QuickView

Students use the WinDynamo II to determine the optimum pitch angle that operates the motor, LED, and buzzer on the Wind Powered Devices activity board.

Standards Addressed

NSTA 5-8
Students develop abilities necessary to do scientific inquiry.

- Students identify questions that can be measured through scientific inquiry.
- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students communicate scientific procedures and explanations.
- Students use mathematics in all aspects of scientific inquiry.

Students develop an understanding of transfer of energy.

- Students understand energy is a property of many substances and is associated with heat, light, electricity, mechanical motion, sound, nuclei, and the nature of a chemical; energy is transferred in many ways.

NCTM 6-8
Students understand patterns, relations, and functions.

- Students represent, analyze, and generalize a variety of patterns with tables, graph, words, and, when possible, symbolic rules.
- Students relate and compare different forms of representation for a relationship.

ITEEA 6-9
Students develop an understanding of the characteristics and scope of technology.

- Students learn that new products and systems can be developed to solve problems or to help do things that could not be done without help of technology.
- Students learn that the development of technology is a human activity and is the result of individual or collective needs and the ability to be creative.
- Students learn that technology is closely linked to creativity, which has resulted in innovation.

Students develop an understanding of engineering design.

- Students learn that modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

Time Required

90-180 minutes (will vary with class size)

Content Areas

Primary: Science
Secondary: Math, technology

Vocabulary

- angle
- conductor
- device
- electron
- generator
- induction
- kinetic
- motor
- pattern
- pitch
- turbine

Materials

- WinDynamo II
- Electric fan
- Wind Powered Devices activity board
- Red and black test leads
- Ruler or tape measure
- Pencil
- "Pitch Angle" worksheet

Procedure

1 There are safety precautions you should follow when completing this activity. Both the fan and WinDynamo II have a spinning motion and operate at a fairly high rate of speed. It's important to keep your hands and fingers at a safe distance when operating both pieces of equipment. Never reach inside the fan cage or grab the turbine blades when they are moving.

It's a good idea to speak with the students about practicing good safety habits when performing this activity. Make sure the wind produced by the fan is not going to disturb the workspace of other students.

2 Locate the WinDynamo II. The kinetic energy produced by the fan causes the turbine blades to spin. As the blades spin, the shaft of the generator rotates and moves a conductor through a magnetic field. When a conductor is moved through a magnetic field, it causes electrons to move and an electrical current is produced. This process is referred to as induction.

The WinDynamo II should be treated as a scientific instrument. Students need instruction concerning the proper treatment and use of this instrument. Turning one blade will turn all three to the desired pitch angle.

3 Make sure the WinDynamo II and the fan are directly facing one another. Measure a distance of 18" between the fan and the base of the wind generator. Be sure the fan is not pointing up or down, but directly at the WinDynamo II.

The fan and the wind turbine must be properly aligned to produce the best results. Best results are produced from the turbine and the fan being at the same height.

4 Connect the red and black leads from the WinDynamo II to the Wind Powered Devices activity board.

5 Locate the "Pitch Angle" worksheet and notice you will test seven pitch angles in increments of 7.5°. Identify the pitch angle scale on the WinDynamo II. The scale markings range from 0° to 45°.

6 Set the pitch angle to 0°.

7 Turn on the fan to a high setting and wait for the blades on the WinDynamo II to reach a constant speed. Test the motor, LED, and buzzer separately.

It is very important for the blades to reach a constant speed before the students test the various devices. Testing before the blades reach a constant speed will result in skewed data.

8 Record the results on the "Pitch Angle" worksheet, in the 0° fields, as to whether each of the devices successfully operated by circling the "YES" or "NO" in the associated field.

Students should notice the blades don't spin at the 0° pitch angle. This is because the force of the wind is directed straight back against the parallel blades.

9 Test all three devices at the same time. Record the result by circling either "YES" or "NO" in the associated field for the 0° pitch angle.

10 Turn off the fan and allow the blades of the WinDynamo II to come to a complete stop. Do not try to stop the blades.

Remind the students to practice proper safety rules.

11 Note any important observations you made while performing the activity at a setting of 0° on the "Pitch Angle" worksheet.

Encourage students to remark about the speed of the turbine blades and the operation of each device concerning the overall effectiveness as it relates to the specific pitch angle.

12 Repeat the following steps for each pitch angle setting, making certain to record accurate results.

- Set the pitch angle according to the worksheet.
- Turn on the fan to a high setting.
- Allow the blades of the WinDynamo II to reach a constant speed.
- Test the motor, LED, and buzzer separately and record the results on the "Pitch Angle" worksheet as each device is tested.
- Test all three devices at the same time and record the result.
- Turn off the fan and allow the blades of the WinDynamo II to come to a complete stop before moving on to the next step. Do not try to stop the blades.
- Note any important observations you made while performing the activity at this pitch angle.

13 Properly store the equipment used to complete this activity.

14 Answer the questions located on the "Pitch Angle" worksheet.

Pitch Angle Answer Key

Pitch Angle	Motor	LED	Buzzer	All 3 Devices	Observations
0°	YES NO	YES NO	YES NO	YES NO	
7.5°	YES NO	YES NO	YES NO	YES NO	
15°	YES NO	YES NO	YES NO	YES NO	
22.5°	YES NO	YES NO	YES NO	YES NO	
30°	YES NO	YES NO	YES NO	YES NO	
37.5°	YES NO	YES NO	YES NO	YES NO	
45°	YES NO	YES NO	YES NO	YES NO	

The tested pitch angle increased by 7.5° increments. Using this information, is there a pattern that can be identified? Explain your answer.
Student answers should explain whether a pattern can or cannot be identified. The answer should be based upon the recorded results from the table.

What is the optimum pitch angle? Justify your answer by supporting it with results from the activity.
Results will vary depending on the fan, but students should see that 15° probably produces the best results that will operate all three devices simultaneously.

1 Describe how to correctly use an anemometer.

2 Wind that causes the blades of a wind generator to move can be classified as what type of energy?

a. potential
b. static
c. kinetic
d. dynamic

3 Correctly define the term "voltage."

4 True or false. In an experiment, the independent variable is influenced to cause a change in the dependent variable.

5 A _____ is the instrument used to control the electricity produced from wind turbines.

6 Name three alternative energy sources.

7 Today, most wind turbines are of _____-axis design.

a. diagonal
b. vertical
c. horizontal
d. linear

8 A wind generator converts _____ energy into _____ current.

9 Describe the ideal geographic location for a wind farm and explain why it is ideal.

10 Dividing the full-size wattage by the model wattage is how you find the _____ of a wind generator.

1 The x-axis on a graph is the _____ axis.
- a. horizontal
- b. vertical
- c. neither

2 Explain how a wind generator creates electricity.

3 _____ is the scientific law that states, "Energy may neither be created nor destroyed."
- a. The law of conservation of matter
- b. The general theory of relativity
- c. The law of induction
- d. The law of conservation of energy

4 Values in an experiment that change in relationship to one another are known as the _____ and _____ variables.

5 What was the nickname given to Poul la Cour?

6 Wind energy is classified as _____ energy.
- a. renewable
- b. nonrenewable

7 What is the unit of measure for electricity that is consumed or produced?

8 Name the factors affecting the amount of electricity a turbine can produce.

9 True or false. Wind farms are owned and operated by business people who sell the electricity they generate to electric utility companies.

10 What is the formula used to determine scaling factor?