Unit Title: Catching the Wind: Designing Windmills **Date Developed/Last Revised:** June 19, 2013 **Unit Author(s):** Kainoa Calip, John Constantinou, Hope Espinda, Jane Wells	**Grade Level:** Grade 4 **Time Frame:** 360 minutes (6 sessions – varied times) **Primary Content Area:** Scientific Inquiry and Electricity

UNIT DESCRIPTION:

In this unit students will discover and discuss electricity, energy, and alternative sources of energy. Throughout this unit, students will focus on activities related to understanding how the wind can do work and how it can create electricity, as well as how to design mechanisms that utilize wind power**.**

Big Ideas (Student Insights that Will Be Developed Over the Course of the Unit):

Students will explore, invent, and investigate the physical science concepts of energy and electricity through engagement in the scientific inquiry and engineering design processes and understand how wind can create energy.

Essential Questions (Questions that Will Prompt Students to Connect to the Big Ideas):

1. What is energy?
2. What is electricity?
3. How can wind energy create electricity?

	BENCHMARKS/STANDARDS/LEARNING GOALS
Science	*Note: The "L" codes at the end of each benchmark refer the Marzano's Taxonomic Level of Understanding, which the benchmark was assigned. So for example, "L1" refers to Taxonomic Level 1: Knowledge Retrieval.* • SC.4.1.1: Describe a testable hypothesis and an experimental procedure (L3) • SC.4.1.2: Differentiate between an observation and an inference (L2) • SC.4.2.1: Describe how the use of technology has influenced the economy, demography, and environment of Hawaii (L2) • SC.4.6.2: Explain what is needed for electricity to flow in a circuit to create light and sound (L2)
Technology	CTE Standard 1: TECHNOLOGICAL DESIGN: Design, modify, and apply technology to effectively and efficiently solve problems • Electric generator • Vernier LabQuest 2 with anemometer • Multimeter

Engineering	• CTE Standard 1: TECHNOLOGICAL DESIGN: Design, modify, and apply technology to effectively and efficiently solve problems
Mathematics	• CCSS.Math.Content.4.MD.A.1: Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
English Language Arts and Literacy	• CCSS.ELA-Literacy.RI.4.3: Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. • CCSS.ELA-Literacy.RI.4.4: Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topics or subject area*. • CCSS.ELA-Literacy.RI.4.9: Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. • CCSS.ELA-Literacy.RL.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. • CCSS.ELA-Literacy.RL.4.2: Determine a theme of a story, drama, or poem from details in the text; summarize the text. • CCSS.ELA-Literacy.RL.4.3: Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions).
STEM Competencies	• Community Contributor: The understanding that it is essential for human beings to work together. • Complex Thinker: The ability to demonstrate critical thinking and problem solving. • Quality Producer: The ability to recognize and produce quality performance and quality products. • Effective Communicator: The ability to communicate effectively. • Effective and Ethical User of Technology: The ability to use a variety of technologies effectively and ethical.

LESSON SEQUENCE

	Lesson Title/Description	Learning Goals (What Students Will Know and Be Able to Do)	Assessments	Time Frame
1	Hook: Intro (or review) to Energy and Electricity	• Explore electricity by forming a class circuit. • Work in groups to brainstorm and create circle maps of electricity and energy. • Share their ideas from their Circle Maps.	**Formative:** • Student participation during brainstorming and sharing of their group's ideas • Circle Maps • Reflection (Science Journaling in Science Notebook)	30 min
2	Creating Circuits	• Use a battery or solar panel to create circuits powering a light bulb, a buzzer, and a motor.	**Formative:** • Student participation during circuit creation • Completion of circuit **Summative:** • Labeled circuit diagram in Science Notebook • Explanation of what is needed for electricity to flow in a circuit to create light and sound	60 min
3	*Leif Catches the Wind*	• Read the story *Leif Catches the Wind.* • Discuss the work of mechanical engineers.	**Formative:** • Student handout, Leif Catches the Wind: Story Elements + Summary + Theme • Partner/Class Discussion	60 min+
4	Guided Inquiry: Number of Blades (or Blade Size)	• Complete a scientific investigation using wind turbines. • Determine if a windmill with 3 or 4 blades will create more energy. • Independently generate their own ideas of different ways they can generate energy. *An alternative inquiry activity is also included focusing on 2 different size blades and students calculating area of the blades	**Formative:** • Ongoing entries in Science Notebook • Observations of students during inquiry process, Windmill Investigation **Summative:** • Completed Lab Report (Rubric attached)	120 min

5	Engineering a Mini-Water Wheel	• Use the engineering design process to design and construct windmill blades. o Ask questions about the problem o Imagine different solutions o Plan and create their group's blade designs o Test their blades o Improve their original designs	**Formative:** • Drawings in Science Notebook **Summative:** • Constructed mini-water wheel • Reflection (Science Journaling in Science Notebook) See Lesson 1 for Science Notebook Rubric	2 sessions 60 min 45 min

Unit Title: Catching the Wind: Designing Windmills Lesson Title: Hook: Intro (or review) to Energy and Electricity Date Developed/Last Revised: 6.19.13 Unit Author(s): Kainoa Calip, John Constantinou, Jane Wells	Lesson #: 1 Grade Level: 4 Primary Content Area: Science Time Frame: 30 min

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- SC.4.6.2: Explain what is needed for electricity to flow in a circuit to create light and sound (L2)

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Brainstorm and share concepts related to energy and begin forming working definitions.
- Know that electricity is a form of energy.
- Form a circuit that powers an energy ball.

2B. Assessment Tools/Evidence:

Formative:

- Student participation during brainstorming and sharing of their group's ideas
- Circle Maps
- Reflection (Science Journaling in Science Notebook)

Summative:

- NA

3. Learning Experiences (Lesson Plan)

Materials:

- Chart paper
- Markers
- Energy Ball (http://www.scientificsonline.com/energy-ball.html ~$6)

Hook:

Use an energy ball to make the entire class a circuit. They must form a big circle and touch each other. The energy ball will light up and make sounds when they complete the circuit. You can also demonstrate how a switch works by having one group of students open the circuit by letting go.

Procedure:

1. Students Create Circle Maps with the words **Electricity** and **Energy** in the middle.
2. They will use 1 color marker for the initial circle map and a different color when they add to their maps after their learning experiences.
3. Assign students to groups consisting of 3-4 students.
4. Assign half the groups **Energy** as their concept.
5. Assign the other half of the groups to **Electricity**.

6. Go over norms of brainstorming:
    a. Give them their time limit (keeping short ~5-10 minutes is better)
    b. Show them the Circle Thinking Map
    c. Explain that there are no bad ideas during brainstorming and that there are absolutely no put downs tolerated
7. Explain that this is a pre-test and that they do not have to worry about being right yet.
8. They will add to their circle maps after they learn more about the topics.
9. Randomly call on different groups to share some of their ideas. Ask other groups with the same topic if they have anything to add.
10. Share the other topic in the same way.
11. Students will recreate the 2 circle maps in their science notebooks and write a reflection to the prompt:
    a. "What is energy? "
    b. "What is electricity?"

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Science Notebook Rubric (for Science Journaling)					
Category	***Wow! (4)***	***Good (3)***	***Almost (2)***	***Poor (1)***	***SCORE***
Content Accuracy	Written responses demonstrate an understanding of science concepts and proper vocabulary use.	Written responses demonstrate an understanding of some science concepts and proper vocabulary use.	Written responses demonstrate a limited understanding of science concepts and proper vocabulary use.	Written responses demonstrate an inaccurate understanding of science concepts and proper vocabulary use.	
Circle Thinking Map	Illustrations and diagrams are clear, accurate and labeled.	Illustrations and diagrams are usually clear, accurate and labeled.	Some illustrations and diagrams are clear, accurate, and labeled, with some missing.	Illustrations and diagrams are sloppy/unclear or missing.	
Comments: Total: _____/					

Unit Title: Catching the Wind: Designing Windmills Lesson Title: Creating Circuits Date Developed/Last Revised: 6.19.13 Unit Author(s): Kainoa Calip, John Constantinou, Hope Espinda, Jane Wells	Lesson #: 2 Grade Level: 4 Primary Content Area: Science Time Frame: 60 min

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- SC.4.6.2: Explain what is needed for electricity to flow in a circuit to create light and sound (L2)
- SC.4.1.2: Differentiate between an observation and an inference (L2)

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Create separate circuits that power a light bulb, a buzzer and an electric motor.
- Create one circuit that powers a light bulb, a buzzer and an electric motor at the same time.
- Identify the energy source powering their circuit.
- Draw and label a diagram of their circuit.
- Explain what is needed for electricity to flow in a circuit to create light and sound.

2B. Assessment Tools/Evidence:

Formative:

- Student participation during circuit creation
- Completion of circuit

Summative:

- Labeled circuit diagram in Science Notebook
- Explanation of what is needed for electricity to flow in a circuit to create light and sound

3. Learning Experiences (Lesson Plan)

Materials (per group):

- 2 AA batteries or a 3-6V photovoltaic panel (Kidwind.org)
- 8- alligator clip wires (Kidwind.org)
- Electric motor (Kidwind.org)
- Buzzer (http://www.jameco.com, Part no. 76065)
- LED light bulb (can get from Christmas lights, Radio Shack or many other online vendors)

Procedure:

1. Form learning groups of 3-4 students.
2. Write on board, read to students and have students write their 3 performance expectations in their science notebooks.
   - Make 3 separate circuits to light the bulb, power the buzzer and power the motor.
   - Make 1 circuit that powers all the elements at the same time.
   - Draw and label the circuit with all three elements in their science notebooks.
3. Ask students to identify the power source for their circuit.

4. To help students differentiate between an observation and an inference:
    - In their science notebooks have students write observations (what they notice) when they power the buzzer (or light bulb) with one battery vs. 2 batteries. Then have students write an inference or explain why they saw or heard what they did.
5. Have students go back to their original circle maps on **Electricity** and **Energy** to add any new knowledge or ideas.

Extension/Enrichments:

- Students create their circuit in parallel and in series and to make labeled diagrams of each. Ask them what happens to the brightness of the bulb in each of the circuits.
- Students can add more batteries to observe the effects of adding more power to their circuits.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Lab Process – Scoring Rubric 4th Grade

SC.4.1.2: Differentiate between an observation and an inference

	Meets Proficiency	Developing Proficiency	Well Below Proficiency
Observation/Inference	I can explain the difference between an observation and an inference. I can give examples and identify observations and inferences.	I can define an observation and an inference. I can sometimes give examples and identify observations and inferences correctly.	I can define an observation and an inference.

Science Notebook Rubric (for Science Journaling)					
Category	*Wow! (4)*	*Good (3)*	*Almost (2)*	*Poor (1)*	*SCORE*
Content Accuracy	Written responses demonstrate an understanding of science concepts and proper vocabulary use.	Written responses demonstrate an understanding of some science concepts and proper vocabulary use.	Written responses demonstrate a limited understanding of science concepts and proper vocabulary use.	Written responses demonstrate an inaccurate understanding of science concepts and proper vocabulary use.	
Circle Thinking Map	Illustrations and diagrams are clear, accurate and labeled.	Illustrations and diagrams are usually clear, accurate and labeled.	Some illustrations and diagrams are clear, accurate, and labeled, with some missing.	Illustrations and diagrams are sloppy/unclear or missing.	
Comments: Total: _____/					

Unit Title: Catching the Wind: Designing Windmills Lesson Title: *Leif Catches the Wind* Date Developed/Last Revised: 6.19.13 Unit Author(s): Kainoa Calip, John Constantinou, Hope Espinda, Jane Wells	Lesson #: 3 Grade Level: 4 Primary Content Area: ELA Time Frame: 60 min+

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- CCSS.ELA-Literacy.RL.4.1: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- CCSS.ELA-Literacy.RL.4.2: Determine a theme of a story, drama, or poem from details in the text; summarize the text.
- CCSS.ELA-Literacy.RL.4.3: Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions).

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Draw inferences based on details and examples from the text
- Determine the theme of the text
- Summarize the text and include the basic story plot elements

2B. Assessment Tools/Evidence:

Formative:

- Student handout, *Leif Catches the Wind: Story Elements + Summary + Theme*, Partner/Class
- Discussion

Summative: N/A

Note: *Leif Catches the Wind* is a storybook from the Engineering is Elementary (EiE) series that includes 20 different units. This book is from the unit, Catching the Wind: Designing Windmills. For EiE assessment for their entire unit, Catching the Wind, go to:
http://www.eie.org/content/student-assessment-designing-windmills

Engineering is Elementary - Student Assessment for Designing Windmills

"These assessments can be used to assess learning objectives targeted in the ***Catching the Wind: Designing Windmills*** unit. Each page is designated as Advanced (A), Basic (B), or Advanced or Basic (AB). Advanced assessments are designed for use with older elementary students, while Basic assessments are designed for use with younger students. Assessments marked "Post Only" serve as summative assessments for students' learning and are administered after completion of the unit. Assessments marked as "Pre/Post" can be used prior to implementation of the EiE unit in order to get a baseline reading on your students' knowledge and/or as a summative assessment. Further opportunities for assessment are embedded throughout the ***Catching the Wind: Designing Windmills*** teacher guide; see the Overview section of your guide for more information."

Examples:
What is a mechanical engineer? Here are the four worksheets that EiE offers.

http://www.eie.org/sites/default/files/WM_A-6a_What_is_a_Mechanical_Engineer.pdf
http://www.eie.org/sites/default/files/WM_A-7b_What_is_a_Mechanical_Engineer.pdf
http://www.eie.org/sites/default/files/WM_A-8a_What_is_a_Mechanical_Engineer.pdf
http://www.eie.org/sites/default/files/WM_A-9b_What_is_a_Mechanical_Engineer.pdf

3. Learning Experiences (Lesson Plan)

The storybook *Leif Catches the Wind* reinforces the science concept of air as wind and introduces students to the field of mechanical engineering.

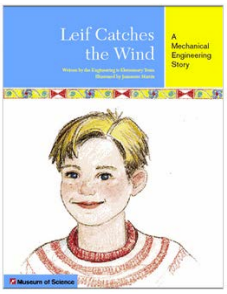
Note: Each of the Engineering is Elementary units begins with a storybook that tells the tale of a child somewhere around the world who solves a problem through engineering. The books integrate literacy and social studies into the unit and illustrate for students the relevance of STEM subjects.

Handouts:

- Student Handout: *Leif Catches the Wind – Story Elements + Summary + Theme*

Other Resources:

- *Leif Catches the Wind: A Mechanical Engineering Story,* illustrated by Jeannette Martin. Written by the Engineering is Elementary Team.
  http://www.eiestore.com/lecawi.html



Story Plot: Leif and his cousin Dana are best friends and keep in touch via email after Dana moves away. Dana's favorite hobby is weather forecasting and her new house has a fishpond outside. Inspired by the wind turbines of Denmark, Leif and Dana realize they might be able to use wind energy to help solve a problem: the fish in Dana's pond seem to be sick. Leif's mother is a mechanical engineer and helps them to design a windmill to save the fish.

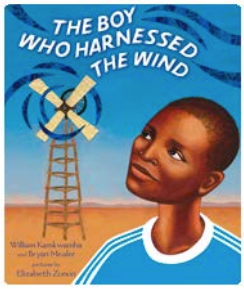
- Story Plot Map
  http://www.educatorworksheets.com/Graphic Organizers/English Language Arts/Story Plot Map.pdf

- Graphic Organizer includes problem, rising action, climax, resolution
  http://worksheetplace.com/index.php?function=DisplayCategory&links=3&id=358&link1=43&link2=261&link3=358

- Free graphic organizers for Elements of a Story
  http://www.scholastic.com/teachers/top_teaching/2011/02/helping-students-grasp-themes-in-literature

    - Finding THE MEssage: Grasping Themes in Literature
        - Theme options, lesson ideas, graphic organizers and more

- *The Boy Who Harnessed the Wind* by William Kamkwamba and Bryan Mealer
  http://www.williamkamkwamba.typepad.com/



"Readers are introduced to the culture of Malawi and see what it is like to live in a country very different than their own. The main character is a boy full of curiosity and can-do spirit who persevered even when people said he was crazy. Children see that hard work pays off and learn the importance in believing in their dreams. The illustrations are worthy of this empowering and hopeful tale, rich and warm and accented with cut-paper collage details. It's an inspiring story of courage in the face of hardship, and ingenuity with limited resources." -- Sarai Brinker, Special to the Star-Telegram

- Ted Talks William Kamkwamba: How I Built a Windmill
  http://www.ted.com/talks/william_kamkwamba_how_i_harnessed_the_wind.html
  http://www.ted.com/speakers/william_kamkwamba.html

Procedure:

BEFORE READING THE BOOK

Preview the book with the students.

- Based on the title and the cover's illustration, what do you think this story will be about?
- Share your prediction with a partner.

WHILE READING THE BOOK

Read the story to the class. Include the following in your class discussion.

A) Discuss story elements.

- Stories have a plot or series of events that center on a problem/conflict
- Conflict: can be a problem between two people or groups, between a person and nature, or within a character
- Rising action – what happened that builds up to the climax?
- Climax- the place where the action builds, and the conflict must be faced
- Resolution – the conflict is solved

B) Make inferences based on what just happened in the story. Use evidence and details from the text to support your inference.

Examples:

1. Chapter One: Lonely Day
   Based on the information in chapter one, who do you think is feeling lonely?
   - Leif
   - Dana
   - Leif and Dana

   Support your answer with evidence from chapter one.

2. Based on the illustration on page 11, do you think you and Leif have anything in common and would be able to be friends? Support your answer with details from the illustration.

AFTER READING THE BOOK

After reading the entire story, students summarize the story with a partner. They should include the main characters, the setting, and the problem and solution of the story.

Explain the Student Handout: *Leif Catches the Wind: Story Elements + Summary + Theme*

- Review each part as needed

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Name: _____ Date: _____

 **Leif Catches the Wind – Story Elements + Summary + Theme** 

1. Make a prediction. Based on the title and the cover illustration, describe what you think this book will be about?

_____

_____

_____

_____

_____

_____

2. Story Elements: Stories have a plot or series of events that center on a problem or conflict. Fill in the following information.

a. Who are the main characters?
_____

b. What is the main conflict in this story? _____

_____

_____

_____

c. What type of conflict was in this story? Circle one.

1. A problem between two people or groups
2. A problem between a person and nature
3. A problem within a character

d. Rising Action: what happened that builds up to the climax?

_____

_____

_____

_____

e. Climax – the place in the story where the action builds and the conflict must be faced

_____

_____

_____

_____

f. Resolution – the conflict is solved

_____

_____

_____

_____

3. Write a summary of *Leif Catches the Wind*

Criteria:

- The first sentence must be the main idea. In one sentence write what the story is mainly about.
- In 2-3 sentences explain what happens in the beginning of the story or what leads to the conflict.
- In 2-3 sentences explain the conflict (the problem) of the story.
- In 2-3 sentences explain how the conflict resolved or the resolution.

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*Tell a partner a summary of the summary! In one sentence, use somebody-wanted-but-so-then for a quick recap of *Leif Catches the Wind: A Mechanical Engineering Story.*

4. What lesson did Leif learn in this story?

_____

_____

_____

_____

5. What is **THE ME**ssage that you can take from this story?

_____

_____

_____

_____

Unit Title: Catching the Wind: Designing Windmills Lesson Title: Guided Inquiry: Number of Blades (or Blade Size) Date Developed/Last Revised:6.19.13 Unit Author(s): Kainoa Calip, John Constantinou, Hope Espinda, Jane Wells	Lesson #: 4 Grade Level: 4 Primary Content Area: Science Time Frame: 2 class periods (120 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- SC.4.1.1: Describe a testable hypothesis and an experimental procedure (L3)
- SC.4.1.2: Differentiate between an observation and an inference (L2)

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Create and test a hypothesis using evidence from a controlled experiment.
- Write a detailed procedure.

2B. Assessment Tools/Evidence:

Formative:

- Ongoing entries in Science Notebook
- Observations of students during inquiry process

Summative:

- Completed Lab Report (rubric attached)

3. Learning Experiences (Lesson Plan)

Materials:

Wind turbines, blades, multi-meters, anemometers (1 set/team of 4 students) ---available online: http://store.kidwind.org/

Handouts/Other Resources:

Student Handouts

- Vocabulary
- Windmill Investigation: Number of Blades
- Windmill Investigation: Blade Size
- Design Your Own Experiment

Procedure:

1. Tell students that they will be working on a scientific investigation.
2. Assign students to lab groups.
3. Pass out Vocabulary handout to each student.
4. Assess their current understanding based on their definitions and drawings for each word: energy, electricity, alternative energy, wind

5. Decide which of the two guided inquiry options you will have your students investigate.
   - Number of Blades: Will a windmill with 3 blades or 4 blades produce more electrical energy?
   - Blade Size: Will the size (area) of the blades affect the amount of energy produced by a windmill?

After investigation is determined:

1. As a class, fill in purpose/hypothesis/prior knowledge areas.
2. Show students the materials that will be used today. As a class, discuss how to set up this lab experiment. Show students how to use a multimeter with a battery.
3. Demonstrate how an electric generator produces energy when it spins. You can also demonstrate that connecting a battery to the motor will cause the motor to spin.
4. Then go over materials and procedure sections.
5. After the lab report has been filled in and students are aware of the procedure, have groups set up their experiments. Each group should be given materials to set up alternative blades (e.g. different sizes), and multimeters.
6. Measure the energy produced by each blade system and record in the data table.
7. Model how to calculate mean energy. Have students calculate the mean energy produced by each blade system.
8. Model how to create a bar graph.
9. Have students create their own bar graphs.
10. Model writing of a conclusion emphasizing using data as evidence to support or refute their hypothesis.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Name of Scientist: _____ Date: _____

Vocabulary

Directions: Answer the following questions. Use drawings and complete sentences.

What is Energy?	What is Electricity?
What is Alternative Energy?	What is Wind?

Lab Report Rubric

SC.4.1.1 I can describe a testable hypothesis and experimental procedure

	Meets Proficiency	Developing Proficiency	Well Below Proficiency
Hypothesis	My hypothesis included if, then, and because statements. It makes sense.	My hypothesis may be missing a part (ex: has the if, then, but not the because). It makes sense.	My hypothesis is missing a lot of parts. It does not make sense.
Experimental Procedure	I listed detailed steps of the scientific procedure. Someone else reading the experimental procedure would know exactly what to do if they followed my instructions.	I listed steps of the scientific procedure. Someone else reading the experimental procedure would know what to do, but might need to ask me questions. Some steps are unclear.	I listed some steps of the scientific procedure, but my instructions are not clear. Someone else would have difficulty reading my steps.

Windmill Investigation: Number of Blades

Question:

Will a windmill with 3 blades or 4 blades produce more electrical energy?

Hypothesis:

IF the windmill has _____ blades, **THEN** it will create more electrical energy **BECAUSE**

_____

_____

_____

Procedure:

1. Set up your windmill hub with 3 blades. Be sure it is balanced.
2. Slide the hub onto the electric motor. Give it a spin and make sure it is still balanced.
3. Set your windmill up in front of the fan with the **fan off.** Measure the distance from the fan to your windmill.
4. Make sure all group members have goggles on and are clear of the spinning blades before you turn on the fan.
5. Connect your multimeter to the wires of the probe.
6. Turn on the fan.
7. Record the voltage reading of your multimeter in your data table.
8. Turn the fan off. Do steps 3-7 two more times.
9. Repeat steps 1-8 using 4 blades.

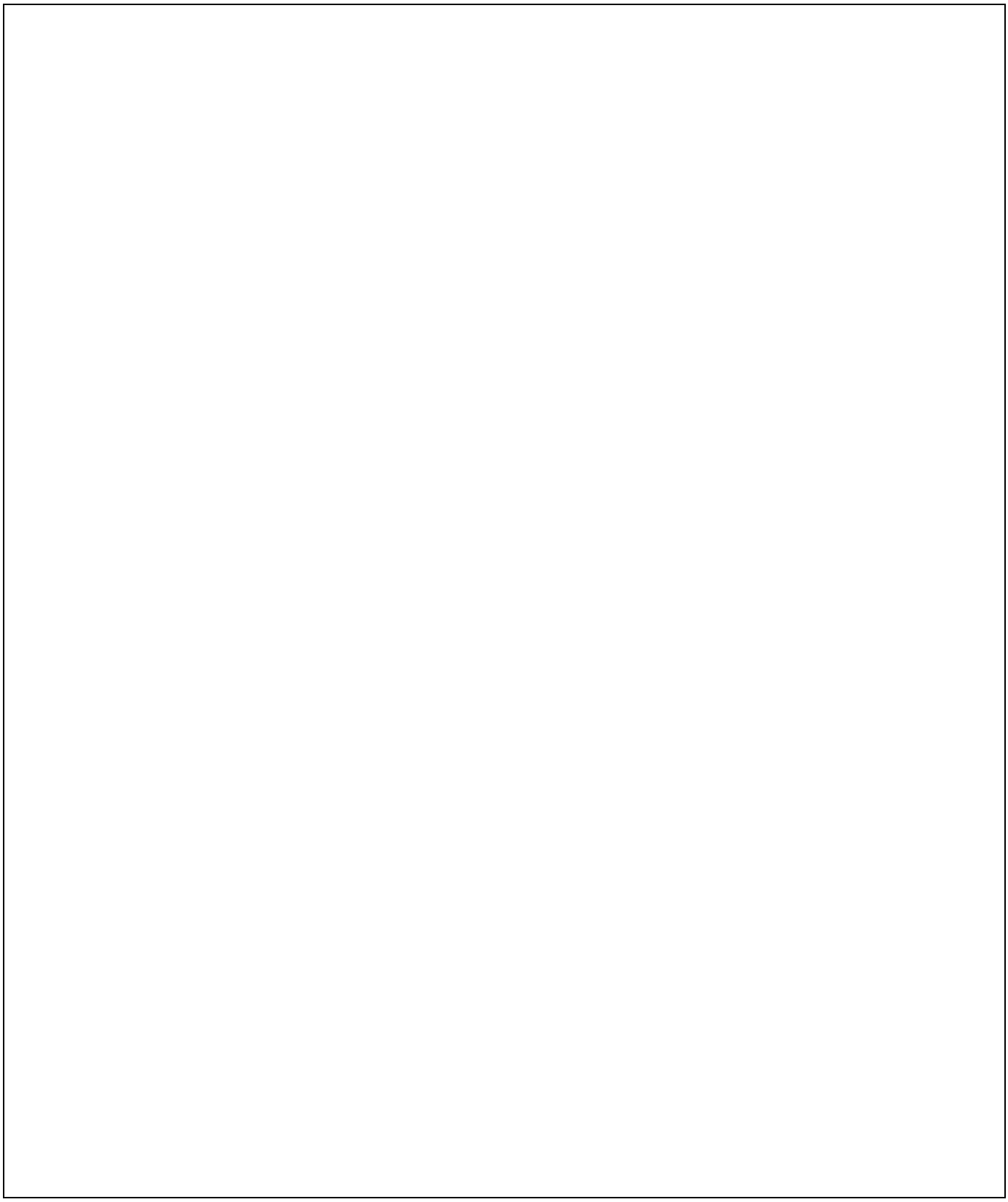
Data (Results):

What should we put on the top of the 2 blank columns? Write it in when you figure it out.

Trial		
1		
2		
3		
Average		

Observations: Record any observations you made while doing the experiment in the box below.

Graph: Make a bar graph to display the results of your experiment. Include a title, label the axes, and include the unit of measurement.



Write a conclusion.

-Restate your hypothesis

-Use your data to explain if your prediction was correct

-Explain the results

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Based on today's investigation, what new wonderings or questions do you now have about windmills or electrical energy? Write a list of questions that you'd like to investigate and explore.

Windmill Investigation: Blade Size

Question:

Will the size (area) of the blades affect the energy produced by a windmill?

Background:

Explain energy, electricity and alternative energy.

Hypothesis:

IF the windmill blades have _____ area **THEN** it will create more electrical energy **BECAUSE**

_____

_____

_____

Procedure:

1. Measure the length and width of the 2 different size blades you will use in the experiment.
2. Calculate area of each blade and record in your data table.
3. Set up your windmill hub with the first 3 blades you will test. Be sure it is balanced.
4. Slide the hub onto the electric motor. Give it a spin and make sure it is still balanced.
5. Set your windmill up in front of the fan with the **fan off.** Measure the distance from the fan to your windmill.
6. Make sure all group members have goggles on and are clear of the spinning blades before you turn on the fan.
7. Connect your multimeter to the wires of the probe.
8. Turn on the fan. Record wind speed with your anemometers.
9. Record the voltage reading of your multimeter in your data table.
10. Turn the fan off. Do steps 7-8 two more times.
11. Repeat steps 2-9 using the other sized blades.

Suggestions for roles:

Materials Manager	- Pick up and return materials.
Recorder (Data Keeper)	- Record data.
Timekeeper	- Keep group on task. Ensure task is completed within the allotted time.
Group Facilitator	- Make sure directions are followed and tasks are completed.

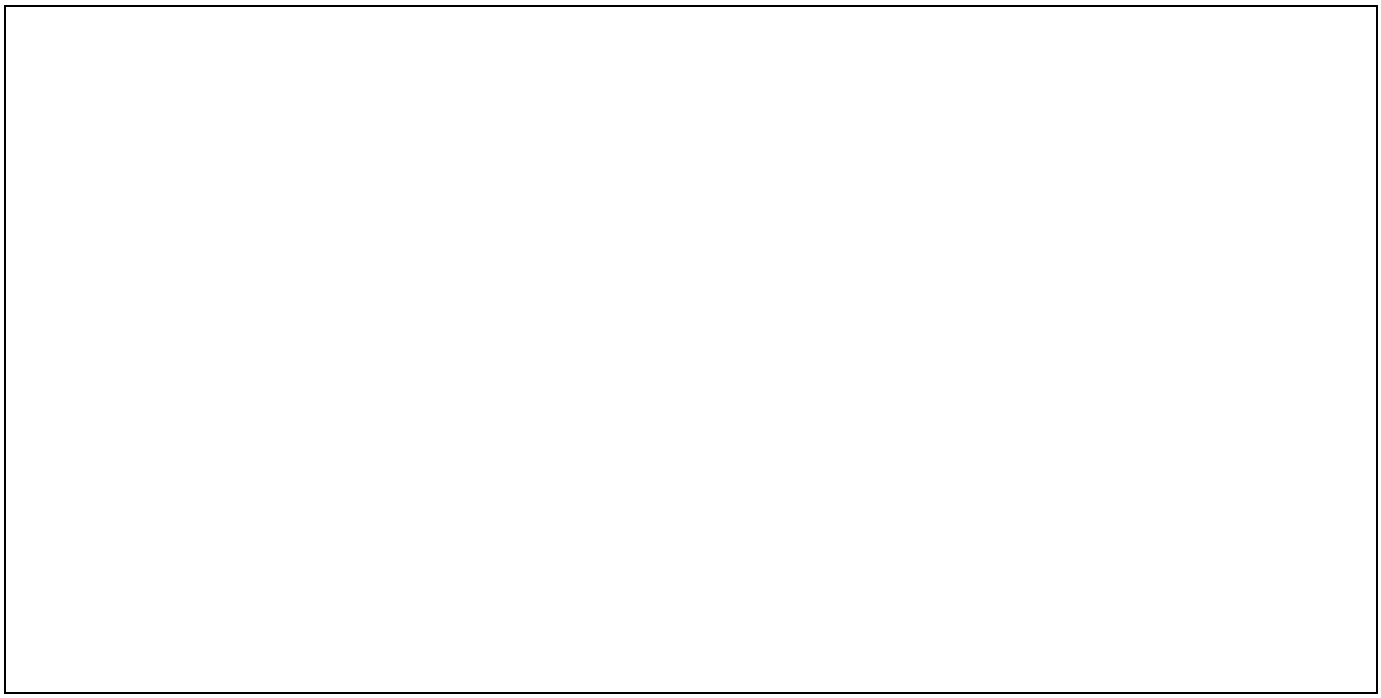
Data (Results):

What should we put on the top of the 2 blank columns? Write it in when you figure it out.

Trial	Energy Produced (mV)	Energy Produced (mV)
1		
2		
3		
Average		

Observations: Record any observations you made while doing the experiment in the box below.

Graph: Make a bar graph to display the results of your experiment. Include a title, label the axes, and include the unit of measurement.



Write a conclusion:

-Restate your hypothesis
-Use your data to explain if your prediction was correct
-Explain the results

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Based on today's investigation, what new wonderings or questions do you now have about windmills or electrical energy? Write a list of questions that you'd like to investigate and explore.

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Name of Scientist: _____ Date: _____

Design Your Own Experiment

Question: _____

_____

_____

_____

Hypothesis:

IF _____,

THEN _____

BECAUSE_____

_____

_____

Materials Needed:

Procedures:

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Data (Results):

Conclusion:

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What things did you try to keep the same in your experiments?

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Can you think of others you should have kept the same?

_____

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_____

These are called constants and controls by scientists and are very important to validate your experimental results.

Unit Title: Catching the Wind: Designing Windmills **Lesson Title:** Engineering a Mini-Water Wheel **Date Developed/Last Revised:** 6.19.13 **Unit Author(s):** Kainoa Calip, John Constantinou, Hope Espinda, Jane Wells	**Lesson #:** 5 **Grade Level:** 4-5 **Primary Content Area:** Science, Engineering **Time Frame:** 2 class periods (60 min & 45 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- CTE Standard 1: TECHNOLOGICAL DESIGN: Design, modify, and apply technology to effectively and efficiently solve problems

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Construct, test, and improve a mini-water wheel.
- Articulate how their system works.

2B. Assessment Tools/Evidence:

Formative:

- Drawings in Science Notebook

Summative:

- Constructed mini-water wheel
- Reflection (Science Journaling in Science Notebook) See Lesson 1 for Science Notebook Rubric

3. Learning Experiences (Lesson Plan)

Materials:

- (1) Mini Water Wheel Engineering Kit per group of 2-4 students (materials may include, but are not limited to scissors, 1.25 or 2L soda bottle, 2 corks, cotton thread, paper plates, stapler, tape, spools, bamboo skewers, fishing weight)

This is just a sample of some of the materials that were included in the kit. The more materials that you are able to include, the more varying types of systems students will be able to create.

Handouts/Other Resources:

Links to on line water wheel making sites with procedures:

- *http://www.solarschools.net/resources/pdf/Make%20Your%20Own%20Water%20Wheel.pdf*
- *http://www.howcast.com/videos/428093-How-to-Make-a-Water-Wheel*

Procedure:

Engineering Design Challenge: Windmills to Water Wheels

1. Use supplies on your table to create a small-scale model of a water wheel.
2. Start with a quick sketch of the model you will build that includes the criteria listed below.
3. Criteria: Your system should be able to lift the maximum weight.
4. Constraints: Water source for all tests will use the same water flow rate measured in L/min. Students should measure the volume collected in a 1 liter graduated cylinder with a stopwatch to calculate the flow rate. Note: Let students discuss and come up with their own plans for how to calculate flow rate.
5. When you complete the model that runs you have completed the **Create** step of the engineering design process and you can consider your system a 'prototype.' NASA engineers need to create at least 100 prototypes before they can build anything. Why?
6. For the **Improve** part of this assignment you need to design a 'new' model using common household materials. You may choose to scale up the model (make a larger model), or improve the current system (e.g., designing a new water paddle).
7. **Math and other extensions**
   - Can you convert the energy produced by your waterwheel to electrical energy?
   - Discuss with your team what measurements are needed to calculate voltage of electrical energy transformed from the water wheel. Take measurements and calculate voltage. Record value in table.
   - Discuss with your team what lab tool will allow you to precisely measure the voltage. Ask your teacher to borrow tool and measure the voltage. Record in table.
   - How did your calculated voltage differ from low water pressure to high water pressure? What could be some of the reasons of the differences between low water pressure and high water pressure?

Trial	Low Water Pressure Voltage	High Water Pressure Voltage
1		
2		
3		
Average		

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes: