

3M



Young Scientist Lab

in partnership with:  **Discovery**
EDUCATION

Science of Summer Family Activities

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.

Materials

Windmill – easy version

- heavy construction paper
- ruler or compass
- pencil
- Scotch™ Precision Scissors
- straw or thin stick
- push pin or metal paper fastener
- Scotch® Adhesive Putty

Windmill – advanced version

- aluminum cans
- 3M™ Protective Eyewear or goggles
- gloves
- Scotch™ Precision Scissors
- 3M™ Sanding Sponge
- old newspapers
- spray paint
- polyurethane spray
- 3M™ Particulate Respirator or mask
- wooden dowels—various sizes
- hammer
- nails

Thought 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 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.*

Activities

Windmill – easy version

- Roll a 1-inch piece of adhesive putty into a ball in your hands. Set it aside.
- Cut construction paper into a square shape. (If your paper is 8 ½ x 11, then cut 2 ½ inches off the long end.)
- 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".
- 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.
- Cut along each line to the pencil mark.
- Now pull the four corners to the center, folding the tips of the facing triangles over each other evenly.
- Push a pushpin or metal fastener carefully through the center of the paper. Make sure it goes through all four corners and pokes out through the back.
- Stick the ball of putty on top of your straw or stick. Then stick the end of the pin or fastener into the putty.
- Now blow on your windmill and watch it spin!

Windmill – advanced version

- 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.)
- Measure the circumference of your can. Calculate how to evenly divide the can lengthwise into 6-8 strips (to be used as windmill blades).
- 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.
- Before beginning the next steps, put on safety goggles and gloves.
- 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, $\frac{1}{4}$ 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.
- Cut along the outlines of each blade, stopping $\frac{1}{2}$ inch from the bottom. (The blades will be left attached to the can.) Use long scissor cuts to cut straight lines smoothly.
- Dispose of scraps carefully. Crush or bend the aluminum scraps and place in a paper bag before putting them in your recycle bin.
- Now bend down each blade.
- Place the can on the ground or a sturdy surface. Lightly hammer the bottom and the blades to flatten them.
- 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.
- 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.
- 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.
- 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!

Discussion points

- 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.

- 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.
- 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 the electrical grid.

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

3M Wind Farms

http://solutions9.3m.com/wps/portal/3M/en_US/3MElectrical/Home/Solutions/WindFarms

From Windmills to Whirlygigs – The Science Museum of Minnesota

<http://www.smm.org/sln/vollis/>

How a boy in Malawi made a windmill from recycled trash – Parade.com

<http://www.parade.com/news/backpage/mitch-albom/100502-the-lost-art-of-building-with-your-hands.html>

Windmill projects for science fairs

<http://www.kidwind.org/lessons/SFBuildingSFintro.html>