This document is not intended to give you all of the information you need to lead the module. You can find the complete instructions at [http://www.chem.ucsb.edu/scitrek/module](http://www.chem.ucsb.edu/scitrek/module). This document is intended to be used as a reference during the module.

**Important Things to Remember During the Module**

1. You are responsible for keeping track of time in the classroom and making sure that ALL activities run smoothly. There will be a time card in the lead box with suggested times to start/stop each activity.
2. You are responsible for keeping volunteers and students on track.
3. Walk around during times volunteers are working with students and help struggling groups.

**Day 1: Procedure Assessment/Technique/Observations**

**Schedule:** You are responsible for **BOLD sections**

- Introduction (SciTrek Lead) – 2 minutes
- Procedure Assessment (SciTrek Lead) – 10 minutes
- Module Introduction (SciTrek Lead) – 5 minutes
- Technique (SciTrek Lead) – 15 minutes
- Observation Discussion (SciTrek Lead) - 2 minutes
- Observations (SciTrek Volunteers) – 23 minutes
- Wrap-Up (SciTrek Lead) – 3 minutes

**Preparation:**

1. If the classroom has a document camera, ask the teacher to use it for the wind farm picture (page 1, picture packet), class question (front cover, student notebook) and technique (pages 2 and 3, student notebook).
2. Write the three group colors on the board (orange, blue, and green) and the volunteer’s name that will be working with each group.
3. Have the multimeter ready to show students during the introduction.
4. Have the swing arm protractor, hub with one dowel, cardstock blade, and wind turbine protractor available to show students during the technique discussion.
5. Make sure that volunteers are setting up for the initial observation. Details of how to do this are on a picture in the volunteer boxes.
Notebook Pages and Notepad Pages:

**Technique: Protractors**

Protractors are used to measure and draw angles.

**How to measure an angle using a protractor:**
1. Line up the zero line with the center point of the object you are measuring.
2. Place the baseline parallel to the bottom of the back of the wind turbine.
3. Move the outer arm to point to the direction you wish to measure.
4. The angle is the value on the outer scale (chart).

**A.**
- Angle: 90°

**B.**
- Angle: 135°

**C.**
- Angle: 45°

**D.**
- Angle: 0°

**Observations**

Experimental Set-Up:
On the picture below, indicate relevant dimensions of the wind turbine.

- 3 weights
- Blade length = 5 cm
- Dowel placement = 3 cm
- Blade angle = 45°

Other aspects of the experimental set-up:
- 3 blades
- Fan distance = 10 cm
- Turbine angle = 90°
- Card stock and cardboard blades
Introduction: (2 minutes – Full Class – SciTrek Lead)

- Introduce the module/SciTrek volunteers.

Procedure Assessment: (10 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Read the question, changing variable (example: the changing variable was wheel material), and controls (example: the controls were wheel circumference, vehicle mass, vehicle type...). Do not read changing variable or control values.
- Read each statement and have students underline controls/circle changing variables/box data collection, and then have students circle if the statement could be an appropriate procedure step.
- Collect assessments.
Module Introduction: (5 minutes – Full Class – SciTrek Lead)

- Have volunteers pass out notebooks.
- Have students fill out the front cover of their notebook.
  - They will not fill out their subgroup number or class question.
- Show students the picture of the wind farm. (page 1, picture packet)
- Have students identify the wind turbines and conclude that they are used to produce electricity.
- Show students the multimeter and introduce the words: multimeter, current, and milliamp.
- Introduce the class question (What variables affect the current a wind turbine produces?) and have students copy it onto the front cover of their notebook.

Technique: (15 minutes – Full Class – SciTrek Lead)

- Have volunteers pass out the protractors.
- Explain that we will use protractors to measure the blade angle and turbine angle.
- Review the parts of a protractor and how to measure angles with a protractor.
- Fill out question A as a class. (page 2, student notebook). Place origin on the base of the turbine, the baseline parallel to the bottom of the back of the wind turbine, and point swing arm at the center of the turbine.
- Have students fill out questions B, C, and D by themselves. Check answers in between each question.
- Take the hub with one blade attached from the lead box and show students how the blade can turn and come off and how to insert the wind turbine protractor so that they will be able to measure the angle.
- On page 3, of the student notebook on wind turbine protractor at the top of the page have students help you identify were 0°, 90°, and 180° are and write them on the picture.
- Tell students that for angles over 90° the protractor shows you the number that you would need to subtract from 180° to get the “real” angle.
- Show students how to get the “real” angle for -40°.
- As a class draw in where the blade would be for question A. (page 3, student notebook)
- As a class draw in where the blade would be for question B, then solve for the “real” angle. (page 3, student notebook)
- Have students fill out question C by themselves before reviewing. (page 3, student notebook)
- As a class, determine the number that need to be subtracted from 180° to give 150° and then draw in where the blade would be for question D. (page 3, student notebook)

Observation Discussion: (2 minutes – Full Class – SciTrek Lead)

- Review the definition of an observation (a description using your five senses).
- Tell students that the more electricity the wind turbine produces, the higher the current the multimeter will read in milliamps.
- Have students move to their groups.
  - If a student does not have a nametag, identify the group with the least number of students in it and write the student’s name on one of the extra nametags that are in the lead box using that color of marker.

Observations: (22 minutes – Groups – SciTrek Volunteers)

- Walk around and help groups that are struggling.
- Make sure that groups are moving along and only spending ~15 minutes on the experimental set-up and ~7 minutes on recording the current for the two different blade materials.
- Example notebook/notepad pages for observations are seen on page 2 and 3 of this packet.
Wrap-Up: (3 minutes – Full Class – SciTrek Lead)

- Have groups share what they did/learned.
  - Blade material affects the current a wind turbine produces, and cardboard blades give slightly greater currents than cardstock blades.

Day 2: Variables/Question/Materials Page/Experimental Set-Up/Procedure Activity

Schedule: You are responsible for BOLD sections

- Introduction (SciTrek Lead) – 5 minutes
- Variables (SciTrek Volunteers) - 14 minutes
- Question and Experimental Set-Up Discussion (SciTrek Lead) – 10 minutes
- Question (SciTrek Volunteers) – 5 minutes
- Materials Page (SciTrek Volunteers) – 5 minutes
- Experimental Set-Up (SciTrek Volunteers) – 5 minutes
- Procedure Activity (SciTrek Lead) – 14 minutes
- Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the day 1 experimental set-up picture (page 2, picture packet), the question (page 7, student notebook), lead materials page (page 3, picture packet), experimental set-up (page 4, picture packet), and procedure activity (page 10, student notebook).

2. Have volunteers set out notebooks in a way that they will allow them to be able to talk to both subgroups at the same time during the variable discussion and that allows students in the same subgroup to work together.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.
### Experimental Considerations:

1. You will only have access to the materials on the materials page.
2. See the materials page restrictions on experimental design.
3. When the wind turbine is on, be still and do not push it.
4. When recording current and wind speed, the wind turbine goes up to speed. Then switch the meter to approximately 50 and record the number you see most often.

**Changing Variables (Independent Variables):** blade material

Discuss with your group how you think your changing variable will affect the wind turbine.

**QUESTION**

- If we change the blade material, what will happen to the current the wind turbine produces?

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### MATERIALS PAGE

**Color Code:**

- Blue: x
- Orange: 
- White: 
- Black: 
- Yellow:

#### Materials

- **Wind Turbine Base**
- **Materials**
- **Blades**
- **Motor**
- **Shaft**
- **Brass Rod**
- **Paperboard**
- **Cord/Tube**
- **Acrylic**
- **Paper**
- **Clips**
- **Nail**
- **Hammer**
- **Screwdriver**
- **Ruler**
- **Scissors**
- **Glue**
- **Paint**
- **Soda Can**
- **Cardboard**
- **String**
- **Scissors**
- **Pliers**
- **Screwdriver**

#### Weight Placements

- **C1:**
  - C1 cm
  - C2 cm
- **C2:**
  - C3 cm
  - C4 cm
- **C3:**
  - C5 cm
  - C6 cm

#### Wind Angles

- **A1:**
  - A1 cm
  - A2 cm
- **A2:**
  - A3 cm
  - A4 cm

#### Fan Distance

- **B1:** 0 cm
  - **B2:** 10 cm
  - **B3:** 20 cm

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Get a materials page from your Scitrek volunteer and fill it out before moving on to the experimental set-up.
**Introduction:** *(5 minutes – Full Class – SciTrek Lead)*

- If needed have SciTrek volunteers set out notebooks where students will sit so students are sitting next to members of their subgroup.
- Put the day 1 experimental set-up picture (page 2, picture packet) under the document camera.
- Review class question and what they learned last SciTrek visit.
- Review the following terms: wind turbine, multimeter, current, and milliamp.
- Review the definition of a variable (something in an experiment that can be changed).
- Explore one possible changing variable with the class and have students share why/how this variable might affect the current a wind turbine produces.
- If needed have students move to their notebooks.

**Variables:** *(14 minutes – Groups – SciTrek Volunteers)*

- Walk around and help groups that are struggling.
- Make sure volunteers are having their group come up with four possible variables as well as how/why these variables might affect the current a wind turbine produces.
- Make sure students are generating at least one additional variable by themselves.

**Question and Experimental Set-Up Discussion:** *(10 minutes – Full Class – SciTrek Lead)*

- Have each group share one variable with the class and why/how they think it will affect the current a wind turbine produces.
- Review experimental considerations with the class: (top of page 7, student notebook)
  - You will only have access to the materials on the materials page.
  - See materials page for restrictions on experimental design.
  - When you start the fan the wind turbine must be still and you may not push it.
When recording currents wait until the wind turbine gets up to speed. Then watch the multimeter for approximately 15 s and record the number you see most often.

- Design an example experiment with the class.
  - For the changing variable pick **blade material**. (page 7, student notebook)
  - Show students how to write the question.
    - If we change the **blade material** what will happen to the **current a wind turbine produces**?
  - Fill out the materials page for the example experiment. (page 3, picture packet)
    - First: underline controls and circle the changing variable on the materials page.
    - Second: select values for the controls and changing variable.
      - Tell students if the variable is one of their controls, they are only allowed to select a single underlined value for each.
      - Write trial letters next to the changing variable values (Example: Cardstock A).
      - Make sure students pick **blade materials** that are both flexible (Kleenex) as well as not flexible (metal).
  - Fill out the experimental set-up for the example experiment. (page 4, picture packet)
    - There will be one additional blank for controls. Lead students to come up with fan speed/3 (high).

**Question**: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Try to encourage subgroups to pick different changing variables.
- Make sure for the second part of the question (what you are measuring/observing) that students are specific (example: they should write “how much current the wind turbine produces,” not just “the wind turbine”).

**Materials Page**: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure subgroups are underlining their controls and circling their changing variable.
- Make sure subgroups do not exceed any limits set on the materials page.
- Make sure subgroups fill out the materials page correctly and completely.

**Experimental Set-Up**: (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that within one subgroup all students have the same order for their changing variable values.
- Make sure all control blanks are filled out.

**Procedure Activity**: (14 minutes – Full Class – SciTrek Lead)

- Review the definition of a procedure (a set of steps to conduct an experiment). (page 10, student notebook)
- Go over what procedures should include:
  - All values of the **controls** and the **changing variable** (**independent variable**).
  - What data will be collected (**dependent variable**).
  - The steps listed in the order that they will be completed.
• Go over what procedures should not include:
  o Extra or irrelevant information.
  o Opinions about the experiment.
  o Incorrect values of controls or the changing variable.
• Tell students that we will underline controls (underline the word control), circle the changing variable (circle the words changing variable), and box information about data collection (box the word data).
• If there is still time go onto page 11 of procedure activity this will make day 3 much easier (see day 3).

Wrap-Up: (2 minutes – Full Class - SciTrek Lead)

• Tell students what they will do next time.

Day 3: Procedure Activity/Procedure

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 3 minutes
Procedure Activity (SciTrek Lead) – 25 minutes
Procedure Discussion/Procedure (SciTrek Lead/SciTrek Volunteers) – 30 minutes
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the procedure activity (pages 11-13, student notebook), and procedure (page 9, student notebook).
2. Have hub with one dowel, cardstock blade, and weight available to show students during the procedure discussion/procedure.
3. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.
**SCIENTIFIC PRACTICES**

**Procedures**

**Question**
If we change the **heat** that will happen in the **number of kernels that pop**?

**Experimental Set-Up**

**Changing Variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Test A</th>
<th>Test B</th>
<th>Test C</th>
<th>Test D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microwave Level</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Popcorn Brand</td>
<td>Pop Secret</td>
<td>Orville</td>
<td>Smart Balance</td>
<td>Act II</td>
</tr>
<tr>
<td>Time</td>
<td>2 minutes</td>
<td>1 minute</td>
<td>2 minutes</td>
<td>1 minute</td>
</tr>
<tr>
<td>Salt Amount</td>
<td>300 mg</td>
<td>200 mg</td>
<td>300 mg</td>
<td>200 mg</td>
</tr>
<tr>
<td>Initial Number of Kernels</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Container Type</td>
<td>Bag</td>
<td>Bag</td>
<td>Bag</td>
<td>Bag</td>
</tr>
</tbody>
</table>

**Directions**

Step 1: Read each statement and underline controls, circle changing variables and box information about data collection.

Step 2: On the line write (C) if you circled anything and/or (D) if you marked anything.

Step 3: Circle yes if the statement could be a correct step for a procedure about the question and experimental set up above. If not, circle no.

- Put the bag in the microwave on high for 2 minutes.
- Get 200 kernels of yellow: Pop Secret, Orville, Smart Balance, Act II.
- Observe what happens.
- Get 200 kernels of yellow: Pop Secret, Orville, Smart Balance, Act II.
- Put 200 kernels of yellow: Pop Secret, Orville, Smart Balance, Act II.
- Count the number of kernels that popped in each bag.
- Put the easy popper in the microwave on high for 2 minutes.

**Underline controls, circle changing variables and box data collection.**

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**Scientific Practices**

**Procedures**

**Directions**

Read the following procedure and underline controls, circle changing variables and box information about data collection.

**PROCEDURE**

1. Hang a 50 cm string.

2. Attach a metal ball with a mass of 20 g, 40 g, and circumference of 20 cm to the string.

3. Full ball back 30 cm from resting point and drop.

4. Measure the time it takes the ball to complete one swing.

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**Scientific Practices**

**Procedures**

**Directions**

Read the following procedure and underline controls, circle changing variables, and box information about data collection.

**PROCEDURE**

1. Get 3 (A) paper, (B) plastic, (C) metal, (D) foam blades.

2. Attach 3 weights at 1 cm on the blade.

3. Attach the blade and rig at 15 cm and yohato to 30°, then attach the rig to base.

4. Sit the wind turbine 50 cm from the fan at an angle of 90°.

5. Turn fan on speed 3 (High).

6. Measure the current the wind turbine can create.

In your procedure underline controls, circle changing variables, and box data collection.
Introduction: (3 minutes – Full Class – SciTrek Lead)

- If needed have SciTrek volunteers set out notebooks.
- Review the class question with students.
- Review the definition of a procedure (set of steps to conduct an experiment).
- Review what should and should not be in a procedure.
- If needed have students move to their notebooks.

Procedure Activity: (25 minutes – Full Class – SciTrek Lead)

- Tell students that they were given a scientist’s question and experimental set-up and they will need to determine if statements could be possible procedure steps. (page 11, student notebook)
- Read the question.
  - Have students circle popcorn brand and box number of kernels that pop.
- Read the changing variable and control values.
- Read each statement.
- Questions used for each statement:
  - What should be underlined, circled, and/or boxed?
    - Have students underline controls/circle changing variables/box data collection.
  - Are there any opinions, incorrect, or extra/irrelevant information in this step?
    - If yes
      - Could this be a correct procedural step?
    - If no
      - What is this step about?
      - Is there any other information that should have been included in this step?
      - Could this be a correct procedural step?
- Letter a: Put the bag in the microwave on high for 3 minutes.
  - Correct – Step with Controls Only
  - Correct – Changing Variable with Values
- Letter c: Find results.
  - Incorrect – Vague Data Collection
- Letter d: Put 200 kernels of yellow Pop Secret popcorn and 220 mg of salt in bag A.
  - Correct – One Changing Variable Value Explained
- Letter e: Get 200 kernels of different yellow popcorn brands.
  - Incorrect – Changing Variable with No Values
- Letter f: Count the number of kernels that have popped in each bag.
  - Correct – Measurement
- Letter g: Put the tasty popcorn in the microwave on high for 3 minutes.
  - Incorrect – Opinion
- Have students open their notebook up so that they can see both pages 11 and 12.
- Read through the procedure and have students underline controls/circle changing variables/box information about data collection.
- Have students tell you what should and should not be in a procedure and correct the procedure accordingly.
• Read the procedure on page 13 of the student notebook.
  o Have students independently underline controls/circle changing variables/box data collection after you read each step.
  o As a group, discuss the answers after each step.

Procedure Discussion/Procedure: (30 minutes – Full Class/Subgroups – SciTrek Lead/SciTrek Volunteers)

• Remind students that we had already decided on an experimental set-up for the class question of “If we change the blade material what will happen to the current the wind turbine produces?”
• Show students the blade, hub with one dowel, and weight and tell them this is how they will receive their materials.
• Have students determine one step for the example experiment and write it in the class notebook, remembering to underline controls/circling changing variables/box information about data collection. Once each step is done, allow students to write that step for their experiment in their notebook.
• Repeat the process for each procedure step.
  o Step 1: Information about number of blades and blade material.
  o Step 2: Information about number of weights and weight placement.
  o Step 3: Information about dowel placement and blade angle.
  o Step 4: Information about fan distance and turbine angle.
  o Step 5: Information about fan speed.
  o Step 6: Information about data collection.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

• Tell students what they will do next time.

Day 4: Results Table/Experiment/Graph

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 15 minutes
Results Table (SciTrek Volunteers) – 5 minutes
Experiment (SciTrek Volunteers) – 28 minutes
Graph (SciTrek Volunteers) – 10 minutes
Wrap-Up (SciTrek Lead) – 2 minutes
Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the results table (page 5, picture packet) and graph (page 15, student notebook).
2. Have hub with one dowel, cardstock blade, binder clip, and wind turbine protractor available to show students during the introduction.
3. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.

Notebook Pages:

Introduction: (15 minutes – Full Class – SciTrek Lead)

- If needed have SciTrek volunteers set out notebooks.
- Review class question with students.
- Show students how to fill out the results table. (page 5, picture packet)
- Show students how to attach the weights to the blades. Show students the tape card and which piece of tape to take first and second. Attach a weight to one blade.
• Show students how to attach the blade to the dowel with the binder clip. Then tell them that they will use the wind turbine protractor to adjust the blade angle.
  o The protractor should be inserted from the front of the hub (where the knob is).
  o When adjusting the blade angle students should have their thumb on the binder clip and fingers on the front of the blade. The flat slide of the blade should be facing out (straw to the back of the hub).
    ▪ If blade angle is less than 90° turn the blade so that it passes 0°, 10°, etc. until you reach the desired angle.
    ▪ If the angle is greater than 90° turn the blade so that it passes 0°, -10°, etc. until you reach the desired angle.
• Tell students once they have their hub set up, they will gently put it on the wind turbine base. The hub must be still before they turn on the fan and they cannot push the blades to make them spin. They will then record the current in mA.
• Use the steps on the top of page 15 (student notebook) to go over how to graph results.
  o A filled out results table is on page 5 of the picture packet.
• If needed have students move to their notebooks.

**Results Table:** (5 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure they are underlining controls/circling changing variables/boxing data collection.
- Make sure that control values are written in trial A with an arrow through the rest of the trials, and that a value of the changing variable is written in each trial’s box.

**Experiment:** (28 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups with their experiment and make sure they will finish their experiment on time.
  o As soon as groups finish making any of their hub set-ups have them start making measurements.
    Do not wait until all hubs are made to make measurements
  o Groups changing number of weights or weight placement will take the most time. Make sure volunteers are helping these groups first.
  o For groups changing number of blades, have them make and run the trial with the largest number of blades first, and then reuse those blades for the trials that have less blades.
- Make sure that students have their blade angles correct.

**Graph:** (10 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that students are graphing their data from smallest current to largest current.
- Make sure that students are writing the numerical value of the current on top of each column.

**Wrap-Up:** (2 minutes – Full Class – SciTrek Lead)

- Tell students what they will do next time.
Day 5: Results Summary/Poster Making

Schedule: You are responsible for BOLD sections

- Introduction (SciTrek Lead) – 10 minutes
- Results Summary (SciTrek Volunteers) – 15 minutes
- Poster Making (SciTrek Volunteers) – 30 minutes
- Wrap-Up (SciTrek Lead) – 5 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the results summary (page 16, student notebook).
2. Ask the classroom teacher for a place to leave the student posters.
3. Have volunteers set out notebooks.
   a. If students are not in the classroom before SciTrek starts, have volunteers set out the notebooks where students should sit when they come into the classroom.
   b. If students are in the classroom before SciTrek starts, have volunteers set out the notebooks where they want students to sit and students will move to these spots after the introduction.

Notebook Page, Poster, and Highlighted/Numbered Notebook:

My experiment shows: The blade materials that produce the largest current are stiff materials because the styrofoam and metal blades (stiff) produced ~1.7 mA and the Kleenex and paper blades (flexible) produced 0mA and 0.4mA.

I acted like a scientist when,

NOTES ON PRESENTATIONS
What variables affect the current a wind turbine produces?

<table>
<thead>
<tr>
<th>Changing Variable</th>
<th>Current Produced (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Changing Variable</th>
<th>Current Produced (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Introduction:** (10 minutes – Full Class – SciTrek Lead)

- If needed have SciTrek volunteers set out notebooks.
- Review the class question (What variables affect the current a wind turbine produces?).
- Review the class’ experimental question (If we change the blade material, what will happen to the current the wind turbine produces?).
- Have students generate a results summary from the data. (page 5, picture packet)
  - My experiment shows that the blade materials that produce the largest current are stiff materials because Styrofoam and metal blades (stiff) produced ~1.9 mA and that the Kleenex and paper blades (flexible) produced 0 mA and 0.4 mA.
- Ask students if this statement is consistent with the data that we gathered from our initial observation?
  - Yes, cardboard gave slightly more current than cardstock.
- Tell the students once they finish their results summary they will make a poster.
- If needed have students move to their notebooks.
Results Summary: (15 minutes – Subgroups – SciTrek Volunteers)

- Walk around and help subgroups that are struggling.
- Make sure that subgroups are generating a claim (ideally the claim will allow them to make a prediction about future experiments) and using data to back it up.
  - Groups will be using measurements as their data, so make sure they are including numerical values in their data statements.
  - Do not reference trial letters in the results summary.
- Volunteers struggle with results summaries, so try to check at least one results summary from each group.
- Have students fill out the sentence frame on page 16, “I acted like a scientist when_____”

Poster Making: (30 minutes – Subgroups – SciTrek Volunteers)

- Help volunteers glue poster pieces onto the poster. When gluing, make sure that the volunteers are gluing the poster in the exact order that is shown on the diagram and that the poster has a landscape orientation.
- Make sure that the student in each subgroup who is presenting the results graph has a sentence frame sticker in their notebook and the volunteer has gone over how to present the four sentences with the student several times.
- Each student should have the part(s) that they are presenting highlighted and numbered in their notebook. (1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) results summary.) (see pictures above)

Wrap-Up: (5 minutes – Full Class – SciTrek Lead)

- Ask students the following questions:
  - How did you act like a scientist during this project?
  - What did you do that scientists do?

Day 6: Poster Presentations

Schedule: You are responsible for BOLD sections

Introduction (SciTrek Lead) – 2 minutes  
Practice Posters (SciTrek Volunteers) – 10 minutes  
Poster Presentations (SciTrek Volunteers/SciTrek Lead) – 46 minutes  
Wrap-Up (SciTrek Lead) – 2 minutes

Preparation:

1. If the classroom has a document camera, ask the teacher to use it for the notes on presentations (pages 6 and 7, picture packet). If there is no document camera write the class question on the board.
2. Give the teacher the “Evaluation of the SciTrek Program by Participating Teacher” form. Ask the teacher to fill this form out and give it back to you next time you are there.
3. Organize posters so that experiments featuring the same changing variable will be presented back to back.
4. Have volunteers pass out notebooks.
**Introduction:** (2 minutes – Full Class – SciTrek Lead)

- If needed have SciTrek volunteers pass out notebooks.
- Tell students that they will have 10 minutes to discuss their experiment and practice their posters.
- DO NOT GIVE STUDENTS MORE THAN 10 MINUTES OR YOU WILL RUN OUT OF TIME FOR POSTERS.

**Practice Posters:** (10 minutes – Subgroups – SciTrek Volunteers)

- Organize posters so that experiments about the same changing variable are presented back to back.
- Make sure students are reading from their notebook and practicing the poster in the following order: 1) scientists’ names, 2) question, 3) experimental set-up, 4) procedure, 5) results graph, and 6) results summary. They will NOT read the “I acted like a scientist when _______” or results table from their poster.

**Poster Presentations:** (46 minutes – Full Class – SciTrek Volunteers/SciTrek Lead)

- Have students present their posters.
- While posters are being presented, record each group’s changing variable values and data on pages 6 and 7 of the picture packet while students record the information on pages 16 and 17 of their notebook.
  - When a group reads their question, record the changing variable.
    - Stop the presentation after the question and have the class identify the changing variable.
  - When a group reads their graph, record the values of the changing variable and their measurements.
• After each presentation ask students:
  o What questions do you have for this group?
  o Can someone summarize what we learned from this group?
  o Which trial produced the largest current?
• Record what they learned under the summary on pages 6 and 7 of the picture packet;
  students will not record the summary in their notebook.
• Students will not record information about their group’s poster presentation.
• After all presentations are over, have students tell you the variable values that they would select to
  produce the most current for the cheapest price, and have them circle those values in their notes.

Wrap-Up: (2 minutes – Full Class – SciTrek Lead)

• Tell the students that the volunteers that have been working with them are undergraduate and graduate
  students that volunteer their time so that they can do experiments. Have the students say thank you to
  the volunteers. This is the last day with their SciTrek volunteers, therefore, they should say goodbye to
  them.
• Tell students to remove the paper part of their nametag from the plastic holder and that they can keep
  the paper nametag but need to give the plastic holder back to their SciTrek volunteer.

Day 7: Procedure Assessment/Tie to Standards/Content Assessment

Schedule: You are responsible for BOLD sections

  Procedure Assessment (SciTrek Lead) – 15 minutes
  Tie to Standards (SciTrek Lead) – 35 minutes
  Content Assessment (SciTrek Lead) – 10 minutes

Preparation:

1. Collect the “Evaluation of the SciTrek Program by Participating Teachers” from the teacher.
2. If the classroom has a document camera, ask the teacher to use it for the tie to standards activity (pages
   18-20, student notebook) and tie to standards pictures (pages 8-11, picture packet).
3. Assemble the experimental set-up. Use the following steps to help you with the set-up:
   a. Verify that the blades on the hub are at a dowel placement = 0.5 cm and a blade angle = 10°,
      then attach the hub to the wind turbine base.
   b. Roll out the tape measure and set the fan distance = 60 cm.
   c. Set the turbine angle = 90°.
   d. Connect the multimeter to the wind turbine stand, making sure the red and black wires do not
      touch. Leave the multimeter and fan off.
4. Set the radiometer on a flat surface where students will be able to see it. It is important that it is not
   moved once it is set down because it takes a long time for the blades to come to rest.
5. Pass out the procedure assessments and notebooks.
6. Remind the teacher to give you their lab coat at the end of the day.
TIE TO STANDARDS

1. What does the current reading tell us? Electricity is being generated by the wind turbine.

2. Electric currents are a form of energy cannot be created nor destroyed, but it can be transferred.

3. Energy stored such as case of gravitational energy.

4. Energy can also be stored such as case of gravitational energy.

5. Forms of energy:
   - electrical current
   - sound
   - gravitational
   - light
   - motion
   - heat

6. Identify the energy transfers in the wind turbine.

   Wind / motion \rightarrow blades / motion \rightarrow electrical current

7. What could the energy in the wind turbine be used for?
   - videogames
   - light

8. Magnets can make electricity if the magnet is moving.

9. What are the blades turning inside the wind turbine housing?
   - magnets

10. What type of area would you recommend that Windy Works purchase land?
    - in a windy area

11. Windy Works has already decided on the manufacturing specifications below, but needs help deciding which values of 3 variables to use in constructing their wind turbines.
    1. Circle the value of the changing variable that you think Windy Works should use.
    2. Look at the data and choose the value of the changing variable that is Windy Works’ “best” option.

Wind Turbine Manufacturing Specifications:
- Blade Material / Cardboard
- Wind Angle / 30°
- Number of Blades / 3
- Weight Placement / 7 cm

Blade Angle:
- 10°
- 30°
- 70°

Dowel Placement:
- 0.5 cm
- 3.5 cm
- 6.0 cm

Number of Weights:
- 0
- 6
- 12

12. Current produced by ideal wind turbine: 8.5 mA
Procedure Assessment: (15 minutes – Full Class – SciTrek Lead)

- Pass out assessments.
- Read the question, changing variable (example: the changing variable was nutrient amount), and controls (example: the controls were plant type, liquid type, plant mass...). Do not read changing variable or control values.
- Read each statement and have students underline controls/circle changing variables/box data collection, and then have students circle if the statement could be an appropriate procedure step.
- Have students draw what they think a scientist looks like and answer the two questions on the bottom of the page.
- Collect assessments.

Tie to Standards: (35 minutes – Full Class – SciTrek Lead)

Energy (15 minutes)

- Review that students where measuring current and found that the greater the current the more electricity the wind turbine was producing.
- Fill in question 1 (page 18, student notebook).
- Have students give you a few examples of things that need electricity.
- Tell students that electricity is a form of energy.
- Fill in question 2.
- Tell students that energy cannot be created or destroyed, but it can be transferred from one form to another.
- Fill in question 3.
- Show students the picture of the girl with the ball (page 8, picture packet) and discuss energy transfer.
  - Talk about what happens when the ball hits a wall (the wall is so large you do not see the wall move even though energy was transferred to it).
- Hold the eraser up and ask students if the eraser has energy.
- Have a student hold the clipboard out while you drop the eraser on it.
- Ask the student who was holding the clipboard what they observed.
  - They felt their hand move and heard a sound when the eraser hit the clipboard.
- Lead students to understand that the eraser did have energy in the form of stored energy. Scientists call this type of stored energy “gravitational energy.”
- Fill in question 4.
- Have students generate a list of forms of energy and record them in question 5.
  - Types of energy: electrical currents, gravitational, motion, sound, heat, and light.
    - If students do not come up with light ask them where the energy from a wind turbine would go it if was attached to a light bulb.
    - Shows students the radiometer and then show them that when light is shined on the device, the blades turn. The blades must get the energy to turn from something. Lead students to understand that the energy must come from the light.
Energy Transfer (10 minutes)

- Go over the energy transfers that happen for the wind turbine and record the answers in question 6 (page 19, student notebook).
- Have students think of an energy source/energy form that the energy of a wind turbine could be used for and record one possible answer for question 7.
- Show students the lightbulb device and explain that it is a lightbulb attached to a coil of wire but not plugged into anything.
- Show students that if you turn the knob the light bulb does not light.
- Take one magnet out of the container and show that it can pick up paperclips, proving that it is a magnet.
- Put the magnets on either side of the lightbulb device (see picture below) and spin the handle.
- Ask students what they see. (light)
- Ask them what this means. (we generated electricity or transferred energy from motion to electrical currents)
- Fill in question 8.
- Ask students what they think there must be inside the wind turbine housing, and fill in question 9. (magnets)

Engineering Extension: Building a Wind Turbine (10 minutes)

- Review with students what engineers are.
- Engineers want to optimize wind turbines to produce the most current for the least cost.
- Tell students about Windy Works, the fictional wind turbine company that needs help.
- Ask them where Windy Works should buy land and fill in question 10.
- Tell them they will now look at three variables and predict which value of the variable will produce the most current for the least amount of money.
- Have them circle which blade angle will produce the most current for the least amount of money.
- Show them the graph of changing blade angle (page 9, picture packet) and have them box what value they would now recommend Windy Works use.
- All blade angles cost the same amount of money and the graph shows the closer the angle is to 0˚/180˚ the higher the current. Therefore, Windy Works should use a blade angle of 10˚.
- Repeat this process for the other two variables: dowel placement (page 10, picture packet) and number of weights (page 11, picture packet).
- Dowel placements will cost different amounts of money, because the longer the dowel, the more material needed to build the turbine. The graph shows the closer the dowel is to the hub, the more current is produced. Therefore, Windy Works should use a dowel placement of 0.5 cm.
- The greater the number of weights, the greater the price because more material is needed. The graph shows that all weights give approximately the same current. Therefore, Windy Works should use no weights.
- Tell students that we will now test the wind turbine that they suggested.
• Turn on the wind turbine and read the current (~8 mA).
• Ask students if anyone got currents that high. Tell them that when we put all our research together we can build a better device.

**Content Assessment:** *(10 minutes – Full Class – SciTrek Lead)*

• Pass out content assessments.
• Read each question to students.
• Collect content assessments.
EXTRA PRACTICE
Procedures

QUESTION
If we change the ___ solid type, what will happen to the temperature at which the sugar begins to melt?

<table>
<thead>
<tr>
<th>Changing Variable</th>
<th>Solid Type</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EXPERIMENTAL SET-UP

Controls (variables you will hold constant):
- Solid Amount: 10 g
- Liquid Amount: 250 ml
- Container Type: Beaker

EXPERIMENTAL SET-UP

- Solid Source: Basin Burner
- Liquid Type: Water
- Container Size: 500 ml

Directions
Step 1: Read each statement and underline or circle changing variables and box information about data collection.
Step 2: Circle yes if the statement could be a correct step for a procedure about the question and experimental set-up above. If not, circle no.

a. Put 15 g of sugar, 5 g salt, 0.15 g baking soda, 2 ml water into each beaker. Yes No
b. Light the average basin burner. Yes No
c. Put 150 ml of water into each 500 ml beaker. Yes No
d. Gather results from the experiment. Yes No
e. Put 15 g of baking soda into beaker C. Yes No
f. Measure the temperature the solution boils at. Yes No
g. Put 15 g of different solid types into each beaker. Yes No

Underline controls, circle changing variables, and box information about data collection.