

Electricity and Wind Energy: Guided Inquiry Lab

Overview

How much electricity can you harness from the wind alone? In this lab, you will design and build a miniature wind turbine to see how much electricity it can produce. It will be up to you and your partner(s) to determine which of the provided materials to use and how to put them together to produce the greatest amount of power. The voltage and amperage of the spinning rotor will be measured with a multimeter to determine the amount of generated power.

Focus on Science Practices

SEP 4 Analyzing and Interpreting Data

SEP 6 Constructing Explanations and Designing Solutions

Materials Per Group

- Bamboo skewers
- Blade material (choose one)
 - Cardboard sheet
 - Foam sheet
 - Manila folder
 - Polystyrene sheet
- Calculator
- Cork
- Glue or tape
- Ruler
- Sandpaper
- Scissors
- Timer

Safety



Exercise caution when handling sharp bamboo skewers. Sandpaper may be used to smooth rough edges. Wear eye protection as rotor components may separate during testing. Never touch any bare wires in an electric circuit with a current. Please follow all laboratory safety guidelines.

Procedure

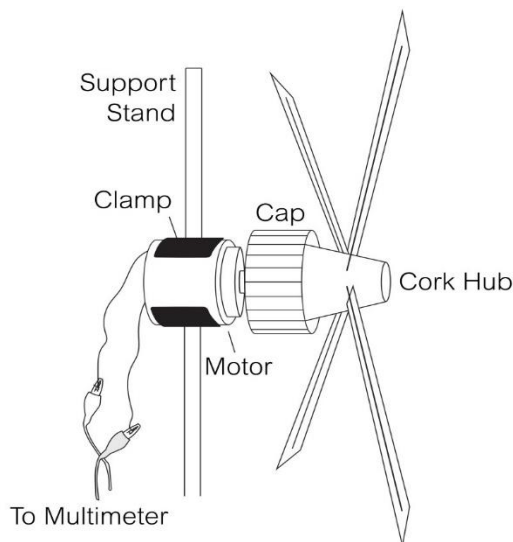
1. Read through the entire Procedure before beginning.
2. Take 5–10 minutes to plan the rotor design using only materials provided by your teacher. Consider the following questions when planning the design:
 - a. How many blades will the rotor have?
 - b. What material will be used to make the blades?
 - c. What size and shape will the blades be?

List the specifications of the chosen rotor design.

Rotor Design

3. Bamboo skewers are used to secure the blades to the central hub (cork). The blades should be attached to the skewers with tape approximately 4–5 cm up from the sharp end of the skewer. After blades have been attached, excess skewer will need to be removed. Cut them part way by scoring around the skewer with scissors and then breaking the skewer by applying pressure on either side of the partial cut. Rough edges should be sanded smooth.
4. Secure your blades to the cork, keeping in mind your answers to the design questions in step 1. The large end of the cork will be placed in the cap to secure the central hub to the motor (Figure 1).

Figure 1



5. Take the completed rotor assembly to the testing station.
6. Your teacher will attach the rotor to the motor at a set distance from the fan.
7. Turn the fan on high speed.
8. If the rotor turns, move on to step 9. If it does not turn, try to determine why not. Remove the rotor, and proceed to step 13.
9. Set the multimeter to measure volts.
10. With the fan on high speed, note the highest voltage displayed in 20 seconds, and record the value on the data table. Note: If the voltage is a negative number, reverse the current by switching the connections to the multimeter.
11. With the fan still running, adjust the multimeter to register milliamps.
12. Note the highest amperage displayed in 20 seconds, and record the value on your data table.
13. Observe other groups' rotors as they are tested.
14. Once each group has tested its rotor, adjust the height of the motor on the support stand so the rotor hub is halfway between the center and the top of the fan. Repeat steps 9–12 with the rotor in this new position. If the rotor does not turn in this position, proceed to step 15.
15. Calculate the power output in milliwatts for each test using Equation 2. Record the value on the data table.

Equation 2: $P \text{ (mW)} = V \times \text{mA}$

Data Table				
Trial	Voltage (V)	Milliamps (mA)	Power (mW)	Observations
Rotor Hub Facing Center of Fan				
Rotor Hub Above Center				

Analyze and Interpret

1. **SEP Interpret Data** Based on the performance of your rotor, and that of the other groups, what modifications could be made to your design to improve the power output?

2. **SEP Construct an Explanation** Traditionally a motor uses electric current to spin objects. In this laboratory activity, the constructed rotor is connected to a motor, but the motor is not attached to any source of electricity.

a. What makes the shaft of the motor spin?

b. As the shaft of the motor turns, electric current runs through the wires. What must be inside the motor for this to happen?

c. What is the motor actually functioning as in this activity?

3. SEP Apply Scientific Reasoning As of November 2018, wind power provided about 6.5 percent of the electricity in the United States. That number is on the rise, and in some states it provides as much as 30 percent.

a. List the advantages of using wind power for electricity.

b. What are some reasons why wind is not being used as much as other resources to generate electricity?