How Science Works

Grade 4

Module 2

Class Question:

Scientist (Your Name): ____________________________________________

Teacher’s Name: ________________________________________________

SciTrek Volunteer’s Name: ________________________________________
**VOCABULARY**

**Science:** The study of the material world using human reason. The scientific method is the way humans reason and apply logic to data to help us gain knowledge of the world.

- **Observation:** A description using your five senses. This could include contents, mass, size, color, temperature, smell, texture ...
- **Opinion:** Something you believe or feel. Not a fact or observation.
- **Inference:** A guess based on past experiences.
- **Testable Question:** A question for which an experiment can be designed to answer.
- **Non-Testable Question:** A question for which an experiment cannot be designed to answer. For example, questions involving opinions, things that cannot be measured, or words that are not well defined.
- **Experimental Set-Up:** The materials, changing variable, and controls that are needed for an experiment.
- **Experiment:** A test or trial to discover something unknown.
- **Procedure:** A set of steps to conduct an experiment.
- **Controls:** The variables that are not changed in an experiment.
- **Changing Variable (Independent Variable):** The variable that is purposely changed in an experiment.
- **Results/Data (Dependent Variable):** The measurements/observations of the experiment, which are influenced/determined by the changing variable.
- **Prediction:** What you expect to happen based off of previous measurements/observations.
- **Scientific Practices:** A series of activities that scientists participate in to both understand the world around them and to communicate their results with others. (The specific practice worked on in this module is procedures.)
- **Technique:** A method for a specific task.
- **Angle:** A measurement telling the separation between two lines that meet at one point.
- **Multimeter:** A tool used to measure voltage, current, or resistance. For this module we will use it to measure the current the wind turbine produces.
- **Current:** A measure of the amount of electricity flowing.
- **Milliamp (mA):** The units that current is measured in.
- **Protractor:** A device used to measure angles.
- **Wind Turbine:** A large “fan like” machine that rotates by wind to generate electricity.
- **Blade:** a long circular piece that is attached to the hub of a wind turbine to guide the wind flow.
- **Hub:** the center part of a wind turbine in which the blades are attached.
- **Dowel:** a wooden piece that attaches to the blade so that the blade can be connected to the hub.
- **Energy:** the ability of an object to do work. Energy can be transferred but it cannot be created or destroyed.
- **Engineering:** a branch of science that focuses on designing, building, modifying, and constructing objects and machines.


TECHNIQUE
Protractors

Protractors are used to measure and draw angles.

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

Identify the turbine angles.

A.

Fan

Angle:_______

B.

Fan

Angle:_______

C.

Fan

Angle:_______

D.

Fan

Angle:_______
**TECHNIQUE**  
*Protractors*

Label 0°, 90°, and 180° on the protractor on the right.

*How to find angles between 90° and 180°:*

For angles greater than 90° take the number shown on the wind turbine protractor and subtract that number from 180°.

*Draw the wind turbine blade at the specified angle.*

A. Angle: 30°

B. Angle: -20°  
This angle is also referred to as:  
180° - __________

C. Angle: -70°  
This angle is also referred to as:  
180° - __________

D. Angle: 150°  
This angle is shown as:  
180° - __________ 150°
OBSERVATIONS

Experimental Set-Up:

On the picture below, indicate relevant dimensions of the wind turbine.

Other aspects of the experimental set-up:

__________________________________________________________________________________________________
__________________________________________________________________________________________________
__________________________________________________________________________________________________
___________________________________________________________
__________________________________________________________________________________________________
__________________________________________________________________________________________________
__________________________________________________________________________________________________
__________________________________________________________________________________________________
### OBSERVATIONS

<table>
<thead>
<tr>
<th></th>
<th>Cardstock Blades</th>
<th>Cardboard Blades</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current (mA):</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Similarities:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Differences:</strong></td>
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</tbody>
</table>

Other Observations:

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
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_________________________________________________________________
## VARIABLES

<table>
<thead>
<tr>
<th>Variable</th>
<th>How will changing this variable affect the current?</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
**Experimental Considerations:**

1. You will only have access to the materials on the materials page.
2. See the materials page for restrictions on experimental design.
3. When you start the fan the wind turbine must be still and you may not push it.
4. When recording currents wait until the wind turbine gets up to speed. Then watch the multimeter for approximately 30 s and record the number you see most often.

**Changing Variable (Independent Variable):** __________________________________________________________

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

**QUESTION**

Question our group will investigate:

- If we change the ________________________________________________________________,
  insert changing variable (independent variable)

  what will happen to the ____________________________________________________________,
  insert what you are measuring/observing (dependent variable)

  ____________________________________________________________________________?

**SciTrek Member Approval______________**

Get a materials page from your SciTrek volunteer and fill it out before moving onto the experimental set-up.
EXPERIMENTAL SET-UP

Determine the values of your changing variable (ex: number of blades) from the materials page and write the values (ex: 4) for your four trials under each wind turbine.

Changing Variable

\[ \text{__}\] : 
\[ \text{(Value 1)} \] 
\[ \text{(Value 2)} \] 
\[ \text{(Value 3)} \] 
\[ \text{(Value 4)} \]

Controls (variables you will hold constant):
Determine the variables that you will hold constant and indicate the specific value you will use in all your trials. (Control/Value)

Blade Material / Cardstock

\[ \text{__}\] / \[ \text{__}\] 
\[ \text{__}\] / \[ \text{__}\] 
\[ \text{__}\] / \[ \text{__}\] 
\[ \text{__}\] / \[ \text{__}\]

SciTrek Member Approval________________________
PROCEDURE

1. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

2. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

3. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

4. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

5. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

6. ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

In your procedure underline controls, circle changing variables, and box data collection.
SCIENTIFIC PRACTICES

Procedures

Directions: Fill in the missing definition.

- Procedure: __________________________________________________________
  __________________________________________________________

A complete procedure MUST have:

- All values of the ___________________________ and the ___________________________

- What __________________________ will be collected (measurements/observations).

- The steps listed in the order that they will be completed.

A complete procedure MUST NEVER have:

- __________________________ or irrelevant information.

- __________________________ about the experiment.

- __________________________ values of controls or the changing variable.
SCIENTIFIC PRACTICES

Procedures

QUESTION

If we change the popcorn brand what will happen to the number of kernels that pop?

EXPERIMENTAL SET-UP

Changing Variable: Trial A Trial B Trial C Trial D
Popcorn Brand: Pop Secret Orville Smart Balance Act II

Controls (variables you will hold constant):

<table>
<thead>
<tr>
<th>Microwave Level / High</th>
<th>Time / 3 Minutes</th>
<th>Popcorn Color / Yellow</th>
<th>Salt Amount / 220 mg</th>
<th>Initial Number of Kernels / 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container Type / Bag</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Directions:
Step 1: Read each statement and underline controls, 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.

Could this be a procedure step?

a Put the bag in the microwave on high for 3 minutes. Yes No

b Get 200 kernels of yellow A) Pop Secret, B) Orville, C) Smart Balance, D) Act II popcorn. Yes No

c Observe what happens. Yes No

d Put 200 kernels of yellow Pop Secret popcorn and 220 mg of salt in bag A. Yes No

e Get 200 kernels of different yellow popcorn brands. Yes No

f Count the number of kernels that have popped in each bag. Yes No

g Put the tasty popcorn in the microwave on high for 3 minutes. Yes No

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

*Procedures*

**Directions:** Read the following procedure that is based on the question and experimental set-up on page 11 and underline controls, circle changing variables, and box data collection. If any controls are missing or incorrect, add the correct values to the procedure. Remove any extra or irrelevant information from the procedure by crossing it out. If any steps are out of order, draw an arrow (↔) to indicate the correct order.

**PROCEDURE**


2. Put each bag in the microwave on high.

3. Put the popcorn and 250 mg of salt into four separate bags.

4. Count the number of kernels that popped in each bag.

5. Eat the popcorn.

6. Have fun.
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 A) 20 g, B) 30 g, C) 40 g and circumference of 20 cm to the string.

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

4. Measure the time it takes the balls to complete one swing.
### RESULTS

**Table**

Fill out the chart for each of your trials. If one of the variables remains constant for all trials write the value in trial A and then draw a line through each box indicating that this variable is a control.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blade Material:</td>
<td><em>Cardstock</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blade Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight Number:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight Placement:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dowel Placement:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blade Angle:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(list both the actual angle and what angle you will find on the wind turbine protractor)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Distance:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbine Angle:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Other Variable**

<table>
<thead>
<tr>
<th>Predictions</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Put an &quot;M&quot; in the trial that will give the most current and an &quot;L&quot; in the trial that will give the least current.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data</th>
<th>Trial A</th>
<th>Trial B</th>
<th>Trial C</th>
<th>Trial D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The independent variable is the changing variable and the dependent variables are current and other.
RESULTS

Graph

Check off the steps as you complete them.
☐ Write what you measured (example: current (mA)) on the y-axis (vertical).
☐ Write your changing variable (example: blade angle) on the x-axis title (horizontal).
☐ On your results table, label your measurements from 1 to 4, with 1 being the trial with the smallest current and 4 being the trial with the largest current.
☐ Plot your data in increasing order.
  ☐ Write the changing variable value (example: 0°/180°) for the trial that you labeled 1 under the first column.
  ☐ Graph your data for that trial and write the measurement above the bar.
  ☐ Repeat the process for the other trials.
RESULTS
Summary

My experiment shows______________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________
________________________________________________________________________________

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></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CurrentProduced (mA):</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

1. What does the current reading tell us?______________________________________________
                                           ____________________________________________

2. Electric currents are a form of_______________________________________________________.

3. __________________________cannot be created nor destroyed, but it can be
                                           ____________________________
                                           ____________________________________________

4. Energy can also be __________________________, such as the case of gravitational
                                           energy.

5. Forms of energy

    electrical currents  ____________________________

    gravitational ____________________________

                                           ____________________________________________
6. Identify the energy transfers in the wind turbine.

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Energy Form</th>
<th>Energy Source</th>
<th>Energy Form</th>
<th>Energy Source</th>
<th>Energy Form</th>
</tr>
</thead>
</table>

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

8. Magnets can generate _____________________ if the magnet is _______________.

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

10. What type of area would you recommend that Windy Works purchase land?
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 box the value of the changing variable that is Windy Works’ “best” option.

**Wind Turbine Manufacturing Specifications:**

<table>
<thead>
<tr>
<th>Blade Material / Cardstock</th>
<th>Wind Angle / 90°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Blades / 3</td>
<td>Weight Placement / 7 cm</td>
</tr>
</tbody>
</table>

   - Blade Angle: 10°, 30°, 70°

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

   - Number of Weights: 0, 6, 12

EXTRA PRACTICE

Procedures

QUESTION

If we change the solid type what will happen to the temperature at which the water boils?

Changing Variable:  
Solid Type:  
Trial A: Sugar  
Trial B: Salt  
Trial C: Baking Soda  
Trial D: None

EXPERIMENTAL SET-UP

Controls (variables you will hold constant):

<table>
<thead>
<tr>
<th>Solid Amount / 10 g</th>
<th>Heat Source / Bunsen Burner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Amount / 250 mL</td>
<td>Liquid Type / Water</td>
</tr>
<tr>
<td>Container Type / Beaker</td>
<td>Container Size / 500 mL</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 underlined anything, (CV) if you circled anything, and/or (D) if you boxed 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.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Is the statement about CV, C, and/or D?</th>
<th>Could this be a procedure step?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Put 10 g of A) sugar, B) salt, C) baking soda, D) none into each beaker.</td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>b Light the awesome Bunsen burner.</td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>c Put 250 mL of water into each 500 mL beaker.</td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>d Gather results from the experiment.</td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>e Put 10 g of baking soda into beaker C.</td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>f Measure the temperature the solution boils at.</td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>g Put 10 g of different solid types into each beaker.</td>
<td></td>
<td>Yes No</td>
</tr>
</tbody>
</table>

Underline controls, circle changing variables, and box data collection.
CROSSWORD PUZZLE

Directions: Fill out the following crossword puzzle using the clues below. The list of words used for the word search can be found on the vocabulary page of your notebook (pg. 1).

Across
4) a set of steps to conduct an experiment
6) a method for a specific task
7) 90 degrees can describe the _______ of the wind turbine in relation to the fan
9) this fan-like machine can generate electricity when wind causes it to rotate
10) we use this tool to measure the amount of current that the wind turbine produces
11) it can be transferred but it cannot be created or destroyed

Down
1) variables that are not changed in an experiment
2) an interpretation or judgement based on knowledge from past experience
3) what you expect will happen based off of previous measurements or observations
5) designing, building, and modifying a wind turbine is an example of this branch of science
8) describing the color of the wind turbine blades would be an example of an ____________
SciTrek is an educational outreach program that is dedicated to allowing 2nd-8th grade students to experience the scientific process first hand. SciTrek partners with local schools to present student-centered inquiry-based modules that not only emphasize the process of science but also specific grade level content standards. Each module allows students to design, carryout, and present their experiments and findings.

For more information please feel free to visit us on the web at [http://www.chem.ucsb.edu/scitrek/](http://www.chem.ucsb.edu/scitrek/) or contact us by e-mail at scitrekadmin@chem.ucsb.edu.

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