NAME PERIOD DATE

POWER AND ENERGY

Driving Question | Objective

How are power and energy related to voltage and current?

What is the difference between power and energy?

As a wind turbine spins, the motor converts mechanical energy into electrical energy. Power describes either how fast the turbine can produce electrical energy or how fast a load connected to the turbine uses energy.

Energy is measured in a unit called joules (J). Power is the amount of energy either produced or used per second. It has the units of joules per second (J/s), which is also known as the watt (W).

Because the turbine you will be using is small and does not produce much power, we will use the unit milliwatts (mW) to measure power, which equals one thousandth of a watt.

Materials

- Wind turbine
- Voltage sensor with red and black banana plug leads
- Current sensor with red and black banana plug leads
- Alligator clip adapters (2, black)
- Alligator clip leads (2, black and green)
- Box fan, 3 or more speeds (same fan as previous activity, with tape)
- 33-Ω resistor
- Textbooks for weight (2)

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Wear safety goggles throughout the experiment.
- Tie back long hair, remove dangling jewelry, secure loose clothing, and roll up long sleeves.
- Always make sure blades are properly inserted in the turbine and screws are secure before turning on the fan.

Consider

1. Think about how power, voltage, and current might be related and choose an explanation that makes sense to you.

   a) Power equals voltage divided by current

   b) Power equals voltage times current

   c) Power equals current divided by voltage

   d) Power equals current minus voltage

   e) Power equals current plus voltage

   f) Power equals voltage minus current

2. Which quantity is the most direct measure of energy alone, without needing to consider rate, time, or speed?

   a) Power

   b) Voltage

   c) Current

Investigate

1. Connect the voltage and current sensors. Use Help (?) if necessary.

2. Build a page with a graph display. Open the Line Graph Properties menu by clicking either measurement on the x or y axis.

3. Select Time for the x-axis. For the y-axis, click Measurement. Choose User-entered from the menu to the right.

4. Find the Calculated Data section. Select Create/Edit Calculation.

5. Type the following equation inside the text box exactly as shown, including capital letters and spacing:

   POWER=

6. With the cursor still in the text box, select the orange Measurements button in the keypad display. Select current. Choose the Measurements button again and select voltage. Your equation should now look like this:

   POWER=[Current][Voltage]

7. Use the keypad display to add *1000 to the equation. Your equation should look like this:

   POWER=[Current][Voltage]*1000

8. Select Return in the keypad. You should see the following message below the equation:

   Model is calculated.

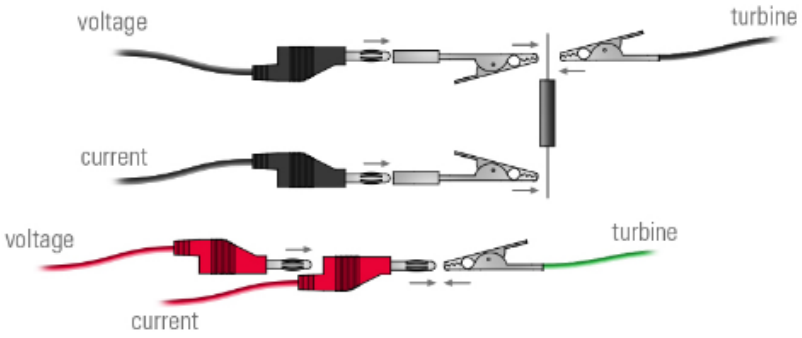
9. Select done on the keypad. Choose OK.

10. In the Line Graph Properties menu, choose Measurement for the y-axis. Select the User-Entered tab to the right and choose POWER from the Calculated Data section. Select OK.

11. Assemble the turbine according to the optimal fan distance, blade length, blade pitch, leaf logo facing the fan, and number of blades found in a previous activity. Add textbooks to the base.

12. Insert banana plug leads into sensors if necessary. Use red for (+) and black for (-).

13. Attach alligator clip leads to the motor terminals. Assemble the voltage sensor, current sensor, and resistor as shown.



14. Turn on the fan to the optimum speed. Wait for the turbine to reach full speed.

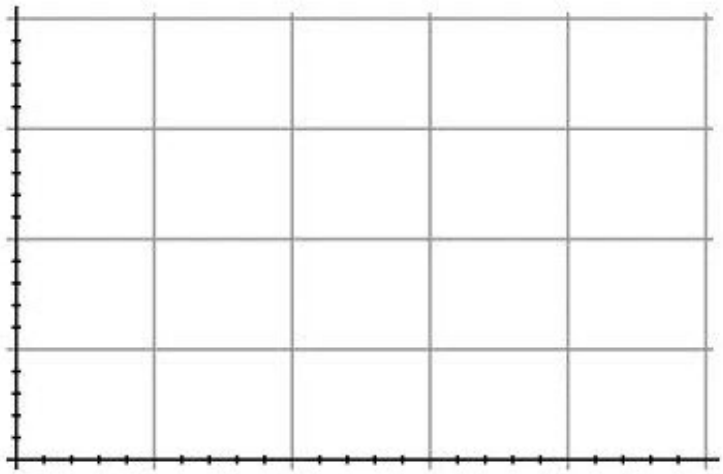
15. Start collecting data.

16. Stop collecting data after two minutes.

17. Scale the graph. Use **Help (?)** if necessary.

18. Turn the fan off.

19. Sketch the results in the graph below. Remember to add a title. Include numbers and labels with units for both axes.



Analyze

1. Open Graph Tools. Under Statistics Tools, select Area. Use **Help (?)** if necessary. The area under the curve is the total energy produced by the wind turbine in two minutes. How much energy did your wind turbine produce?

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2. If you collected data over three minutes, which would stay the same: energy or power? Explain your answer.

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3. Return to the graph to draw your prediction of how power might change if you collected data outdoors instead of indoors with a fan. Use **Help (?)** if you are not familiar with the prediction tool. Explain your prediction in the space provided.

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Extend

Design and conduct an experiment to produce the same amount of energy with the turbine at a different power.