

Activity Instructions - Classroom Wind Farm

The purpose of this activity is for students to build their own windmill generator, which will then be one unit of the classroom wind farm.

In addition to the materials listed in the *Prep Instructions*, the following items will be needed for this activity:

- one 2 L pop bottle (with cap)
- one scrap CD
- one 1 in. nail with decent head
- one metal bottle cap
- one paper towel tube
- two long wires with alligator clip ends
- one electric motor
- one 6 in. x 6 in. piece of thin card stock
- two 1 in. x 1 in. x 1/4 in. piece of balsa wood

Tools

- hot glue gun
- scissors
- electric drill
- hammer
- ruler
- pencil

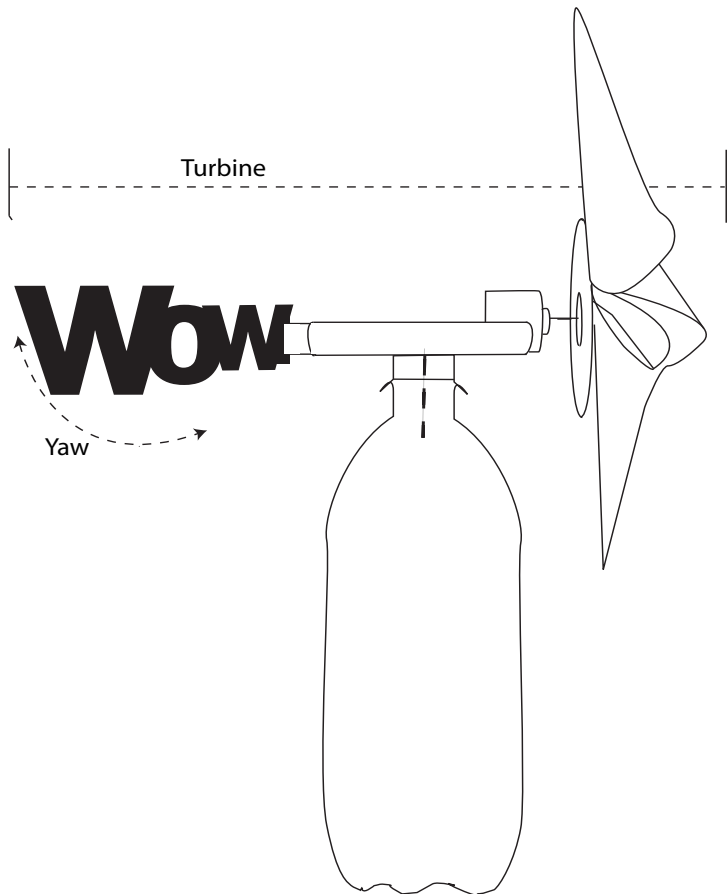


Figure 1

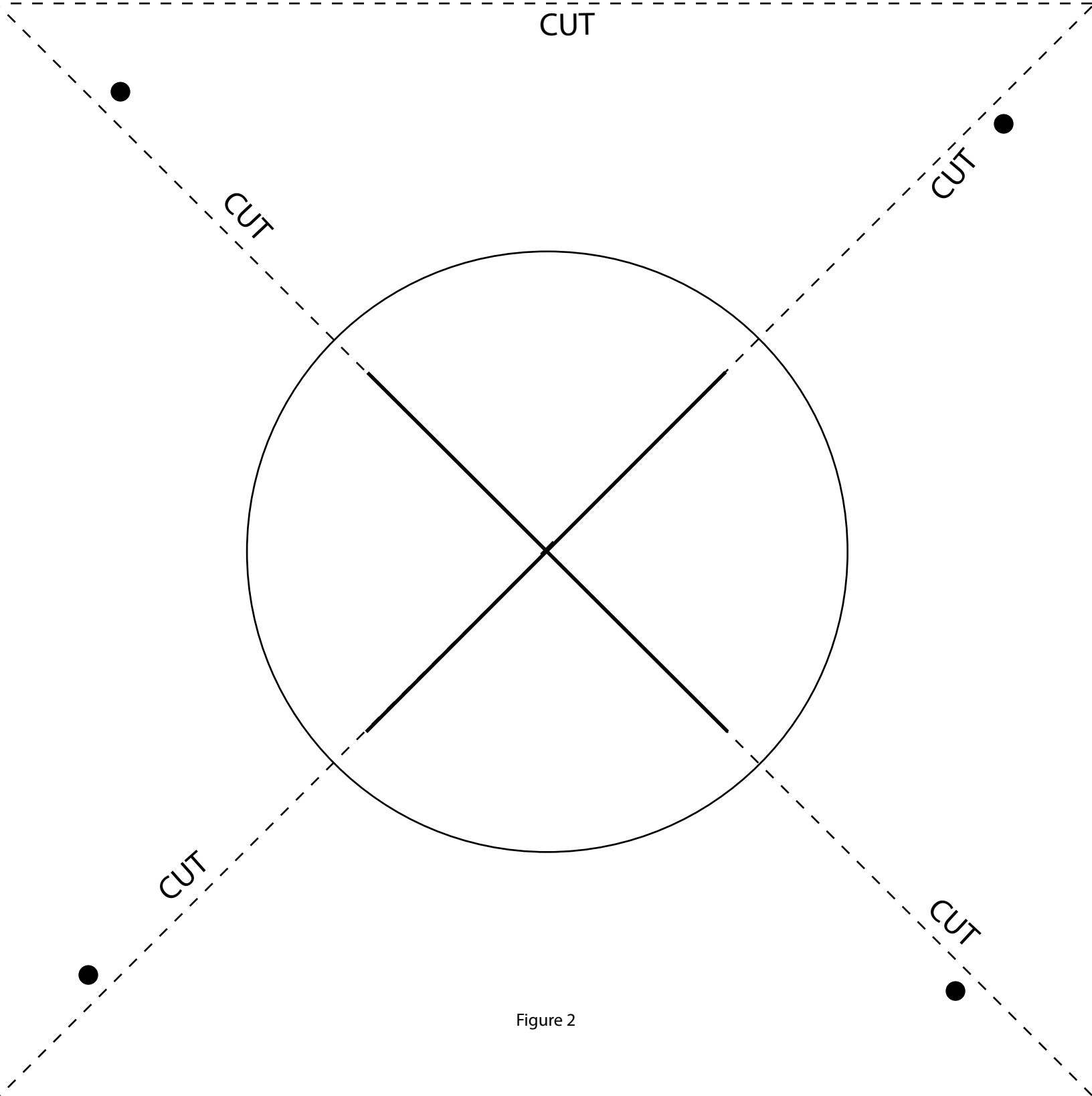


Figure 2

Part I - Construction of a Paper Windmill

Step 1

Use the windmill template on the previous page (**Figure 2**) and cut along the dotted lines.

Step 2

Using the hot glue gun, glue a CD onto the template, inside the circle on the printed side of the paper (**Figure 3**).

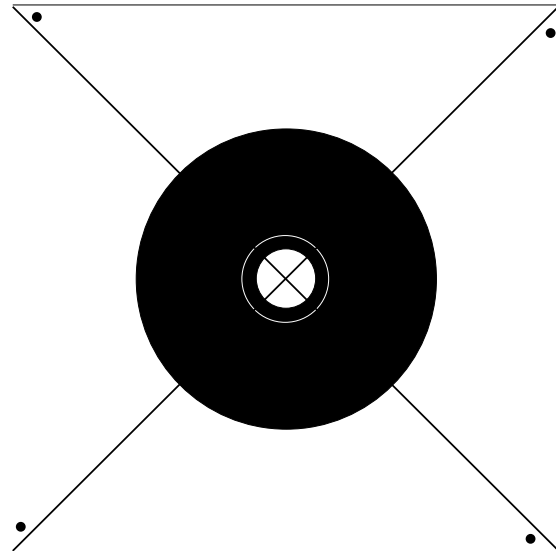


Figure 3

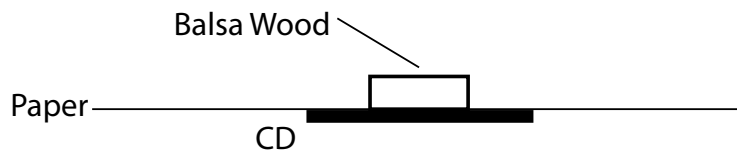


Figure 4

Step 3

On the opposite side of the paper, glue a 1 in. x 1 in. x 1/4 in. piece of balsa wood in the centre of the page (where the lines cross) (**Figure 4**).

Step 4

Turn the paper over so that the CD is on top. Drill a 1/8 in. hole through the centre of the page (where the lines cross). Drill all the way through the balsa wood (**Figure 5**).

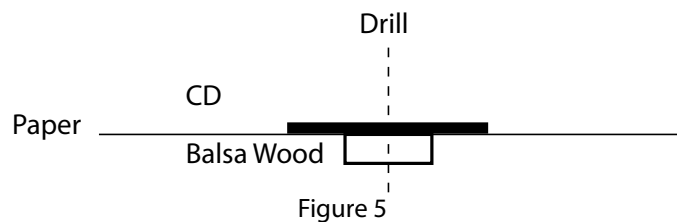
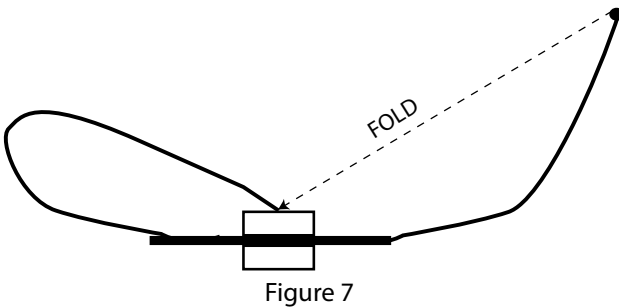
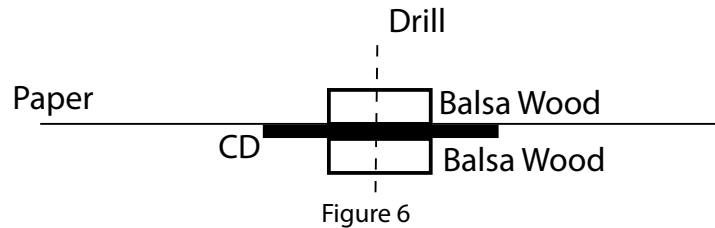


Figure 5

Step 5

Glue the second piece of balsa wood in the centre of the CD. Turn the paper and CD over. Drill through the existing hole in the balsa wood on this side in order to extend the hole through the second piece of balsa wood (**Figure 6**).



Step 6

Orient the CD so that it is under the paper and place a drop of glue over the hole in the balsa wood. Take each of the corners of the paper marked with a black dot and fold them towards the centre, placing them in the drop of glue (**Figure 7**).

Part II - Assembling the Turbine and the Yaw System

The turbine of the windmill is the part that spins and generates electricity. The yaw system allows the turbine to pivot so that it always points into the wind.

Step 1

Cut a paper towel tube so that is approximately 8 in. long. Then, cut it in half lengthwise and glue one half of the tube into the other.

Step 2

Glue the motor in the bottom of the tube so that the axis sticks out the end as shown in **figure 8** and wait one minute for the glue to dry.



Figure 8

Step 3

Grab the tube with the motor now glued in place and cut a slit on the opposite side of the motor. The slit should be about 1 in. long (**Figure 9**).



Figure 9

Step 4

Cut a tail for the windmill from a piece of card. Any shaped tail can be used as long as the tail has enough room to rotate once the yaw is fitted on top of a pop bottle. Next, slide the tail into the slit on the cardboard tube and glue it in place (**Figure 10**).

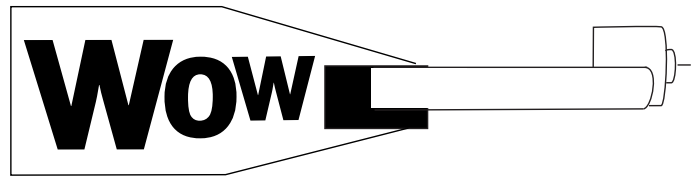


Figure 10

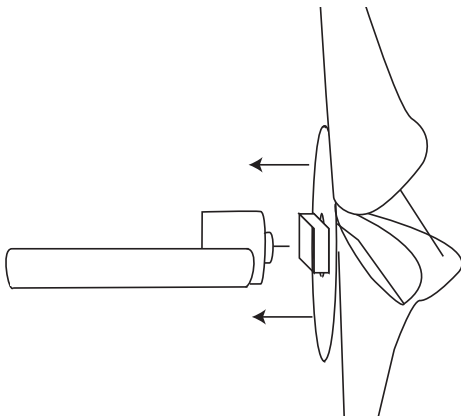


Figure 11

Step 5

Slide the paper windmill onto the shaft of the motor (**Figure 11**).

Step 6

Find the centre of mass of the turbine by balancing the turbine on a pencil that is held horizontally. Mark the spot where it is balanced (**Figure 12**).

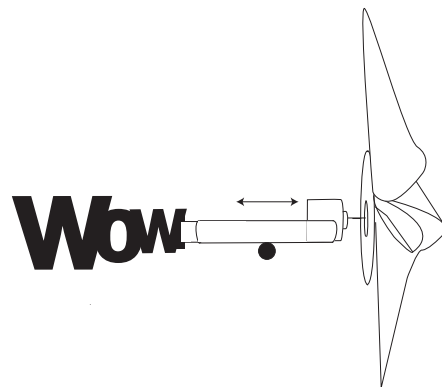


Figure 12

Wind Power - Activity Instructions

Step 7

Place a hole in the centre of the tube at the centre of mass using a nail. Remove the nail. Next, thread the nail through the following, noting the order from top to bottom: metal bottle cap, turbine tube, 2 L pop bottle cap (**Figure 13**). Screw the cap back on the bottle. The turbine should now be able to rotate horizontally.

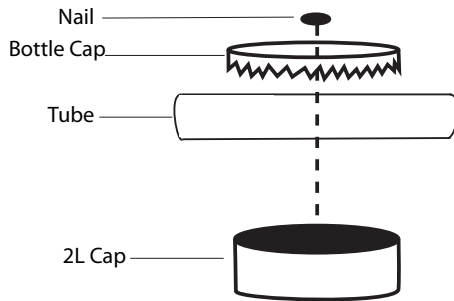


Figure 13

Step 8

Fill the bottle with water to weigh it down.

Part III - Assembling the Wind Farm

In addition to the materials listed in the *Prep Instructions*, the following items will be needed for this stage:

- many windmills constructed by the class
- many long wires with alligator clip ends, or long wires (at least two per windmill)
- several box fans
- multimeter

The exact setup of a classroom wind farm is highly dependent on the number and efficiency of the windmill generators involved as well as the power and number of fans in use. For this reason, only suggestions and tips on how to set up the classroom wind farm can be provided.

Step 1

Clear a large area of floor space. Place the box fans side by side and facing the same direction.

Step 2

Place four windmills in a row facing the box fans, approximately a foot away from them.

Step 3

Connect the windmills in series. For the windmills that spin clockwise, connect the terminal labelled with the minus sign to the terminal labelled with the positive. For the windmills that spin counter-clockwise, connect the terminals labelled with like-signs (**Figure 14**).

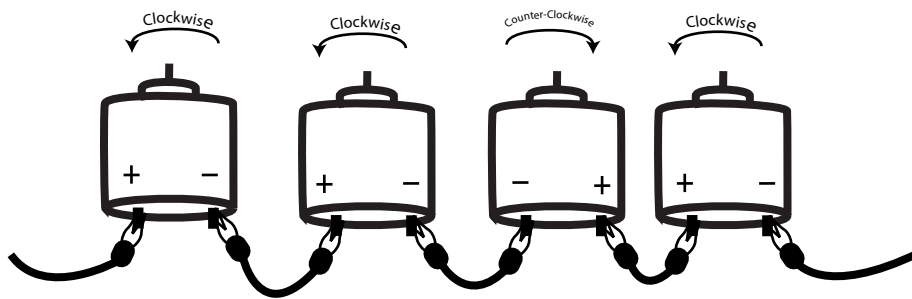


Figure 14

Step 4

Setup a second row of windmills and connect them using the same method as in Step 3 (**Figure 15**).

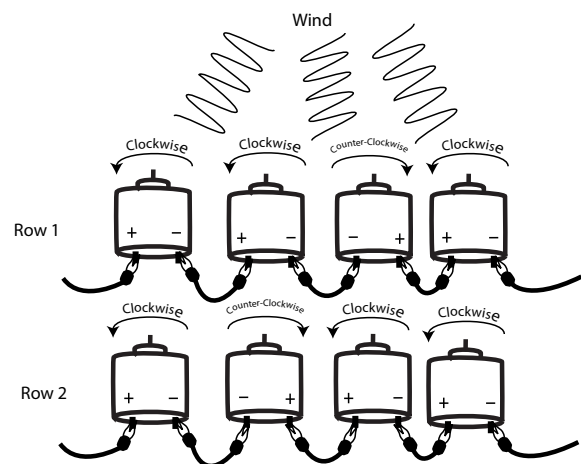


Figure 15

Step 5

Attach the rows together by connecting the last leads of the outer motors. If both motors spin in the same direction, attach the terminals labelled with like-symbols (see the left side of **figure 16**). If the motors spin in opposite directions, attach the terminals labelled with two different-symbols (see the right side of **figure 16**).

Step 6

Repeat Steps 2-5 until the wind farm is complete (**Figure 17**).

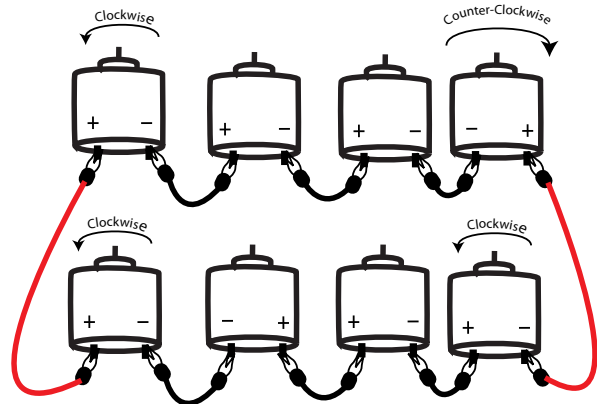


Figure 16

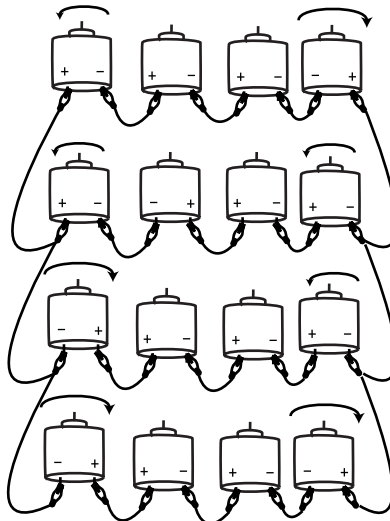


Figure 17