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Activity 4

Wind Energy

Teacher Procedure

Objective

In this activity, students learn about wind energy by making a model wind turbine and powering a bubble machine.

Background

Wind turbines are different from windmills. Windmills are used to pump water (get water out of a well) or grind grain, whereas wind turbines are used to produce electricity. Wind is a renewable resource, and engineers design wind turbines to change the kinetic energy of the wind into mechanical and electrical energy.



Typically, wind farms are in regions that have strong and steady wind – typically in open fields, on top of mountains, or on the ocean’s surface. For most wind turbines to turn fast enough to generate electricity, the wind must roar at a minimum of 12 to 14 mph. When the wind blows, the angled blades of the turbine turn a gear transmission box that is connected to a generator that generates electricity. To avoid damage to the blades, the turbine includes a brake just in case the wind gets too strong.



A turbine usually produces 50 to 300 kilowatts (kW) of electricity. So, 300 kW of electricity can light up 3,000 one-hundred-watt lightbulbs. The challenges for engineers in this industry are how to make wind turbines or farms more efficient and how to find better ways to store or transport the electricity generated.

Teacher Procedure

Procedure

Construct the Wind Turbine

Show the *Pitsco Wind Gen* video for visual instructions that illustrate the kit construction procedure.

Assist students as needed as they follow the Student Procedure.

Construct the Wand Motor Platform

Assist students as needed as they follow the Student Procedure.

For Step 2, students may use a drill and drill bit to make the hole.

Construct Transmission Lines and Connect Wires

Assist students as needed as they follow the Student Procedure.

Connect Wires to Wand Motor

Assist students as needed as they follow the Student Procedure.

Connect Wind Gen Motor and Wire to Potentiometer

Assist students as needed as they follow the Student Procedure.

Assemble Wand Motor Apparatus

This assembly uses currently available LEGO® parts and bubble wands commonly found in bubble bottles in retail stores. If the parts do not fit together as indicated, students will need to brainstorm and problem solve to determine how to make a secure connection between the wand and the motor shaft.

In Step 11, students use the wind turbine and bubble machine to complete their “Wind Turbine Data Sheet.” This part of the activity may be done outside – a little extra wind will aid in the production and flight of the bubbles.

Safety

- Knives and scissors are very sharp. Make sure students use them with care and do not cut close to their fingers.
- Supervise students while they construct the Wind Gen.

Extension Activities

- Have students change the speed of the wand motor using LEGO® or other gears.
- Have students redesign the bubble maker to make it even better.

Activity 4

Wind Energy

Student Procedure

Vocabulary

- wind energy
- wind farm
- wind turbine
- windmill

Materials

- Waxed paper
- Tape
- Wind Gen Kit
- Scissors
- Hole punch
- White glue
- Glue stick
- Balsa wood sheets
- 2 – 18" pieces of wire (Pitsco product 12741)
- Craft knife
- Potentiometer
- 2 straws
- Ruler
- Piece of cardboard
- Wire strippers
- Shrink tubing, 3/16" (four 1" pieces and one 1/2" piece)
- Blow dryer
- Bottle of bubble liquid with a built-in wand
- Container for bubble liquid trough (such as a disposable foil loaf pan – be sure to recycle it)
- Extra Motor 500 (Pitsco product 50075)
- Wand holder constructed of LEGO® parts (one each of the Long Black Connector Peg [970605], Connector Pegs with Axles [970606], Cross Blocks [970628]) – or a similar construction
- Pencil
- “Wind Turbine Data Sheet”

Procedure

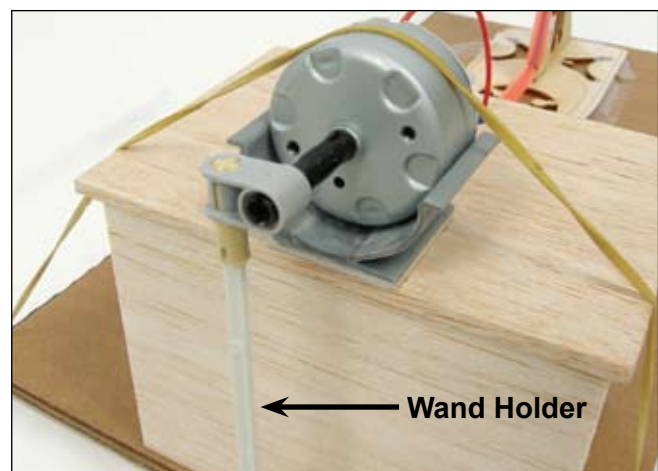
Build the Wind Gen Kit according to its instructions.

Construct Wand Motor Platform

When the wind turbine is built, make the wand motor platform for the bubble wand motor.

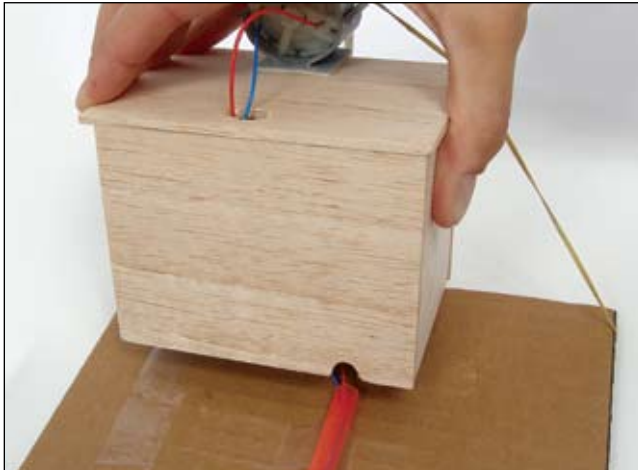
1 Out of the balsa wood sheets, make a bottomless box 4" long, 3" wide, and 3" tall.

2 Cut a hole in the balsa wood box top in the middle on the side that will be closest to the wind turbine when the two are placed together on the cardboard (see the Construct Transmission Lines and Connect Wires section).



Student Procedure

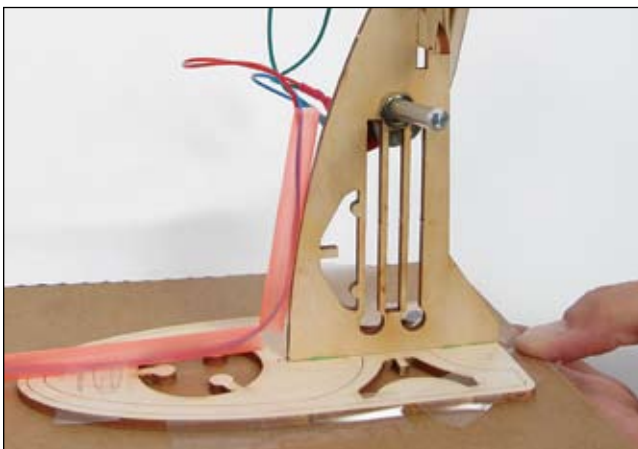
- 3 Cut a half moon on the bottom of the box. This is where the transmission lines will enter the motor platform.



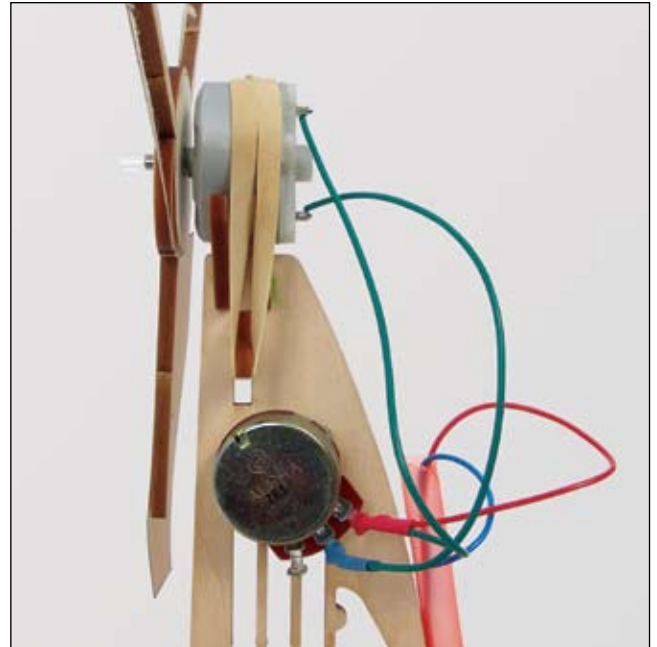
Construct Transmission Lines and Connect Wires

When the Wind Gen and bubble wand motor platform are built, you need to run the electricity transmission lines and hook up everything.

- 1 Glue or tape the wind turbine to the piece of cardboard.



- 2 Insert the potentiometer into the top hole in the wind turbine.



- 3 Cut a straw piece that is 2-1/2" long.

- 4 Run the wires through both straws and then up through the hole in the top of the motor platform. Do not connect the wires yet.

- 5 Place the Wind Gen motor into the motor holder.

- 6 Remove the adhesive tape from the motor housing and press the housing onto the top of the balsa wood platform.

Activity 4

Wind Energy

Student Procedure

7 Tape or glue the straws with the wire onto the back of the Wind Gen and tape the long straw onto the piece of cardboard.

8 Tape or glue the motor platform onto the cardboard with the straw hole over the straw.

Connect Wires to Wand Motor

1 Strip all four wire ends to expose 1/2" of bare wire.

2 With the wires dangling out of the straws, cut four 1" pieces of shrink tubing.

3 Place the extra motor, which will be the bubble wand motor, on top of the balsa wood platform. Locate two pieces of the shrink tubing you just cut. Slide a piece of tubing on each wire on the motor platform side. Make sure the tubing does not fall into the motor housing.

4 On the motor platform, wrap the wire through the terminals and twist it on itself to make sure it has a good electrical connection.

5 Bring up the shrink tubing on the wire and cover any bare connections (bare metal) you see. Blow-dry the tubing to shrink it and protect the connection.

Connect Wind Gen Motor and Wire to Potentiometer

1 Connect one wire from the Wind Gen motor to a wire from the bubble wand motor. Twist the two wires together.

2 Connect the other wire from the Wind Gen motor to the other wire from the bubble wand motor. Twist the two wires together.

3 Fit each of the pair of wires through a small piece of shrink tubing.

4 Take one set of wires and twist them onto the middle lead of the potentiometer. Pull the tubing over all the exposed wire and the terminal of the potentiometer.

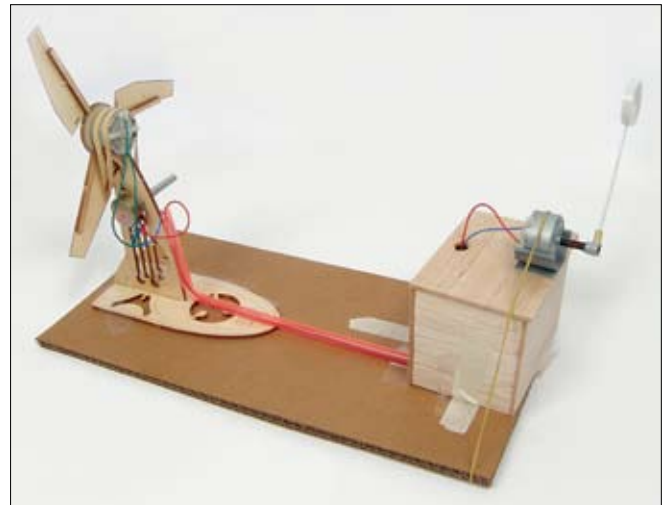
5 Take the other set of wires and twist them onto one of the other leads on the potentiometer – it doesn't matter which one. Pull the shrink tubing over all of the exposed wire and the terminal of the potentiometer.

6 Blow-dry to shrink the tubing until you can see the outline of the wires in the tubing.

Student Procedure

Assemble Wand Motor Apparatus

- 1 Place a 1/2" piece of shrink tubing over the motor shaft. This keeps the friction peg from turning.
- 2 Push the friction peg over the tubing on the shaft.
- 3 Place the gray LEGO® piece onto the friction peg and connect the other linking peg onto the gray piece.
- 4 Insert the bubble wand into the last piece put in.
- 5 Locate the bubble trough and place it next to the bubble wand motor platform.
- 6 Estimate the desired length of the wand. You want the entire circular portion of the wand to dip into the bubble liquid.
- 7 Cut the wand to the right length.
- 8 Place the Wind Gen in front of a fan and test it to ensure it turns the wand.
- 9 Adjust the potentiometer so the wand turns slowly and doesn't splash the bubble liquid out of the trough.
- 10 When satisfied with the speed of the wand, fill the trough with bubble liquid and watch the bubbles go!
- 11 Complete the "Wind Turbine Data Sheet."



Wind Turbine Data Sheet

1. What is the difference between a windmill and a wind turbine?
2. Why is wind energy renewable?
3. Name three variables that can make the Wind Gen turn faster or slower.
4. What is the slowest that the wand motor turns? Have a team member time one revolution of the wand.
5. What problems did you encounter making the bubble maker?

Student Procedure

Wind Turbine Data Sheet continued

6. How did you solve those problems?

7. Is there a way you could make the bubble maker work even better?

conservation – the wise and efficient use of natural resources

electrolysis – the splitting apart of water into hydrogen and oxygen gases by means of passing an electric current through the water

energy – the ability to do work

energy vampire – device plugged into the wall 24 hours a day that uses energy even when it is not in use

four-wheel drive – method of providing power to all four of a vehicle's wheels

foot-candles (Fc) – lumens per square foot

fuel cell – device that combines hydrogen, or other fuels, and oxygen and produces electricity in the process

hydrogen – known as Element 1 because it has one electron and one proton, making it the first element listed in the periodic table; the smallest, lightest, and most abundant element in the universe

lumen – measure of the amount of light that falls on a surface

modification – a change in design, hypothesis, or prototype

nonrenewable energy – source of energy that is used up after being converted to electrical or mechanical energy, such as coal, natural gas, oil, other fossil fuels, and nuclear energy

parabolic surface – a surface that has a side view in the shape of a parabola

renewable energy – a source of energy that is not used up after being converted to electrical or mechanical energy, such as solar, wind, wave, geothermal, or hydropower energy

solar cell – a semiconductor device that converts the energy of sunlight into electric energy; also called photovoltaic cells

solar cooking – way to cook using the energy of the Sun

solar energy – energy from the Sun

wind energy – energy produced from the wind – typically by way of windmills or wind turbines

wind farm – group of several wind turbines used to produce large amounts of electricity

wind turbine – converts kinetic energy of the wind into mechanical and electrical energy

windmill – used to pump water out of a well or to grind grain

work – force on an object multiplied by the distance it moves (force multiplied by distance – or $W = F \times d$)