were only able to grab a couple of supplies before the boat sank. You have no flashlight or matches and night is fast approaching. You do, however, find in your backpack a battery, a piece of wire, a small light bulb, a journal and a pencil. You and your partner will work together to get the light bulb to light."*

2. Next, give each student a sheet of white printer paper. Have them fold the paper in half long-ways (like a hotdog bun) and then in half again (like a hamburger bun). Have the students fold the paper one more time in half. When they unfold the paper, there should be 8 equal-sized rectangles.

3. Explain to students that they need to figure this out on their own, and they are not allowed to give up. The teacher will, however, provide several hints along the way if needed. In order to get a hint from the teacher, students will need to draw all the ways that they try that DID NOT work to make the light bulb light up in their journals. After they have drawn in their journal at least 4 different configurations that did not make the light bulb light, the teacher may give them the following hint- "*You must use ALL 3 of the materials (light bulb, wire and battery)*". Using this tip, students will need to try out and draw four additional unsuccessful configurations. After students have done this, the teacher may give the group the following hint, "*You must use BOTH ends of the battery.*" **NOTE: Sometimes I skip straight to this hint because the students have already figured out that you need to use all 3 items. I look at the students' drawings to see if all their diagrams have all three items. If so, then skip to the next hint.**

4. At this point, some groups will most likely have figured out a way to make the light bulb light. From there it is basically a chain reaction as the students peak at the other groups to see how they did it. If students still have not figured it out, the teacher may give students the following hint- "*You have to use BOTH the side and the bottom of the light bulb*" or may allow the other groups who have figured it out to help them. The students will get very excited when they discover how to make the light bulb light and will feel proud that they figured it out on their own (mostly).

5. When a group figures out how to make the light bulb light, explain that there are at least four ways to make the light bulb light and that they should try to discover more ways. Of course, each time the students discover a way to make the light bulb light up, they should diagram it in their notebook and color the light bulb yellow. At the end of Session 2 of this lesson, select student diagrams to share with the class.

Lesson 2: Conductors and Insulators

Grade Level: 3rd – 5th grade

Objectives: Students will identify materials that electricity can flow through easily (conductors) and materials that electricity cannot flow through easily (insulators).

Standards:
SC.5.P.11.2
Identify and classify materials that conduct electricity and materials that do not.

Time: One 30 – 45 minute lesson

Materials:

- For teacher preparation
  - Wire cutters/strippers*
  - Spool of copper wire*
- Per team of 2 students
  - 1 small incandescent light bulb* (1.5 volts)
  - 1 battery holder with 2 electrical clips*
  - Three 6-inch pieces of insulated copper wire (1/2 inch of each end of wire should be stripped)
    - OR: one 6-inch piece of insulated copper wire (1/2 inch of each end of wire should be stripped) and 2 alligator clips
  - 1 D battery*
  - Science Journal (one for each student)
  - Materials to test- rubber balloon*, plastic spoon, metal spoon, metal screw or nail, piece of Styrofoam plate, wooden popsicle stick, piece of aluminum foil, rubber or wood cork, etc.

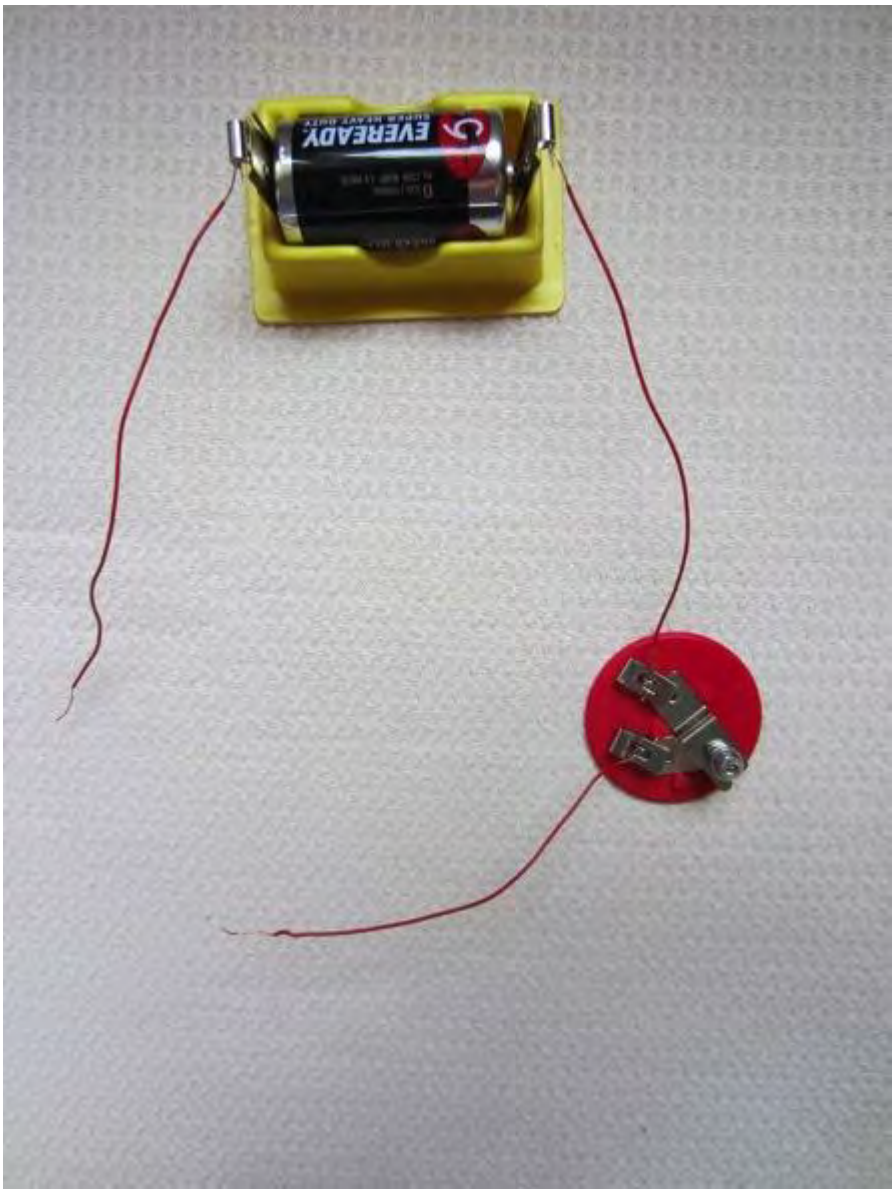
*Can be found in 4th and 5th grade Delta Hands-On Kits

- **Wire cutters/strippers**: 5th and 4th grade Delta Hands-On Kits (Bin # 6)
- **Spool of insulated copper wire**: 5th and 4th grade Delta Hands-On Kits (Bin # 6)
- **Light bulbs**: can be taken out of small penlights in 5th grade Delta Hands-On Kits (Bin # 3)
- **Rubber balloon:** 5th grade Delta Hands-On Kits (Bin # 4)
- **Battery holder:** 5th grade Delta Hands-On Kits (Bin # 6) OR **Delta Circuitworks™ Bases**: 4th grade Delta Hands-On Kits (Bin # 6)
- **Electrical clips:** 5th and 4th grade Delta Hands-On Kits (Bin # 6)
- **D Battery:** 5th grade Delta Hands-On Kits (Bin # 6); 4th grade Delta Hands-On Kits (Bin # 4)

<u>Procedure</u>:

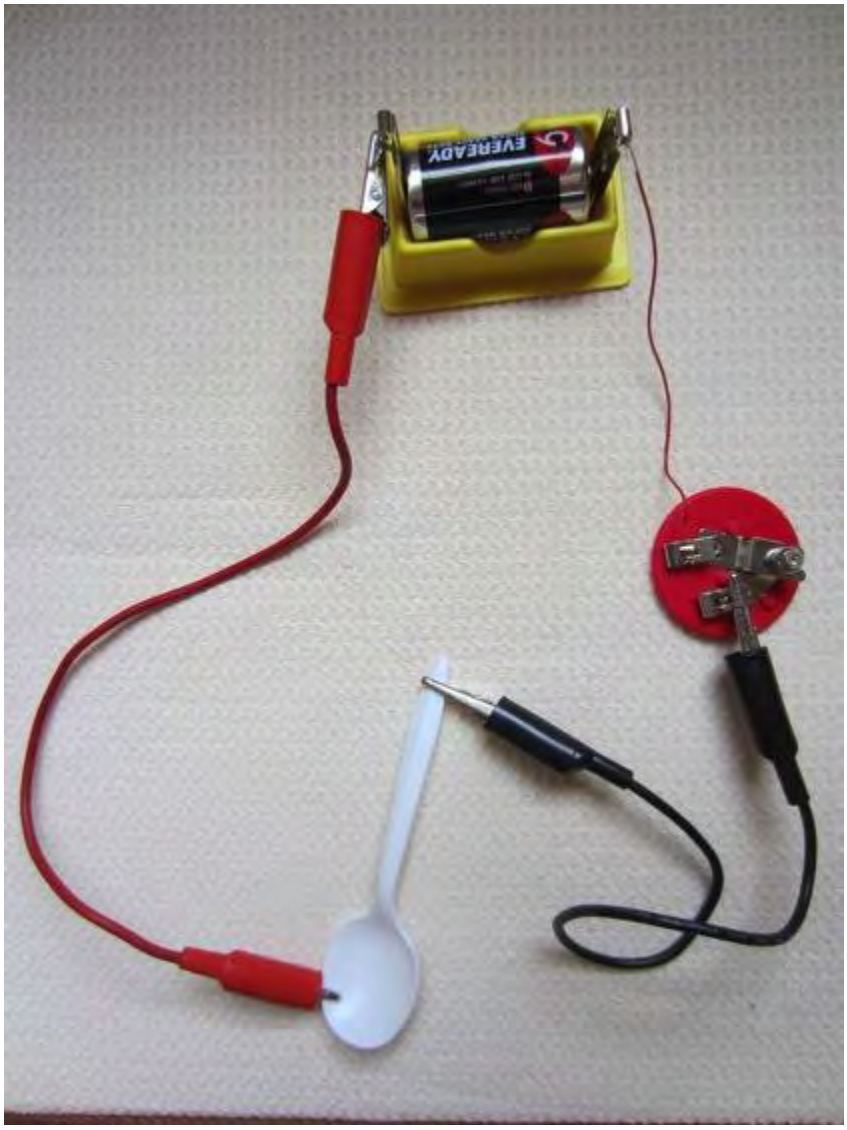
If not using the alligator clips-

1. Have students place battery in battery holder. If using Delta Hands-on Kit battery holder, students will also need to place electrical clips in the battery holder.
2. Clamp a piece of wire to each end of the battery holder.
3. Attach one of the metal clips of the lamp holder to one of the pieces of wire that is attached to the battery holder.
4. Attach the third wire to the other metal clip on the lamp holder.
   SEE BELOW



If using the alligator clips-

1. Have students place battery in battery holder. If using Delta Hands-on Kit battery holder, students will also need to place electrical clips in the battery holder.
2. Clamp a piece of wire to one end of the battery holder and clamp an alligator clip to the other end (NOTE: the color of the alligator clip is not important).
3. Attach one of the metal clips of the lamp holder to the piece of wire that is attached to the battery holder.
4. Attach the other alligator clip to the other metal clip on the lamp holder.
   SEE BELOW



   Notice that the light bulb is not lit with the plastic spoon completing the circuit.

5. Explain to students that- "Right now your circuit is open. In order for electricity to flow to the light bulb and make it light, you will need to close the circuit. You close the circuit by making it into a continuous loop. We will test different materials to complete the loop. Electricity can flow very easily through some materials. Electricity cannot flow easily through other materials. How do you

think we will know if electricity can flow easily through the material we are testing? What will we observe?" (ANSWER: the light bulb will light up). "Before we begin, let's make some predictions about which materials you think electricity will flow easily through (making the light bulb light) and which materials you think the electricity will not flow easily through (light bulb will not light).

6. Have students use the attached worksheet (or copy the table in their science journals) to make their predictions and record their observations. Have students make two piles on their table. One pile will be the materials that electricity did flow easily through (light bulb did light-up) and materials that electricity did not flow easily through (light bulb did not light-up).
7. After students are done testing materials and sorting them into two piles, ask students- "Did you notice anything in common with the objects in the pile that did light the bulb?" (ANSWER: they are all metal), "What about within the pile of objects that didn't light the bulb?" (ANSWER: they are made of plastic, rubber, wood, etc.).
8. Now explain to the students that scientists have a special name for objects that electricity can flow easily through. Ask if any students know what it is called. After taking guesses from students, explain that a **conductor is a material that electricity can flow easily through**. Have students write the word conductor in their notebooks, along with the definition listed above (BOLD). Have students list examples under their definition of materials that are conductors.
9. Next, explain to the students that scientists have a special name for objects that electricity cannot flow easily through. Ask if any students know what it is called. After taking guesses from students, explain that an **insulator is a material that electricity cannot flow easily through**. Have students write the word insulator in their notebooks, along with the definition listed above (BOLD). Have students list examples under their definition of materials that are conductors.
10. Engage students in discussion with some of the following questions-
    - Why do you think they coat the wire you used with rubber?
    - Can only solids be conductors? Is there a way we could test liquids? (EX: Water)

Lesson 3: Circuits & Switches

Grade Level: 3rd – 5th grade

Objective:

- The student will be able to distinguish between an open- and closed-circuit.
- The student will explain how a switch works to open and close a circuit.
- The student will understand that electricity can flow through a closed circuit, but not an open circuit.

Go to the following link for the activity:
http://4h.uwex.edu/pubs/showdoc.cfm?documentid=33865

or See activity on following page

Lesson 4: Simple Motor

Broward County Hands-On Science Delta Kits

Grade 4, Quarter 4

39. A Simple Motor

Activity Sheet 39

40. A Motor Model

Activity Sheet 40

*You can access these documents through BEEP

- http://www.beep.browardschools.com
- Login to the "Teacher Portal"
    - Username: P********
        - (P + personnel #)
    - Password: ********
        - (personnel #)
- Click on "Online Textbooks" on the right-hand side under *Teacher Tools*.
- Click on "Hands-On Science Kits" on the left-hand side under *Elementary*.
- Click on "Grade 4"
- Click on "Quarter 4"
- Click on the following links to access the documents-
    - 39. A Simple Motor
    - *Activity Sheet 39*
    - 40. A Motor Model
    - *Activity Sheet 40*

Or check out the following links for building a simple motor:

http://makeprojects.com/Project/Simple+Motor/67/1

http://mit.edu/cmse/educational/motor_lp_kristy.pdf

Put masking tape on a toy motor and hook it up to a battery to demonstrate how a motor works. For a motor, chemical energy (batteries) or electrical energy (electrical outlets) is transformed to mechanical energy (seen here where the motor turns). Now if you take that same toy motor and turn it yourself, you have created a generator. Generators transform mechanical energy into electrical energy.

Motor

Electrical Energy → **Mechanical Energy**

Generator

Mechanical Energy → **Electrical Energy**

Lesson 5: Simple Generator

View Lesson at:
http://www.amasci.com/amateur/coilgen.html
or view the following 8 pages

Watch DVD: *Rough Science,* "*Power Supplies*" episode

How a Generator Works:

Source: http://www.pbs.org/weta/roughscience/series1/challenges/generator/

"The simplest generator consists of just a coil of wire and a bar magnet. When you push the magnet through the middle of the coil, an electric current is produced in the wire. The current flows in one direction as the magnet is pushed in, and in the other direction as the magnet is removed. In other words, an alternating current is produced. If you hold the magnet absolutely still inside the coil, no current is generated at all. Another way of producing the current would be for the magnet to be rotated inside the coil, or for the coil to be rotated round the magnet.

This method of generating electricity, called induction, was discovered by Michael Faraday in 1831. He found that the stronger the magnets were, the more turns of wire in the coil, and the quicker the motion of the magnet or coil, the greater the voltage produced. Faraday also observed that it was more efficient if the coil was wound around a metal core, as this helped to concentrate the magnetic field."

Lesson 6: Wind Turbine Generator

Wind Turbine Generators

Grade Level: 3rd – 5th grade

Objective:

- The student will be able to explain how energy is transformed from one form (such as mechanical energy) to another form (such as electrical energy).
- The student will be able to explain the difference between a motor and a generator.
- The student will be able to explain how electricity is generated with a coil of wire and a magnet.

Time: Five 30-minute sessions

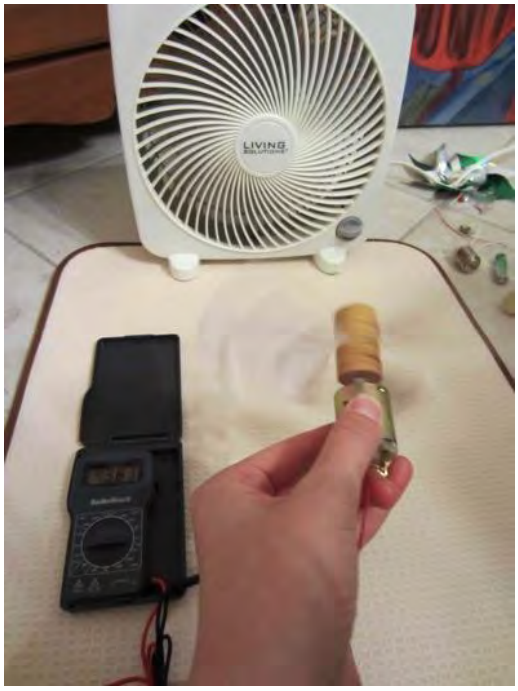
Materials:

- **For teacher preparation and testing station**
  - Box fan

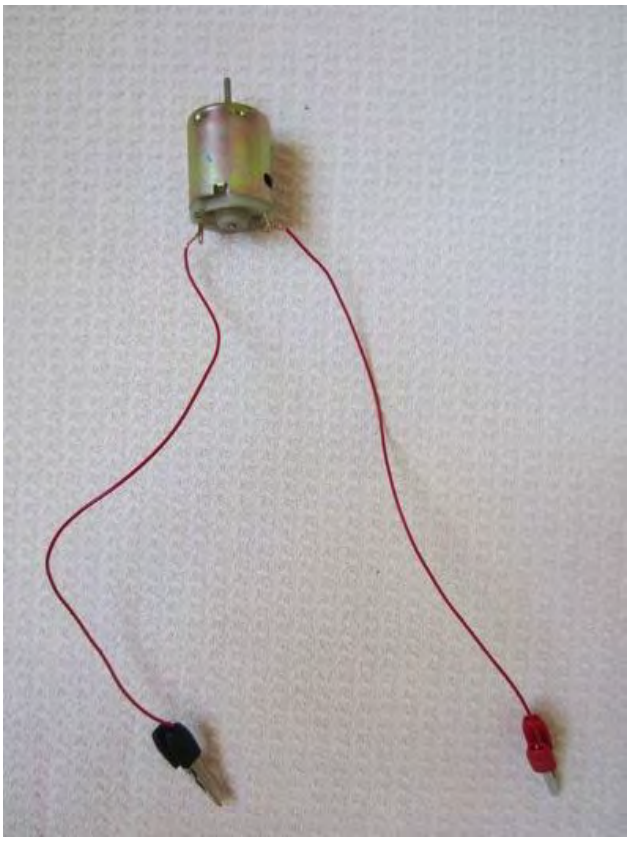
Wind Turbine Testing Station 1 (with generator and multimeter)

- Wire cutters/strippers*
- Spool of copper wire*
- 2 Alligator clips
- One 9-18 V DC motor
- multimeter

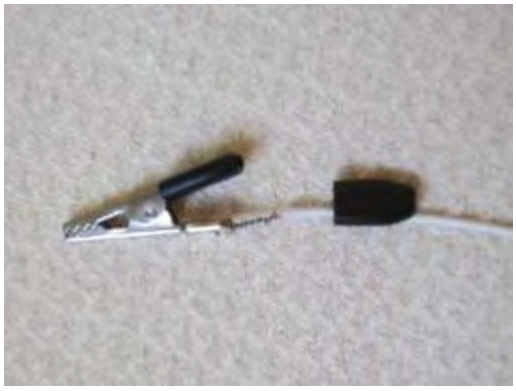
SEE SET-UP BELOW



multimeter, box fan and DC motor with turbine attached for testing



DC Motor with insulated copper wire and alligator clips attached



Attaching wire to alligator clip

Alligator Clips

Wind Turbine Testing Station 2 (with weights)

- unwaxed dental floss, yarn or string (about a meter long)
- washers
- 1 bamboo skewer
- 2 corks
- One 2-liter bottle filled with water or sand
- 1 jumbo paperclip

SEE SET-UP BELOW

Wind turbine lifts paperclip with washer

- **Tools**
  - Low-temp hot glue gun
  - Hand miter saw
  - Scissors
  - Hand powered drill
- **For wind turbine blades**
  - 1 cork
  - jumbo paper clips
  - paper, cardstock, used file folders, etc.
  - Styrofoam trays
  - Masking tape
  - Bamboo skewers, chop sticks, craft sticks, wooden coffee stirrers, etc.
  - Glue
  - Plastic bottles
  - Straws
  - Thumb tacks, push-pins

*Can be found in 4th and 5th grade Delta Hands-On Kits

- **Wire cutters/strippers**: 5th and 4th grade Delta Hands-On Kits (Bin # 6)
- **Spool of insulated copper wire**: 5th and 4th grade Delta Hands-On Kits (Bin # 6)

Procedure:

1. Explain to students that they have been contracted by the government to create a wind turbine. Students will form companies consisting of 2 – 3 students each. Their budget for the project is $400.00. The student company that creates the fastest spinning wind turbine (with the largest electrical output) will win the contract. If there is a tie for the contract, the company with the lowest budget (money left over) will win. The government will be measuring the speed of the turbine by measuring how fast the turbine can wind a string with 1 washer attached. They will measure the strength of the turbine by determining how many washers the turbine can fully wind to the top. The electrical output of the wind turbine generator will be measured by the electrical current output measured on the multimeter. When testing, students will be able to hold the box-fan up to the wind turbine as close as they like. Unless you buy a high-powered fan, it will be necessary to have the fan very close to the wind turbine.

Day 1	Students will form companies, establish roles, develop a design, and fill-out projected budget, and checks.
Day 2	Students will purchase materials and begin construction of wind turbine.
Day 3	Students will continue construction of wind turbines and begin testing.
Day 4	Students will modify design based on testing results and re-test.
Day 5	Students will compile final project report, present projects, and final trials will be conducted.

Approved Subcontractor List		
SUBCONTRACTOR	**ITEM/SERVICE**	**UNIT COST**
Pop-top Corporation	1 Cork	$25
Styrofoam Goods	1 Styrofoam tray- large	$100
	1 Styrofoam tray- small	$60
International Paper Products	1 sheet of copy paper (scrap)	$5
	1 letter-size folder (used)	$70
Bind-it Inc.	masking tape (12 inches)	$15
	1-day glue rental (liquid or stick)	$5
	1 push-pin or 1 thumb tack	$10
	Duct tape (6 inches)	$40
	1 jumbo paperclip	$20
Saw-works Service	1 cut with the miter saw	$10
	1 drilled hole with hand drill	$10
Lumber Yard Ltd.	1 bamboo skewer- 6 inch	$35
	1 bamboo skewer- 12 inch	$55
	1 craft stick	$20
	1 chop stick	$40
	1 wooden coffee stirrer	$15
American Plastics Corporation	1 straw- regular	$5
	1 straw- coffee	$5
	1 small plastic bottle	$100
Wind-Works Consultation	Question/Advisement	$5
Turbine Testing Rental Center	1 Trial	$10

Evaluation & Student Assessment

Project Rubric

Wind Turbine Project Rubric

Part I: DOCUMENTATION

Document	**Neatness** 0 = very messy 1 = messy 2 = neat 3 = very neat	**Completeness** 0 = < 50 % complete 1 = 50% complete 2 = 75% complete 3 = 100% complete	**Accuracy** 0 = 5 or more mistakes 1 = 3 – 4 mistakes 2 = 1 – 2 mistakes 3 = No mistakes	**Document TOTAL**
Projected Budget	0 1 2 3	0 1 2 3	0 1 2 3	
Design Plans				
Balance Sheet				
Trial Log				
Company Journal				

Part I TOTAL _____/35

Part II: EXECUTION

Requirement	0 = No	5 = Yes	**TOTAL**
Design met guidelines	0	5	
Stayed within budget	0	5	
Completed on time	0	5	

Part II TOTAL _____/15

Part III: RESULTS

	Data	**Class Rank** Out of_____ Student Groups	**Points Obtained** 1st = 7 5th = 3 2nd = 6 6th = 2 3rd = 5 7th = 1 4th = 4 8th = 0
Highest voltage on multimeter			
Fastest time winding 1 washer			
Highest number of washers wound			

Part III TOTAL _____/21

Part IV: TEAMWORK

Team Members	**Participation**	**Cooperation**	**Sportsmanship**	**Team Member TOTAL**
Name: Job/Role:	______/10 Day 1= 0 1 2 Day 2= 0 1 2 Day 3= 0 1 2 Day 4= 0 1 2 Day 5= 0 1 2	______/10 Day 1= 0 1 2 Day 2= 0 1 2 Day 3= 0 1 2 Day 4= 0 1 2 Day 5= 0 1 2	______/10 Day 1= 0 1 2 Day 2= 0 1 2 Day 3= 0 1 2 Day 4= 0 1 2 Day 5= 0 1 2	_______/30 COMMENTS:
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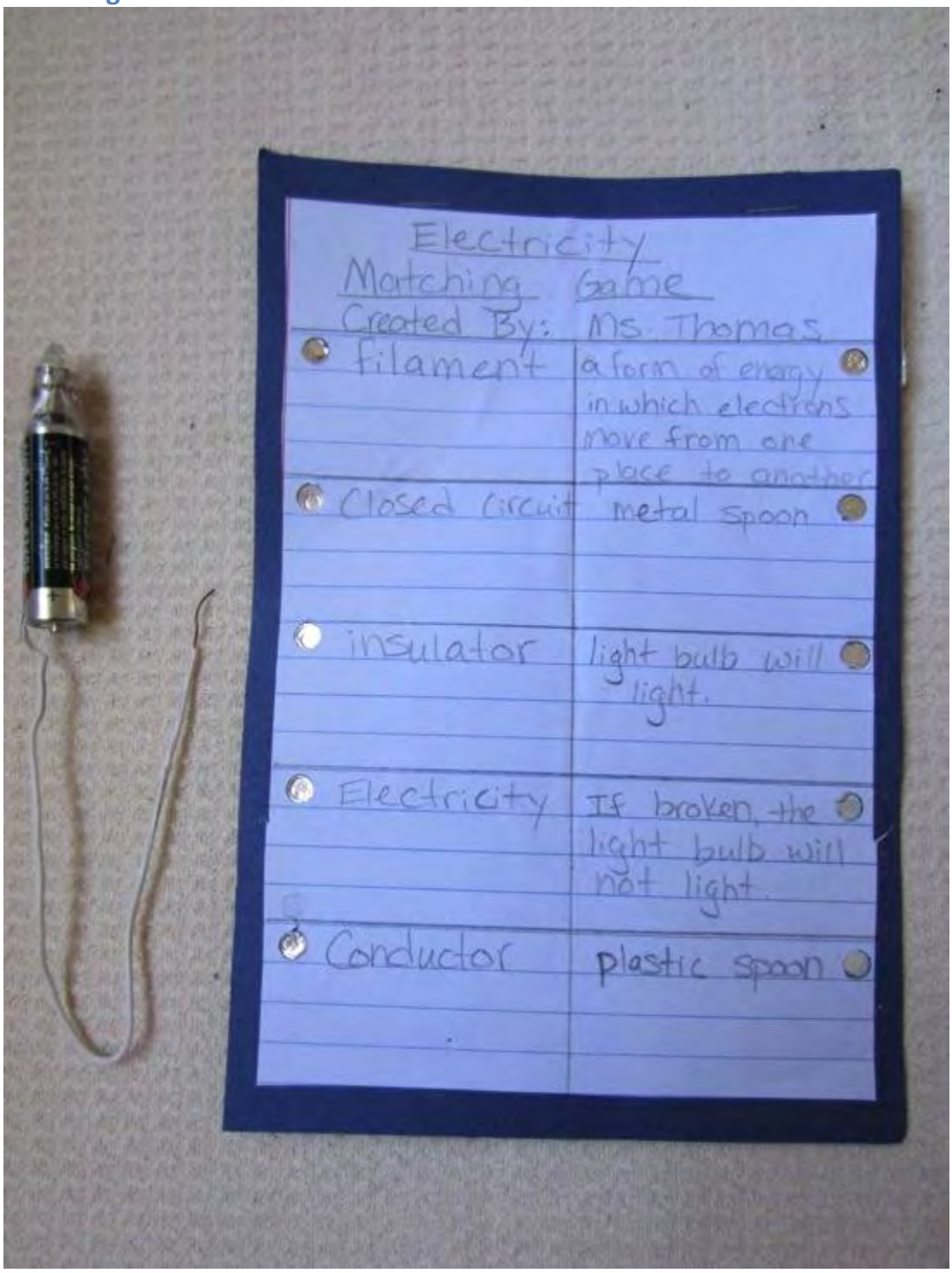
Name: Job/Role:	______/10 Day 1= 0 1 2 Day 2= 0 1 2 Day 3= 0 1 2 Day 4= 0 1 2 Day 5= 0 1 2	______/10 Day 1= 0 1 2 Day 2= 0 1 2 Day 3= 0 1 2 Day 4= 0 1 2 Day 5= 0 1 2	______/10 Day 1= 0 1 2 Day 2= 0 1 2 Day 3= 0 1 2 Day 4= 0 1 2 Day 5= 0 1 2	_______/30 COMMENTS:

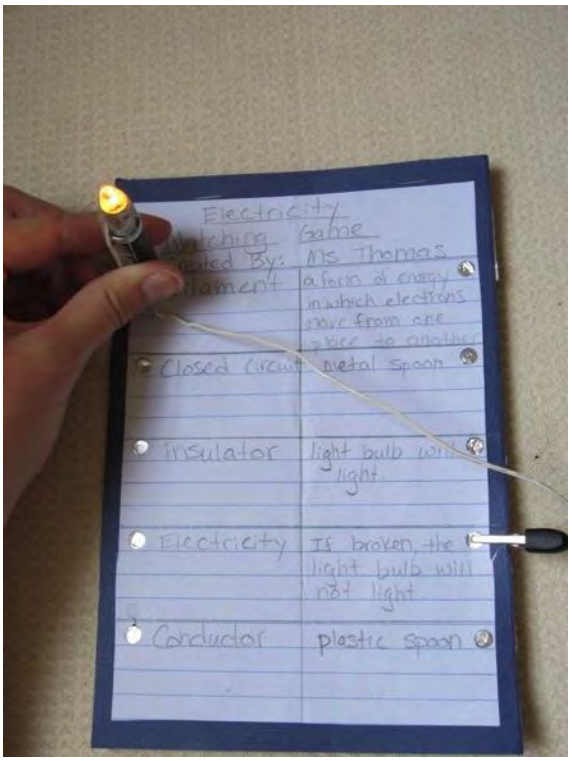
Matching Game



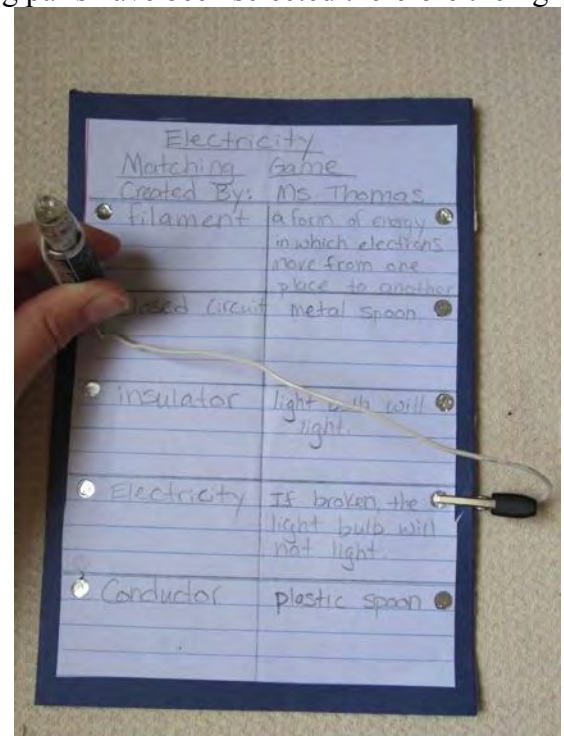
The object of the game is to match the words on the left with the correct description, definition, example or statement on the right.

When you open the inside of the matching game, you can see the circuit board. The masking tape covers each strip of aluminum foil to act as an insulator so that the bulb will only light when the correct answer is matched.

AA battery with small incandescent light bulb taped to top with transparent tape. Notice one end of the wire is stripped and wrapped around the side of the light bulb.



The correct matching pairs have been selected therefore the light bulb is illuminated.



An incorrect match has been selected therefore the light bulb is not illuminated.

Resource List

Websites

- www.need.org
- http://learn.kidwind.org/
- http://icreatetoeducate.com/
- http://www.amasci.com/amateur/coilgen.html
- http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html
    - Scroll down on the right-hand side and click on "Faraday's Law" Link
- http://www.tbgf.org/sustainable-kids/curriculum/docs/re-energy-hydroelectric-generator-plans.pdf
- http://www.mahster.com/content/view/54/43/
- http://www.otherpower.com/
- http://phet.colorado.edu/en/simulation/generator
- http://www.tbgf.org/sustainable-kids/curriculum/index.php
- http://www1.eere.energy.gov/wind/wind_how.html
- http://www.amasci.com/amateur/coilgen.html
- http://web.archive.org/web/20030204155144/www.eskimo.com/~billb/amateur/coilgen.html
- http://www.aeronautics.nasa.gov/pdf/wind_power_9-12.pdf
- http://www.pbs.org/weta/roughscience/series1/challenges/generator/

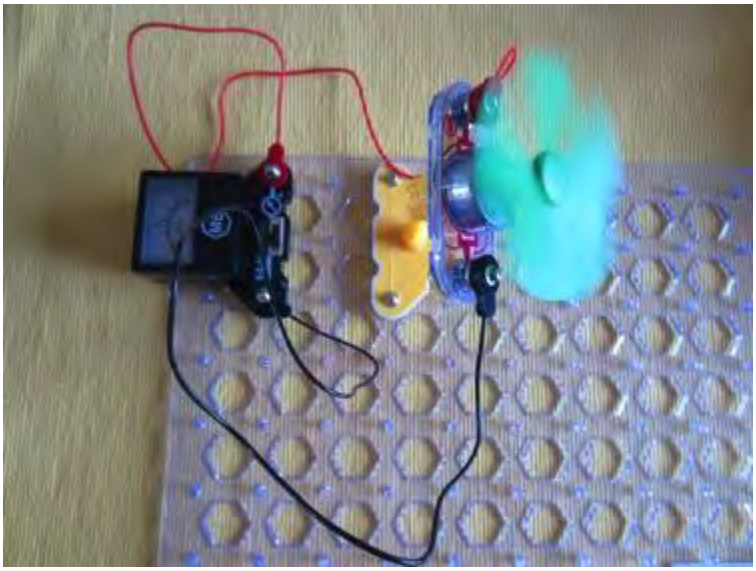
Reference for Student Company, Checkbooks, Purchase Orders, etc.

- **http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html**

Supplemental Materials

ITEM Description	Vendor	Cost
Snap Circuits Green	http://www.fatbraintoys.com/	$65.95
Advanced Wind Experiment Kit SKU: A0012	http://learn.kidwind.org/	$125.00
Advanced Wind Experiment Kit - Classroom Pack SKU: A0015	http://learn.kidwind.org/	$349.00
simpleGEN SKU: A0051, A0062	http://learn.kidwind.org/	$27.00
Ceramic magnets	Radio Shack	
multimeter	Radio Shack	
Alligator clips	Radio Shack	
Insulated copper wire	Radio Shack	
Wire cutters	Radio Shack	
AA Batteries	Radio Shack	
D Batteries	Radio Shack	
Small incandescent light bulb	Radio Shack	
Small motor	Radio shack	
Heavy duty aluminum foil	Grocery Store	
Paper clips	Office supply	
Thick rubberbands	Office supply	
Brass fasteners	Office supply	
Masking tape	Office supply	
Battery holders	Radio Shack	
Lamp holders	Radio Shack	
Christmas tree lights	Target	
Alligator clips	Radio Shack	
Box fan	Target	
ID Badge Holder	Office supply	
DVD: Rough Science	www.bullfrogfilms.com	$24.95


SNAP CIRCUITS
GREEN
By ELENCO
Alternative Energy
AGE 8 - 108
SNAP CIRCUITS
Build over 125 projects!
Features:
FM Radio
Hand Crank
Solar Cell
LED's
Energy Cell
Rechargeable Battery
Windmill
Clock
Analog Meter
Have fun learning about new energy sources
Model SCG-125



http://store.kidwind.org/wind-energy-kits/complete-kits/basic-wind-experiment-kit

http://store.kidwind.org/more-kits/generator-kits-and-parts/simplegen

The simpleGEN kit from KidWind is an easier modification for students too young or teachers not comfortable making William Beaty's Ultra-Simple Generator

Bibliography

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Robertson, B. (2009). How do windmills generate power? *Science and Children, 46 (9), 55 - 57.*

How to use a multimeter
http://store.kidwind.org/videos#product-tabs

Broward County Hands-On Science Delta Kits

Grade 4

38. Building an Electromagnet

Activity Sheet 38

39. A Simple Motor

Activity Sheet 39

40. A Motor Model

Activity Sheet 40

Grade 5

19. Designing a Solar Collector

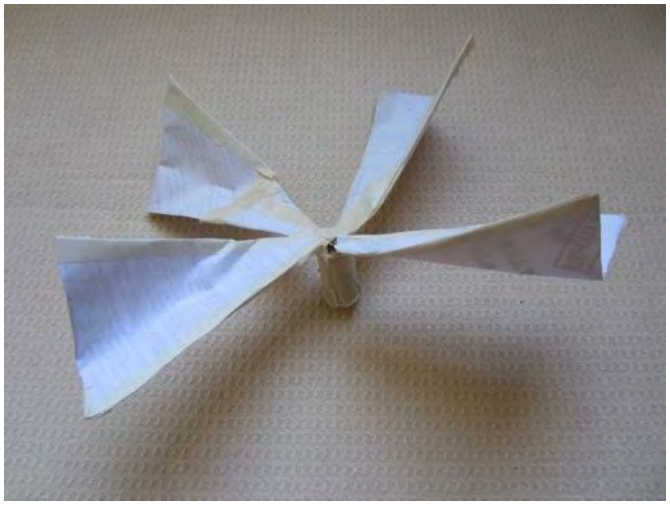
Activity Sheet 19

20. Solar Cells

Activity Sheet 20

Science Fusion Gr. 4
Inquiry Flipchart Unit 6, Lesson

Student Work Samples



Wind turbine blades made with paper, 8 jumbo paper clips and masking tape.

Wind turbine blades made with duct tape and bamboo skewers.

Wind turbine blades made with a plastic bottle.