Activity 5

Blowin' in the Wind

BUILD A WINDMILL THAT LIFTS WEIGHT.

Windmills have been used for thousands of years to grind grain, pump water, and even generate electricity. They lost popularity as new sources of energy, such as fossil fuels, arose. But the idea of using wind for energy has made a comeback in recent decades, and careers in wind energy are growing rapidly as the demand for clean energy increases.

SMART START: It is *highly* recommended that you build your own windmill before running this activity to see what challenges your girls will face!

You'll Need (per small group):

2+ hours

Part 1:

- 12-in. (or larger) electric fan (or set up several fan stations around the room)
- 12-in. long wooden dowel (diameter needs to fit through the spool in Part 2)
- 6-in. piece of PEX tubing (found at a hardware store) or large plastic drinking straw or empty cardboard milk carton
- 4-8 index cards (4 "x 6 ")
- 4 wooden skewers
- Styrofoam ball (with 2 in. diameter) or squares cut from Styrofoam blocks
- 6 T-pins (office supply stores)
- duct tape or sticky tack
- 18 in. piece of clear tape
- scissors
- safety glasses
- paper and pencil
- optional: protractor, sand or stones to weigh down milk carton

Part 2:

- windmill from Part 1
- 4 ft. length of string
- paper or plastic cup
- 15 steel nuts or washers, for weights
- plastic or wooden spool

1-7 See **SciGirls Seven** strategies on page 3.

Blowin' in the Wind continued

Part 1
Build a Windmill That Spins

Here's how:

1. **Introduce windmills.** Start with a discussion of how we use energy in our everyday lives. [2] Where does that energy come from? (power plants, coal, gas) What are alternative forms of energy? (solar, wind, hydro) Ask your girls if anyone has ever seen a real windmill or wind turbine. Where? Can they draw an example?

POINTER: If girls have no familiarity with a wind farm, bring in pinwheels or even use the fan itself as a model.

Show video of actual wind turbines on the *SciGirls Engineer It* DVD. (Select Blowin' in the Wind: Research 2.)

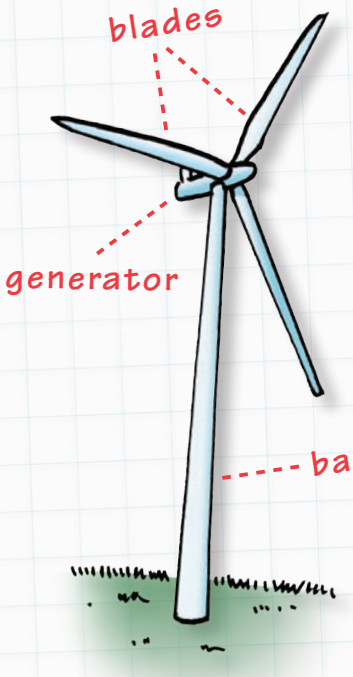
Now, start with what they know. [5] Can they name the parts or features of a windmill or wind turbine? Create a drawing and label the parts. (See right.) Talk about why the blades are shaped and arranged in a particular way.

2. **Understand supply constraints.** Ask your girls to get into small groups [1] and then present the **SciGirls Challenge:** Build a windmill that spins when placed in front of a fan. Then get the windmill to lift a cup filled with weights. Hand out the materials, stressing that they don't have to use all of them. [3] There are not enough materials to build a tower for the windmill, unless you choose to use the milk carton as your base. (See Weight-Lifting Windmill on page 17.) Guide girls to hold their windmills in front of the fan by hand. (See page 16.)

3. **Think and plan.** Ask each group to brainstorm, plan, sketch, and agree on a windmill design before building. [3] [6]

Safety First

Wear safety glasses. The skewers are sharp and should not be pointed at anyone's eyes or face. Never stick your fingers into the spinning blades. Either turn off the fan or rotate your windmill 90˚ to stop the blades. Stand behind the windmill, not to the side of it, to avoid being hit if a blade flies off during testing.

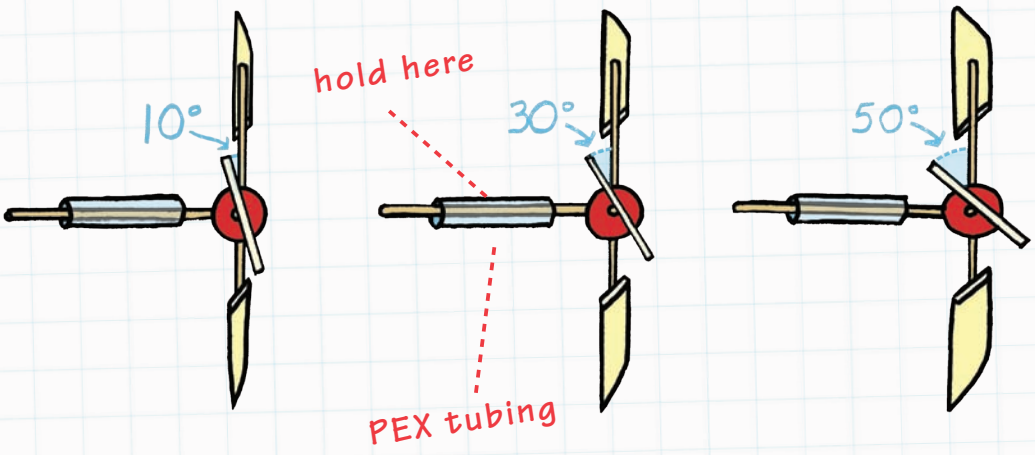


Blowin' in the Wind continued

4. Test prototypes. Remind girls they should first focus on getting the windmill to rotate when placed in front of the fan and not worry about lifting weight yet. Having the fans on a low setting encourages girls to build more efficient designs. They should test their prototypes and redesign before moving on to Part 2.

5. Optimize blade design. Focus girls on the following ideas:

- Pitch is the angle of the blades. For instance, blades that lie completely flat are at 0˚. Have girls experiment with pitch to improve their designs. (See below.)



- Shape helps maximize lift and minimize drag. Lift is a force that pushes up against the blades to make them move; whereas drag (also called wind resistance) is a force that works against the rotation of the blades and slows them down. Encourage girls to think about turbine blades or other devices that move efficiently through the air. [2] To produce lift, airplanes' propellers and wings have curved structures that create a difference in air pressure as wind passes over them. Turbine blades, specifically, have a wider base and narrower tip. The tip of the blade travels faster than the base because there is more distance to cover per turn. Thus, the narrow shape helps reduce drag.

Blowin' in the Wind continued

Part 2
Test Your Windmill with Weight

6. **Introduce the new challenge.** For groups ready to do the weight-lift challenge, hand out the spool, string, cups, and weights. Try getting the windmill to lift the cup alone before adding weight. (See below.)

7. **Test and redesign.** If needed, remind girls to consider the size, shape, pitch, and number of blades. Each one of these factors is a separate variable, so encourage groups to change only one at a time.

To see girls model this process, watch the *SciGirls Engineer It* DVD. (Select Blowin' in the Wind: Test.) [7]

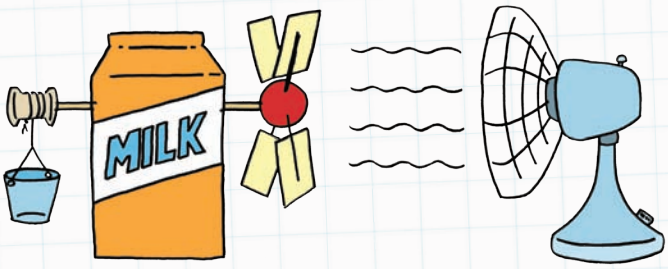
After agreeing on which variable to change, girls should conduct a trial, then measure and record the results before testing a different variable. The fan speed and distance from the windmill should be kept constant.

8. **Problem solve.** If groups are struggling, encourage them to look at other groups' designs. Which techniques work well? Remind girls that this activity is not a competition and everyone can learn from and support one another. [5]

9. **Share results.** After each group has had a chance to get its windmill to lift weight and tested at least one variable, reconvene as a large group and discuss the designs that lifted the most weight. Which variables improved performance? Brainstorm uses for your device. Would you want a windmill on your tree house to carry cargo up and down? [4] [2] Be creative!

Share results of your weight-lifting creations on our website at pbskidsgo.org/scigirls.

Weight-Lifting Windmill



Special thanks to KidWind for their ideas and expertise. The KidWind Project is a team of teachers, engineers, and scientists committed to innovating energy education. They promote the elegance of wind power through affordable tools and training programs that challenge, engage, and inspire students of all ages. For more wind energy activities, visit kidwind.org.

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