Smarter Science – Stage 2 – Experimentation

GRADE: 6

ACTIVITY TITLE: Air Hogs / Micro-avion à haute performance

KEY WORDS:

KEY WORDS:	**MOTS CLÉS:**
flight	le vol
lift	la portance
thrust	la poussée
drag	la traînée
force	la force
gravity	la gravité
air	l'air
airplane	un avion

INTRO:

In this lesson, students will expand their knowledge of the properties of air and how those properties enable flight. Students will experiment with various modifications to an Air Hogs model airplane. Once modified, the plane will be flown to determine the effect of the modification on its flight. Students will then be challenged to explain the reasoning behind the altered flight characteristics of the plane. For example, if a student were to add weight to the plane, they may find the plane to have a decreased flight distance. This could be explained by discussing how gravity excerpts a greater pull on objects with greater mass. If the mass of the plane increases but the amount of lift and thrust generated do not, the plane will not fly as effectively.

FORM OF ASSESSMENT:

Diagnostic

This lesson begins with an outdoor demonstration of the Air Hogs plane. As a quick diagnostic assessment, and to help students recall prior knowledge, conduct a quick think-pair-share activity. Ask the question, "What are the different forces acting on a plane in flight? (lift, gravity, thrust, drag)

Formative

This lesson gives the teacher a chance to observe while students plan, conduct, and collect data from an investigation. As students participate in the activity, the teacher may choose to make anecdotal notes and engage in direct questioning with students. See the "Look Fors" section for an idea of what types of process skills to look for.
Students will record their experiment data for this activity in a science journal. This journal will provide a way for the teacher to review and respond to the work of each student as they progress through the lesson. Avoid giving judgemental comments, marks, or grades in this stage of assessment, opting instead for written feedback that will help students improve the quality of their work. The journal will have seven parts. Consider setting it up as follows:

1. **Observations - Draw and describe the air hogs plane. Label it's parts using appropriate terms.**
2. **Brainstorming - List as many possible modifications to the plane as you can think of. Remember that the plane can not be permanently altered. Consider what changes you can make to the plane that might effect its flight.**
3. **Experiment Plan - Decide on what modification you will do to the plane. Describe and draw what the plane will look like**

after you have modified it. Consider the following questions. What supplies will you need? How long will it take? Is it safe? Will you need the teacher's help?

4. **Predictions - Predict the results of your experiment. How do you think your modification will effect the planes flight? Apply what you know about the properties of air how they are related to the principles of flight.**
5. **Data Collection Part 1 - Unmodified Plane - As a whole class, record the average flight distance and average air time of the unaltered Air Hogs plane. To record distance, measure from the Launch point to the landing area. Use a stop watch to record flight time. Begin timing as the plane leaves the throwers hand, and stop timing as the plane hits the ground. Collect measurements from at least ten different flights to get an average distance.**
6. **Data Collection Part 2 - Modified Plane - Conduct test flights with your modified plane. Follow the same procedure as you did for Data Collection Part 1**
7. **Conclusions - What happened during your experiment? What was the effect of your modification? Why did your plane fly differently? Apply what you know about the properties of air how they are related to the principles of flight.**
8. **Reflections - What did you learn about the properties of air and flight from modifying the Air Hogs plane? Why was it important to conduct more than one test flight? Why was it important to record flight data for the unmodified plane?**

INQUIRY TYPE:

teacher initiated, partially designed; partially student designed, run and tested

MATERIALS RESOURCES:

In the Catalyzer:
Air Hogs plane
Balloons
Provided by Teacher:
50 metre measuring tape or trundle wheel
Science journal
Other materials as required by student experiment design (possibilities include different types of tape, string, foam, weights, paper, cardboard, cellophane, etc.)

TARGET PROCESS SKILL:

Inquiry: Experimentation (Plan & Conduct Investigations; Collect Data)

STRAND:

Structures & Mechanisms: Properties of Air and Flying Devices

BIG IDEAS:

Air has many properties that can be used for flight and for other purposes.
Flight occurs when the characteristics of structures take advantage of certain properties of air.

ENGAGE:

On a calm day take the class outside to demonstrate the flight of the Air Hogs plane. A fairly good size field will be required. If space is a concern, don't inflate the plane's air tank to it's full capacity.
After a few flights of the plane, help students recall prior knowledge by conducting a quick think-pair-share activity. Ask the question, "What are the different forces acting on a plane in flight? (lift, gravity, thrust, drag) Further the discussion by asking what parts of the plane are developing lift (wings), what parts are developing thrust (propeller) and what parts are causing drag (whole plane).
Allow students to investigate different launch methods for the plane. Vary the launch angle (level throw vs angled up or down), the speed with which it is thrown, and the direction it is launched relative to the wind.
As a group, determine which combination of the above variables results in the longest flight distance

EXPLORE:

1. Students return to the classroom and brainstorm possible modifications to the plane. Ideas will be recorded in the Science Journal (TM-1 Science Journal).

2. Students then choose one modification, and complete the experiment plan and prediction section of the Science Journal
3. **Experiment Plan** - Decide on what modification you will do to the plane. Describe and draw what the plane will look like after you have modified it. Consider the following questions. What supplies will you need? How long will it take? Is it safe? Will you need the teacher's help?
4. **Prediction**s - Predict the results of your experiment. How do you think your modification will effect the planes flight? Apply what you know about the properties of air how they are related to the principles of flight.
5. Follow up by returning to the field for **data collection part 1**. Remember to launch the plane in the same way determined in the engage section. In this stage, flight data for the unmodified plane will be collected. To record distance, measure from the Launch point to the landing area using the measuring tape or trundle wheel. Use a stop watch to record flight time. Begin timing as the plane leaves the throwers hand, and stop timing as the plane hits the ground. Collect measurements from at least ten different flights to get an average distance.
6. At this point, students **must begin their experiments** by taking the Air hogs plane, performing the modification, and testing the results. Again, remember to launch the plane in the same way determined in the engage section. This is an important variable to control.
7. As there is only one plane available, the process of modifying and testing will have to take place gradually as other lessons and activities continue.

EXPLAIN/ELABORATE: .

- As each student or student group modifies and then tests the plane, have them complete the Data Collection Part 2 and Conclusion sections of their Science Journal
- **Data Collection Part 2 - Modified Plane** - Conduct test flights with your modified plane. Follow the same procedure as you did for Data Collection Part 1
- **Conclusions** - What happened during your experiment? What was the effect of your modification? Why did your plane fly differently? To answer the questions, apply what you know about the properties of air how they are related to the principles of flight.
- Provide time for students to share their experiment plan and conclusions with classmates.

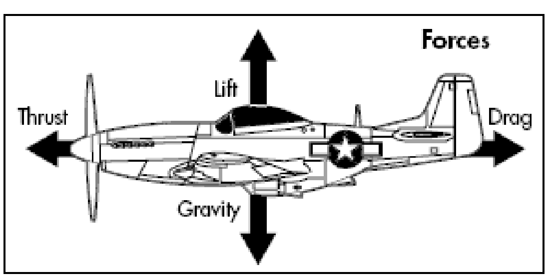
EVALUATE:

Have students return to their science journals and answer the following questions:

- What did you learn about the properties of air and flight from modifying the Air Hogs plane?
- Why was it important to conduct more than one test flight?
- Why was it important to record flight data for the unmodified plane?
- If students have had prior experiences with this type of experimenting, and they have had previous opportunities to practice and apply the skills demonstrated in this lesson, then consider using the entire science journal as a summative assessment. It could be evaluated using a rubric, a checklist, or a rating scale. If this is the first time that students have completed such a task, evaluating the entire journal will not be a fair summative assessment.

BACKGROUND INFORMATION:

The miracle of flight exists because man has the technology to oppose natural forces that keep all objects on the ground. Four forces affect an aircraft — two assist flight (thrust and lift), and two resist flight (gravity and drag). The important thing to note here is that when an aircraft is flying straight and level, all four of these forces are balanced, or in equilibrium.



Thrust

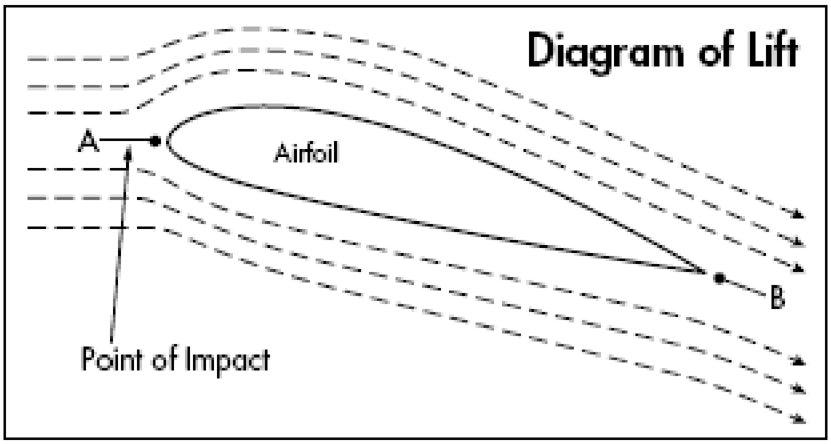
Thrust is created by the engines. As propeller blades push air through the engine (or as jet fuel is combusted to accomplish the same end), the aircraft moves forward. As the wings cut through the air in front of the aircraft, lift is created. This is the force that pushes an aircraft up into the air.

Lift

Lift occurs because air flows both over and under the surface of the wing. The wing is designed so that the top surface is "longer" than the bottom surface in any given cross section. In other words, the distance between points A to B is greater along the top of the wing than under it. The air moving over the wing must travel from A to B in the same amount of time. Therefore, the air is moving faster along the top of the wing.

This creates a difference in air pressure above and below—a phenomenon called the Bernoulli effect. The pressure pushing up is greater than the downward pressure, and lift is created. If you're banking, lift occurs in a slightly sideways direction. If you're inverted, lift actually pulls you downward toward the ground. Note that lift occurs perpendicular to a line drawn parallel to the center line of the wing and occurs at a slightly backward angle.

Several factors determine how much lift is created. First, consider the angle at which the wing hits the air. This is called the angle of attack, which is independent of the aircraft's flight path vector. The steeper this angle, the more lift occurs. At angles steeper than 30° or so, however, airflow is disrupted, and an aircraft stall occurs. During a stall, no lift is created. The aircraft falls into a dive and can recover lift only after gaining airspeed.



Drag
Drag opposes thrust. Although it mainly occurs because of air resistance as air flows around the wing, several different types of drag exist. Drag is mainly created by simple skin friction as air molecules "stick" to the wing's surface. Smoother surfaces incur less drag, while bulky structures create additional drag.
Some drag has nothing to do with air resistance and is actually a secondary result of lift. Because lift angles backward slightly, it is has both an upward, vertical force and a horizontal, rearward force. The rearward component is drag. Another type of drag is induced at speeds near Mach 1, when a pressure differential starts building up between the front and rear surface of the airfoil. The pressure in front of the wing is greater than the pressure behind the wing, which creates a net force that opposes thrust. In WW II aircraft, this last type of drag occurred only during prolonged dives.
Gravity
Gravity is actually a force of acceleration on an object. The Earth exerts this natural force on all objects. Being a constant force, it always acts in the same direction: downward. Thrust creates lift to counteract gravity. In order for an aircraft to take off, enough lift must be created to overcome the force of gravity pushing down on the aircraft.
Related to gravity are G-forces—artificially created forces that are measured in units equivalent to the force of gravity.
from "The Basics of Flight" http://avia.russian.ee/theory/basics_of_flight/index.html

LOOK FORS:

Students are...

- collecting accurate data
- asking relevant questions
- using prior knowledge to hypothesize and predict the results of new experiments
- controlling variables as they test their modifications (launch speed, angle, and direction)
- recording the results of their experiments clearly and concisely
- making connections between what they know about the properties of air and flight, and what they observe when flying the Air Hogs plane
- communicating the results of their experiment clearly

SEQUENCE:

This lesson should come after students have learned the basic properties of air and how these properties relate to flying devices. This activity may serve to reinforce these ideas as it provides a real life example of a flying device to interact and experiment with.

TEACHING STRATEGIES:

Think-pair-share

SAFETY:

Follow safety procedures as outlined in the Air Hogs plane manual and packaging

BLACK LINE MASTER[S]:

- TM-1: Science Journal

TEXT REFERENCES:

Teacher

Bennett, M. & Rolheiser, C. (2001). Beyond Monet: The Artful Science of Instructional Integration. Toronto: Bookation
Flight. (2007, July 26). In Wikipedia, The Free Encyclopedia. Retrieved 16:38, August 1, 2007, from http://en.wikipedia.org/w/index.php?title=Flight&oldid=147189431
Harlen, W. (2006) Teaching, Learning, and Assessing Science 5-12. London: Sage

Student

Busby, Peter (2002). First to Fly: How WIlbur and Orville Wright invented the airplane. Toronto: Scholastic
"The Story of Flight" Series - Ole Steen Hansen

Science & Technology Curriculum Expectations:

2.1 follow established safety procedures for using tools and materials and operating flying devices

2.2 use scientific inquiry/experimentation skills (see page 12) to investigate the properties of air

2.5 use appropriate science and technology vocabulary, including *aerodynamics*, *compress*, *flight*, *glide, propel*, *drag*, *thrust*, and *lift*, in oral and written communication

3.1 identify the properties of air that make flight possible

3.3 identify and describe the four forces of flight – lift, weight, drag, and thrust

3.4 describe, in qualitative terms, the relationships between the forces of lift, weight, thrust, and drag that are required for flight

3.6 describe ways in which the four forces of flight can be altered

Mathematic Curriculum Connections:

Language Curriculum Connections:

Name:____ Date:_________________

Science Journal

#	What I want to change	How I will change the model	What I observed

GRADE: 6
ACTIVITY TITLE: It's Electrifying! / C'est électrifiant!

KEY WORDS:	MOTS CLÉS:
open circuit	un circuit ouvert
closed circuit	un circuit fermé
series circuit	un circuit en série
simple circuit	un circuit simple
electricity	l'éléctricité
energy	l'énergie
light bulb	un ampoule
light bulb holder	la douille de l'ampoule
battery	une pile
positive terminal	une borne positive
negative terminal	une borne négative
design	conception

INTRO:
Students design and share an electrical matching game to demonstrate an understanding of simple circuits.

INQUIRY TYPE: teacher initiated, partially designed; partially student designed, run and tested

MATERIALS RESOURCES:
Provided in Catalyzer:
small light bulb + holder
D battery + holder
Wire (2 m per game)
4 x 30cm lengths of Jinx wood (in intermediate Kit) or a pre fabricated 11x17" frame
glue guns & glue sticks (in intermediate kit)

Provided by Teacher:
paper fasteners X 8 per game
metal tacks X 8 per game
other adhesives: tape, tacks, sticky tack
cardboard or other stiff paper
goggles
optional: Operation Board Game

TARGET PROCESS SKILL:
Technological Problem Solving (Develop Possible Plans; Select & Carry Out the Plan)

STRAND: Energy and Control

BIG IDEA:
Electrical energy can be transformed into other forms of energy.

ENGAGE:
Prep: Create a sample electronic quiz game to demonstrate to the class. The game is built in such a way that a bulb will light when a question is linked with a correct answer. Refer to TM-6 Game Board Instruction Sheet for detailed instructions on how to make the game board. TM-4 "Sample Game Board" has possible game questions and set-up. Once you are finished making your game, deliberately loosen one wire (behind the game) connected to the last question.

- Use the sample energy game to activate prior knowledge about electricity and simple circuits. (Before demonstrating, remember to loosen off the one wire connected to the last question.)
- Play the game with the students going through the questions in order. When you get to the last question, the bulb will not light up. Prompt students to ask questions to find out what is happening. Sample questions could include: "Why doesn't the bulb light up?"; "We all agree that we have found the correct answer, but it isn't responding...Why not?"; "Where could the problem be located?"

- Have students examine the game board to determine how the game works. Prompt them to make predictions on what the problem with the last question might be. Sample predictions would include: a problem with the fasteners? the battery? light bulb? wire? connections between the different parts? (Through questioning and predicting, students will explore and learn to anticipate many variables, especially how a loose wire may prevent the game from working.)
- Explain to the students that they will be given the opportunity to build their own model. Create an anchor chart with the students that outlines a checklist that they could use after completing the building of their board to ensure proper working order.

EXPLORE:
- Have students work through TM-1 Game Planning sheet. They should consider: What is required for your game to be successful? What would this look like?
- Students should describe specific elements required for their game to be successful (e.g., electricity, conductors, circuit, set of questions, a way to demonstrate success), and fill in the appropriate sections of the chart. Have students share responses with a partner.

- Brainstorm possible questions with the students that could be used on their gameboards (e.g. questions to test a reading buddy on subject matter of their choice, review questions for science or math, etc.) There should be at least 4 questions with matching answers. Remind students that questions and answers should not be aligned on the quiz board.
- Students should be encouraged to use word processing software to type up questions and answers for their game board.

EXPLAIN:
- Explain to students the importance of sketching and planning possible designs before making a decision about what to build. Emphasize that even though at this point they will be finalizing the design that they would like to build, changes can still be made throughout the building process.

- Using TM-2 Circuit Planning, have students consider: "What is happening to allow your game to function?" and "What does your circuit look like?."
- Have students draw a diagram and explain their circuitry and game that they plan on building (the first chart on the handout). Again, remind them that changes can be made as they construct and test their game.

- Students return to the "explore" stage to build their model.

EXTEND:
- After they build their model and test it, students perform error analysis and complete the second portion of TM-2, "What does your circuit look like?" to draw and explain any necessary changes. In the last portion of this exercise, students must illustrate and answer the question, "What if you have the right answer, but the bulb doesn't light up?" Students can refer to the anchor chart previously created for assistance.

- Students participate in a sharing session in which their peers provide them with "Two Stars and a Wish." See TM 3 Peers provide 2 'nuggets' of positive feedback and one (positively phrased) suggested improvement for "next time."

EVALUATE:
Student checklist TM 5 "Self Assessment" Students answer questions (yes/no and how/why?). This may be used as a rubric in which they assess their level of understanding. (Formative assessment)

BACKGROUND INFORMATION:
The class is demonstrating the difference between open and closed circuits. Electricity only flows through a completed circuit, or a closed loop. The electricity in this case has its source in the battery (connected to the circuit through a wire when the student touches the wire to a paper fastener). The electrical energy flows through a conductor (the paper fastener) to the device (the light bulb). In this instance, the light bulb lights up when the electricity flows through it (when the student "chooses" the correct answer on the game board). Behind the matching questions game board is a circuit with wires crossed, but a simple circuit nonetheless. An open circuit is a circuit with a break in it. The flow of electricity is stopped by a break (when a wire is not properly attached to the paper fastener) and therefore the light bulb will not light up. Open circuits in real life applications may be the result of a disconnected wire or it may have been done on purpose as in using a switch.

LOOK FORS:
(Taken from the Continuum for Technological Problem-Solving Skills, Ontario Curriculum Grades 1-8: Science & Technology 2007, pg. 17)

Students:
- identify practical problems to solve
- identify possible solutions to a practical problem and explain how each might solve the problem
- selects a possible solution to implement, and provides reason for the choice
- outlines (individually or in small groups) the steps of a plan, including labelled drawings and/or diagrams, to solve the problem
- carries out the pre-determined plan (individually or in small groups)
- designs, builds and tests (on the basis of pre-determined criteria) a device or an object to solve the problem
- records results in a variety of ways

SEQUENCE (where in the unit does this lesson best fit?):
This activity should follow an introduction to the basic principles of electricity. (Ex. Using the Energy Ball Lesson from the STAGE 1 Catalyzer) The students should be aware of the definitions of electron, proton and neutron and understand how electricity flows. This lesson will allow students to demonstrate an understanding of, how can one can control the flow of electrical energy. (Lessons include how electricity flows through a circuit, different types of circuits, and devices that can be used to control electrical energy.)

TEACHING STRATEGIES:
Demonstration, Guided Reflection, Plus Minus Interesting

SAFETY:
All designs should be approved by teacher before construction can begin. If students are creating wooden frames for the game boards, then instruction must be given on how to use special tools (e.g., saw, mitre box, hand drill, etc.). Wear goggles during all building. Students should be carefully monitored while drilling, cutting and assembling of their designs. Hot glue guns should be used by adults only.
Ensure that students do not attach a wire from the top to the bottom of the battery, creating a short circuit and as a result, heat. This will also drain the battery quickly of its power.

BLACK LINE MASTER[S]:
TM-1: Game Planning (Handout)
TM-2: Circuit Planning (Handout)
TM-3: Design Brief
TM-4: Sample Game Board (Reference)
TM-5: Self Assessment Form
TM-6: Game Board Instruction Sheet (Reference)

TEXT REFERENCES:

<u>Read-a-loud's to introduce the lesson:</u>
"Switch On, Switch Off" By Melvin Berger, Harper Collins, ISBN-0-06-445097-X
"Electricity-Bulbs, Batteries and Sparks" by Darlene Stille, Picture Window Books, ISBN-1-4048-0245-2
"Electricity"- I Know That Series-by Claire Llewellyn, Sea to Sea Publications, ISBN-1-932889-35-3
"Electricity" by Karen Bryant-Mole, Rigby Interactive Library, ISBN-140344048-2
"Flick a Switch-How Electricity Gets to Your Home- by Barbara Seuling, Holiday House, ISBN-0-8234-1729-8

The following books could be used at a centre with a "Plus Minus Interesting" chart (See Instructional Intelligence flip book for instructions)
"Electricity-from Amps to Volts" by Christopher Cooper, Heinemann Library, ISBN-140340950-1
"Facts About Electricity" by Rebecca Hunter, Franklin Watts, ISBN-1-58340-453-8
"Conductors and Insulators" by Angela Royston, Heinemann Library, ISBN-140340851-3

Additional Resources:
T VDSB Energy & Control Curriculum Unit A Energy Games Galore
http://www.tvdsb.on.ca/currscielementary/curriculum/EC%20Unit.shtml

Let's Talk Science UBC Partnership Program
www.gss.ubc.ca/LTS/docs/Electricity_Kit.doc

Science & Technology Curriculum Expectations:
2.1 follow established safety procedures for working with electricity
2.2 design and build series and parallel circuits, draw labelled diagrams identifying the components used in each, and describe the role of each component in the circuit
2.5 use technological problem-solving skills (see page 16) to design, build, and test a device that transforms electrical energy into another form of energy in order to perform a function
2.6 use appropriate science and technology vocabulary, including *current*, *battery*, *circuit*, *transform*, *static*, *electrostatic*, and *energy*, in oral and written communication
3.5 identify ways in which electrical energy is transformed into other forms of energy
3.6 explain the functions of the components of a simple electrical circuit
3.7 describe series circuits (components connected in a daisy chain) and parallel circuits (components connected side by side like the rungs of a ladder), and identify where each is used

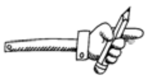
Mathematics Curriculum Connections:

The volt is the unit for measuring electrical force. The first battery was invented in 1800 by an Italian count, Alessandro Volta. The measuring unit was named after him. The power of a cell or battery is measured in volts. A small cell may give 1.5 volts of electricity. Cells can be connected together into batteries to provide more electricity. A small flashlight may use two 1.5 volt cells, so it has three volts. A radio may use a nine-volt battery that contains six 1.5 volt cells. Do a search around the house and find objects that are run by electricity. Record the voltage that is required for them to work.

Adapted from: The Facts About Electricity by Rebecca Hunter-See References

Language Curriculum Connections:

Name: ____

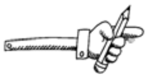


Consider:

- **What is required for your game to be successful?**
- **How will this work?**
- **What materials do you need?**

What is required for your game to be successful?	How will this work in your game board? What materials do you need in order to produce each section of your game?
1. Electricity	
2. Conductors	
3. Circuits	
4. A set of questions	
5. A way to demonstrate success (correct answers)	

Name: ____



Consider:

- **What will this look like?**
- **What is happening to allow your game to function?**
- **Draw a diagram and explain what will happen.**

Before Testing Your Game	
Draw a diagram:	Explain what will happen:

Après avoir évalué ton jeu	
Draw a diagram:	What changes did you make? Why?

It's Electrifying!!

Electricity Project: Circuit Quiz Game

Learning Outcome: In this task, you will be able to demonstrate your knowledge of a 'simple' circuit while incorporating your expertise with word processing software. (Not to mention your specialization in a trivia topic of your choice!!!)

Task: You are to design and build a creative quiz game using the concept of a 'simple' circuit. The game board must consist of a column of 4 questions opposite a column of 4 answers. If the correct match is made, a bright light bulb shows that you have the right response. Once the board is complete, you are to bring it to school to test your friends and even your teacher.

Materials Required:

- Circuit Wire
- Paper Fasteners
- 8 ½ X 11 paper for questions
- 2 sheets of 8 ½ X 11 cardstock for reinforcement and backing
- Wood and glue for frame(optional)
- A must: creativity and desire to deliver your best :)

Process:

1) Select a trivia topic and create a catchy title for your quiz on the computer. Create a column of 4 questions down the left hand side of your page. On the opposite side of the page, create a column of answers in a random order.

2) Add pictures or graphics to make your quiz pleasing to the eye. Remember: Keep it clear and simple. *Print it!*

3) Take your sheet and glue it to a sheet of cardstock for reinforcement.

4) You will now need to create a total of 8 holes to accommodate your paper fasteners (one for each question and one for each answer). How you choose to space these out is entirely up to you, so long as it is clear to your audience which fastener belongs to each question or answer. Install paper fasteners.

5) Really fun part!!! Turn your page over. Take your wire and hold one end to a question and extend it to the appropriate answer. Allow a little slack, as you'll need to wrap it around the fastener, and cut. Do this for all 4 questions.

6) Using a pair of scissors, carefully cut enough of the plastic casing off the wire so you will be able to slide the casing off and expose the wire (conductor). Do this for all sides.

7) Wind the exposed wire (conductor) around the paper fastener (conductor) for each question and answer pair. *Why?*

8) Attach the remaining cardstock to the backside of your quiz to cover the wires. Please ensure that the back card can be removed to allow for troubleshooting and assessment.

It's Electrifying!

(Sample Quiz Board Game)

What are some examples of other forms of energy into which electrical energy can be transformed?	**For example, by batteries using chemical energy; by dams using water power; by generating stations using nuclear energy**
What are some examples of how electricity is produced?	Knife and pressure
What are two types of circuits?	**televisions, telephones, radios, computers**
What are examples of how chemical energy can be transformed into electrical energy?	light, heat, sound
What are two types of switches?	series, parallel
What types of devices use electricity to send signals?	**For example, in batteries, or you can also build a circuit using a lemon or a potato**

Name: ____

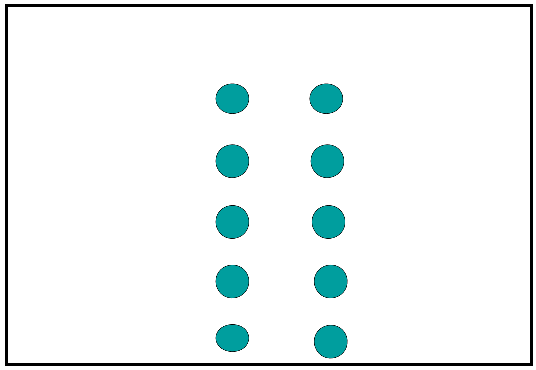
Self-Evaluation

1. Did your game work? Yes___ No ____	Explain your answer. How? Why?
2. How would you rate your team's ability to work together? Level: 1 _____ 2 _____ 3 _____ 4 _____	Explain your answer. How? Why?
3. Did you economize on supplies and materials? Yes___ No ____ Sometimes _______	Explain your answer. How? Why?
4. Did you follow safety guidelines and procedures? Yes___ No ____ Sometimes _______	Explain your answer. How? Why?
5. Did you follow the recommended procedure? Yes___ No ____ Sometimes _______	Explain your answer. How? Why?

Game Board Instruction Sheet

1. Use the jinx wood to create a frame for the game board. Glue or tape a piece of cardboard to be the backing of the game board.

2. Drill 10 holes using an electric or hand drill with a ¼ inch bit, or use a single-hole punch to create 10 holes like the pattern below.



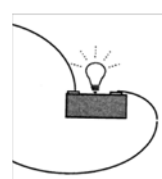
3. Slip a brass paper fastener through each hole and open up the prongs of each one on the back side of the board.

4. Write your questions on five of the cards and glue them onto the left side of your board, one beside each paper fastener. Then, write the answers to the questions on the other card pieces and glue them by the paper fasteners on the right side. Be sure to mix your answers so they aren't right next to the questions they match.

6. Using pieces of insulated wire with ½" of insulation stripped from each end, connect the prongs of the paper fasteners for the correct questions and answers on the back of the board. You can secure the wire to the paper fastener prongs with tape.

7. Turn over your board. From the front, you should not be able to tell which paper fasteners are connected to each other.

8. Connect a bulb and holder or a buzzer in an open circuit as shown:



9. Now, test the game board. Touch the two ends of wires from the tester (from the light/ buzzer) to a matching question and answer pair. Does the light come on (or the buzzer buzz)? If not, check to make sure that:
- You have the right question and answer connected by wire in the back; and
- Your connections in the circuit are tight.

10. Try out all of your question-and-answer pairs to make sure that only the correctly matched questions and answers cause the light to come on (or the buzzer to sound).

(Adapted from: TechLinks for CTCs - Build It Game Board)