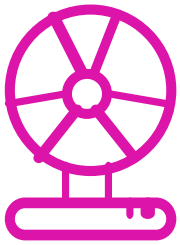
3M Young Scientist Lab

Family Activity | Grades 6–8

Make a Model Windmill



OVERVIEW

Make a toy or model windmill for your windowsill or garden and learn about the fundamentals of wind energy first-hand.

OBJECTIVES

Students will be able to:

- explain the fundamentals of wind energy.
- describe how wind turbines collect the wind's kinetic energy.
- design and build a working windmill.

BACKGROUND INFORMATION

Like old-fashioned windmills, today's wind machines (also called wind turbines) use blades to collect the wind's kinetic energy. The wind flows over the blades creating lift, like the effect on airplane wings, which causes them to turn. The blades are connected to a drive shaft that turns an electric generator to produce electricity.

There are two types of wind machines (turbines) used today, based on the direction of the rotating shaft (axis): horizontal-axis wind machines and vertical axis wind machines. The size of wind machines varies widely. Small turbines used to power a single home or business may have a capacity of less than 100 kilowatts. Some large commercial-sized turbines may have a capacity of 5 million watts, or 5 megawatts. Larger turbines are often grouped together into wind farms that provide power to an electrical grid.

MATERIALS (BY ACTIVITY)

Activity#1: Windmill - Easy Version

- Heavy construction paper
- Ruler or compass
- Pencil
- Scissors
- Straw or thin stick
- Push pin or metal paper fastener
- Sticky Putty

Activity#2: Windmill – Advanced Version

- Aluminum cans
- Protective eyewear or goggles
- Gloves
- Scissors
- Sanding sponge
- Old newspapers
- Spray paint
- Polyurethane spray
- Respirator or mask
- Wooden dowels—various sizes
- Hammer
- Nails

HOME ACTIVITIES

Activity#1: Windmill - Easy Version

1. Roll a 1-inch piece of adhesive putty into a ball in your hands. Set it aside.
2. Cut construction paper into a square shape. (If your paper is 8 ½ x 11, then cut 2 ½ inches off the long end.)
3. Fold the paper diagonally to form a triangle. Unfold and then fold diagonally in the other direction, forming another triangle. When you open the paper you'll see the creases form an "X".
4. Use a ruler or compass to measure 1 inch from the center of the X. Mark this measurement on all four lines with a pencil.
5. Cut along each line to the pencil mark.
6. Now pull the four corners to the center, folding the tips of the facing triangles over each other evenly.
7. Push a push pin or metal fastener carefully through the center of the paper. Make sure it goes through all four corners and pokes out through the back.
8. Stick the ball of putty on top of your straw or stick. Then stick the end of the pin or fastener into the putty.
9. Now blow on your windmill and watch it spin!

Activity #2: Windmill – Advanced Version

1. Wash your used cans thoroughly in warm soapy water. Rinse well and dry completely before beginning the project. (Do this the day before if possible.)
2. Measure the circumference of your can. Calculate how to evenly divide the can lengthwise into 6-8 strips (to be used as windmill blades).
3. You can either draw blade outlines directly on the can, using a measuring tape as a guide, or you can make a template and trace your blades on the can using that.
4. Before beginning the next steps, put on safety goggles and gloves.
5. With adult supervision or help, use scissors to cut off the top of the aluminum can. Insert one blade of your scissors into the side of the can, ¼ inch from the top. Then snip around the circumference, being careful not to touch the sharp edge. Remove the top. The edges of the cut cans will be sharp, so handle them carefully.
6. Cut along the outlines of each blade, stopping ½ inch from the bottom. (The blades will be left attached to the can.) Use long scissor cuts to cut straight lines smoothly.
7. Dispose of scraps carefully. Crush or bend the aluminum scraps and place in a paper bag before putting them in your recycle bin.
8. Now bend down each blade.
9. Place the can on the ground or a sturdy surface. Lightly hammer the bottom and the blades to flatten them.
10. Sand the front and back sides of the aluminum. This should make the edges less sharp and the surface easier to paint. Dust off the aluminum after sanding.
11. Spray paint the blades, using two thin coats of paint. (Put newspapers underneath first to protect the ground.) Make sure to do this in a well-ventilated area.
12. Wait a few minutes for the spray paint to dry. Then apply two coats of polyurethane spray to protect the paint. Be sure to wear a mask while spraying.
13. Hammer a nail through the center of the windmill into the wooden dowel. Wiggle the nail around a bit to widen the nail hole. (If there's no wiggle room, the windmill won't spin.) Now stick it in the ground in your garden and wait for a breeze!

VOCABULARY

- **Wind energy:** energy from the bulk movement of air.
- **Kinetic energy:** the energy an object has when it is in motion.
- **Wind turbine:** tall towers topped with blades that use wind to make electricity.

THOUGHT/CONVERSATION STARTERS

Ask these questions before you begin:

- What is wind?
  - A: It is moving air.
- Where does it get its energy?
  - A: From the sun.
- How does the sun move the air?
  - A: It works something like this: The sun heats the Earth's surface, but not very evenly. [For instance, water absorbs less heat than land, and different types of terrain on land absorb heat at different rates.] So the air above the Earth's surface also warms—and cools—at different rates.
- Where does the movement come from?
  - A: Hot air rises. When it rises, the atmospheric pressure near the Earth's surface drops, drawing in cooler air. This "drawing" or whoosh of horizontal air is wind. The greater the difference in pressure between the warm and cool air, the stronger the wind.
- What is kinetic energy?
  - A: The energy created by mass in motion.
- How do we capture energy?
  - A: One way to capture energy is through Windmills (and high-tech wind turbines). They capture the wind's kinetic energy and convert it to other forms of energy—like electricity or mechanical power.

DOCUMENT THE LEARNING IDEA

- Allow your young scientist to document their learning at home by reflecting in their science journal.
- Take photos using a smartphone or tablet of your family creating their windmills. Use text and/or stickers to explain photos.
- Record a video to inform the class about what was learned after researching and creating your windmills.

If your young scientist documents the learning, encourage them to bring their creations to class and share with the teacher.

CONTINUE MAKING CONNECTIONS

With the new wind machines, there is still the problem of what to do when the wind isn't blowing. At those times, other types of power plants must be used to make electricity.

Can you think of any way to create artificial wind for when the wind isn't blowing, so the wind turbines can still be productive? Discuss your thoughts as a family.

ADDITIONAL LINKS:

- For more information on wind turbines, see the U.S. government's Renewable Wind page: http://www.eia.doe.gov/kids/energy.cfm?page=wind_home-basics
- TLC: How Recycled Aluminum Can Crafts Work http://tlc.howstuffworks.com/family/recycled-aluminum-can-crafts.htm
- Energy Kids – U.S. Dept of Energy Learn all about wind energy and wind turbines http://www.eia.doe.gov/kids/energy.cfm?page=wind_home-basics
- From Windmills to Whirlygigs – The Science Museum of Minnesota http://www.smm.org/sln/vollis/